



Faculty of Sciences
Department of Mathematics & Statistical Sciences

An Investigation of Economic Development and Economic Growth in Botswana

by

Kagiso Molalapata

Reg. No: 14002125
MSc (Statistics), BIUST, Botswana

A Dissertation/Thesis Submitted to the Faculty of Sciences in Partial Fulfilment of the
Requirements for the Award of the Degree of Master of Science in Statistics of BIUST

Supervisor(s):

Dr Richard Mumo
Department of Mathematics & Statistical Sciences,
Faculty of Sciences, BIUST
E-mail: mumok@biust.ac.bw

July 10, 2023

DECLARATION REGARDING THE WORK AND COPYRIGHT

Candidate Kagiso Molalapata

Student ID: 14002125

Thesis Titled: An Investigation of Economic Development And Economic Growth In Botswana

I **Kagiso Molalapata**, certify that the Thesis is all my own original work and that I have not obtained a degree in this University or elsewhere on the basis of any of this work.

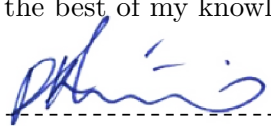
This dissertation/thesis is copyright material protected under the Berne Convention, the Copyright and Neighbouring Rights Act, Act. No. 8 of 2000 and other international and national enactments, in that behalf, on intellectual property. It must not be reproduced by any means, in full or in part, except for short extracts in fair dealing; for researcher private study, critical scholarly review or discourse with an acknowledgement, without the written permission of the office of the Postgraduate School, on behalf of both the author and the BIUST.

Signed: K. Molalapata.

Date: July 10, 2023

Primary Supervisor Dr. Richard Kitati Mumo

I **Dr. Richard Kitati Mumo**, hereby confirm that I have inspected the above-titled thesis and, to the best of my knowledge, it is based on the original work of the candidate.

Signed: 

Date: July 11, 2023

Abstract

By analyzing annual data from 1980 to 2020, the study sought to identify the main factors influencing economic growth in Botswana and empirically analyze the link between the interest rate, inflation rate, exchange rate, Foreign Direct Investment (FDI), trade openness, population growth, and economic growth. In order to explore the long-term relationships between variables, measure the short term dynamics of the model, and assess the causal relationships between variables, the study employed the Johansen-Juselius cointegration, Vector Error Correction Model (VECM), and Granger causality approaches. The results demonstrated that while exchange rate, interest rate, population growth rate, and trade openness are long term inversely related to economic growth, FDI and inflation rate had a positive and significant impact on economic growth. VECM results revealed that exchange rate and interest rate have a substantial role in explaining growth in the short run, whereas FDI and trade openness have a negative and significant impact. According to the Granger Causality test, in the long run, the exchange rate, inflation rate, and trade openness are the main drivers of growth. The Impulse Response Function (IRF) displayed that even after 20 years, economic growth still responds effectively to shocks in all variables. The policy recommendations from this study advise maintaining low inflation rate and open up more to international markets; development and implementation of new persuading and effective investment incentive packages to investors.

Keywords: Economic growth; economic development; macroeconomic factors; Botswana; VECM.

List of Acronyms and Abbreviations

AD	Aggregate Demand
AIC	Akaike Information Criterion
ADF	Augmented Dickey-Fuller
AR	Autoregressive model
ARCH	Autocorrelation Conditional Heteroscedastic
BCL	Bamangwato Concessions Limited
BWP	Botswana Pula
CPI	Consumer Prices Index
DEBSWANA	De Beers Botswana
EGR	Economic Growth Rate
ECT	Error Correction Term
EX	Exchange Rate
FPE	Final Prediction Error
FEVD	Forecast Error Variance Decomposition
FDI	Foreign Direct Investment
GFEVD	Generalized Forecast Error Variance Decomposition
GMM	Generalized Method of Moments
GDP	Gross Domestic Product
HQIC	Hannan-Quinn Information Criterion
IRF	Impulse Response Function
INF	Inflation Rate
IR	Interest Rate
JB Test	Jarque-Bera Test
LNEGR	Logarithm of Economic Growth Rate
LNEX	Logarithm of Exchange Rate

LNFDI	Logarithm of Foreign Direct Investment
LNINF	Logarithm of Inflation Rate
LNIR	Logarithm of Interest Rate
LNPOP	Logarithm of Population Growth Rate
LNT0	Logarithm of Trade Openness
LRE Stat	Logistics Readiness Evaluation Statistic
NDP	National Development Plan
PP Test	Phillips-Perron Test
PMG	Pooled Mean Group
POP	Population Growth Rate
PPI	Producer Price Index
SBIC	Schwarz-Bayesian Information Criterion
SADC	Southern African Development Community
SE	Standard Error
TO	Trade Openness
USD	United States Dollar
VDA	Variance Decomposition Analysis
VAR	Vector Autoregression
VECM	Vector Error Correction Model

List of Symbols

ε_t	White Noise Error
α	A Constant
L	Lag Operator
R^2	Coefficient of Determination
Δ	Difference Operator
Π	Cointegrating Coefficient Matrix
Φ	$m \times m$ Coefficient Matrix
Ψ	$m \times q$ Coefficient Matrix
t	Time Index
$\hat{\lambda}^2$	Estimate of Covariance
$\hat{\sigma}^2$	Estimate of Variance
N	Number of Parameters
n	Number of Variables
p	Finite order
λ_i	Eigenvalue
β	Cointegrating Vector
β'	Cointegrating Vector Transpose
$\theta(L)$	Lag Polynomial
$\chi^2(k)$	Chi-Squared Distribution
$F(k_1, k_2)$	F Distribution
$iid(0, \sigma^2)$	Normal Distribution
$E(X)$	Expected Value of Random Variable X
$E(X Y)$	Expected Value of Random Variable X given Y
$rk(\mathbf{A})$	Matrix Rank
$X \sim$	Distribution of X

Σ	Summation Sign
Σ	Covariance Matrix
I_n	$n \times n$ Identity Matrix
*	Statistical Significance
GI_x	Generalized Impulse Response Function of x_t
=	Equals Sign
$\neq$	Not equal Sign
()	Parentheses
{ }	Braces
$\mathbf{w}_t$	$q \times 1$ Vector of Deterministic and / Exogeneous Variables
X_t	Time Series Process
$Tr()$	Trace Statistic
λ_{max}	Maximum Eigenvalue Test Statistic

Dedications

This study is devoted to my mother Kutlwano Molalapata, who has served as a constant source of motivation for me. She has given me the confidence and motivation to approach any assignment with zeal and determination. Without her love and support, it would not have been possible to complete this endeavor.



Acknowledgements

Without God's assistance and direction—who is truly marvelous, this research would have been a pointless endeavor. It is also very much appreciated that my supervisor, Dr. Richard Kitati Mumo, advised and assisted with the research.

Regarding this work, the Department of Mathematics and Statistical Sciences offered insightful remarks; their input is valued. I thank the Simons Foundation for contributing financially to my postgraduate studies. Last but not least, I would like to express my sincere appreciation to my family for their unwavering support.



Contents

Declaration Regarding the Work and Copyright	i
Abstract	ii
List of Acronyms and Abbreviations	iv
List of Symbols	vi
Dedications	viii
Acknowledgements	ix
List of Figures	xi
List of Tables	xii
1 Introduction	1
1.1 Overview of the Study	1
1.2 Background of the Study	2
1.3 Economic Growth in Botswana	4
1.4 Economic growth and Macroeconomic Factors	4
1.5 Statement of the Problem	5
1.6 Research Objectives	6
1.7 Research Major Area of Contribution to Knowledge	6
1.8 Structure of the Dissertation	7
2 Literature review	8
2.1 Introduction	8
2.2 Theoretical Review	8
2.3 Empirical Literature	9
2.3.1 Economic Growth and Trade Openness	9
2.3.2 Economic Growth and Foreign Direct Investment	10
2.3.3 Economic Growth and Exchange Rate	11
2.3.4 Economic Growth and Inflation Rate	12
2.3.5 Economic Growth and Population Growth Rate	12
2.3.6 Economic Growth and Interest Rate	13
2.4 Literature Review Overview	13
3 Research Methodology And Design	15
3.1 Introduction	15

3.2	Description and Theory of Proposed Methods of Analysis	15
3.2.1	Unit Root Test	16
3.2.2	Lag Selection	19
3.2.3	The Johansen Cointegration Test	19
3.2.4	Vector Autoregressive (VAR) Model	20
3.2.5	The Vector Error Correction Model (VECM)	21
3.3	Evaluation Measures of the Proposed Method of Analysis	23
3.3.1	Serial Correlation Test	23
3.3.2	Jarque-Bera (JB) Test	24
3.3.3	Heteroscedasticity	24
3.4	Impulse Response Analysis	25
3.5	Variance Decomposition Analysis	26
3.6	Description of Application Dataset and Statistical Software used for Analysis . .	27
3.6.1	Justification of Variables	28
3.6.2	Statistical Software used for Analysis	30
4	Data Analysis And Empirical Results	32
4.1	Empirical Results and Discussion	32
4.2	Unit Root Test	32
4.3	Lag Selection	33
4.4	Cointegration Test	33
4.4.1	Correlations	34
4.5	Vector Error Correction Model (VECM)	35
4.6	Granger Causality Test Results	38
4.7	Evaluation Measures of the Proposed Method of Analysis	39
4.7.1	Serial Correlation	39
4.7.2	Normality Test	39
4.7.3	Heteroscedastic Test	40
4.8	Impulse Response Analysis	40
4.9	Variance Decomposition Analysis	41
5	Conclusion And Policy Implications	42
5.1	Summary and Conclusion	42
5.2	Policy Recommendations	43
5.2.1	Foreign Direct Investment and Trade Openness Policies	43
5.2.2	Monetary Policies	44
5.2.3	Population Policies	44
5.3	Limitations and Directions for Further Research	44
6	Appendix A	57
6.1	Eviews Commands and Output	57
6.1.1	Unit Root Test	57
6.1.2	Lag-order selection	57

6.1.3	Vector Error Correction Estimates	57
6.1.4	Serial Correlation Test	58
6.1.5	Normality Test	58
6.1.6	Heteroscedastic Test	58
6.1.7	Impulse Response Function	58
6.1.8	Variance Decomposition	58
6.2	Data Source Link	58



List of Figures

3.1	Dynamics of Economic growth rate, Exchange rate, FDI, Inflation rate, Interest rate, Population growth rate, and Trade openness in Botswana from 1980 to 2020.	29
4.1	Response of Economic Growth to Innovations	40
6.1	Unit Root Test output	57
6.2	Lag-order selection criterion output	57
6.3	Johansen Cointegration Test	58
6.4	Correlation Matrix	58
6.5	Error Correction Term	59
6.6	VECM Short Run Dynamics	59
6.7	Pairwise Granger Causality Test Output	60
6.8	Serial Correlation Test Output	60



List of Tables

3.1	Description of the variables	28
4.1	ADF and PP unit root test statistics	32
4.2	Lag-order selection criterion	33
4.3	Trace Test	34
4.4	Maximum Eigenvalue Test	34
4.5	Correlation Matrix	35
4.6	Error Correction Term	36
4.7	VECM Short Run Dynamics	37
4.8	Pairwise Granger Causality Test	38
4.9	Serial Correlation Test	39
4.10	Jarque-Bera Test	39
4.11	Heteroscedastic Test	40
4.12	Variance Decomposition of LNEGR	41

1. Introduction

1.1 Overview of the Study

Economic growth is a concept that entails quantitative changes in economic variables and is connected to higher levels of output overall or per capita. This suggests that economic growth is static and leads to quantitative changes. It also takes into account how a nation's economy has grown more capable of producing throughout a specific time span in contrast to the preceding one. Economic growth can be measured in real Gross Domestic Product (GDP) which excludes inflation (the total has been adjusted to remove the effect of inflation) and nominal GDP which includes inflation[1]. A study in [2] contributed to expounding the role and aspects that strengthen the economic growth of a nation. In spite of these efforts to assume growth as an indicator of macro-fiscal policy, in economic theory and practice, there are not yet final determinants that logically explain why other countries develop faster than others [3]. Having very strong growth stability can facilitate sustained economic growth, and most countries have identified their intention as achieving sustainable rapid economic growth. However, they seem to have encountered obstacles to achieving their goal. In many countries, GDP is regarded as an indicator of economic growth [4]. A number of macroeconomic factors influence economic growth, including inflation, interest rate, money supply, index of industrial production, exchange rate, foreign direct investment, and so on. According to studies in [5, 6], at the time of her independence in 1966, Botswana was one of the 24 most impoverished nations in the world, with a per capita income of US\$60, however, it is currently classified as an upper middle-income nation with a per capita income in excess of US\$7523.22. One of the highest rates of growth has been seen in the economy's GDP growth in the world since the mid-1970s, amounting to 10.1% a year [7]. The country is prominent for enjoying the longest-running liberal democracy in Africa with a track history of good leadership and a market-based economy. Since gaining its independence, Botswana has relied on the production of diamonds to maintain steady growth, with good policies and sizeable financial reserves helping to safeguard the country's economy [8].

The country drives its economy with the aid of a National Economic Development Plan which incorporates development policies together with strategies for poverty reduction and which was ushered in subsequent to independence by the four national principles of; Democracy, Development, Self-reliance, and Unity. The fourth National Development Plan (NDP) added another principle of Social Harmony. The main objectives of the NDP include sustained development, rapid economic growth, economic independence, and social justice. Sustained development is about ensuring a pattern of extended development and sustainability is essential for economic diversification [9]. The Botswana governmental body intends to attain this by allocating the wealth generated from non-renewable resources, for instance, minerals, into social and physical infrastructure; and by strengthening feasible beneficial endeavors that can secure economic growth, lower sensitivity to economic wavering, and create employment. Economic growth is

necessary for overall development and economic growth must surpass the rate of population expansion in an effort to gain an improvement in the general standard of living. Restructuring policies cannot be sustained in the absence of economic growth. Economic independence requires infrastructure development, expanding markets and output, and improving program or policy initiative ownership. Justice for all identifies that the paramount development's goal is to make sure the lifestyle quality is enhanced and it consists of two major corollaries: a worry for integrity in advancement and access to opportunities and that each citizen must possess a minimum living standard consistent with health and human dignity. These goals have strengthened each other in modeling the gross development innovation for the country [10].

Nevertheless, the nation's real GDP growth rate, which has been persistent since independence in 1966, has had a minimal impact on economic diversification and principally on managing elevated unemployment and poverty levels, which are excessive for a nation with this degree of GDP per capita income. Botswana endures a number of development challenges which include a lack of resources and/or abilities required to meet fundamental human requirements, and an inability to eradicate poverty [11].

The remainder of this chapter is structured as follows: Section 1.2 gives the background of the study; sections 1.3 and 1.4 discuss the economic growth landscape in Botswana and the association between economic growth and macroeconomic variables. Section 1.5 presents the statement of the research problem; section 1.6 describes the overall objective and the specific objectives of the study. Section 1.7 presents the major areas of research contributions to knowledge and the last section of this chapter; Section 1.8 outlines the structure of the dissertation.

1.2 Background of the Study

Every country, both developed and developing, is concentrating on increasing the productive capacity of their economy through the production of additional quantities of goods and services [12]. The aforementioned will generate a perfect series of prosperity and opportunity as strong growth and employment opportunities vitalize the government and parents to invest in the education of the younger generation. Thus, leading to the emergence of a great and rising group of entrepreneurs, which will bring pressure for improved governance. Similar rates of growth can have varying consequences on poverty, possibilities for poor people to find employment, and other broad indices of human development depending on the circumstances. The degree to which economic growth lowers poverty places reliance on how the poor engage in the growth process and share in its proceeds. As a result, the rate and pattern of economic growth are important in reducing poverty. Increasing employment is essential for generating higher economic growth since robust expansion of the world economy implies that the majority of working-age citizens are now employed and do not entirely depend on the government [13].

[14] argues that living standards were relatively fixed for a limitless number of years. Humans are said to have lived a basic hunter-gatherer lifestyle, not far above subsistence. Maipose, (2008) [10] stated that in the long run, economic growth has enhanced and diverse models of growth have been established to show how static living standards for generations gave way to

the current era of economic growth, for example; the growth models in [2, 15–17]. Interpreting how some countries can be so wealthy while some are extremely impoverished is considered among the most crucial hurdles facing social science. The attention to income divergence across countries does not indicate, however, that per capita can be applied as a “sufficient statistic” for the welfare of a standard citizen or that it is the only factor that should be exercised caution over. Economic growth is normally good for welfare, but it regularly leads to “winners” and “losers”. Production relationships, firms, and, at times, individual livelihoods served as aspects of economic growth, which were frequently disintegrated by the process of economic growth, as highlighted in [18]. South Africa under apartheid shows the reality that growth does not necessarily mean an improvement in everyone’s or most people’s quality of life. The country’s GDP per capita increased significantly beginning in the early twentieth century and ending with the end of apartheid control, however, during this time, actual wages for black South Africans, who constitute the majority of the population, decreased [19].

Economic growth is triggered by two main factors: both an increase in the workforce and growth in the productivity (output per hour worked) of that workforce. Growth in Aggregate Demand (AD) is affected by a number of factors; lower interest rates, increased government spending, devaluation, lower tax and financial stability. Economic growth is generated by an increase in AD in the short run. At the same time, in the long run, it requires an increase in aggregate supply (productive capacity) as well as AD. Lower interest rates are claimed to minimize the cost of borrowing, therefore stimulating consumer spending and firm investment. Economic growth motivates an increase in capital, the working population, labour productivity, the discovery of new raw materials and advancements in technology that augment the productivity of capital and labour. Political stability also contributes to economic growth by reassuring firms and encouraging them to increase investment; however, when uncertainty rises, confidence falls and firms delay investment [20].

Some studies have highlighted the impact of macroeconomic indicators on overall economic growth, notably, the work in [21–24]. Few empirical studies, however, have investigated the effects of macroeconomic factors on emerging economies, particularly Botswana. This study aims to fill the gap in the literature by providing some valuable insights into the development and implementation of fiscal policies. As a result, this study empirically explores the possible links between the economic growth rate and a number of key macroeconomic aggregates such as interest rate, inflation rate, exchange rate, Foreign Direct Investment (FDI), trade openness and population growth rate in Botswana using annual data from 1980 to 2020. By analyzing annual data from 1980 to 2020, the study utilizes a Johansen cointegration test and a Vector Error Correction Model (VECM) in order to access the endogeneity of the economic growth rate in the short run and long run. In general, the results of this study will eventually allow policy-makers, practitioners and other stakeholders to identify the major macroeconomic factors that influence growth and design effective facilitation schemes and a proactive dynamic development programme. It will also enable the government to diversify its economy away from a reliance on inefficacious factors while promoting dominating components.

1.3 Economic Growth in Botswana

Botswana encountered her first phase of economic growth, which coincides with colonial control from the 1960s through independence to 1975, regarded as a time of early base-creation. It is a transitional period that begins with uncertainty about the nature and economic foundation of the state and ends with organizational transition and developmental policy direction. The second phase from 1975-1989 experienced consolidations of both the market economy-led development approach and the multi-party governance system. Botswana participated in negotiating into the beef European market, creating a market incentive of general interest for Botswana based on cattle and land ownership, resulting in a widespread appreciation of the export market for beef, minerals, and a well-defined system of property rights. One of the most critical policy decisions was an agreement to negotiate a joint partnership with mining companies - agreements that resulted in the assignment of enterprise management to private partners, which has been retroactively observed as the beginning of what can rightly be described as an institutionalized private-government smart partnership. The De Beers Botswana (Debswana) mining firm is a partnership between the Botswana government and De Beers [25].

The country has seen an upsurge in a political rivalry, an intimidating joint party challenge, a restructuring of the country's core interests as a result of increased development and educational advancement, together with citizens venturing into new products, resulting in complicated policy decisions in a dynamic global and regional setting. It is also a term for the contracted rate of GDP growth, and it is affiliated with high rates of unemployment and social inequality - at least initially, before the economy began to pick up and welfare dependency began to decline again, all made clear by complex political choices given Botswana's modern progressive economy order. An active National Development Plan 11 (NDP 11), which covers the period from April 2007 to March 2023, was prepared to steer the economy of the country. The pointed programme targets to promote inclusive growth for sustainable employment and poverty reduction falls under the administration of Vision 2036 which was launched in September 2016 [26].

1.4 Economic growth and Macroeconomic Factors

The macroeconomic framework is presented as stable whenever interest rates are appropriate, the inflation rate is low and predictable, revenue policy is predictable and consistent, and the real exchange rate is attractive. The inflation rate serves as a measure of the government's overall capacity to steer the economy. It measures the rate at which products and service prices increase in an economy and emerges when prices rise due to an increase in production expenses such as raw materials and salaries. Increased demand for goods and services can drive up inflation since people are ready to pay more for them [27]. A few indicators are adapted as a measure of the inflation rate. The golden indicator, the Consumer Prices Index (CPI), concentrates on the costs of an economy's range of goods and services such as food, education, automobiles, and entertainment [28]. An alternative statistic, the Producer Price Index (PPI), reflects price shifts that impact domestic producers. It targets the cost of energy, farm supplies, chemical

items, and metals. Price surge causes the PPI to strike, which affects consumers and is reflected in the CPI. Inflation is not useful to consumers as it is to investors, who gain a boost if they maintain the affected asset in the market. For instance, energy companies' investors experience a rise in their stock prices if energy prices are rising and companies tend to charge extra in order to benefit from a growing inflation rate. Generally, inflation provides enterprises with pricing power and enhanced profit margins.

The interest rate is the cost of storing or lending money, commonly expressed as a percentage of the principal. Higher interest rates increase the motivation to save because the benefit of saving is now greater. As a result, saving in the economy is predicted to rise, reducing consumption (assuming that residents' income remains stable). It also raises the cost of lending and, as a result, the cost of investment, discouraging firms from making an investment and, as a consequence, lowering economic activity. The government's debt interest payments will escalate as a result of an increased borrowing cost, but the impact on government spending is not predictable. The effect on net exports will be driven by the change in interest rates of trade partners. Assuming they remain stable, there will be an increase in the value of the currency, which will result in foreign imports being more affordable for citizens and exports becoming more expensive, resulting in reduced net exports. Aron and Muellbauer, (2002) [29] applied multistep forecasting techniques in estimations with a stochastic trend to determine output growth in South Africa one year ahead. It was discovered that levels of real rates impact output and the effect lasts up to three years, and there were important and persistent influences of high real interest rates, which remarkably constrained growth.

Foreign Direct Investment (FDI) is a long-term investment in another economy's enterprise that generates a long-term interest with a significant influence over the overseas enterprise [30]. The Bank of Botswana in (2010) discovered that the level of FDI inflows was still very low, which is mainly in the mining and finance sectors. The country was driven by FDI flows from South Africa, Mauritius, India and Zimbabwe, which covered sectors like insurance, banking, agriculture, mining and clothing [31]. Botswana, just like any other economy in the Southern African Development Community (SADC), relies on investment from other countries to aid in achieving its long-term economic goals. Some of the characteristics that attract investors into the economy are a stable political and macroeconomic climate, favorable regulations, qualified human resources, a comprehensive legal system, and high-quality economic infrastructure.

This study employs a VECM to investigate whether significant macroeconomic factors can define Botswana's economic growth rate. It also hypothesizes that macroeconomic factors like interest rate, inflation rate, exchange rate, foreign direct investment, trade openness, and population growth will be relevant to Botswana's economic growth. The study also analyzed a causal relationship between economic growth rate and macroeconomic variables.

1.5 Statement of the Problem

Botswana is classified to be a country with a middle income, having experienced one of the most rapidly rising GDP in Africa for the past decade. The stability that lies behind high levels of growth arises from diamond extraction, which contributes over one-third of GDP, this

accounts for nearly all export earnings and half of the government revenue. Other leading sectors which were identified in order to diversify the economy beyond diamond extraction are tourism, financial sectors, subsistence farming, and livestock husbandry. Even though the country is showing some signs of growth, the rate of economic growth continues to remain lower than the anticipated level of growth of 7.5%, which was projected in the National Vision 2016 aims. In 2019, the travel and tourism sectors contributed 13% to the GDP of the country, which was observed as an increase from 6.3% in 2000, while the agricultural and manufacturing sectors accounted for just over 2% and 5% of GDP respectively. The future of the country is indefinite as the current principal source of growth is unsustainable and the productivity, together with the development of other sectors, is yet to be well established. This may be addressed by also paying attention to macroeconomic variables that may potentially participate in the economic growth process. It is challenging to fully make clear explanations of which macroeconomic factors are more significant in stimulating economic growth. Each specific factor has an insightful effect on economic growth, and it is difficult to identify the one with increased importance in economic connections. The following macroeconomic variables will be investigated in order to determine which has the most influence on economic growth in Botswana: interest rate, inflation rate, exchange rate, FDI, trade openness, and population growth rate.

1.6 Research Objectives

The overall objective of this study was to investigate economic development and economic growth in Botswana.

The specific objectives of the study were:

- (i) To examine the rate of economic growth in Botswana.
- (ii) To extend previous work by investigating potential linkages between economic growth and macroeconomic aggregates in Botswana by adopting a VECM.
- (iii) To investigate the major drivers of economic growth in Botswana.

1.7 Research Major Area of Contribution to Knowledge

Besides addressing the existing gap in previous studies, this study is important in a number of ways. First, this study used various data sets and proposes that it may be possible to aggregate growth within identifiable sectors. A sector-by-sector understanding of how macroeconomic factors would greatly enhance the perception of the likelihood of growth. Improved knowledge of the rate and the major drivers of economic growth may help inform cost-effective mechanisms that can provide an optimal approach to promoting the growth of Botswana's economy. Secondly, this study contributes to understanding how economic growth can be maintained in relation to macroeconomic factors. An insight into how macroeconomic factors influence economic growth through the modification of market variation is presented. This provides the Ministry of Finance and Economic Development and financial institutions such as the Bank of Botswana with an idea of how they can enhance economic growth and stay above in times of

economic shifts. Also, by ensuring the financial system's continued viability and monitoring of the economy and fiscal performance that is, deepening the financial status which will increase the country's competitiveness.

1.8 Structure of the Dissertation

This thesis is divided into five chapters; they are structured as follows, Chapter 1 presents an introduction to the study. Chapter 2 reviews the literature on economic growth, which includes a theoretical review, exploring theories that expound on economic growth for better understanding, and an empirical review that will cover previous studies undertaken and establish gaps. In Chapter 3, the research methodology and design are presented. Chapter 4 discusses the data analysis and empirical results of the study. Finally, Chapter 5 provides a summary of the major findings and conclusions drawn from the data. It discusses the major policy implications and recommendations arising from the research. The chapter also provides the major contributions, limitations of the study and areas for further research.



2. Literature review

2.1 Introduction

This chapter examines previous research and highlights research needs in an investigation of the causes of economic growth and the possible links between economic growth and macroeconomic aggregates. The chapter is organized as follows: Section 2.2 provides a theoretical analysis; Section 2.3 examines pertinent empirical research on the potential relationships that exist between economic growth and macroeconomic aggregates; and Section 2.4 provides a literature overview, which is a summary of the key findings from past studies.

2.2 Theoretical Review

The proportion of economic growth for developing nations can be demonstrated by the degree to which they retain an interest in the level of technology. The technology diffusion model suggests that the rate of growth for a developing economy is subject to the level at which they engage and make use of the technology which is employed by the developed countries, which is advantageous to drawing in new developments. Technology diffusion follows when there are innovative technologies and ideas spread into the country. There exist theories which complement the model of technology diffusion, for example, Barro, (1990) [32] and Lucas Jr (1988) [33] established endogenous-growth models which back the idea that growth is boosted by improvement.

This study note however that Smith, (1937) [34] was the first economist to expand the economic growth theory. He believed that economic growth would come directly from the sum of all these factors, not just capital accumulation, wealth creation, technologies, land ownership, labour and exports [35]. Arguably, the major influence of Smith's theoretical framework [34] is the establishment of the concept of incremental income in the distribution of labour-based economy and specialization. Another vital contribution in [34] is that he also identified the significance of international labour exchange and free trade as a technique for economic growth.

The theory of economic growth was advanced by Harrod, (1939) [36] and Domar, (1946) [37], and established a growth model stating that “economic growth rate is a function of the relationship between the savings rate and the capital coefficient.” This model suggests the capital coefficient is equal to the relationship between the investment rate/investment rate in GDP and the rate of growth of real GDP, the reciprocal of the marginal capital return. In the 1950s, the neoclassical philosopher [2] developed the theory of economic growth and was interested in exogenous growth models. He concentrated on three elements: technology, capital and labour, and argued that physical capital accumulation was a major factor for short-term economic growth, and technological progress was the main determinant of long-term economic growth. An essential expansion of the neoclassical growth model was the introduction of human capital stock as one of the principal elements motivating economic growth to complement the accumulation of physical capital. Solow, (1956) [2] concluded that “less than half of US productivity growth per capita

comes from productivity and profitability payments.” Until the mid-1980s, no important studies related to economic growth theory other than neoclassical growth theory were established. But so far, economic growth theory and empirical analysis have evolved, first complemented by what is considered “endogenous growth theory.” These theories are connected with the names; Grossman and Helpman, (1991), Aghion and Howitt, (1992) and Smokey, (1995) [38–40]. These economists started their theories with the assumption that individual decision-makers are more rational and less adaptable. Commitment is based on the recognition of productivity variables like hands-on learning and functional technical expertise (research innovation) as important causes of economic growth. As long as there is an agreement that government factors such as physical investment and accumulation of human capital, and, on the other hand, productivity factors (technical growth), are crucial macroeconomic factors for almost all countries’ economic growth [41], other supporters argue that factors that influence the effectiveness of savings and investment are also important elements of economic growth [42–44]. These proficiency factors became noticeable during the 1990s, with three key results being focused on: solidness of the macroeconomic climate; adequacy of the institutional system of an economy connected with political and monetary administration; motivating force designs and social infrastructure; and the setting up of the right value instrument and essential administrative climate to clear business sectors [45]. The sensitivity it generates to the anticipation of the future value of financial components is the primary reason why macroeconomic stability matters to monetary advancement.

2.3 Empirical Literature

A number of researchers in [4, 23, 46, 47] have discovered an association between economic growth and various macroeconomic variables. Macroeconomic indicators have long been acknowledged to play a significant role in a country’s economic development. Numerous studies from various countries have used diverse methods in attempting to find an association between economic growth and macroeconomic factors, including cross-country approach, panel data, Cobb Douglas production function, Vector Autoregression, Autoregressive distributed lag bound test and ordinary least squares among others.

2.3.1 Economic Growth and Trade Openness

The studies in [48–54] discovered a significant positive relationship between economic growth and trade openness, but there exists an investigation that found a negative link between the two which was done in [55]. According to a study in [56], there may be a weak link between trade openness and economic growth. Research in [57] stated that trade openness has a major effect on economic growth patterns and that the link between the two is still unconfirmed. An investigation in [47] which focused on the impact of macroeconomic factors on economic growth in Ghana by adopting the Johansen approach to cointegration, and established a cointegration between real GDP per capita (economic growth) and the macroeconomic factors that contribute to it. Augmented Dickey-Fuller (ADF) test highlighted that interest rates obtained stationarity after first differencing. They further indicated that foreign direct investment and inflation play a role in Ghana’s long-run economic growth. Kim, Lin and Suen (2010) [58] examined 88 countries

from 1960 to 2005 to discover how trade openness influenced financial development. The Pooled Mean Group (PMG) approach was utilized in the study, which generated a significant positive long run association between trade openness and financial development but a negative link in the short run. These findings were applicable only to low-income countries. An investigation in [59] focused on the trade-growth nexus for 75 developing countries using the quantile regression approach. Their research results imply that the impact of openness on economic growth is significantly larger in low-growth countries than it is in high-growth countries. In Pakistan, a study in [60] revealed that no causal relationship between exports and economic growth, nor between imports and economic growth. Studies in [61, 62] questioned these results, affirming the trade-led growth hypothesis for Pakistan. Another study in [63] centers its attention on analyzing the causal link between trade openness and economic growth with the aid of an econometric technique based on time series analysis. According to the study, China and South Africa have growth-led export and growth-led import.

2.3.2 Economic Growth and Foreign Direct Investment

The impact of FDI on growth can be both beneficial and detrimental according to studies in [64, 65], for instance, new technology is developed as FDI enters the country, which is essential for growth, however on the other hand, FDI crowds out domestic investment. According to a study in [66], FDI has a significant impact on economic growth because it has the power to stimulate economic growth by attracting capital investment, technology, and management. Utilizing time series data, the research explored the relationship between FDI and economic growth in Malaysia and OLS regressions were employed to determine the model's coefficients. According to their findings, there is enough evidence to suggest that there is a significant positive correlation between economic growth and FDI in Malaysia. Additionally a study in [67] measured the link between FDI, the state of the financial industry, as well as economic growth. An increase in the share of FDI resulted in a higher extra economic growth rate in nations with a more established financial sector, emphasizing the importance of a strong financial system capable of channeling excess resources into substantial profitable investments. Research by Mbulawa, (2015) [68] employed a VECM and a Vector Autoregression (VAR) techniques in a study that tests the impacts of macroeconomic factors on economic growth. According to the study, FDI and inflation presented a positive impact on economic growth. A linear multiple regression model was adapted in [46] using the data covering a period from 1993 to 2009. The study accessed the effect of FDI on India and China's economic growth rates and explained that economic growth in India is less driven by FDI than it is in China because China can expand FDI more quickly than India. Although it may appear logical to assert that FDI can provide significant benefits to economic growth, Carkovic and Levine, (2005) [69] argued that the exogenous component of FDI has no strong, independent influence on growth. The Generalized Method of Moments (GMM) panel estimator was used in the study to obtain consistent and efficient estimates of the effect of FDI flows on economic growth.

2.3.3 Economic Growth and Exchange Rate

From a perspective of Aliyu, (2011) [70], an improvement in the exchange rate results in more imports and fewer exports, whilst a decrease would increase exports and decrease imports. Additionally, a reduction in the currency's worth tends to result in a shift from imported to domestic commodities. As a result, there is a shift in the terms of trade, which causes wealth from nations that import to be diverted to countries that export, potentially affecting both countries economic growth. In a similar sense, Hossain, (2002) [71] concurred that the exchange rate determines the number of imports and exports, and the position of the country's balance of payments, and also functions to connect the price systems of two distinct countries by enabling international trade. Previous studies on the effect of exchange rates on economic growth produced conflicting results. For comparison purposes, empirical evidence indicates that shifts in real exchange rates can influence growth outcomes. Considering the research in [72], economies with more flexible exchange rates develop faster. Rapid economic growth is strongly associated with real exchange rate depreciation [73]. There is a sizable quantity of empirical literature on the effects of exchange rate depreciation on economic growth. Many existing studies have acknowledged that the effects of devaluation on economic growth could be recessionary. To this extent, multiple channels for deflationary devaluation have been identified. Studies in [74–76] are among the few regression-based studies on contractionary devaluation. Edwards, (1989) [74] regressed real GDP on nominal and real exchange rates, government spending, terms of trade, and measures of money growth in a pool-time series/cross-country sample. The study discovered that devaluation reduced economic growth in the short term even when other factors remained constant. The outcomes for the long-term effect of a real devaluation were more mixed, but it was concluded that the initial declining effect was not reversed. Similarly, Agenor, (1991) [75] regressed economic growth on contemporaneous and lagged levels of the real exchange rate, as well as deviations of actual changes from expected ones in the real exchange rate, government spending, the money supply, and foreign income, using a sample of twenty-three developing nations. The analysis indicated that unexpected depreciation of the real exchange rate enhanced output growth, but that depreciation of the level of the real exchange rate had a recessionary effect. On the contrary, Linjouom, (2007) [77] contends that exchange rate overvaluation has been a huge hindrance in Nigeria and Benin Republic's recovery processes. Furthermore, the study argued that depreciation combined with well-targeted measures, as well as an increase in the domestic price of tradable goods, could restore exchange rate equilibrium and enhance economic performance. In order to ascertain the effects of various regimes on the growth of the Nigerian economy, Obi, Oniore and Nnadi, (2016) [78] looked into the relationship between exchange rate regimes and economic growth. The generalized method of moments was used to analyze data for the years 1970 through 2014. The outcome showed that the exchange rate had a negligible negative impact on economic growth throughout the entire review period. While the study provided evidence of a non-significant beneficial impact of exchange rates on output growth under a floating rate regime, it demonstrated a significant negative impact of exchange rates under a fixed exchange rate policy.

2.3.4 Economic Growth and Inflation Rate

Countless studies with a variety of theories have been conducted with the express goal of examining the connection between inflation and economic growth. All such empirical studies have sought to determine whether there is a linear, non-linear, casual or nonexistent relationship between inflation and long-run growth. In-depth research has been done in the economic literature on the connection between inflation and economic growth. Studies on this relationship have produced mixed results. Some claim that inflation restricts economic growth and has a threshold at which it starts to have a negative impact [79–83]. Studies in [84, 85] provided some information about the relationship between inflation and growth in the context of Fiji. According to Dewan, Hussein and Morling, (1999) [84], changes in the output gap—the difference between actual GDP and potential GDP—had an impact on Fiji’s inflation results. Another study in [85] discovered that inflation was negatively correlated with economic growth in a sample of 41 middle-income developing nations, including Fiji. A study undertaken in [86] asserts that while inflation’s short-term negative effects on growth are minimal, they are disastrous for living standards. According to a study in [80], a 10% annual increase in inflation is predicted to result in a 30-year real GDP decline of 4% – 7%. Growth is negatively impacted by inflation, and there is no long-term correlation between the two according to a study in [87]. However studies in [88–90] revealed that inflation has no bearing on economic expansion. Fischer, (1983) [79] became the first to establish a non-linear relationship between low inflation rates and growth, which becomes negative as inflation rises.

2.3.5 Economic Growth and Population Growth Rate

Extensive research in [91] on the connection between population growth and economic output growth has been carried out. Considering the research in [92], many analysts predict that high-income nations’ population growth will slow significantly over the coming years, which will contribute to their predicted relatively slow economic growth. A work in [93] contends that population growth has been and will remain problematic since more people use more of the planet’s limited resources, which lowers the potential for long-term growth. While some authors have found evidence to support the idea that strong population growth boosts economic growth, others have found evidence to the contrary. Others discovered that the impacts are not uniform and depend on a country’s level of development, the source or nature of population growth, or other variables. Headey and Hodge, (2009) [91] noted that a variety of methodologies, control variables, and other elements have led to significant variations in empirical analyses of the relationship between population growth and growth in per capita income. There are primarily three schools of thought regarding the connection between population growth and economic growth [94]. The first is the traditional (or Malthusian) perspective, which contends that population growth is a direct cause of poverty and slower economic growth. The Revisionist school, which holds the opposing perspective, contends that higher population growth raises the stock of human capital, which in turn promotes economic growth. Finally, the Transition view argues that changes in income are partly responsible for population growth, i.e., highly populated nations are densely populated as a result of being economically underdeveloped. In a study in

[95] that examined the dynamic relationship between population growth and economic growth in Mexico using a structural break cointegration analysis for the years 1960 to 2014, it was found that while there is a short-term negative correlation between the two, there is a long-term positive correlation. A bidirectional causality between population growth and economic growth was revealed by the study.

It is interesting to examine the case of Botswana to find out whether there is a connection between population growth rate and economic growth because many of these relationships are merely descriptive and do not necessarily indicate a causal link.

2.3.6 Economic Growth and Interest Rate

The return, yield on equity, or opportunity cost of delaying current spending into the future is referred to as the interest rate. Interest rate and economic growth are inversely correlated, according to macroeconomic theory [96]. Some economists contend that there is a negative relationship between interest rate and economic growth. Furthermore, the interest rate has significantly hampered developing nations' efforts to achieve sustainable development and economic growth. Low-interest rate, according to Tridico, (2017) [97], is a complex issue that requires the harmonious interaction of a number of socioeconomic and institutional factors. Research in [98] contended that interest rate has a significant impact on Nigeria's economic growth and an analysis of 13 Asian developing nations, in [99] found that interest rate stimulates economic growth. The ADRL approach was utilized for cointegration analysis in a study in [100], which examined the impact of interest rate on economic growth in Malaysia. The study revealed a long-term inverse relationship between interest rate and economic growth. Additionally, a study in [101] used quarterly time series data for the years 2006 to 2014, which investigated the impact of financial sector development on economic growth in Botswana. The ADRL model was implemented in the study to calculate the consequences of economic growth determinants, including the interest rate on economic growth. The findings demonstrated that both in the short and long terms, the interest rate had a detrimental and statistically important effect on economic growth. There was evidence for an inverse association in [102] which argued that a decline in interest rate boosts economic growth. The work adopted the Dynamic Ordinary Least Estimation technique to examine data for the years 1980 to 2016. However, a study in [103] investigated how changes in interest rate affected economic growth in SADC nations through savings and investments. The PMG estimate method and ARDL bounds tests were used in the study to assess cointegration and discovered a positive link between interest rates and economic growth. A study undertaken in [104], however, found no connection between the interest rate and economic expansion. Results from earlier studies on the connection between interest rate and economic growth are still disputed in the literature following differing viewpoints. By studying the connection between interest rates and economic growth in Botswana, this study aims to close the knowledge gap.

2.4 Literature Review Overview

Understanding the factors that influence economic growth is crucial across all economies [105]. Thus, policymakers are curious about how to foster rapid economic growth, particularly in de-

veloping countries that always intend to elevate their standing to that of advanced nations. The various engines of growth have thus been thoroughly addressed and investigated in both theoretical and empirical research. According to economic literature, FDI, inflation rate, and trade openness are three of the most crucial factors for long-term economic growth, particularly when determining an economy's long-run productive capacity because investment produces new capital goods, and capital stock will increase quickly [106]. The main objectives of macroeconomic policy are a free market economy, low levels of domestic and foreign debt, and stable prices (low inflation). This alone demonstrates how these components are connected to one another in some way, indicating the need to examine their interactions more closely. Researchers have studied the factors that influence economic growth, with differing degrees of success. FDI inflows have a number of favorable economic effects on the recipient countries, which in turn may stimulate economic growth by creating various positive externalities and spillover effects, according to research in [107–113]. From a perspective of a research in [114], the flow of foreign capital from more developed to less developed nations is an effort to exploit the receiving nation's natural resources rather than provide aid, making it an unreliable source for long-term, sustainable economic progress. Some empirical studies have found a strong correlation between a nation's rate of economic growth and its openness to foreign commerce, while [115] was unable to demonstrate such a connection. As mentioned in [116, 117], differences in technique and how the openness measures were defined are at the heart of the discrepancies in these outcomes. Numerous techniques used to evaluate the investment channel reveal a negative correlation between interest rate and growth. For instance, Tobin's monetary growth model [118] postulates that a greater real yield on money as a substitute for capital has a negative impact on demand for capital in the medium run, but it makes no mention of the short term timeframe. By affecting the supply and demand for money or other alternative assets, monetary authorities can modify the investable premium.

Other studies were directed at identifying critical economic growth determinants, numerous growth economists have depended on choosing as many predictors as possible as long as there was enough collected data and degrees of freedom to carry out the investigation [47, 68, 119–123].

3. Research Methodology And Design

3.1 Introduction

The research methodology employed in this study is outlined in this chapter. The methodology gives a description of the research method used to investigate the links between economic growth and macroeconomic variables such as the interest rate, inflation rate, exchange rate, FDI, trade openness, and population growth.

The rest of the chapter is organized as follows: Section 3.2 gives the Description and Theory of Proposed Methods of Analysis; Section 3.3 gives a brief Description of the Application Dataset and Statistical Software used for Analysis. Section 3.4 presents the vector error correction model equation and the associated test, and lastly, Section 3.5 describes the data, data source, and variables.

3.2 Description and Theory of Proposed Methods of Analysis

This study's analysis method involves forecasting or investigating the relationship between economic output and macroeconomic variables. The model's general nature is derived from the theoretical connection between macroeconomic factors such as; interest rate, inflation rate, exchange rate, FDI, trade openness, population growth, and economic growth rate displayed in economic theory and empirical studies. The relation between economic growth and macroeconomic variables can be formulated into a function model in the form:

$$EGR = F(IR, INF, EX, FDI, TO, POP, \dots) \quad (3.1)$$

where EGR denotes economic growth rate, IR denotes the interest rate, INF presents the inflation rate, EX represents the exchange rate, FDI represents foreign direct investment, TO is the trade openness, and POP describes the population growth rate of Botswana. The equation (3.1) can be formulated into an econometric model (3.2) as follows:

$$EGR_t = \alpha_0 + \alpha_1 IR_t + \alpha_2 INF_t + \alpha_3 EX_t + \alpha_4 FDI_t + \alpha_5 TO_t + \alpha_6 POP_t + \dots + \varepsilon_t, \quad (3.2)$$

$\alpha_0, \alpha_1, \alpha_2, \alpha_3, \alpha_4, \alpha_5, \alpha_6$ are intercept, coefficients of IR, INF, EX, FDI, TO and POP respectively and t is time.

$IR, INF, EX, FDI, TO, POP$ are as defined in equation (3.1), ε_t is the error term.

The study employs the Vector Error Correction Model (VECM), which has been applied in the past to estimate the short and long run dynamics of variables, in an effort to determine the rela-

relationship between the variables. The study conducted all the time series data preliminary tests, including the Augmented Dickey-Fuller test for stationarity, the Akaike Information Criterion (AIC), the Hannan-Quinn Information Criterion (HQIC) method, the Final Prediction Error (FPE), and the Schwarz Bayesian Information Criterion (SBIC) for the selection of optimal lag length, the Johansen cointegration tests for cointegration, and the Error Correction Term for long run model fitting. Granger Causality Test is conducted to ascertain the direction of causality among the variables. The study also performs the Impulse Response Function (IRF) and Forecast Error Variance Decomposition (FEVD) tests to better understand the primary factors influencing economic growth over the study period.

Model Assumptions

- All variables are stationary after first differencing (integrated of order one), that is they have a constant mean and variance.
- Variables are cointegrated.
- Errors should be normally distributed, that is they follow white noise.
- There is homoscedasticity and no autocorrelation among errors.

3.2.1 Unit Root Test

Testing for the presence of a unit root in the time series is a key step before attempting to estimate economic variables. Generally, the majority of economic variables tend to be non-stationary. It is therefore crucial to test for stationarity before establishing any relationship. The stationarity of a series is an essential phenomenon for the reason that it has the ability to influence its behavior. For example, modeling an association between non-stationary random processes (integrated), X and Y , as a simple Ordinary Least Square Regression (OLS) as in equation (3.3) will only produce a spurious regression.

$$Y_t = \alpha + \beta X_t + \varepsilon_t \quad (3.3)$$

Time series stationarity is the statistical characteristic of a series with a constant mean, variance, and covariance, where its fluctuations are around a constant mean and the variance does not change throughout the period. When a time series variable is independent of time and the autocovariance and variance are not infinite, the probability distribution of the data has no fluctuation over time at this instant, and we can say that the time series variable is stationary. Non-stationarity of the data is corrected by differencing a series, which designs differenced sets of observations. An integrated of order 0 is a series that is stationary without differencing. In addition, a series that has a stationary first difference is set apart as integrated of order one. A unit root test is one method for evaluating objectively whether differencing is necessary. In addition, the unit root test determines whether the variables follow a random walk, and in addition, it helps in finding the order of integration at which the variables become stationary. Unit root testing is necessary to ensure data is stationary and, if not, it is transformed to

stationary data to avoid spurious regression [124]. There are several unit root tests available, each of which is based on a various set of assumptions and may yield contradictory results. The Dickey-Fuller Test is based on regression analysis and poses a serial correlation problem, in which case the Augmented Dickey-Fuller (ADF) test can be used; the Phillips-Perron (PP) Test is a modified version of the Dickey-Fuller test that rectifies autocorrelation and heteroscedasticity in the errors; and the Schmidt-Phillips Test, which includes the deterministic variable coefficients in the null and alternate hypotheses. We will test for stationarity of all variables in this study using the Augmented Dickey-Fuller (ADF) test and the Phillips-Perron (PP) Test.

Augmented Dickey-Fuller Test

There are a few reasons why ADF is widely preferred; it works with serial correlation, can manage more complex models than Dickey-Fuller tests, and is more effective. However, it does have a relatively high Type I error size, similar to other unit root tests.

An AR(p) process such that:

$$y_t = \rho_1 y_{t-1} + \rho_2 y_{t-2} + \dots + \rho_p y_{t-p} + \varepsilon_t \quad (3.4)$$

is referred to as stationary if all the roots of the characteristic equation lie outside of the unit circle. The AR(p) in equation (3.4) can be expressed in the lag polynomial notation:

$$(1 - \rho_1 L - \rho_2 L^2 - \dots - \rho_p L^p) y_t = \varepsilon_t \quad (3.5)$$

Replacing the lag operator L by a variable (call it q) and equating the resulting polynomial to zero gives a characteristic equation:

$$(1 - \rho_1 q - \rho_2 q^2 - \dots - \rho_p q^p) y_t = 0 \quad (3.6)$$

The values which solve equation (3.6) are referred to as characteristic roots and there are p of them (some of them may be equal). Some of the characteristic roots may be complex or real. If all roots are real, then y_t is stationary if the absolute value of roots greater is than one. A unit root occurs when roots lie between plus and minus one making a series to be non-stationary.

For example; an AR(1) process: $y_t = \rho_1 y_{t-1} + \varepsilon_t$ with a characteristic equation $1 - \rho_1 q = 0$ has one characteristic root $q^* = \frac{1}{\rho_1}$. The series is stationary if and only if $|q^*| > 1$ which implies that $|\rho_1| < 1$.

Testing for a unit root is equivalent to testing $\phi = 1$ in the following model.

$$Y_t = \phi Y_{t-1} + \sum_{j=1}^p \rho_j \Delta Y_{t-j} + \varepsilon_t \quad (3.7)$$

Or

$$\Delta Y_t = (\phi - 1) Y_{t-1} + \sum_{j=1}^p \rho_j \Delta Y_{t-j} + \varepsilon_t \quad (3.8)$$

This can be written as a function of Y_{t-1} and a series of differenced lag terms. ADF test equation:

$$\Delta Y_t = \delta Y_{t-1} + \sum_{j=1}^p \rho_j \Delta Y_{t-j} + \varepsilon_t, \quad (3.9)$$

where Δ is the difference operator,

t is the time index,

δ is the coefficient presenting process root,

Y_{t-j} denotes the first differences,

p is the lag order of the first differences autoregressive process

$\varepsilon_t \sim iid(0, \sigma^2)$.

If $\delta = 0$, then the system has a unit root and the hypotheses are as follows:

$H_0 : Y_t$ is a random walk (non-stationary) or $\delta = 0$

$H_a : Y_t$ is a stationary process or $\delta < 0$

The ADF t-statistic is based on the least square estimates of equation (3.7) and is given by :

$$ADF_t = t_\delta = \frac{\hat{\delta}}{SE(\hat{\delta})} \quad (3.10)$$

where $SE(\hat{\delta})$ is the standard error of coefficient estimator.

If the value(s) of $|t_\delta|$ are greater than the MacKinnon critical values, the null hypothesis that Y_t is a non-stationary time series is rejected.

Phillips–Perron (PP) Test

The test statistics is a modified form of Dickey-Fuller which has a null hypothesis $\rho = 1$ or Y_t is a non-stationary process and an alternative hypothesis that $\rho \neq 1$ from the equation below:

$$\Delta Y_t = (\rho - 1)Y_{t-1} + \varepsilon_t \quad (3.11)$$

where $\Delta Y_t = Y_t - Y_{t-1}$ and Δ denotes the first difference operator.

The PP test, like the ADF, conveys the potentiality that the procedure that gathers information for Y_t has a higher order of autocorrelation than is permitted in the test equation, rendering Y_{t-1} endogenous, and the Dickey-Fuller test invalid. The PP test adjusts non-parametric errors in the t-statistic. The test is resistant to undefined autocorrelation and heteroscedasticity in the disturbance process of the test equation. The PP test statistic is as follows:

$$Z_t = \left(\frac{\hat{\sigma}^2}{\hat{\lambda}^2} \right)^{\frac{1}{2}} \cdot t_{\rho=1=0} - \frac{1}{2} \left(\frac{\hat{\lambda}^2 - \hat{\sigma}^2}{\hat{\lambda}^2} \right) \cdot \left(\frac{T \cdot SE(\hat{\rho} - 1)}{\hat{\sigma}^2} \right) \quad (3.12)$$

$\hat{\sigma}^2 = \frac{1}{T} \sum_{t=1}^T \hat{\varepsilon}_t^2$ - estimate of variance

$\hat{\lambda}^2 = \hat{\sigma}^2 + 2 \sum_{j=1}^p [1 - \frac{j}{p+1}] \hat{\gamma}_j$, $\hat{\gamma}_j = \frac{1}{T} \sum_{t=j+1}^T \hat{\varepsilon}_t \hat{\varepsilon}_{t-j}$ - estimate of covariance of order j,

p is the number of lags.

If the p-value is less than the critical size of 0.05, then the null hypothesis is rejected in favor of the alternative hypothesis that Y_t is a stationary process. It can also be done by comparing the PP test statistics with the test critical values, that is whenever $|Z_t|$ is greater than the test critical value then the null hypothesis can be rejected.

3.2.2 Lag Selection

Before performing cointegration tests and modeling VECM, first decide the optimal number of lags. According to Gutierrez et al., (2009) [125], choosing a higher order lag length than the accurate one results in an increase in the mean square errors, while under-fitting often prompts auto-correlated errors. The mechanism used to select the lag order and the structure of the rank of short-run restrictions was performed by minimizing the modified information criteria listed below:

$$AIC(p, s) = \sum_{i=n-s+1}^T \ln(1 - \lambda_i^2(p)) + \frac{2}{T} \times N \quad (3.13)$$

$$HQ(p, s) = \sum_{i=n-s+1}^T \ln(1 - \lambda_i^2(p)) + \frac{2\ln T}{T} \times N \quad (3.14)$$

$$SC(p, s) = \sum_{i=n-s+1}^T \ln(1 - \lambda_i^2(p)) + \frac{\ln T}{T} \times N \quad (3.15)$$

$$N = [n \times (n \times (p - 1)) + n \times r] - [s \times (n \times (p - 1) + (n - s))] \quad (3.16)$$

where n is the number of variables in the VECM and N is the number of parameters. The value N is acquired by subtracting the total number of mean parameters in the VECM for a given r (number of cointegration vectors) and p (finite order), from the number of restrictions the common dynamics impose. The eigenvalues λ_i are determined for each p . To calculate a pair (p, s) , Hecq, (2006) [126] assumed that there are no constraints, that is $r = n$. After selecting a pair (p, s) , use the Johansen approach to examine the cointegration relationship.

The optimum lag length for a VAR model was selected in this study using the Akaike Information Criterion (AIC), the Hannan-Quinn Information Criterion (HQIC) method, the Final Prediction Error (FPE), and the Schwarz-Bayesian Information Criterion (SBIC).

3.2.3 The Johansen Cointegration Test

Correlation between several series can be established by performing a cointegration test [127]. The Johansen cointegration test examines the linear combinations of variables for unit roots. The test also provides an estimate of all cointegrating vectors. There are two main forms of Johansen's cointegration test; the Maximum Eigenvalue and the Trace test, which determines the number of cointegrating vectors. The Maximum Eigenvalue statistic compares the null hypothesis of r cointegration relationship with $r = 0, 1, 2, \dots, n - 1$ and the alternative of $r + 1$ cointegration relationship. The null hypothesis and the alternative hypothesis for the existence of cointegrating vectors were stated as:

$$H_0 : r = r_0$$

$$H_a : r = r_0 + 1, \text{ respectively.}$$

This test statistic is computed as:

$$\lambda_{max}(r/r + 1) = -T \times \log(1 - \hat{\lambda}) \quad (3.17)$$

where $\hat{\lambda}$ denotes the maximum eigenvalue and T is the sample size.

In order to demonstrate that there is a cointegration relationship among non-stationary time series data, the null hypothesis should be rejected, revealing the existence of $r + 1$ linearly independent cointegrating equations. The null hypothesis is rejected if the Maximum Eigenvalue statistic is greater than the critical value.

On the other hand, the Trace statistic inspects the null hypothesis of r cointegrating interactions to the alternative hypothesis of n cointegrating interactions, where n is the number of variables in the system for $r = 0, 1, 2, \dots, n - 1$. The null hypothesis and the alternative hypothesis for the existence of cointegrating vectors were stated as:

$$H_0 : r = r_0$$

$$H_a : r \geq r_0, \text{ respectively.}$$

The Trace test statistic was evaluated according to the following formula;

$$Tr(r/n) = -T \times \sum_{i=r+1}^n \log(1 - \hat{\lambda}_i) \quad (3.18)$$

In some cases, Trace and Maximum Eigenvalue statistics may produce different results, so the Trace test should be preferred. The Trace statistic must be greater than the critical value in order to reject the null hypothesis. If the null hypothesis is rejected, then a conclusion is made that there exists a long-run association between n variables. The number of cointegrating equations corresponds to the number of error terms of the long-run relationship.

3.2.4 Vector Autoregressive (VAR) Model

A VAR model, developed by Sims, (1980) [128], can model the joint dynamics and interrelations among a set of macroeconomic factors [129]. A VAR(p) model is a multivariate version of the Yule-Walker equation of a Univariate AR(p) [130]. If two variables are considered say; Y_t and X_t then a VAR model consists of two systems of equations. First-order VAR for a bivariate system can be written in the form:

$$Y_t = \alpha_y + \theta_1(L)Y_t + \theta_2(L)X_t + \mu_{1t} \quad (3.19)$$

$$X_t = \alpha_x + \theta_1(L)X_t + \theta_2(L)Y_t + \mu_{2t} \quad (3.20)$$

where Y_t and X_t are time series processes; α_y and α_x are constants; $\theta_1(L)$ and $\theta_2(L)$ are lag polynomials and μ_{1t} and μ_{2t} are two white noise processes. If the coefficient of the independent variable X_t in equation (3.19) is not equal to zero, then the history of X aids in explaining Y .

Lag Operator and Lag Polynomials

Lag operator is defined as $Ly_t = y_{t-1}$. It can also be detailed in powers as $L^k y_t = y_{t-k}$. Lag polynomials are formed from lag operators. Let $\theta(L)$ be a lag polynomial such that;

$$\theta(L) = A_0 + A_1L + A_2L^2 + \dots + A_pL^p \quad (3.21)$$

Which is defined as an operator such that;

$$\begin{aligned} \theta(L)\Delta X_t &= \mathbf{A}_0\Delta X_t + \mathbf{A}_1\Delta X_{t-1} + \dots + \mathbf{A}_p\Delta X_{t-p} \\ &= \sum_{i=0}^p \mathbf{A}_i\Delta X_{t-i} \end{aligned} \quad (3.22)$$

where $\mathbf{A}_i, i = 1, \dots, p$ are $k \times k$ parameter matrices.

This details that the equation (3.22) defines $\theta(L)$ by the way it operates on ΔX_t and p identifies the optimal lag length.

In general, a VAR(p) model with k -dimensional vector $\mathbf{y}_t$ is defined by

$$\mathbf{y}_t = \alpha + \mathbf{A}_1\mathbf{y}_{t-1} + \dots + \mathbf{A}_p\mathbf{y}_{t-p} + \mu_t \quad (3.23)$$

where $\mathbf{A}_i, i = 1, \dots, p$ are parameter matrices ($k \times k$) at different lags ; α is a vector of constants; $\mathbf{y}_{t-i}$ is a vector of lagged k time series processes; μ_t is a k -dimensional vector of white noise terms with covariance matrix Σ and k is the number of variables in the model.

3.2.5 The Vector Error Correction Model (VECM)

The standard VAR model can only be evaluated when variables are stationary. Applying the first difference in a series is a conventional way of removing a unit root model [129]. Conversely, when dealing with cointegrating series, this would give rise to over differencing and misinterpretation of data conveyed by the long-run comovement of variables. A unique application of the VAR model is the Vector Error Correction Model (VECM) which incorporates the Error Correction Term into the VAR model as part of the specification of the VECM. The VECM works best for series which are cointegrating, and after detecting cointegration between series, then there exists a long term equilibrium relationship, that is there is an association between series that has been persistent to the exclusion of any other relationship, for a period of at least two (2) years. Consequently, the study advances and engages the VECM to assess the short run interactions of the cointegrated series. The short run is a notion that within a certain period, at least one factor is fixed while others remain variable. In the event of no cointegration, the VECM is no longer accurate and directly begin the Granger causality tests to discover the significant links between variables.

The levels form of the VAR model in equation (3.23) may not be the most useful presentation if $\mathbf{y}_t$ is integrated of order one and the variables are potentially cointegrated due to its failure

to explicitly include the cointegration relations, and these relations are frequently of particular interest. Then, it may be beneficial to reparameterize the equation (3.23) by deducting y_{t-1} from both sides of the equation sign and rearranging the terms to obtain

$$\Delta \mathbf{y}_t = \alpha + \theta(L)\Delta \mathbf{y}_t + \gamma \mathbf{Y}_{t-1} + \mu_t \quad (3.24)$$

where Δ represents the first difference operator; $\mathbf{y}_t$ is a vector of k time series processes; α is a k -dimensional vector of constants; $\theta(L)$ is a lagged polynomial; μ_t is a vector of stochastic error terms also called impulses, innovations or shocks and the cointegrating vector, $\mathbf{Y}_{t-1}$ denotes an Error Correction Term (ECT) which is acquired through cointegrating regression of the dependent variable on the regressors. The regression coefficient on the cointegration term γ , represents a k -dimensional vector of speed adjustment, that is, the speed at which the deviations from the long-run equilibrium are ‘corrected’.

$\mathbf{Y}_{t-1} = \beta' \mathbf{y}_{t-1} \sim I(0)$ and so the components of $\mathbf{y}_t$ have r linearly independent cointegrating relations. The rank of $\gamma\beta'$, $\text{rk}(\Pi)$ is the cointegrating rank of the process.

Let $\text{rk}(\Pi) = r, 0 < r < k$, then according to matrix theory there exists $(k \times r)$ matrices; γ and β with $\text{rk}(\gamma) = \text{rk}(\beta) = r$ such that $\Pi = \gamma\beta' = -(\mathbf{I}_k - \sum_{i=1}^p A_i)$.

Equation (3.24) can be rewritten as

$$\Delta \mathbf{y}_t = \alpha + \sum_{i=1}^{p-1} A_i \Delta \mathbf{y}_{t-i} + \Pi \mathbf{y}_{t-1} + \mu_t \quad (3.25)$$

If $\text{rk}(\Pi) = k$, the time series process y_t is $I(0)$. Moreover, for $r = 0$, then $\Pi \mathbf{y}_{t-1}$ disappears in a VECM so, $\mathbf{y}_t$ has a stable VAR($p-1$) representation in first differences.

Interactive characteristics of equation (3.24) are that the error-correction specification maintains details of the long-run equilibrium together with the short-run relationship between the first differences of the variables. A significant negative VECM coefficient indicates that any short term shifts in the independent variables and the dependent variable will result in a stable long run relationship between the variables. The model uses logarithms of variables in order to stabilize the variance of a series [131].

NOTE: By assumption, Δy_t does not contain stochastic trend since y_t is integrated of order one.

According to Pfaff, (2008) [132] a bivariate $I(1)$ vector $(Y_{1t}, Y_{2t})' = \mathbf{Y}_t$ with cointegrating vector $\beta = (1, -\beta)$ where $\beta' \mathbf{Y}_{t-1} = (1, -\beta)(Y_{1t-1}, Y_{2t-1})' = Y_{1t-1} - \beta Y_{2t-1} \rightarrow I(0)$.

A VECM exists in the form:

$$\Delta Y_{1t} = \alpha_1 + \gamma_1(Y_{1t-1} - \beta_2 Y_{2t-1}) + \sum_{i=1}^{p-1} \varphi_{1i} \Delta Y_{1t-i} + \sum_{i=1}^{p-1} \varphi_{2i} \Delta Y_{2t-i} + \varepsilon_{1t} \quad (3.26)$$

$$\Delta Y_{2t} = \alpha_2 + \gamma_2(Y_{1t-1} - \beta_2 Y_{2t-1}) + \sum_{i=1}^{p-1} \varphi_{1i} \Delta Y_{1t-i} + \sum_{i=1}^{p-1} \varphi_{2i} \Delta Y_{2t-i} + \varepsilon_{2t} \quad (3.27)$$

where Δ depicts the first difference operator; α_i ; $i = 1, 2$ are constants; γ_1 and γ_2 are adjustment speed coefficients for Y_{1t} and Y_{2t} respectively; $p - 1$ is the optimal lag length and φ_{1i} and φ_{2i} are short-run dynamics for Y_{1t} and Y_{2t} respectively.

Granger Causality Test

The test is carried out following a VECM estimation under the presumption of cointegration between the variables. As a result, Granger causality can be tested in both the short term and long term. The idea of causality was initiated by Wiener, (1956) [133] and Granger, (1969) [134], and it comprises a fundamental concept for dissecting dynamic connections between time series. Practically, Granger-causality is continually investigated for bivariate cycles. However, various conclusions may be reached when multiple variables are considered. In the event that factors exceeding two are available, non-causality conditions become more complicated. A standard description of the Granger causality test in a bivariate (X, Y) setting can be presented as:

$$Y_t = \alpha_0 + \alpha_1 Y_{t-1} + \dots + \alpha_i Y_{t-i} + \beta_1 X_{t-1} + \dots + \beta_i X_{t-i} + \mu \quad (3.28)$$

$$X_t = \alpha_0 + \alpha_1 X_{t-1} + \dots + \alpha_i X_{t-i} + \beta_1 Y_{t-1} + \dots + \beta_i Y_{t-i} + \mu \quad (3.29)$$

The subscripts in the model represent time periods and μ is a white noise error. The constant component α_0 models the stationary growth rate of Y in equation (3.28) and X in equation (3.29) and therefore the trend in these variables can be perceived as conventional movements of cointegration between X and Y that follows the unit root technique. Two tests from this analysis: the first examines the null hypothesis that X does not Granger-cause Y and the second test examines the null hypothesis that Y does not Granger-cause X and the alternative hypotheses are that the null hypotheses are not true. Failure to reject the null hypothesis from the first test signifies that X does not contribute to the explanatory power of equation (3.28) which suggest that there would be no lagged values of X in equation (3.28). Unidirectional causality will happen if either the null hypothesis of equation (3.28) or (3.29) is rejected. There is a bidirectional causality link if both null hypotheses are rejected, and there is no causality if neither null hypothesis of equations (3.28) nor (3.29) is rejected.

3.3 Evaluation Measures of the Proposed Method of Analysis

The study used diagnostic procedures to determine whether the designed model and assumptions were consistent with the recorded data.

3.3.1 Serial Correlation Test

Serial correlation, also known as autocorrelation, in time series rises when there is a dependency between residuals and their lagged version. It is a fairly sized problem since most statistical strategies consider random errors to be independent. Instead, whilst serial correlation is present, every error (or residual) is relied upon by the preceding residual [135]. Serial correlation test is

carried out with the null hypothesis of no serial correlation against the alternative hypothesis of serial correlation. And the test statistic is:

$$\rho = \frac{\sum_{i=2}^n e_i \times e_{i-1}}{\sum_{i=1}^n e_i^2} \times \frac{n}{n-1} \sim \chi^2(p) \quad (3.30)$$

where $e_i = y_i - \hat{y}_i$; p is the number of parameters; n is the sample size.

$$H_0 : \rho_1 = \rho_2 = \dots = \rho_p = 0$$

$$H_a : \rho_i \neq 0 \text{ for } i = 1, 2, \dots, p$$

The null hypothesis is rejected when $\rho_i \neq 0$, and this implies that there is enough evidence to conclude that there is serial correlation between residuals.

3.3.2 Jarque-Bera (JB) Test

This tests whether the data sample has skewness and kurtosis that are consistent with a normal distribution. The test statistic is defined by:

$$JB = n/6(S^2 + 1/4(K - 3)^2) \sim \chi^2(\alpha, 2) \quad (3.31)$$

Where n is the sample size; S is the sample skewness coefficient, and K defines the sample kurtosis coefficient. A normally distributed dataset has a JB statistic with a chi-squared distribution and two degrees of freedom. The statistic is used to test the hypothesis

H_0 : the sample under study comes from a normal distribution

against the alternative hypothesis

H_a : the sample does not come from a normal distribution.

The null hypothesis of normality is rejected if $JB > \chi^2(\alpha, 2)$ then this outlines that there is enough evidence to conclude that the data does not follow a normal distribution.

3.3.3 Heteroscedasticity

It outlines the conditions where the variance of the errors or the model is different for all observations. It is therefore essential to carry out a test for heteroscedasticity, and various tests have been established with a null hypothesis of residuals being homoscedastic versus an alternative hypothesis of residuals being heteroscedastic. The availability of heteroscedasticity contradicts the statistical test of significance that variances are homogenous and identically distributed.

If a regression of squared residuals on explanatory variables in equation (3.32)

$$\mu^2 = \delta_0 + \delta_1 x_1 + \dots + \delta_k x_k, \quad (3.32)$$

where k is the number of regressors; δ_0 is the constant; $\delta_1, \delta_2, \dots, \delta_k$ are coefficients then Breusch-Pagan test for heteroscedasticity with the null hypothesis

$$H_0 : \delta_1 = \delta_2 = \dots = \delta_k = 0$$

against the alternative hypothesis

H_a : at least one of the $\delta_i \neq 0; i = 1, 2, \dots, k$ has a test statistic:

$$F = \frac{R_{\hat{\mu}_i^2}^2/k}{(1 - R_{\hat{\mu}_i^2}^2)/(n - k - 1)} \sim F_{k, n-k-1} \quad (3.33)$$

There is a Lagrange Multiplier (LM) statistic which is an alternative test statistic and is detailed in equation (3.34)

$$LM = n \cdot R_{\hat{\mu}^2}^2 \sim \chi_k^2 \quad (3.34)$$

where n is the number of observations used in order to estimate the auxiliary regression and $R_{\hat{\mu}^2}^2$ is the coefficient of determination of equation (3.33).

If $LM > \chi_k^2$ or $p\text{-value} < 0.05$ then the null hypothesis is rejected and a conclusion that there is significant evidence of heteroscedasticity is made, therefore, in order to account for the variability of the variance, data must be transformed before modeling techniques are used.

3.4 Impulse Response Analysis

The relative strength of causality is determined by performing the impulse response analysis, which indicates how much feedback exists from one variable to another beyond the specified sample period. A study in [136] acknowledged that impulse response analysis is essential for evaluating the experimental variable's sensitivity in the VAR shocks to each of the independent variables. This study utilizes generalized impulse response analysis. According to a study in [137], as cited in [138], this method completely incorporates past correlation relationships between various events.

Consider the augmented VAR model:

$$\mathbf{x}_t = \sum_{i=1}^p \Phi_i \mathbf{x}_{t-i} + \Psi \mathbf{w}_t + \varepsilon_t, t = 1, 2, \dots, T, \quad (3.35)$$

where $\mathbf{x}_t = (x_{1t}, x_{2t}, \dots, x_{mt})'$ which comprise of jointly determined response variables, $\mathbf{w}_t$ is a $q \times 1$ vector of deterministic and/or exogenous variables, and $\Phi_i, i = 1, 2, \dots, p$ and Ψ are $m \times m$ and $m \times q$ coefficient matrices. The following standard assumptions are made as stated in [139, 140].

Assumption 1. $E(\varepsilon_t) = \mathbf{0}$, $E(\varepsilon_t \varepsilon_t') = \Sigma$ for all t , where $\Sigma = \sigma_{ij}, i, j = 1, 2, \dots, m$ is an $m \times m$ positive matrix, $E(\varepsilon_t \varepsilon_t') = 0$ for all $t = t'$ and $E(\varepsilon_t | \mathbf{w}_t) = \mathbf{0}$.

Assumption 2. All the roots of $|\mathbf{I}_m - \sum_{i=1}^p \Phi_i z^i| = 0$ fall outside the unit circle.

Assumption 3. $\mathbf{x}_{t-1}, \mathbf{x}_{t-2}, \dots, \mathbf{x}_{t-p}, \mathbf{w}_t, t = 1, 2, \dots, T$ are not perfectly collinear.

$\mathbf{x}_t$ would be covariance-stationary under Assumption 2, and equation (3.35) can be rewritten as the representation of an infinite moving average,

$$\mathbf{x}_t = \sum_{i=0}^{\infty} \mathbf{A}_i \varepsilon_t + \sum_{i=0}^{\infty} \mathbf{G}_i \mathbf{w}_{t-i}, t = 1, 2, \dots, T, \quad (3.36)$$

where the $m \times m$ coefficient matrices, $\mathbf{A}_i$ can be acquired by applying the subsequent recursive relations.

$$\mathbf{A}_i = \Phi_1 \mathbf{A}_{i-1} + \Phi_2 \mathbf{A}_{i-2} + \dots + \Phi_p \mathbf{A}_{i-p}, \quad i = 1, 2, \dots, p \quad (3.37)$$

where $\mathbf{A}_0 = \mathbf{I}_m$ and $\mathbf{A}_i = \mathbf{0}$ for $i < 0$, and $\mathbf{G}_i = \mathbf{A}_i \Psi$. The impact of shocks at a given moment on the (anticipated) future values of variables in a dynamical system is measured by an Impulse Response Function (IRF). An impulse response is best understood as the result of a conceptual experiment in which the temporal profile of the impact of a hypothetical $m \times 1$ vector of shocks of size $\boldsymbol{\delta} = (\delta_1, \delta_2, \dots, \delta_m)'$, given the history of the economy, an impact hitting it at time t is compared to a baseline profile at time $t + n$. There are three primary concerns: (i) the types of shocks that are predicted to affect the economy; (ii) the economy's state at time $t - 1$ before being shocked; and (iii) the types of shocks that are affecting the economy from $t + 1$ to $t + n$. The generalized impulse response function of $\mathbf{x}_t$ at horizon n , advanced in [141], denotes the established history of the economy up to $t - 1$ by the non-decreasing information set $\boldsymbol{\Omega}_{t-1}$, and is defined by

$$\mathbf{GI}_x(n, \boldsymbol{\delta}, \boldsymbol{\Omega}_{t-1}) = E(\mathbf{x}_{t+n} | \varepsilon_t = \boldsymbol{\delta}, \boldsymbol{\Omega}_{t-1}) - E(\mathbf{x}_{t+n} | \boldsymbol{\Omega}_{t-1}). \quad (3.38)$$

Applying equation (3.38) in equation (3.36), $\mathbf{GI}_x(n, \boldsymbol{\delta}, \boldsymbol{\Omega}_{t-1}) = \mathbf{A}_n \boldsymbol{\delta}$, which is reliant on the structure of the shocks as specified by $\boldsymbol{\delta}$ but independent of $\boldsymbol{\Omega}_{t-1}$. It is obvious that the characteristics of the IRF are largely dependent on the selection of the appropriate shock vector, $\boldsymbol{\delta}$. The conventional strategy, as proposed in [142], is to use the Cholesky decomposition of $\boldsymbol{\Sigma}$ to address the issue around the selection of $\boldsymbol{\delta}$,

$$\mathbf{P}\mathbf{P}' = \boldsymbol{\Sigma}, \quad (3.39)$$

where $\mathbf{P}$ is an $m \times m$ lower triangular matrix. Then equation (3.36) can be rewritten as

$$\mathbf{x}_t = \sum_{i=0}^{\infty} (\mathbf{A}_i \mathbf{P}) (\mathbf{P}^{-1} \varepsilon_{t-i}) + \sum_{i=0}^{\infty} \mathbf{G}_i \mathbf{w}_{t-i} = \sum_{i=0}^{\infty} (\mathbf{A}_i \mathbf{P}) \boldsymbol{\xi}_{t-i} + \sum_{i=0}^{\infty} \mathbf{G}_i \mathbf{w}_{t-i}, \quad t = 1, 2, \dots, T, \quad (3.40)$$

such that $\boldsymbol{\xi}_t = \mathbf{P}^{-1} \varepsilon_t$ are orthogonalized, that is $E(\boldsymbol{\xi}_t \boldsymbol{\xi}_t') = \mathbf{I}_m$. The $m \times 1$ vector of the orthogonalized IRF of a unit shock to the j th equation on $\mathbf{x}_{t+n}$ is therefore given by

$$\psi_j^o(n) = \mathbf{A}_n \mathbf{P} \mathbf{e}_j, \quad n = 0, 1, 2, \dots, \quad (3.41)$$

where $\mathbf{e}_j$ is an $m \times 1$ selection vector with unity as its j th element and zeros elsewhere.

3.5 Variance Decomposition Analysis

Following the completion of the impulse response analysis, Variance Decomposition Analysis (VDA) is used to establish additional evidence on the relationship between economic growth rate and independent variables of the study. From a perspective of Romanov and Okamoto, (2010) [136] VDA provides movement measurements of the dependent variables that are due to their own shocks and the shocks of other variables. The proportion of unanticipated variation

in each variable caused by shocks from other variables is given by variance decomposition of the forecast error.

Consider a k -dimensional VAR model:

$$x_t = G(x_{t-1}, \dots, x_{t-p} : \Psi) + \varepsilon_t, \quad (3.42)$$

where $G(\cdot)$ is a nonlinear function depending on the parameter vector Ψ and ε_t is an independent and identically distributed error term. Pesaran and Shin, (1998) [143] focused on the shocks that only affect one equation at a time, then define the generalized impulse response function of x_t as in equation (3.38). Based on equation (3.38), Pesaran and Shin, (1998) [143] proposed a Generalized Forecast Error Variance Decompositions (GFEVD) for linear models, but it has the drawback that if the covariance matrix of the error ε_t is not a diagonal matrix, the contributions of the shocks to the forecast error variance of a given variable at horizon l do not total to unity. This complicates their understanding. In contrast, GFEVD of shock i , variable j , horizon h and history Ω_{t-1} is defined by

$$\lambda_{ij, \Omega_{t-1}}(h) = \frac{\sum_{l=0}^{\infty} GI(l, \delta_{it}, \Omega_{t-1})_j^2}{\sum_{i=0}^k \sum_{l=0}^{\infty} GI(l, \delta_{it}, \Omega_{t-1})_j^2}, \quad i, j = 1, 2, \dots, k \quad (3.43)$$

The cumulative effect of the i th shock is measured by the numerator, while the aggregate cumulative effect of all shocks is measured by the denominator.

3.6 Description of Application Dataset and Statistical Software used for Analysis

The data used in this study was obtained online from World Bank Indicator's website <https://data.worldbank.org/indicator>. The data consists of the annual economic growth rate, exchange rate, foreign direct investment, inflation rate, interest rate, population growth rate, and trade openness in Botswana and covers the period from 1980 to 2020. Table (3.1) presents the variables and their descriptions together with where the data was obtained.

Botswana's GDP had grown at an annual rate of 19.45% in 1988, with a 7.57% annual change. Then GDP growth experienced a drop that was consistently sustained. Botswana's GDP decreased by 8.9 percent in 2020, after increasing by 3.0 percent in 2019, as a result of the COVID-19 lockdown as well as other movement restrictions. The interest rate is repeatedly referenced as a leading indicator of the economic growth rate [144–146]. Figure (3.1) depicts Botswana's interest rate between 1980 and 2020. A significant rise was recorded in 1982, and then interest rates consolidated around 0% and 15%. Economic growth is logically related to FDI since low venture levels in developing countries have been connected with low economic development and various challenges like low living standards and widespread poverty. The majority of developing countries made progress as a result of opening their economies to FDI. It has the strength to generate technology that aids in elevating production, management, and marketing advantages, the competitiveness of the host economy, as well as advancing the integration of the host country into the global world. From Figure (3.1), large inflows of FDI were recorded in Botswana's early

Table 3.1: Description of the variables

Variables	Description
Economic Growth Rate	Percentage change of a GDP within a specific time period.
Inflation Rate	Elevation in the overall price level of products and services.
Exchange Rate	The value of US currency (USD) in terms of the Botswana currency (BWP).
Foreign Direct Investment	An investment from one party into a business or corporation in another country with the purpose of building a long-term commitment.
Interest rate	After-inflation lending rates received by an investor, saver, or lender.
Population Growth Rate	The total of individuals occupying an area or making up a whole.
Trade Openness	Relative proportion of exports plus imports to GDP.

opening to FDI and endured a stable inflow, fluctuating between \$50 million (during 1981-1985) and approximately \$70 million (through 1986-1990 and 1996-2000), excluding the years 1991-1995, which attained a negative FDI. Massive negative flows appeared in 1993 as a consequence of diminishing returns announced by a copper-nickel mine, Bamangwato Concessions Limited (BCL) mine, following changes in its ownership. FDI helped in the development of the manufacturing sector because, even though small, it was expanded with a greater level of participation in FDI. Over 60% of all manufacturing ventures were entirely foreign-owned [15]. Economic growth is probably closely integrated with trade openness, especially in the production industry where it accelerates productive gains and economic growth. It does not only boost economic growth but also targets social aspects like standards of living and life expectancy. Developing countries started to have a notable benefit from openness in the 1980s. This led to structural changes as well as the development of resource allocation and an increase in efficiency. Trade openness is among the essential elements that influence the growth of the economy, but there is a need to analyze the causality that exists between the two. Another possible indicator fundamental to the economic growth rate is inflation. A substantial rise in prices might have a reasonably higher impact on those costs payable on inputs as opposed to on profits, which would have an unhealthy effect on economic growth. An inflation rate is used as a variable to assess the change in price. Additionally, an obvious time series association between economic growth and changes in business formations is expected [147, 148]. Figure (3.1) portrays inflation and consumer prices (annual %) from 1980 to 2020. It shows a maximum inflation rate in 1981 and 1992 and entered into a consolidation. A drop is recorded from 2010 until 2020.

3.6.1 Justification of Variables

This subsection is concerned with the variables of the study; it gives light on the expected correlation between economic growth rate and macroeconomic variables under study and the units used to measure the variables.



Figure 3.1: Dynamics of Economic growth rate, Exchange rate, FDI, Inflation rate, Interest rate, Population growth rate, and Trade openness in Botswana from 1980 to 2020.

Economic Growth Rate

To measure or monitor a nation's economic growth, various methods are employed. Real GDP and Gross Domestic Product are two examples. Because real GDP has been utilized by previous researchers as a dependent variable in their work, this study employed it as a measure of the pace of economic growth.

Inflation Rate

Controlling inflation is by far the most crucial task facing economists and economic officials in every nation in order to accomplish economic growth through the creation of suitable infrastructure. Due to the rapid economic progress over the past few decades, inflation has been kept at a low level, social welfare has been fostered, and the residents' living conditions have increased. In most developing nations, including Botswana, a high inflation rate is a relatively typical phenomenon. As a result, the analysis anticipates a negative correlation between Botswana's

inflation and economic development.

Exchange Rate

It is the minimum quantity of one currency's units needed to purchase an equivalent quantity of another currency's units. According to a study in [149], the exchange rate is a factor that affects the economic growth rate since a rising exchange rate is associated with rising imports and declining exports. This analysis anticipates a negative correlation between the exchange rate and economic growth.

Foreign Direct Investment

Foreign Direct Investment is anticipated to have quite an effect on growth according to studies in [150, 151] which found a variety of effects that differ depending on technological progress and emerging nations. Foreign Direct Investment significantly contributes to economic growth by raising productivity levels. It is widely acknowledged as the most significant component in boosting economic growth and the level of living standards in emerging economies. As a result, the study anticipates that the FDI coefficient will be positive.

Interest Rate

Numerous methods for monetary policy are available to governments and monetary authorities. One of them is the interest rate, which is employed to have an impact on the economy. Reduced interest rates can increase borrowing and investment, which enhances economic growth. On the other hand, might encourage excessive growth and inflation when they are too low, which would lower purchasing power and threaten the stability of economic development [152].

Population Growth Rate

Population growth rate and economic growth are intimately related. The size, composition, organization, distribution and movement of a population can promote or retard the pace of economic growth. In order to maintain economic growth, a developed nation with low population density and a low proportion of employable individuals must see an increase in population. On the other hand, any population growth will hurt an underdeveloped nation's economy because of its high population density and a large proportion of employable individuals.

Trade Openness

One indicator of a nation's participation in the international trading system is its trade openness. Theoretical proportions show that, while trade openness increases economic efficiency, market imperfections may have a negative impact on trade liberalization for some nations.

3.6.2 Statistical Software used for Analysis

Modern econometric, statistical, and forecasting software called EViews was used in this study to provide strong analytical capabilities in a customizable and user-friendly environment. EViews

manages data fast and effectively, performs statistical and econometric research, creates forecasts or model simulations and creates high-quality graphs and tables. The software enables data input and import, data visualization, statistical analysis, estimation, forecasting and model solution as well as the output of a presentation of publishing quality which are simple to carry out by the creative EViews user interface.



4. Data Analysis And Empirical Results

4.1 Empirical Results and Discussion

This section presents results obtained from estimating equation (3.24) utilizing Botswana's annual data on the economic growth rate, exchange rate, foreign direct investment, inflation rate, interest rate, population growth rate and trade openness for the period from 1980 to 2020. Diagnostic tests were carried out to validate the parameter evaluation of the results generated by the VECM model applied in the study.

4.2 Unit Root Test

In order to determine whether the variables were stationary or not, this study examined the time series characteristics of the data by applying an ADF test and the PP test. Table (4.1) displays the results of the unit root test when there is an intercept but no trend. Most variables were not stationary at level except the natural logarithm of EGR (LNEGR) and the natural logarithm of IR (LNIR) under an ADF test and LNEGR, LNIR and the natural logarithm of FDI (LNFDI) under the PP test, since the absolute value of their test statistics was greater than that of the test critical values at 5% level of significance. The null hypothesis of a unit root was rejected using an ADF test and the PP test therefore all variables were stationary after applying the first difference under both tests and they acquired absolute test statistics which were greater than that of the test critical values at 5% level of significance. It can be inferred that the variables are integrated in the same order (order one). A cointegration test can be employed since the variables are stationary and integrated of order one.

Table 4.1: ADF and PP unit root test statistics

Variable	ADF		PP	
	Level	1 st Difference	Level	1 st Difference
<i>LNEGR</i>	-4.284821 **	-4.283277 **	4.260412 **	10.07143 **
<i>LNEX</i>	-1.728618	-5.173754 **	2.059955	5.065256 **
<i>LNT0</i>	-1.430084	-5.983174 **	1.619202	6.119024 **
<i>LNFDI</i>	-1.839007	7.803183 **	5.220003 **	16.24793 **
<i>LNINF</i>	0.274907	2.896389 **	0.080960	8.070735 **
<i>LNIR</i>	-4.234846 **	7.091572 **	4.227263 **	12.39601 **
<i>LNPOP</i>	-1.449729	-3.761514 **	1.794555	15.57063 **

NB: ** denotes statistical significance at 5%.

Where *LNEGR*, *LNEX*, *LNT0*, *LNFDI*, *LNINF*, *LNIR* and *LNPOP* are natural logarithms of economic growth rate, exchange rate, trade openness, foreign direct investment, inflation rate, interest rate and population growth rate respectively.

All variables of this study were converted to natural logarithms in order to reduce heteroscedasticity.

4.3 Lag Selection

After performing a unit root test, Likelihood-ratio (LR), Final Prediction Error (FPE), Akaike Information Criterion (AIC), Schwarz Information Criterion (SC) and Hannan-Quinn information criterion (HQ) were tested in order to select an optimum lag number for the VAR model. The information criterion with the smallest criterion value indicates the most optimal length to employ. According to observations in Table (6.2), the criterion with the smallest criterion value is an AIC which suggests that the best VAR model has three (3) optimal lags and this implies that a VECM has two (2) optimal lags.

Table 4.2: Lag-order selection criterion

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-55.7954	NA	0.0000	3.3051	3.6067	3.4124
1	72.6632	202.8309*	0.0000*	-0.8770	1.5363*	-0.0184*
2	121.9716	59.6819	0.0000	-0.8932	3.6317	0.7167
3	173.7350	43.5902	0.0000	-1.0387*	5.5979	1.3225

Where * indicates lag order selected by the criterion

4.4 Cointegration Test

Johansen's technique develops two likelihood estimators for the cointegration rank: a Trace test and a Maximum Eigenvalue. The results are displayed in Tables (4.3) and (4.4) respectively. When the probability value is less than 0.05 under both the trace statistic and the maximum eigenvalue method, the null hypothesis, which claims the absence of cointegration, is rejected. At 5% significance level, both tests fail to reject the null hypothesis that there are at most five cointegrating equations, that is a maximum of five cointegration exists. As a result, there is a cointegration relationship between the economic growth rate and independent variables.

Table 4.3: Trace Test

Hypothesized No. of Cointegrating Equation(s)	Eigenvalue	Trace Statistic	Critical Value	Probability Value**
None	0.971184	363.7760*	125.6154	0.0000
At most 1	0.950823	232.5430*	95.75366	0.0000
At most 2	0.775864	121.0872*	69.81889	0.0000
At most 3	0.546474	65.75354*	47.85613	0.0005
At most 4	0.458578	36.49750*	29.79707	0.0073
At most 5	0.243932	13.79591	15.49471	0.0887
At most 6	0.089024	3.449840	3.841465	0.0633

Trace test indicates five cointegrating equations at 0.05 level.

*denotes rejection of the hypothesis at 0.05% level.

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

Table 4.4: Maximum Eigenvalue Test

Hypothesized No. of Cointegrating Equation(s)	Eigenvalue	Max-Eigen Statistic	Critical Value	Probability Value**
None	0.971184	131.2330*	46.23142	0.0000
At most 1	0.950823	111.4558*	40.07757	0.0000
At most 2	0.775864	55.33365*	33.87687	0.0000
At most 3	0.546474	29.25604*	27.58434	0.0302
At most 4	0.458578	22.70159*	21.13162	0.0298
At most 5	0.243932	10.34607	14.26460	0.1902
At most 6	0.089024	3.449840	3.841465	0.0633

Maximum-eigenvalue test indicates five cointegrating equations at 0.05 level.

* denotes rejection of the hypothesis at 0.05% level.

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

Considering that the results presented the existence of cointegration between variables, then there exists a linear, stabilized and long-run association between variables. This acknowledges that the disequilibrium errors would tend to shift around mean zero. This also implies that there is an Error Correction Model that portrays the long-run adjustment mechanism.

4.4.1 Correlations

A linear association between factors were measured and Table 6.4 indicates the correlation coefficients and each cell reflects the correlation between two specific variables. The strength of a linear relationship between the economic growth rate and the exchange rate is -0.425941 , this signifies that the two variables are inversely related. Also, a positive association between the economic growth rate and trade openness is displayed by the results. Economic growth rate and FDI presented a remarkably weak positive correlation in terms of the strength of a linear relationship. In accordance with the study results, the population growth rate generally increases whenever the economic growth rate enhances and interest rate declines provided that

Table 4.5: Correlation Matrix

	LNEGR	LNEX	LNFDI	LNINF	LNIR	LNPOP	LNT0
LNEGR	1.000000						
LNEX	-0.425941	1.000000					
LNFDI	0.118727	0.008955	1.000000				
LNINF	0.431685	-0.745985	-0.0886003	1.000000			
LNIR	-0.234956	0.235471	0.048232	0.015515	1.000000		
LNPOP	0.260276	-0.845438	-0.057937	0.478818	-0.371806	1.000000	
LNT0	0.525215	-0.617451	0.201081	0.396520	0.309000	0.358762	1.000000

the economic growth rate increases. Equivalently, a moderate positive correlation connecting the economic growth rate and inflation rate in Botswana has been detected.

4.5 Vector Error Correction Model (VECM)

The existence of cointegration between factors illustrates a long-term association among variables under study. After accomplishing a Johansen cointegration test, a VECM was applied. The cointegration equation is used to derive the long-run model, which is represented as the Error Correction Term in a VECM.

$$ECT_{t-1} = 1.000LNEGR_{t-1} + 1.747LNEX_{t-1} - 1.186LNFDI_{t-1} - 1.230LNINF_{t-1} + 2.100LNIR_{t-1} + 4.100LNPOP_{t-1} + 5.071LNT0_{t-1} - 32.297 \quad (4.1)$$

where $LNEGR$ denotes the logarithm of the economic growth rate, $LNEX$ represents the logarithm of the exchange rate, $LNFDI$ represents the logarithm of foreign direct investment, $LNINF$ presents the logarithm of the inflation rate, $LNIR$ denotes the logarithm of interest rate, $LNPOP$ describes the logarithm of population growth rate, and $LNT0$ is the logarithm of trade openness in Botswana. The long-run association between economic growth, exchange rate, FDI, inflation rate, interest rate, population growth, and trade openness of Botswana for one cointegrating vector in the period 1980-2020 is defined as:

$$1.000LNEGR_{t-1} = -1.747LNEX_{t-1} + 1.186LNFDI_{t-1} + 1.230LNINF_{t-1} - 2.100LNIR_{t-1} - 4.100LNPOP_{t-1} - 5.071LNT0_{t-1} + 32.297 \quad (4.2)$$

Equation (4.2) implies that a percentage change in the exchange rate will result in a 1.747% decrease in the economic growth rate, while a percentage change in FDI will bring about a 1.186% increase in the economic growth rate in the long run. The equation also shows that a unit increase in the interest rate, population growth rate and trade openness will cause a 2.1%, 4.1% and 5.071% decrease, respectively, in the economic growth rate.

Table (4.6) displays cointegration coefficients as well as their standard errors in () and t-statistics in [], and if the absolute value of the t-statistics is higher than the critical value that corresponds to 0.05 level of significance, the coefficients are considered to be significant. The p-values in Table

(4.6) are less than the 0.05 level, this suggests that a cointegrating equation has significant coefficients for all variables.

Table 4.6: Error Correction Term

Cointegrating Equation:	Cointegrating Equation 1	Probability value
LNENGR(-1)	1.000000	
LNEX(-1)	1.746764 (0.46514) [3.75537]	0.000599
LNFDI(-1)	-1.186449 (0.19868) [-5.97167]	< 0.00001
LNINF(-1)	-1.230378 (0.28856) [-4.26389]	0.000123
LNIR(-1)	2.100189 (0.20539) [10.2253]	0.00001
LNPOP(-1)	4.100095 (0.84015) [4.88017]	0.000018
LNTO(-1)	5.070638 (0.88062) [5.75801]	< 0.00001
C	-32.29709	

To capture both the long-run and the short-run dynamics of Botswana's economic growth, a VECM was generated using Engle-Granger (1987) approach. It engages the inclusion of the lagged residuals from a regression model. Table (4.7) arrays the short-run coefficients of the study for one cointegration equation. Short run coefficients and long-run coefficients are substituted according to equation (3.24).

Table 4.7: VECM Short Run Dynamics

Variables	Coefficient	Standard Error	T-Statistic	Prob.
ECT	-0.824	0.185	-4.44957	0.0000 * *
D(LNEGR(-1))	-0.157	0.24356	-0.64494	0.5199
D(LNEGR(-2))	-0.148	0.21008	0.70329	0.4829
D(LNEX(-1))	-0.252	1.03500	-0.24352	0.8079
D(LNEX(-2))	2.163	1.04182	2.07576	0.0396 * *
D(LNFDI(-1))	-0.608	0.25784	-2.35926	0.0196 * *
D(LNFDI(-2))	-0.069	0.15909	-0.42427	0.6647
D(LNINF(-1))	-2.315	0.60357	-3.83516	0.0002 * *
D(LNINF(-2))	-1.160	0.68524	-1.69310	0.0925*
D(LNIR(-1))	1.256	0.34540	3.63728	0.0004 * *
D(LNIR(-2))	0.681	0.28400	2.39949	0.0176 * *
D(LNPOP(-1))	0.032	2.14107	0.01504	0.9880
D(LNPOP(-2))	2.147	2.30216	0.93265	0.3525
D(LNTO(-1))	0.070	1.53411	0.04538	0.96395
D(LNTO(-2))	-2.941	1.58869	-1.85096	0.0661*
c	-0.375	0.14233	-2.63729	0.0092 * *

Note: ** and * denote statistical significance at 5% and 10% respectively.

R^2 0.696830

Adj. R-Squared 0.490123

Sum sq. residuals 6.522645

SE. equation 0.544503

F Statistic 3.371098

According to Table (4.7), the model has a significant ($p\text{-value} = 0.000 < \alpha = 0.05$) error correction term of -0.824 , which indicates that there is a relationship between the variables and the negative value suggests that there is a tendency for the variables to correct any deviations from equilibrium, and this correction occurs at a speed of 82.4% per period. The results also show that the first two lags of the economic growth rate have a negative and negligible impact on the current period of economic growth rate. This implies that the past values of the economic rate do not have a significant influence on the current growth rate. The first lag of the exchange rate variable is negative but insignificant, while the second lag is positive and significant. This suggests that the exchange rate has a delayed impact on economic growth. The positive significance of the second lag indicates that an increase in the exchange rate can positively affect economic growth. FDI has a negative and significant impact on the economic growth rate. This suggests that an increase in FDI can lead to a decrease in economic growth. The inflation rate variable has a negative and significant impact in the first lag, indicating that higher inflation negatively affects economic growth. However, the insignificance in the second lag suggests that the effect of inflation diminishes over time. Both lags of the interest rate variable exert a positive and significant influence on the economic growth rate. This suggests that higher interest rates can have a stimulating effect on economic growth. The positive relationship indicates that an increase in interest rates can lead to higher economic growth. The population growth rate variable shows a

positive and insignificant relationship with economic growth. This implies that the population growth rate does not have a significant impact on economic growth in the model. The second lag of trade openness has a negative and significant impact on economic growth at the 10% level of significance. This suggests that a more open trade policy can have a negative effect on economic growth in the longer term. The significant negative constant indicates a systematic bias or trend in the model that is affecting the economic growth rate. This could be due to various factors that are not accounted for in the model.

The coefficient of determination (R^2) indicates that about 69.7% of the variation in economic growth is accounted for by the variations in the independent variables. This implies that the model used in this study explains a sizable percentage of variations in economic growth as well as a good strength of the relationship between the model and the economic growth of Botswana. The overall significance of the model using the F-statistic value with a p-value= 0.000103, which appears to be less than $\alpha = 0.05$. This suggests that the rejection of the null hypothesis of the model is not significant in explaining the variations of economic growth in Botswana.

4.6 Granger Causality Test Results

The Granger causality test is performed under the assumption of cointegration. The test is used to investigate the causal association between variables. It tests the causal link with a joint significance of all coefficients using a joint F distribution [134]. Table (4.8) below presents results of causality that are significant.

Table 4.8: Pairwise Granger Causality Test

Null Hypothesis	F-Statistic	Probability value
EX_t does not Granger Cause EGR_t	4.01434	0.0272
INF_t does not Granger Cause EGR_t	0.13394	0.0441
EGR_t does not Granger Cause POP_t	6.38052	0.0044
TO_t does not Granger Cause EGR_t	4.02455	0.0270
IR_t does not Granger Cause FDI_t	3.85217	0.0310
INF_t does not Granger Cause POP_t	3.71183	0.0348
INF_t does not Granger Cause TO_t	3.88613	0.0302
TO_t does not Granger Cause IR_t	3.41171	0.0446
TO_t does not Granger Cause POP_t	8.91576	0.0008
POP_t does not Granger Cause TO_t	2.88656	0.0695
EX_t does not Granger Cause IR_t	2.50745	0.0964
EX_t does not Granger Cause POP_t	33.084	0.0000

According to the research results shown in Table (4.8), the null hypothesis of the exchange rate does not Granger cause the economic growth rate was rejected since the p-value= 0.0272 is less than the conventional level of p-value= 0.05. As a result, it is determined that the exchange rate influences changes in the rate of economic growth. The results also specify other variables: inflation rate and trade openness to have a unidirectional causality with the growth of the

economic rate, however, the population growth rate does not Granger cause economic growth rate but economic growth rate contributes to the movement of the population growth rate. The results also indicate no causal relationship between the economic growth rate and the interest rate, as either null hypothesis involving the economic growth rate and the interest rate were not rejected.

4.7 Evaluation Measures of the Proposed Method of Analysis

The diagnostic tests are performed to explore serial correlation, normality of residuals and Autocorrelation Conditional Heteroscedastic (ARCH) conclusions in residuals.

4.7.1 Serial Correlation

Serial correlation was tested, results presented by Table (4.9) and the null hypothesis was not rejected in all lags both in LRE* stat (Logistics Readiness Evaluation) and Rao F-stat since all probability values are greater than 0.05. This shows that the model is free from serial correlation.

Table 4.9: Serial Correlation Test

Null hypothesis: No serial correlation Test						
Lag	LRE* stat	df	Prob.	Rao F-stat	df	Prob.
1	51.93868	49	0.3601	1.048271	(49, 50.1)	0.4340
2	60.86630	49	0.1190	1.315300	(49, 50.1)	0.1686
3	33.59427	49	0.9543	0.591462	(49, 50.1)	0.9661

4.7.2 Normality Test

Table (4.10) presents the normality of residuals and the joint statistic is 58.868 with 14 degrees of freedom and a p-value=0.0000 $< \alpha = 0.05$. This implies a rejection of the null hypothesis that the data is normally distributed at 5% level of significance hence errors are not normally distributed.

Table 4.10: Jarque-Bera Test

Component	Jarque-Bera	df	Prob.
LNEGR	0.487261	2	0.7838
LNEX	7.873688	2	0.0195
LNFDI	33.24514	2	0.0000
LNINF	1.427276	2	0.4899
LNIR	8.401808	2	0.0150
LNPOP	7.251539	2	0.0266
LNT0	0.181286	2	0.9133
Joint	58.86800	14	0.0000

4.7.3 Heteroscedastic Test

The results of heteroscedasticity from Table (4.11) illustrate that no conditional heteroscedasticity was detected since $p\text{-value} = 0.3354 > \alpha = 0.05$. This suggests that there is no strong statistical evidence to suggest that the variability of the residuals in the model significantly changes with the values of the independent variables. This indicates that the assumption of homoscedasticity holds, and the variability of the residuals can be considered constant.

Table 4.11: Heteroscedastic Test

Joint test:		
Chi-squared	df	Probability Value
856.8667	840	0.3354

4.8 Impulse Response Analysis

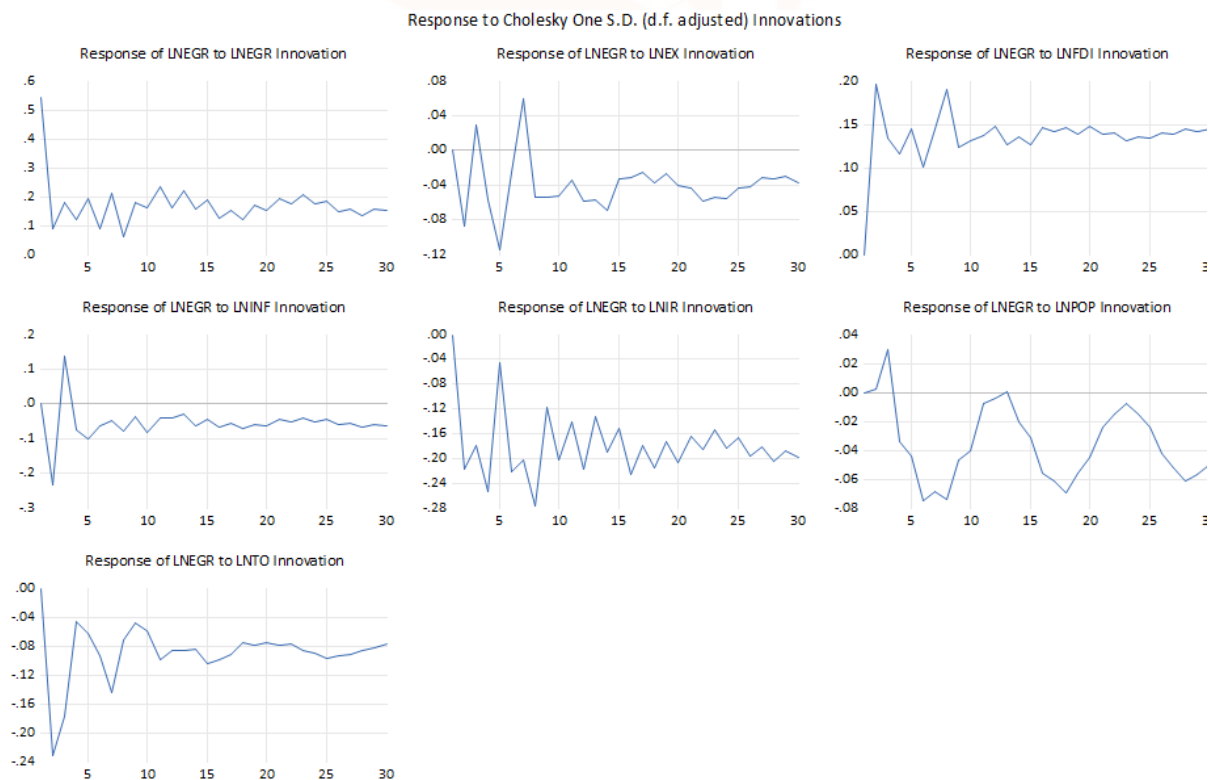


Figure 4.1: Response of Economic Growth to Innovations

Figure (4.1) shows evaluation results for the impulse response function. The first one shows the response of economic growth to its shocks which declines in the first period but response are positive. Economic growth is also positively related to FDI as the response EGR to FDI shocks

lies above zero. Conversely, economic growth responds negatively to inflation rate shocks except in the fourth period as one standard deviation increase in the inflation rate leads to 0.1 standard deviation increase in economic growth. A shock in the interest rate causes economic growth to decrease with a negative relationship and fluctuations. The results indicate a positive response in economic growth from the innovation of population growth's first four periods the economic growth experience a decline and a consolidation between zero and -0.8 . This study observes a negative response of economic growth to trade openness shocks in all periods.

4.9 Variance Decomposition Analysis

The evaluation of variance decomposition provides a method for determining the relative importance of shocks in explaining variations in an outcome variable [153]. The variance decomposition method was applied to determine the relative importance of shocks in the exchange rate, FDI, inflation rate, interest rate, population growth rate, and trade openness in discussing variations in economic growth. The results of the variance decomposition evaluation are provided in Table (4.12) and this displays the amount of the forecast error variance in economic growth as explained by its own innovations and innovations in real exchange rates, FDI, inflation rate, interest rate, population rate and trade openness.

Table 4.12: Variance Decomposition of LNEGR

Decomposition of LNEGR								
Period	SE	LNEGR	LNEX	LNFDI	LNINF	LNIR	LNPOP	LNT0
1	0.540452	100.0000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
2	0.617144	80.29089	6.031851	8.481817	3.678223	0.910767	0.013403	0.593048
3	0.675388	73.27697	5.629524	7.136826	4.872220	6.753331	0.136587	2.194543
4	0.685137	72.85903	5.480476	7.005893	5.143564	6.604952	0.365562	2.540523
5	0.695113	71.04628	5.451757	8.175302	5.174745	7.143786	0.456562	2.551566
6	0.704906	69.11502	5.963236	8.834335	6.003429	7.100277	0.475512	2.508193
7	0.710856	68.46460	5.969952	9.099037	6.181431	7.342057	0.471345	2.471580
8	0.715690	67.56439	5.957155	9.290495	6.668876	7.534968	0.544766	2.439347
9	0.721593	66.57312	5.916526	9.220415	7.330654	7.868606	0.691073	2.399604
10	0.727552	65.78895	6.043463	9.087529	7.710663	8.143002	0.864029	2.362363

Table (4.12) shows that 100% of forecast error variance in *LNEGR* is explained by *LNEGR* in the first period (year 1). It also specifies that the contribution of all independent factors is strongly exogenous, which means their influence on predicting *LNEGR* is very weak in the short run. Independent factors show growth in percentage as time goes on. That is, they exhibit endogenous influence as periods increase, while *LNEGR* experiences a weak exogenous influence on itself.

5. Conclusion And Policy Implications

5.1 Summary and Conclusion

This study attempted to empirically examine the rate of economic growth in Botswana; to establish a possible link between Botswana's economic growth and six macroeconomic factors, including interest rate, inflation rate, exchange rate, FDI, trade openness, and population growth rate and to investigate the major drivers of economic growth in Botswana using annual data from the period 1980 to 2020. The study utilized a VECM technique to identify the main drivers of economic growth in Botswana as well as the effects of these macroeconomic variables on economic growth. The data's stationarity was tested using the ADF and PP tests, and the results showed that there was a unit root present. However, the series were transformed into first differences, where they then attained their stationarity state. The long-term equilibrium relationship between variables exists as detected by the Johansen-Juselius cointegration procedures test. The study used a VECM to ascertain the model's short-run dynamics since the series are cointegrated. According to the VECM findings, the short-term model converges to the long-run equilibrium with an adjustment speed of 82.4%. This is implied by the negative and significant error correction term that was observed. Short-term interest rate and exchange rate have a direct impact on Botswana's economic growth while trade openness and inflation rate had a detrimental effect on economic growth. Unlike a study in [68], this study detected a negative and essential effect between the first lag of FDI and economic growth, but the second lag of FDI presented a negative and insignificant impact. The study further revealed that trade openness's first lag showed a favorable but negligible influence, while the second lag displayed a harmful and significant impact on economic growth at 10% level of significance. The outcome may be potentially influenced by the driving out of local investment and expanding external liability and inducing over-reliance. This attests that Botswana has to be financially sound for economic growth to be impacted by the FDI and trade openness of previous periods.

The results on trade openness go along with results in [154, 155] but differ from that in [156, 157], who detected a desirable and significant association between trade openness and economic growth. A negative and significant impact may be a result of Botswana's inadequate financial development, thus leading to the production of low-demand products in the international market and thus lowering local production. Population growth appears to have a positive but insignificant influence on the economic growth of Botswana in the short run. This brings the study to the conclusion that population growth may not imply economic growth since the relationship between the two is insignificant. Additionally, Botswana's high population growth appears to be a serious issue because it slows down the country's economic progress in the long run. An increase in the number of unemployed individuals might serve as the cause of a negative association. This leads to an increase in non-productive members, which raises the dependent population and inhibits economic progress because these people are not contributing to society's advancement through increased productivity, more labor access, or increased production

of commodities. This study also identified that the previous lags of economic growth do not have a significant impact on the current economic growth, which suggests that Botswana's economic growth cannot be explained by its previous lags. This study revealed a significant and positive effect between the second lag of the exchange rate: United States Dollar to Botswana Pula USD/BWP and the economic growth rate of Botswana. This suggests that the economic growth of Botswana is favored whenever USD gets stronger than BWP. A negative constant was detected by the VECM, and this demonstrates that without minimal policy action and strategic inventions, Botswana will persist with recording a lower economic growth rate in the short run while in the long run a positive constant was found.

This study's interest rate findings go along with those in [158, 159] who discovered that lower interest rate encourage the demand for loans and mortgages thus stimulating economic growth. It also promotes investment and degrades the cost of borrowing and discourages saving. The study also revealed the exchange rate, inflation rate and trade openness to be the major drivers of economic growth as presented by the Granger causality test. According to the impulse response function, a positive shock on the inflation rate will lead to a negative economic growth rate both in the short run and in the long run except in the fourth period. It is also evident that positive shocks to the economic growth rate will impact the growth of the country positively in the short term while in the long run, it will not have an impact on the growth rate. The economic growth rate negatively responds to innovations from the exchange rate while FDI shocks bring about a positive economic growth response.

5.2 Policy Recommendations

The results of this study have considerable policy implications. The policy recommendations are divided into FDI and trade openness, monetary and population policies.

5.2.1 Foreign Direct Investment and Trade Openness Policies

Based on the results of this study, FDI and trade openness measures can be established. The results of this study show that FDI has a positive influence on the economic growth rate in the long run that is a unit increase in FDI will contribute to a 1.186% increase in growth. As it was uncovered in [156], an implication will be established on if the economy is financially developed, thus increased local capacity in manufacturing, industrial development, technology, and agriculture should be used to divert the government's focus from import reliance to export-driven growth. This is projected to boost government revenue, reduce the impact of global and local economic crises, and increase domestic capacity, which is connected to the modeling of jobs and an increase in the standard of living. In the short term, FDI has a negative and considerable effect on growth. This might be due to higher FDI outflows throughout the time period. This indicates that additional efforts should be made to boost FDI inflows, which are beneficial to economic growth. Hence, in addition to extending and implementing fresh, persuading, and pertinent investment incentive packages to investors, the government needs to keep a careful eye on the economy. To meet the demands and expectations of foreign investors, the government should work to establish domestic infrastructure, a labor force with industry-relevant skills, and

well-managed financial resources. Improving the investment climate should be the top priority in order to encourage and facilitate investment. The country would benefit from policies that encourage trade with other nations because the level of openness matters.

5.2.2 Monetary Policies

This study discovered that interest rate has a significant and positive effect on Botswana's economic growth in the short run while in the long run a negative impact was revealed, that is a unit increase in interest rate will decrease GDP growth by approximately 2.1%. A positive relationship between the inflation rate and economic growth rate was established in the long run. This suggests that monetary policy can be used to achieve high economic growth in the long run. This study encourages constant money growth in the long run which is promoted by high exports but this would not have a favorable effect in the short run as the study detected a negative and significant relationship between the inflation rate and economic growth rate in the short run. Additionally, the study suggests preserving a low inflation rate and expanding access to international markets thus promoting rapid growth. Furthermore, the study displayed that BWP depreciation will bring about an expansionary effect on the GDP growth rate in the short run. This demonstrates that policymakers can increase international competitiveness, which stimulates export sector output. It was observed that in the long run, the exchange rate (USDBWP) has a negative impact on the GDP growth rate. This indicates that the growth rate will be decreased as a result of BWP depreciation or devaluation. Depreciation is therefore appropriate in the short term but should be avoided in the long term.

5.2.3 Population Policies

In the long run, the population growth of Botswana has a significant and negative impact on its economic growth. This may be due to a rise in the number of unemployed individuals, which increases the dependent population and slows economic growth since resources are diverted away from productive uses to support the growing population. In order to decrease the number of dependent citizens and raise the number of individuals who can produce unique goods or improve competitiveness both locally and worldwide, thereby driving demand, this research supports engaging in entrepreneurial development.

5.3 Limitations and Directions for Further Research

The principal limitation was the inaccessibility of quarterly data for some factors recommended by the theoretical model with regard to the impact of macroeconomic factors on the economic growth rate. The second limitation is that the secondary data used in this study were acquired from a source that is subject to error and inconsistent reporting methods, which may in turn reduce the validity of some variables. This study suggests the need to explore the possibility of nonlinear relationship among variables, while VECM captures linear relationships, economic phenomena often exhibit nonlinear dynamics. By incorporating nonlinear models such as threshold or smooth transition VECM, to assess whether there are threshold effects or nonlinear interactions between the variables in Botswana's context. Additionally, a sector-specific

analysis is needed to analyze how the relationships differ across sectors since different sectors may have unique characteristics that affect the relationship between macroeconomic factors and economic growth. Conducting a sector-specific analysis can provide valuable insights for policymakers and investors. The findings are highly suggestive, but they also emphasize how crucial it is to keep unemployment in check in order to limit its consequences on economic growth in both the short and long term.



Bibliography

- [1] W. Arthur Lewis. *Theory of economic growth*. Routledge, 2013.
- [2] Robert M. Solow. A contribution to the theory of economic growth. *The quarterly journal of economics*, 70(1):65–94, 1956.
- [3] Daron Acemoglu. Introduction to modern economic growth: Parts 1-5. *Department of Economics, Massachusetts Institute of Technology*, 2007.
- [4] Himani Saxena and P.K. Bansal. Relationship between economic factors and economic growth. In *Proceedings of 10th International Conference on Digital Strategies for Organizational Success*, 2019.
- [5] Local Enterprise Authority. Small, medium and large enterprises database, sector mapping and validation in botswana: “Findings and strategies” for local enterprise authority in the Republic of Botswana, 2007.
- [6] Thabani Nyoni and Lovemore Muchingami. Modeling and forecasting Botswana’s Growth Domestic Product (GDP) per capita. 2019.
- [7] Michael Jetter. Volatility and growth: Governments are key. *European Journal of Political Economy*, 36:71–88, 2014.
- [8] D. Mahachi and L.S. Ketsabile. Diamond mining as a possible strategy for tourism product diversification in Botswana. *J. Dev. Leadersh*, 2(2):35–50, 2013.
- [9] Latang Sechele et al. Urban bias, economic resource allocation and national development planning in Botswana. *International Journal of Social Science Research*, 4(1):1–18, 2016.
- [10] G.S. Maipose. Institutional dynamics of sustained rapid economic growth with limited impact on poverty reduction prepared for the United Nations Research Institute for Social Development (UNRISD). 2008.
- [11] Theresa Moyo. Promoting industrialisation in Mauritius, South Africa and Botswana: Lessons for the future. *Africa Development*, 41(3):139–163, 2016.
- [12] Noel T. Palmer. The importance of economic growth. *Dublin: CPA Ireland*, 2012.
- [13] Happy K. Siphambwe et al. *Growth and Employment Dynamics in Botswana: A case study of policy coherence*. Citeseer, 2007.
- [14] Robert E. Lucas et al. The industrial revolution: Past and future. *Lectures on economic growth*, 109:188, 2002.
- [15] Stephen R. Lewis and Jennifer Sharpley. *Botswana’s industrialisation*. Institute of development studies at the University of Sussex, 1988.

- [16] Walt Whitman Rostow. The stages of economic growth. *The economic history review*, 12(1):1–16, 1959.
- [17] Paul M. Romer. The origins of endogenous growth. *Journal of Economic Perspectives*, 8(1):3–22, 1994.
- [18] Joseph Schumpeter and Ursula Backhaus. The theory of economic development. In *Joseph Alois Schumpeter*, pages 61–116. Springer, 2003.
- [19] Dani Rodrik. Understanding South Africa’s economic puzzles. *Economics of Transition*, 16(4):769–797, 2008.
- [20] Ari Aisen and Francisco José Veiga. How does political instability affect economic growth? *European Journal of Political Economy*, 29:151–167, 2013.
- [21] Lukman Safdar. Financial deepening and economic growth in Pakistan: An application of cointegration and vecm approach. *Interdisciplinary journal of contemporary research in business*, 5(12):368–385, 2014.
- [22] A.K. Giri and Pooja Joshi. The impact of macroeconomic indicators on Indian stock prices: An empirical analysis. *Studies in Business and Economics*, 12(1):61–78, 2017.
- [23] Evans Agalega and Samuel Antwi. The impact of macroeconomic variables on gross domestic product: Empirical evidence from Ghana. *International Business Research*, 6(5):108, 2013.
- [24] Rajesh Sharma, Pradeep Kautish, and D. Suresh Kumar. Impact of selected macroeconomic determinants on economic growth in India: An empirical study. *Vision*, 22(4):405–415, 2018.
- [25] Gervase S. Maipose. Policy and institutional dynamics of sustained development in Botswana. 2008.
- [26] Emmanuel Botlhale. Enhancing public project implementation in Botswana during the NDP 11 period. *Africa’s Public Service Delivery and Performance Review*, 5(1):1–9, 2017.
- [27] C.G.F. Simkin. Notes on the theory of inflation. *The Review of Economic Studies*, 20(2):143–151, 1952.
- [28] Zaimy Johana Johan. Investors with the Golden-i: Preference in Gold-i investment. *Journal of Emerging Economies and Islamic Research*, 8(2):40–50, 2020.
- [29] Janine Aron and John Muellbauer. Interest rate effects on output: evidence from a GDP forecasting model for South Africa. *IMF Staff Papers*, 49(1):185–213, 2002.
- [30] J. Chen. Foreign Direct Investment (FDI). Investopedia, 2020.
- [31] UNDP UNCTAD. Asian foreign direct investment in Africa: Towards a new era of cooperation among developing countries. *United Nations, New York, NY and Geneva, Switzerland*, 2007.

- [32] Robert J. Barro. Government spending in a simple model of endogenous growth. *Journal of political economy*, 98(5, Part 2):S103–S125, 1990.
- [33] Robert E. Lucas Jr. On the mechanics of economic development. *Journal of Monetary Economics*, 22(1):3–42, 1988.
- [34] Adam Smith. *The wealth of nations [1776]*, volume 11937. na, 1937.
- [35] Alush Kryeziu. The impact of macroeconomic factors in economic growth. *European Scientific Journal*, 12(7), 2016.
- [36] Harrod R.F. An essay in dynamic theory. *ECONOMIC JOURNAL*, 49:14–33, 1939.
- [37] Evsey D. Domar. Capital expansion, rate of growth, and employment. *Econometrica, Journal of the Econometric Society*, pages 137–147, 1946.
- [38] Gene M. Grossman and Elhanan Helpman. Quality ladders and product cycles. *The Quarterly Journal of Economics*, 106(2):557–586, 1991.
- [39] Philippe Aghion and Peter Howitt. A model of growth through creative destruction. *Econometrica*, 1992.
- [40] Nancy L. Stokey. R&D and economic growth. *The Review of Economic Studies*, 62(3):469–489, 1995.
- [41] Gene M. Grossman and Elhanan Helpman. Protection for sale, 1992.
- [42] Stanley Fischer. Macroeconomic stability and growth. *Cuadernos de Economía*, 29(87):171–186, 1992.
- [43] Philippe Aghion and Peter Howitt. A model of growth through creative destruction, 1990.
- [44] N. Gregory Mankiw, David Romer, and David N. Weil. A contribution to the empirics of economic growth. *The Quarterly Journal of Economics*, 107(2):407–437, 1992.
- [45] Brian Snowdon and Howard R. Vane. *Modern macroeconomics: Its origins, development and current state*. Edward Elgar Publishing, 2005.
- [46] Gaurav Agrawal and Mohd Aamir Khan. Impact of FDI on GDP: A comparative study of China and India. *International Journal of Business and Management*, 6(10):71, 2011.
- [47] Samuel Antwi, E.F. Mills, Xicang Zhao, et al. Impact of macroeconomic factors on economic growth in Ghana: A cointegration analysis. *International Journal of Academic Research in Accounting, Finance and Management Sciences*, 3(1):35–45, 2013.
- [48] Georgios Karras. Trade openness and economic growth can we estimate the precise effect? *Applied Econometrics and International Development*, 3(1), 2003.
- [49] Halit Yanikkaya. Trade openness and economic growth: a cross-country empirical investigation. *Journal of Development economics*, 72(1):57–89, 2003.

- [50] Caroline Freund and Bineswaree Bolaky. Trade, regulations, and income. *Journal of Development Economics*, 87(2):309–321, 2008.
- [51] Anupam Das, Biru Paksha Paul, et al. Openness and growth in emerging Asian economies: Evidence from GMM estimations of a dynamic panel. *Economics Bulletin*, 31(3):2219–2228, 2011.
- [52] Thomas Gries, Margarete Redlin, et al. Trade openness and economic growth: a panel causality analysis. In *International conferences of RCIE, KIET, and APEA, March*, volume 16, page 18, 2012.
- [53] Baboo M. Nowbutsing. The impact of openness on economic growth: Case of Indian Ocean rim countries. *Journal of Economics and Development Studies*, 2(2):407–427, 2014.
- [54] Qazi Muhammad Adnan Hye, Shahida Wizarat, and Wee-Yeap Lau. The impact of trade openness on economic growth in China: An empirical analysis. *The Journal of Asian Finance, Economics and Business*, 3(3):27–37, 2016.
- [55] Roberto Rigobon and Dani Rodrik. Rule of law, democracy, openness, and income: Estimating the interrelationships¹. *Economics of Transition*, 13(3):533–564, 2005.
- [56] Mohamed Fenira. Trade openness and growth in developing countries: An analysis of the relationship after comparing trade indicators. *Asian Economic and Financial Review*, 5(3):468–482, 2015.
- [57] Eduardo A. Cavallo and Jeffrey A. Frankel. Does openness to trade make countries more vulnerable to sudden stops, or less? Using gravity to establish causality. *Journal of International Money and Finance*, 27(8):1430–1452, 2008.
- [58] Dong-Hyeon Kim, Shu-Chin Lin, and Yu-Bo Suen. Dynamic effects of trade openness on financial development. *Economic Modelling*, 27(1):254–261, 2010.
- [59] Gilles Dufrenot, Valerie Mignon, and Charalambos Tsangarides. The trade-growth nexus in the developing countries: A quantile regression approach. *Review of World Economics*, 146:731–761, 2010.
- [60] Mohammad Afzal, Ijaz Hussain, et al. Export-led growth hypothesis: Evidence from Pakistan. *Journal of Quantitative Economics*, 8(1):130–147, 2010.
- [61] Mushtaq Ahmad Klasra. Foreign direct investment, trade openness and economic growth in Pakistan and Turkey: An investigation using bounds test. *Quality & Quantity*, 45:223–231, 2011.
- [62] Muhammad Shahbaz. Does trade openness affect long run growth? Cointegration, causality and forecast error variance decomposition tests for Pakistan. *Economic Modelling*, 29(6):2325–2339, 2012.
- [63] L.G. Burange, Rucha R. Ranadive, and Neha N. Karnik. Trade openness and economic growth nexus: A case study of BRICS. *Foreign Trade Review*, 54(1):1–15, 2019.

- [64] Niels Hermes and Robert Lensink. Foreign direct investment, financial development and economic growth. *The Journal of Development Studies*, 40(1):142–163, 2003.
- [65] Nauro F. Campos and Yuko Kinoshita. Foreign direct investment as technology transferred: Some panel evidence from the transition economies. *The Manchester School*, 70(3):398–419, 2002.
- [66] Wai-Mun Har, Kai-Lin Teo, and Kar-Mun Yee. FDI and economic growth relationship: An empirical study on Malaysia. *International Business Research*, 1(2):11–18, 2008.
- [67] Laura Alfaro, Areendam Chanda, Sebnem Kalemli-Ozcan, and Selin Sayek. Does foreign direct investment promote growth? Exploring the role of financial markets on linkages. *Journal of Development Economics*, 91(2):242–256, 2010.
- [68] Strike Mbulawa. Effect of macroeconomic variables on economic growth in Botswana. 2015.
- [69] Maria Carkovic and Ross Levine. Does foreign direct investment accelerate economic growth. *Does Foreign Direct Investment Promote Development*, 195:220, 2005.
- [70] Shehu U.R. Aliyu. Oil price shocks and the macroeconomy of Nigeria: A non-linear approach. *Journal for International Business and Entrepreneurship Development*, 5(3):179–198, 2011.
- [71] Akhtar Hossain. Exchange rate responses to inflation in Bangladesh. 2002.
- [72] Eduardo Levy-Yeyati and Federico Sturzenegger. To float or to fix: Evidence on the impact of exchange rate regimes on growth. *American Economic Review*, 93(4):1173–1193, 2003.
- [73] Ricardo Hausmann, Lant Pritchett, and Dani Rodrik. Growth accelerations. *Journal of Economic Growth*, 10:303–329, 2005.
- [74] Sebastian Edwards. Exchange rate misalignment in developing countries. *The World Bank Research Observer*, 4(1):3–21, 1989.
- [75] Pierre-Richard Agénor. Output, devaluation and the real exchange rate in developing countries. *Review of World Economics*, 127(1):18–41, 1991.
- [76] Samuel A. Morley. On the effect of devaluation during stabilization programs in LDCs. *The review of Economics and Statistics*, pages 21–27, 1992.
- [77] Mireille Linjouom. The impact of the real exchange rate on manufacturing exports in Benin. 2007.
- [78] Kenneth O. Obi, J.O. Oniore, and K.U. Nnadi. The impact of exchange rate regimes on economic growth in Nigeria. *Journal of Economics and Sustainable Development*, 7(12):115–127, 2016.
- [79] Stanley Fischer. Inflation and growth, 1983.

- [80] Robert J. Barro. Inflation and economic growth, 1995.
- [81] Richard C.K. Burdekin, Arthur T. Denzau, Manfred W. Keil, Thititthep Sitthiyot, and Thomas D. Willett. When does inflation hurt economic growth? Different nonlinearities for different economies. *Journal of Macroeconomics*, 26(3):519–532, 2004.
- [82] Max Gillman and Michal Kejak. Contrasting models of the effect of inflation on growth. *Journal of Economic Surveys*, 19(1):113–136, 2005.
- [83] Stephanie Kremer, Alexander Bick, and Dieter Nautz. Inflation and growth: new evidence from a dynamic panel threshold analysis. *Empirical Economics*, 44:861–878, 2013.
- [84] Edwin Dewan, Shajehan Hussein, and Steven Morling. *Modelling inflation processes in Fiji*. Citeseer, 1999.
- [85] Edwin Dewan and Shajehan Hussein. *Determinants of economic growth (Panel data approach)*. Citeseer, 2001.
- [86] Robert J. Barro. Inflation and economic growth. *ANNALS OF ECONOMICS AND FINANCE*, 14(1):121–144, 2013.
- [87] Faraji Kasidi and Kenani Mwakanemela. Impact of inflation on economic growth: A case study of Tanzania. *Asian Journal of Empirical Research*, 3(4):363–380, 2013.
- [88] U. Tun Wai. The relation between inflation and economic development: A statistical inductive study. *Staff Papers (International Monetary Fund)*, 7(2):302–317, 1959.
- [89] Graeme S. Dorrance. Inflation and growth: The statistical evidence (inflation et croissance: la preuve statistique)(inflación y crecimiento: la comprobación estadística). *Staff Papers-International Monetary Fund*, pages 82–102, 1966.
- [90] Miguel Sidrauski. Inflation and economic growth. *Journal of Political Economy*, 75(6):796–810, 1967.
- [91] Derek D. Headey and Andrew Hodge. The effect of population growth on economic growth: A meta-regression analysis of the macroeconomic literature. *Population and development review*, 35(2):221–248, 2009.
- [92] Dean Baker, J. Bradford De Long, and Paul R. Krugman. Asset returns and economic growth. *Brookings Papers on Economic Activity*, 2005(1):289–330, 2005.
- [93] Eugene Linden. Remember the population bomb? It’s still ticking. *New York Times: Sunday Review*, 4, 2017.
- [94] A.F. Darrat and Y.K. Al-Yousif. On the long-run relationship between population and economic growth: Some time series evidence for developing countries. *Eastern Economic Journal*, 25(3):301–313, 1999.

- [95] Jorge Garza-Rodriguez, Cecillia Andrade-Velasco, Karen Martinez-Silva, Francisco Renteria-Rodriguez, and Pedro Vallejo-Castillo. The relationship between population growth and economic growth in Mexico. *Jorge Garza-Rodriguez and Cecilia I. Andrade-Velasco and Karen D. Martinez-Silva and Francisco D. Renteria-Rodriguez and Pedro A. Vallejo-Castillo,(2016)"The relationship between population growth and economic growth in Mexico", Economics Bulletin*, 36(1):97–107, 2016.
- [96] Hieu Trung Tran. Relationship between interest rate and bank common stock return: Evidence from the top 10 United States banks and financial sector index. 2013.
- [97] Pasquale Tridico. *Inequality in financial capitalism*. Routledge, 2017.
- [98] James S. Guseh and Emmanuel Oritsejafor. Government size, political freedom and economic growth in Nigeria, 1960-2000. *Journal of Third World Studies*, 24(1):139–165, 2007.
- [99] Muzafar Shah Habibullah and Yoke-Kee Eng. Does financial development cause economic growth? A panel data dynamic analysis for the Asian developing countries. *Journal of the Asia Pacific Economy*, 11(4):377–393, 2006.
- [100] Priscilla Dorothy anak Impin and Sook Ching Kok. The effect of inflation rate, interest rate and unemployment rate on the economic growth of Malaysia. *Malaysian Journal of Business and Economics (MJBE)*, 8(1):125–140, 2021.
- [101] Johane Moilwa Motsatsi et al. Financial sector innovation and economic growth in the context of Botswana. *International Journal of Economic Finance*, 8(6):291–300, 2016.
- [102] S.O. Akinwale. Bank lending rate and economic growth: Evidence from Nigeria. *International Journal of Academic Research in Economics and Management Sciences*, 7(3):111–122, 2018.
- [103] Clement Moyo and Pierre Le Roux. Interest rate reforms and economic growth: the savings and investment channel. 2018.
- [104] C. Obute, A. Adyorough, and A.I. Itodo. An assessment of the impact of interest rates deregulation on economic growth in Nigeria (1964-2009). *Journal of Business and Organizational Development*, 4(1):39–57, 2012.
- [105] P. Parjiono. Economic growth in Indonesia: The driving forces of the level and the growth rate of real per capita income: An econometric time series approach. *School of Business), James Cook University*, 2009.
- [106] D. Romer. *Advanced Macroeconomics [m]*. 2nd, 2001.
- [107] Ronald Findlay. Relative backwardness, direct foreign investment, and the transfer of technology: a simple dynamic model. *The Quarterly Journal of Economics*, 92(1):1–16, 1978.
- [108] Jian-Ye Wang. Growth, technology transfer, and the long-run theory of international capital movements. *Journal of international Economics*, 29(3-4):255–271, 1990.

- [109] Bee Wah Tan and Chor Foon Tang. Examining the causal linkages among domestic investment, FDI, trade, interest rate and economic growth in ASEAN-5 countries. *International Journal of Economics and Financial Issues*, 6(1):214–220, 2016.
- [110] Chor Foon Tang. A re-examination of the role of foreign direct investment and exports in Malaysia’s economic growth: A time series analysis, 1970-2006. *International Journal of Management Studies (IJMS)*, 15:47–67, 2008.
- [111] Rudra Prakash Pradhan. The FDI-led-growth hypothesis in ASEAN-5 countries: Evidence from cointegrated panel analysis. *International Journal of Business and Management*, 4(12):153–164, 2009.
- [112] Palaniyappan Srinivasan, M. Kalaivani, and Peter Ibrahim. FDI and economic growth in the ASEAN Countries: Evidence from cointegration approach and causality test. *IUP Journal of Management Research*, 9(1), 2010.
- [113] Debashis Chakraborty and Jaydeep Mukherjee. Is there any relationship between foreign direct investment, domestic investment and economic growth in India? A time series analysis. *Review of Market Integration*, 4(3):309–337, 2012.
- [114] Keith B. Griffin and John L. Enos. Foreign assistance: objectives and consequences. *Economic development and cultural change*, 18(3):313–327, 1970.
- [115] J.C. Jin. Openness, growth and inflation: Evidence from South korea before the economic crisis. Chinese University of Hong Kong. Technical report, Working Paper Series, 2002.
- [116] Robert E. Baldwin. Openness and growth: what’s the empirical relationship? In *Challenges to globalization: Analyzing the economics*, pages 499–526. University of Chicago Press, 2004.
- [117] S. Ibi Ajayi. Globalisation and Africa. *Journal of African Economies*, 12(suppl_1):120–150, 2003.
- [118] James Tobin. Money and economic growth. *Econometrica: Journal of the Econometric Society*, pages 671–684, 1965.
- [119] Sabine D’Costa, Enrique Garcilazo, and Joaquim Oliveira Martins. The impact of structural and macroeconomic factors on regional growth. 2013.
- [120] Norman Sedgley and Bruce Elmslie. The geographic concentration of knowledge: Scale, agglomeration, and congestion in innovation across US states. *International Regional Science Review*, 27(2):111–137, 2004.
- [121] Nicola Gennaioli, Rafael La Porta, Florencio Lopez-de Silanes, and Andrei Shleifer. Human capital and regional development. 2011.
- [122] Antonio Minniti and Carmelo Pierpaolo Parello. Trade integration and regional disparity in a model of scale-invariant growth. *Regional Science and Urban Economics*, 41(1):20–31, 2011.

- [123] Andrea Bassanini and Stefano Scarpetta. The driving forces of economic growth: Panel data evidence for the OECD countries. *OECD Economic Studies*, 2001(2):9–56, 2002.
- [124] Damodar N. Gujarati and D.C. Porter. Qualitative response regression models. *Gujarati, D., Basic econometrics (4th Edition, International Edition)*, pages 580–635, 2003.
- [125] Carlos Enrique Carrasco Gutierrez, Reinaldo Castro Souza, and Osmani Teixeira de Carvalho Guillén. Selection of optimal lag length in cointegrated VAR models with weak form of common cyclical features. 2009.
- [126] A. Hecq, F.C. Palm, and J.P. Urbain. Common cyclical features analysis in VAR models with cointegration. *Journal of Econometrics*, 132:117, 2006.
- [127] Robert F. Engle and Clive W.J. Granger. Co-integration and error correction: representation, estimation, and testing. *Econometrica: Journal of the Econometric Society*, pages 251–276, 1987.
- [128] Christopher A. Sims. Martingale-like behavior of prices, 1980.
- [129] S. Winarno, Mustofa Usman, D. Kurniasari, et al. Application of Vector Error Correction Model (VECM) and Impulse Response Function for daily stock prices. In *Journal of Physics: Conference Series*, volume 1751, page 012016. IOP Publishing, 2021.
- [130] Wen-Jen Tsay. Maximum likelihood estimation of stationary multivariate ARFIMA processes. *Journal of Statistical Computation and Simulation*, 80(7):729–745, 2010.
- [131] H. Lutkepohl and F. Xu. The role of the log transformation in forecasting economic variables. *CESifo Group Munich*, 2009.
- [132] Bernhard Pfaff. *Analysis of integrated and cointegrated time series with R*. Springer Science & Business Media, 2008.
- [133] Nobert Wiener. What is information theory? *IRE Transactions on Information Theory*, 2(2):48, 1956.
- [134] Clive W.J. Granger. Investigating causal relations by econometric models and cross-spectral methods. *Econometrica: journal of the Econometric Society*, pages 424–438, 1969.
- [135] Xia Pan and Jeffrey Jarrett. Using Vector Autoregressive residuals to monitor multivariate processes in the presence of serial correlation. *International Journal of Production Economics*, 106(1):204–216, 2007.
- [136] Anton Romanov and Eiji Okamoto. Introductory econometrics for finance introductory econometrics for finance, 2008. *IEICE Transactions on Communications*, 93(6):1411–1421, 2010.
- [137] Helmut Lütkepohl. *Introduction to multiple time series analysis*. Springer Science & Business Media, 2013.

- [138] Tatonga Gardner Rusike. *Trends and determinants of inward foreign direct investment to South Africa*. PhD thesis, Rhodes University Alice, 2007.
- [139] Helmut Lütkepohl and Don S. Poskitt. Estimating orthogonal impulse responses via Vector Autoregressive Models. *Econometric Theory*, 7(4):487–496, 1991.
- [140] Paresh Narayan. *Reformulating critical values for the bounds F-statistics approach to cointegration: An application to the tourism demand model for Fiji*, volume 2. Monash University Australia, 2004.
- [141] Gary Koop, M. Hashem Pesaran, and Simon M. Potter. Impulse response analysis in nonlinear multivariate models. *Journal of Econometrics*, 74(1):119–147, 1996.
- [142] Christopher A. Sims. Macroeconomics and reality. *Econometrica: Journal of the Econometric Society*, pages 1–48, 1980.
- [143] H. Hashem Pesaran and Yongcheol Shin. Generalized impulse response analysis in linear multivariate models. *Economics Letters*, 58(1):17–29, 1998.
- [144] Huw Pill. Real interest rates and growth: Improving on some deflating experiences. *The Journal of Development Studies*, 34(1):85–110, 1997.
- [145] FFAH Asari, Nurul Syuhada Baharuddin, Nurmadihah Jusoh, Zuraida Mohamad, Norazidah Shamsudin, and Kamaruzaman Jusoff. A Vector Error Correction Model (VECM) approach in explaining the relationship between interest rate and inflation towards exchange rate volatility in Malaysia. *World Applied Sciences Journal*, 12(3):49–56, 2011.
- [146] Barry Bosworth. Interest rates and economic growth: are they related? *Center for Retirement Research at Boston College Working paper*, (2014-8), 2014.
- [147] Edward I. Altman and Edith Hotchkiss. *Corporate financial distress and bankruptcy*, volume 1998. New York: John Wiley & Sons, 1993.
- [148] John Hudson. An analysis of company liquidations. *Applied Economics*, 18(2):219–235, 1986.
- [149] Mehdi Basirat, Arezoo Nasirpour, and Alireza Jorjorzadeh. The effect of exchange rate fluctuations on economic growth considering the level of development of financial markets in selected developing countries. *Asian Economic and Financial Review*, 4(4):517–528, 2014.
- [150] Lucyna Kornecki, Vedapuri Raghavan, and Dianne H.B. Welsh. Foreign direct investment stimulates economic growth: an empirical evidence from Central and Eastern Europe. In *The Academy of World Business, Marketing & Management Development Conference, conference proceedings*, volume 3, pages 402–412, 2008.
- [151] Huay Huay Lee and Hui Boon Tan. Technology transfer, FDI and economic growth in the ASEAN region. *Journal of the Asia Pacific Economy*, 11(4):394–410, 2006.

- [152] R.G. Lipsey and K.A. Chrystal. Economics Oxford University Press, 2007.
- [153] Thomas Andren. *Econometrics*. Bookboon, 2007.
- [154] Ioanna Vlastou. Forcing Africa to open up to trade: Is it worth it? *The Journal of Developing Areas*, pages 25–39, 2010.
- [155] Adedoyin Isola Lawal, Tony I Nwanji, Abiola Asaleye, and Victor Ahmed. Economic growth, financial development and trade openness in Nigeria: An application of the Ardl bound testing approach. *Cogent Economics & Finance*, 4(1):1258810, 2016.
- [156] Markus Brueckner and Daniel Lederman. Trade openness and economic growth: Panel data evidence from Sub-Saharan Africa. *Economica*, 82:1302–1323, 2015.
- [157] Henok Arega Asfaw. Trade policy and economic growth in Sub-Saharan Africa: A panel data approach. *American Journal of Trade and Policy*, 1(3):95–102, 2014.
- [158] Chris O. Udoka and Roland A. Anyingang. The effect of interest rate fluctuation on the economic growth of Nigeria, 1970-2010. *International Journal of Business and Social Science*, 3(20), 2012.
- [159] Lyndon M. Etale, Peter E. Ayunku, et al. The relationship between interest rate and economic growth in Nigeria: An Error Correction Model (ECM) approach. *International Journal of Economics and Financial Research*, 2(6):127–131, 2016.

6. Appendix A

6.1 Eviews Commands and Output

6.1.1 Unit Root Test

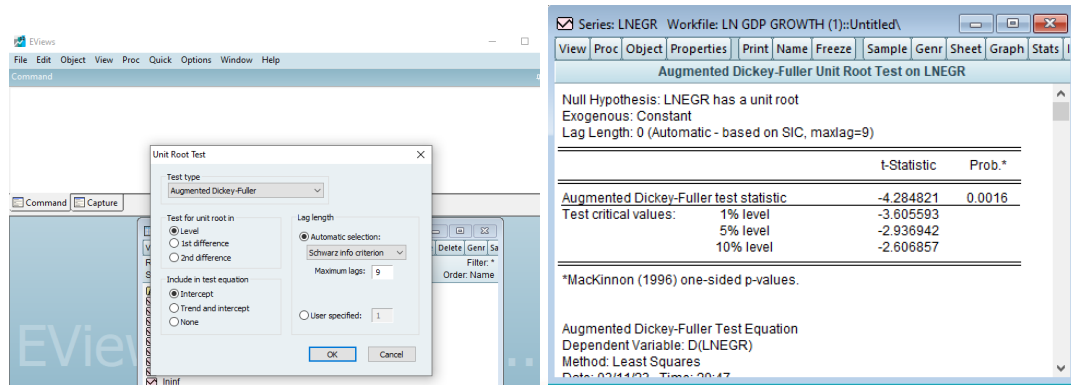


Figure 6.1: Unit Root Test output

6.1.2 Lag-order selection

```
%var.ls 1 2
%var.ls 1 4 lnegr lnex lnfdi lninf lnir lnpop into
%var.results
%var.laglen(4)
%var.ls 1 2
%var.ls 1 3 lnegr lnex lnfdi lninf lnir lnpop into
%var.results
%var.laglen(3)
```

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-81.96386	NA	2.55e-07	4.682308	4.983969	4.789637
1	84.76702	263.2593	5.43e-10	-1.514053	0.899231*	-0.655425
2	173.0373	106.8535	9.02e-11	-3.580911	0.943998	-1.970983
3	261.7774	74.72852*	2.55e-11*	-5.672497*	0.964037	-3.311269*

Figure 6.2: Lag-order selection criterion output

6.1.3 Vector Error Correction Estimates

```
%var.ec(c,1) 1 2 lnegr lnex lnfdi lninf lnir lnpop into
%var.results
```

Unrestricted Cointegration Rank Test (Trace)					Unrestricted Cointegration Rank Test (Maximum Eigenvalue)				
Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**	Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.971184	363.7760	125.6154	0.0000	None *	0.971184	131.2330	46.23142	0.0000
At most 1 *	0.950823	232.5430	95.75366	0.0000	At most 1 *	0.950823	111.4558	40.07757	0.0000
At most 2 *	0.775864	121.0872	69.81889	0.0000	At most 2 *	0.775864	55.33365	33.87687	0.0000
At most 3 *	0.546474	65.75354	47.85613	0.0005	At most 3 *	0.546474	29.25604	27.58434	0.0302
At most 4 *	0.458578	36.49750	29.79707	0.0073	At most 4 *	0.458578	22.70159	21.13162	0.0298
At most 5	0.243932	13.79591	15.49471	0.0887	At most 5	0.243932	10.34607	14.26460	0.1902
At most 6	0.089024	3.449840	3.841465	0.0633	At most 6	0.089024	3.449840	3.841465	0.0633

Figure 6.3: Johansen Cointegration Test

	LNEGR	LNEEX	LNFDI	LNINF	LNIR	LNPOP	LNTO
LNEGR	1.000000	-0.425941	0.118727	0.431685	-0.234956	0.260276	0.525215
LNEEX	-0.425941	1.000000	0.008955	-0.745985	0.235471	-0.845438	-0.617451
LNFDI	0.118727	0.008955	1.000000	-0.086003	0.048232	-0.057937	0.201081
LNINF	0.431685	-0.745985	-0.086003	1.000000	0.015515	0.478818	0.396520
LNIR	-0.234956	0.235471	0.048232	0.015515	1.000000	-0.371806	-0.309000
LNPOP	0.260276	-0.845438	-0.057937	0.478818	-0.371806	1.000000	0.358762
LNTO	0.525215	-0.617451	0.201081	0.396520	-0.309000	0.358762	1.000000

Figure 6.4: Correlation Matrix

6.1.4 Serial Correlation Test

`%var.arlm(3)`

6.1.5 Normality Test

`%var.jbera`

6.1.6 Heteroscedastic Test

`%var.white`

6.1.7 Impulse Response Function

`%var.impulse(30)`

6.1.8 Variance Decomposition

`%var.decomp(m)`

6.2 Data Source Link

<https://data.worldbank.org/indicator>

Sample (adjusted): 1983 2020
Included observations: 38 after adjustments
Standard errors in () and t-statistics in []

Cointegrating Eq:	CointEq1
LNENR(-1)	1.000000
LNEX(-1)	1.746764 (0.46514) [3.75537]
LNFDI(-1)	-1.186449 (0.19868) [-5.97167]
LNINF(-1)	-1.230378 (0.28856) [-4.26389]
LNIR(-1)	2.100189 (0.20539) [10.2253]
LNPOP(-1)	4.100095 (0.84015) [4.88017]
LNT0(-1)	5.070638 (0.88062) [5.75801]
C	-32.29709

Figure 6.5: Error Correction Term

Vector Error Correction Estimates														Vector Error Correction Estimates																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																														
Error Correction	DLNENR	DLNEX	DLNFDI	DLNINF	DLNIR	DLNPOP	DLNTO		DLNENR(-1)		DLNEX(-1)		DLNFDI(-1)		DLNINF(-1)		DLNIR(-1)		DLNPOP(-1)		DLNTO(-1)		DLNENR(-2)		DLNEX(-2)		DLNFDI(-2)		DLNINF(-2)		DLNIR(-2)		DLNPOP(-2)		DLNTO(-2)		DLNENR(-3)		DLNEX(-3)		DLNFDI(-3)		DLNINF(-3)		DLNIR(-3)		DLNPOP(-3)		DLNTO(-3)																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																											
CointEq1	-0.824300 (0.18025) [-4.44957]	0.071945 (0.03550) [2.02686]	0.027702 (0.02043) [1.35371]	-0.246260 (0.07203) [-3.41668]	-0.447618 (0.20446) [-2.18923]	0.007699 (0.00730) [1.05527]	-0.014120 (0.02211) [-0.63674]		1.256313 (0.34540) [3.63728]	-0.138185 (0.08618) [-1.58003]	0.464270 (0.13430) [3.45595]	0.368097 (0.11420) [3.21986]	0.314764 (0.11420) [2.75407]	-0.007147 (0.11420) [-0.62658]	0.028385 (0.11420) [0.24822]																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																													

Figure 6.6: VECM Short Run Dynamics

Null Hypothesis:	Obs	F-Statistic	Prob.
LNEX does not Granger Cause LNEGR	39	4.01434	0.0272
LNEGR does not Granger Cause LNEX		0.56434	0.5740
LNFDI does not Granger Cause LNEGR	39	0.13394	0.8751
LNEGR does not Granger Cause LNFDI		0.14405	0.8664
LNINF does not Granger Cause LNEGR	39	3.42717	0.0441
LNEGR does not Granger Cause LNINF		1.04987	0.3611
LNIR does not Granger Cause LNEGR	39	0.82710	0.4459
LNEGR does not Granger Cause LNIR		0.27050	0.7646
LNPOP does not Granger Cause LNEGR	39	0.82045	0.4488
LNEGR does not Granger Cause LNPOP		6.38052	0.0044
LNTD does not Granger Cause LNEGR	39	4.02455	0.0270
LNEGR does not Granger Cause LNTD		0.55368	0.5799
LNFDI does not Granger Cause LNEX	39	0.27782	0.7591
LNEX does not Granger Cause LNFDI		0.58337	0.5635
LNINF does not Granger Cause LNEX	39	0.74570	0.4820
LNEX does not Granger Cause LNINF		0.33253	0.7194
LNIR does not Granger Cause LNEX	39	2.29732	0.1159

Figure 6.7: Pairwise Granger Causality Test Output

Var: UNTITLED

Workfile: LN GDP GROWTH (1)::Untitled\

View

Proc

Object

Print

Name

Freeze

Estimate

Forecast

Stats

Impulse

Resids

VEC Residual Serial Correlation LM Tests

Date: 03/11/23 Time: 23:18

Sample: 1980 2020

Included observations: 38

Null hypothesis: No serial correlation at lag h

Lag	LRE* stat	df	Prob.	Rao F-stat	df	Prob.
1	51.93868	49	0.3601	1.048271	(49, 50.1)	0.4340
2	60.86630	49	0.1190	1.315300	(49, 50.1)	0.1686
3	33.59427	49	0.9543	0.591462	(49, 50.1)	0.9661

Null hypothesis: No serial correlation at lags 1 to h

Lag	LRE* stat	df	Prob.	Rao F-stat	df	Prob.
1	51.93868	49	0.3601	1.048271	(49, 50.1)	0.4340
2	113.2680	98	0.1388	0.901158	(98, 21.6)	0.6492
3	NA	147	NA	NA	(147, NA)	NA

*Edgeworth expansion corrected likelihood ratio statistic.

Figure 6.8: Serial Correlation Test Output