Czech University of Life Sciences Prague

Faculty of Economics and Management

Department of Economics

The impact of agriculture on economic development in Zambia

This dissertation is submitted for the degree of

Doctor of Philosophy (Sector Economics and Economics of Enterprise)

Autor: **Ing. Joseph Phiri**

Supervisor: **Prof. Ing. Mansoor Maitah, Ph.D. et Ph.D.**

DEDICATION

This thesis is dedicated to my family.

DECLARATION

I, hereby declare that all this information in this dissertation has been obtained and presented in accordance with academic rules and ethical conduct. I, also declare that this is my own original work, and I have fully cited and referenced all material and results that were obtained from external sources.

Name, Surname: Joseph Phiri

Signature:

Prague, 2022.

ACKNOWLEDGEMENTS

I would like to express my gratitude and appreciation to my supervisor, Professor Mansoor Maitah, for his guidance, inspiration, and support throughout my Ph.D. studies and thesis. I would also like to thank Dr. Karel Malec, and Dr. Pavel Kotyza for their moral support and advise throughout my Ph.D. studies at the university. I also, wish to appreciate my friend Aubrey Sakala, for assisting with my data collection process and Puruweti Siyakiya for the helpful suggestions on how to improve my work. Appreciation goes to the examination committee and the thesis defense panel for contributing their time and effort, which enabled the success of this Ph.D. dissertation, as well as the Department of Economics and the Rectorate's office for providing the necessary resources and material support for all my research works at the institution. Special appreciation goes to the Czech Republic Government, through the Ministry of Education, Youth, and Sport for providing me with a Ph.D. scholarship, which made it possible for me to pursue my higher Degree. Without this financial support, I would not have managed to complete my Ph.D. studies. Before anything else, I would like to thank my entire family, especially my mother Lubinda Alisinda, my late father Jonathan Afunika Phiri, my siblings, Namakau, Mercy, Charity, Chaonza, and Tisilile, with all their relations for being there for me and supporting me throughout my academic and professional journey. I would also like to acknowledge my best friend and fiancé Josephine for all her support and prayers through the stresses of this journey and thank everyone else who has been there for me during my academic and professional journey. The greatest thanks go to my God Jehovah, who is the author of my success story.

ABSTRACT

Zambia is amongst developing countries experiencing increasing poverty, falling productivity, and rising over reliance on unprocessed raw materials like copper, which are mostly impacted by global markets volatility, and has had an immense impact on the country's level of economic prosperity. To address this, the government has instituted policies that promote economic diversification, with agriculture as one of the most viable options, thanks to its ability to create employment, ensure food security, and contribute to gross domestic product (GDP), through value addition and increased output. Agriculture has contributed an average of twenty to forty percent to Zambia's GDP over the last fifty years. The main objective of this thesis was to look at the role of agriculture and its impact on GDP, by looking at factors impacting economic output through agriculture, and most importantly make policy recommendations on how it can serve as a catalyst for sustained economic development, and a pillar for upgrading the standards of living in the country. This dissertation analyzed using timeseries data spanning from 1983 to 2020. It assessed the impact of agriculture on GDP growth using the Autoregressive Distributed Lag (ARDL) Bounds test and predicted the impact of agriculture on GDP using the and ARDL Bounds Test and the Wald test. The Wald test is used as a supplementary method to predict agriculture causality towards changes in GDP growth, and additionally, a Kaplan survival auxiliary model is also used to indicate the factors impacting durability of agricultural exports (1996-2019). By way of impact in the short run and long run, a percentage increase in agriculture value addition impacted GDP growth by 0.698 and 0.90 percent increment respectively. The Wald test results indicate that agriculture causes an increase in GDP growth, while the ARDL Bounds test indicates convergence to long run equilibrium of the variables agricultural, forestry, and fisheries; manufacturing; services; and mineral rent against GDP growth at a speed of 97.4 percent. The benefits of the country's agriculture sector have been undermined by several challenges, poor rainfall and irrigation culminated from climate change which has impacted yield output in the last decade; low production output culminating from limited technologies, limited irrigations, including lack of innovation and capital; lack of market access (locally and globally) hampered by poor infrastructure and technology which has hampered the ability of farmers to reinvest and innovate, diseases, and limited institutional and stakeholder support, which has made it difficult for farmers to access inputs, and expand their businesses regionally, and globally. Against this backdrop, these challenges can be addressed and this thesis proposes a variety of policy recommendations, namely: providing resources that enable research and development and ensuring availability of a legal framework to protect property rights for farmers; developing infrastructure and promoting direct investment towards growing food-processing zones, including the promotion of exports through incentives, credit support and farming inputs support, and subsidies to help them access markets locally and globally; and developing irrigation techniques and promoting the use of solar and other renewable energy sources to ensure a continued supply of farm produce despite changing climate dynamics.

Keywords: Agriculture, Economic Growth, Gross Domestic Product, ARDL Bounds Tests, Wald Test, Zambia

ABSTRAKT

Zambie patří mezi rozvojové země, které zažívají rostoucí chudobu, klesající produktivitu a rostoucí závislost na nezpracovaných surovinách, jako je měď, které jsou nejvíce ovlivněny nestabilitou globálních trhů, což mělo obrovský dopad na úroveň ekonomické prosperity země. Vláda zavedla politiky, které podporují ekonomickou diverzifikaci, přičemž zemědělství je jednou z nejschůdnějších možností díky své schopnosti vytvářet pracovní místa, zajišťovat potravinovou bezpečnost a přispívat k hrubému domácímu produktu (HDP) prostřednictvím přidané hodnoty a zvýšeného výkonu. Zemědělství přispělo za posledních padesát let k HDP Zambie v průměru dvaceti až čtyřiceti procenty. Hlavním cílem této disertační práce bylo prozkoumat roli zemědělství a jeho dopad na HDP, a to prostřednictvím pohledu na faktory ovlivňující ekonomický výstup zemědělství, a především vytvořit doporučení pro hospodářskou politiku o tom, jak může zemědělství sloužit jako katalyzátor udržitelného hospodářského rozvoje, a pilíř pro zvyšování životní úrovně v zemi. Tato disertační práce analyzovala časové řady dat od roku 1983 do roku 2020. Práce odhaduje dopad zemědělství na růst HDP pomocí testu hranic autoregresivních distribuovaných zpoždění (ARDL Bounds test) a předpovídá dopad zemědělství na HDP pomocí testu hranic autoregresivních distribuovaných zpoždění a Waldova testu. Waldův test se používá jako doplňková metoda k predikci kauzality zemědělství vůči změnám v růstu HDP a navíc se také používá Kaplanův pomocný model přežití k označení faktorů ovlivňujících trvanlivost zemědělských exportů (1996-2019). Krátkodobě a dlouhodobě, procentuální nárůst přidané hodnoty zemědělství ovlivnil růst HDP o 0,698 a 0,90 procenta. Výsledky Waldova testu naznačují, že zemědělství způsobuje zvýšení růstu HDP, zatímco test hranic ARDL naznačuje konvergenci k dlouhodobé rovnováze proměnných zemědělství, lesnictví a rybolov; výrobní; služby; a nerostné renty vůči růstu HDP s rychlostí 97,4 procenta. Přínosy zemědělského sektoru v zemi byly podkopány několika problémy, špatné srážky a zavlažování vyvrcholily změnou klimatu, která v posledním desetiletí ovlivnila produkci; nízký výrobní výkon vycházející z omezených technologií, omezeného zavlažování, včetně nedostatku inovací a kapitálu; nedostatečný přístup na trh (lokálně i globálně), který brání špatná infrastruktura a technologie, které brání schopnosti zemědělců reinvestovat a inovovat, nemoci a omezená institucionální podpora a podpora zúčastněných stran, což ztěžuje zemědělcům přístup ke vstupům a rozšiřování jejich podniky regionálně i celosvětově. V této souvislosti lze tyto výzvy řešit a tato práce navrhuje řadu doporučení pro hospodářskou politiku: poskytování zdrojů umožňujících výzkum a vývoj a zajištění dostupnosti právního rámce na ochranu vlastnických práv pro zemědělce; rozvoj infrastruktury a podpora přímých investic do rostoucích potravinářských zón, včetně podpory vývozu prostřednictvím pobídek, úvěrové podpory a podpory zemědělských vstupů a dotací, které pomohou získat místní a globální trhy; a vývoj zavlažovacích technik a podpora využívání solárních a jiných obnovitelných zdrojů energie k zajištění nepřetržitých dodávek zemědělské produkce navzdory měnící se dynamice klimatu.

Klíčová slova: Zemědělství, Ekonomický růst, Hrubý Domácí Produkt, ARDL Bounds Tests, Wald Test, Zambie

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ABBREVIATIONS

ACMP: Agriculture Credit Management program

ADF: Augmented Dickey-fuller

AIDS: Acquired Immunodeficiency Syndrome

ARDL: Autoregressive Distributed Lag

ASEAN: Association of East Asian Countries

AU: African Union

CASP: Comprehensive Agriculture Support Program

CEA: Controlled Environment Agriculture

CGE: Computational General Equilibrium

COMESA: Common Market for Eastern and Southern Africa

CUSA: Credit Union and Savings Association of Zambia

ECM: Error Correction Model

EEWMP: Energy-Efficient Water Management Platform

EU: European Union

FAO: Food and Agriculture Organization

FRA: Food Reserve Agency

FISP: Farmer Input Support Program

FSP: Fertilizer Support Program

GDP: Gross Domestic Product

GHG: Green House Gases

GSP: Generalized Scheme Preference

HDI: Human Development Index

HIV: Human Immunodeficiency Virus

HS: Harmonized System

IMF: International Monetary Fund

IoT: Internet of Things

ISIC: International Standard Industrial Classification

LUS: Land Use System

LUSE: Lusaka Stock Exchange

MMD: Movement for Multiparty Democracy

NAMBOARD: National Agriculture Marketing Board

NAP: National Agriculture Policy

NDP: National Development Plan

OECD: Organization for Economic Cooperation and Development

OLS: Ordinary Least Squares

PF: Patriotic Front

OLS: Ordinary Least Squares

PF: Patriotic Front

PP: Phillips-Peron

PPH: Pollution Harven Hypothesis

PRISMA: Preferred Reporting Items for Systematic Reviews and Meta-Analysis

PTA: Preferential Trade Area

RTA: Regional Trade Agreements

SAARC: South Asian Association of Regional Corporation

SACU: Southern African Customs Union

SADC: Southern African Development Community

SAP: Structural Adjustment Programs

SSA: Sub-Saharan Africa

SSGRA: Second Synthetic Degree of Grey Relations Analysis

SWAMP: Smart Water Management Platform

UAV: Unmanded Ariel Vehicle

UN: United Nations

UNIP: United Nations Independence Party

UPND: United Party for National Development

USA: United States of America

USD: United States Dollar

VAR: Vector Autoregressive

VECM: Vector Error Correction Model

WHO: World Health Organization

WITS: World Integrated Trade Solutions

WSN: Wireless Sensor Network

WTO: World Trade Organization

ZDA: Zambia Development Agency

1. INTRODUCTION

1.1. BACKGROUND

Ending poverty, deescalating malnourishment, and improving living standards of people is amongst the biggest 21st century developmental challenges experienced in the Sub-Saharan African (SSA) region. Between the years 2014 and 2015, over 153 million people, constituting over 26 percent of the people over 25 years in the SSA region were affected by some form of food insecurity (FAO, 2018). Despite the rich endowment in natural resources, Zambia is amongst the countries experiencing the resources curse (also known as the paradox of plenty), which is a reality where rich resource endowment does not manifest into improved standards of living of the people but is instead the opposite of the expected reality, where the country is regarded amongst the poorest economies in the world (World Bank, 2022). Amongst the most pronounced challenges facing Zambia include but not limited low economic productivity, which culminates into lower income, poor living standards, and quality of life including undernourishment. The role of agriculture as one of the entry points and catalyst for sustained economic development was suggested by several noble scholars (Johnston and Mellor, 1961; Kuznets, 1961; Rostow and Rostow, 1990; Schultz, 1966). This has reaffirmed calls by developmental stakeholders to have agriculture as a driver for development in accordance with Zambia's Eighth National Development Plan (NDP), Africa Union (AU)'s agenda 2063, and the United Nations (UN) vision 2030, supported by the Sustainable Development Goals (SDGs), where agriculture plays a cardinal role. Agriculture makes an important contribution in ensuring food security, supporting GDP by being a pillar of economic diversification, and income and employment creation. This stresses the need to improve our agricultural sector as a key contributor to the nation's economic growth. Previous studies have indicated that agriculture can be a catalyst for accelerating economic growth (Awokuse and Xie, 2015; Enu, 2014; Mapfumo et al., 2012; Moussa, 2018; Odetola and Etumnu, 2013; Phiri et al., 2021b, 2020; Sertoğlu et al., 2017; Tahamipour and Mahmoudi, 2018; Tiffin and Irz, 2006). The agricultural sector is part of the global supply chain aiding other sectors (Luthra et al., 2018). However, agriculture can negatively be affected in the eventuality of labor migration from agriculture to the more productive non - agriculture sector (Gardner, 2005). The Zambian economy was previously depended on the mining sector, which was not properly managed and hugely affected by economic shocks such as declining copper prices occurred in the mid 1970's (Auty, 1991; Phiri et al., 2020). The eighth NDP has emphasized the need for a diversified economy, and the agricultural sector as a potential alternative major contributor to GDP growth (Ministry of Agriculture, 2022). With high levels of unemployment in many third world countries, Zambia included, the abundance of both arable and pastoral land in the country seeks to provide agriculture as an alternative to accelerating economic growth and improving the standards of living, thus the agricultural sector acts as a potential alternative major contributor to GDP growth (Mabhaudhi et al., 2016; Ministry of Agriculture, 2022; Phiri et al., 2020, 2021b). In line with eighth NDP running from 2021 to 2026, AU's agenda 2063 as well as the UN's vision 2030 plan dubbed as the SDGs, agriculture is expected to play an essential role in supporting of some of the SDGs, some of which include ending poverty (Goal 1), ending hunger (Goal 2), ensuring good health and wellbeing (Goal 3), clean water and sanitation (Goal 6), decent work and economic growth (Goal 8), reducing inequality (Goal 10), responsible consumption and production (Goal 12), climate action (Goal 13), life below water (Goal 14), and life on land (Goal 15) (United Nations, 2022). These SDGs can either affect or be affected by agriculture practices and have an impact on economic development, hence the need for farmers, consumers, governments, the international community, and all stakeholders to work together in seeing agriculture as a key determinant of Zambian sustained economic development over the medium and long-term as supported by the policy actions for Zambia, the AU, and UN that were indicated by the SDGs.

1.2. STATEMENT OF PROBLEMS

Zambia has over the years possessed abundance of Africa's fresh waters with over 40 percent of those water bodies belonging to SSA (Mabhaudhi et al., 2016). Despite this abundance, the agriculture sector still performs below its fullest potential and concerns on the levels of malnourishment and poverty exists with at least 63 percent of the citizens living below the poverty line (World Bank, 2022). Also, the country's agriculture contribution to GDP have deescalated over the decades (World Bank, 2022; Zambia Statistics Agency, 2022). Another limitation is that the country's agriculture products have not been able to compete on the international markets (Phiri et al., 2021b). The country also faces challenges including malnutrition, unemployment, underproductivity, declining contribution to GDP and negative effects from climatic change. Also, the Zambian economy has previously depended on the mining sector, which was not properly managed and hugely affected by economic shocks such as declining copper prices, which occurred in the mid-1970s till the present day. These challenges limiting the agriculture sector requires all stakeholders' involvement including the state as this dissertation will suggest. This re-emphasizes the need for a diversified economy, with the agricultural sector as a potential alternative major contributor to GDP growth. This is a basis for believing that a proper agriculture system and policies can help in deescalating unemployment, malnourishment, and climatic effects, but most importantly help towards contributing to sustained GDP growth. This dissertation seeks to serve as a basis for addressing the problems indicated in this problem statement and supported by the objective and research questions of this dissertation, which follows.

1.3. OBJECTIVE AND RESEARCH QUESTIONS

The main objective of this dissertation is to determine the role of agriculture and quantify its effect and importance in enabling sustainable economic development in Zambia. This objective is broken down into specifics, which be addressed by answering five fundamental questions namely:

1. What is contribution of agriculture and several sectors to Zambia's GDP and economic development?
2. What is the impact of agriculture on GDP and economic development in Zambia?
3. What are some challenges impacting the agriculture sector in Zambia?
4. How has Zambia's agricultural production been locally, and trade performance been on the global market?
5. What policy recommendations will help the country and the state put Zambia on the path of realizing sustained economic development, and help the nations towards the realization of the UN's vision 2030 and AU's Agenda 2063 for developing nations especially SSA economies?

1.4 RESEARCH HYPOTHESIS

This dissertation focusses on reaffirming that narrative that agriculture is essential for economics sustainability and prosperity of developing countries. This concepts were over the years developed and supported by proponents and school thoughts including but not limited to: Rostow's stages of development (Rostow , 1960; Rostow and Rostow, 1990); Johnston-Mellor Model (Johnston and Mellor, 1961); Schultz's Transformation of Traditional Agriculture (Schultz, 1966); Kuznets theory on the role of agriculture on development (Kuznets, 1961). This thesis ascertains to the relevance of agriculture for economic development and will be tested against the hypothesis below:

Null hypothesis: Agriculture is importance and significantly contributes to economic development and GDP growth in Zambia.

Alternative hypothesis: Agriculture is not importance and does not significantly contribute to economic development and GDP growth in Zambia.

These hypotheses and their impacts will be tested in both short and the long run and explained during the results and discussions section respectively. Note that the above theories Rostow's stages of development, Johnston-Mellor Model, Schultz's Transformation of Traditional Agriculture, and the Kuznets theory on the role of agriculture on development will be further development in section 3.1.

1.5 SIGNIFICANCE AND STRUCTURE OF PAPER

Although prior studies have looked at agriculture's performance, its impact, and factors affecting agriculture in Zambia across different districts, and some focused on the narrative of policy, to the author's best knowledge, there is no quantifiable study on the impact of agriculture on GDP at country level. The novelty of this study is that it measures the empirical effect of agriculture on economic development in Zambia at country level, and further Zambia's agricultural performance, contributions, including export performance over the years. It also makes recommendations on how agriculture can serve as a catalyst for economic sustainability as it moves to diversify the economy and serve as a long-term substitute for over reliance on mining, and a as solution to deescalate the effects of poverty and undernourishment in the country. The structure of this dissertation is divided as follows. The next section, chapter 2, gives the overview of the Zambian economy and agriculture in Zambia. This chapter covers indicators of economic development and Zambia's performance and comparison with other countries in that regard. It also covers macroeconomic indicators overtime, Zambia's agriculture, and agro-ecological demographics, the country's agricultural export performance and survival, agriculture policies under different governments, contributions of Foreign Direct Investment (FDI) to agriculture and other sectors of the economy, concludes with challenges facing agriculture in Zambia. Chapter 3 reviews literature and is sub-divided into the conceptual and theoretical framework on the importance of agriculture for development, and the overview of previous studies. Chapter 4 has, data and methodology, which looks at the variables of interests, definitions, and sources, as well as the empirical and econometric procedure. Chapter 5 provides the results and discussions sections. The last section, chapter 6 concludes and makes recommendations on how problems associated with agriculture can be addressed to enable agriculture serving as a catalyst for Zambia's sustained economic development.

2. OVERVIEW OF THE ZAMBIAN ECONOMY AND AGRICULTURE IN ZAMBIA

In this chapter of the dissertation, the focus will be on the overview of the Zambian economy and agriculture in Zambia, with specific reference to indicators of economic development, macroeconomic indicators; agro-ecological zones, and provinces, and food production; and agriculture policies, agriculture global market performance, agriculture policies under different regimes from independence to date, FDI pledges and contributions to all sectors of the Zambian economy, including challenges facing the agriculture sector.

2.1. INDICATORS OF ECONOMIC DEVELOPMENT

Economic theory suggests that welfare is increased through economic development (Cowen and Tabarrok, 2021; Mankiw, 2016; Stiglitz and Walsh, 2006; Todaro and Smith, 2015). Usually as the nation improves in development, development indicators improve in line with improvements in indicators such as GDP, poverty and inequality, education, health, and HDI. The following sections will explain these indicator's meanings and computations, as well as Zambia's current state on each of these indicators.

2.1.1. GDP

GDP is the most widely used measure of economic development and is regarded as the monetary value of total final goods and services produced in a country (Tadora and Smith, 2015). The goods and services included in the computation of GDP include but not limited to smart phones, clothing, food, cars, computers, steel, college education, health, and banking services. Normally, GDP is measured in local currency unit or internationally recognized reserve currency such the USD. This measurement can be quantified either in real or nominal GDP. Nominal GDP entails GDP computed by adding the sum of the products of individual components of the economy and their respective current prices in a given time normally a year. This measurement has limitations of not accounting for inflation, making it inferior to real GDP. Real GDP is computed by adding the product of output of various products multiplied by the prices of the product for a given base year. The current real GDP computed by the World Bank uses product prices for 2015 as the base year. This is also considered as GDP constant prices, with nominal GDP referred to as GDP current prices (World Bank, 2022). A related measure to real GDP is real GDP per capita, which is the ratio of real GDP and the population each year. According to the World Bank, Zambia's real GDP and real GDP per capita for the year 2019 were 2 408 986 649 USD and 1 348.738 USD respectively (World Bank, 2022). The percentage change in GDP overtime from one time to another (normally a year) is normally referred to as economic growth or GDP growth and is also an indicator of economic progress.

2.1.2. Poverty/Inequality

Development can also be measured using the levels of poverty as an indicator. Poverty is when a person, or persons are not able to afford the necessities of life, for example food, shelter, health, and sanitation (Todaro and Smith, 2015). The poverty measurement can be computed daily, measuring the minimum dollar requirement to purchase daily necessities such as food, water, sanitation, shelter. The World Bank considers someone extremely poor if they cannot afford the minimum daily threshold of accessing necessities with the dollar equivalent to purchase those necessities. According to the World Bank, a person is deemed poor if they can't afford necessities worth 3.20 USD a day, and 1.90 USD a day in severe cases (World Bank, 2022). The indicator of the poverty lines is computed using the purchasing power parity (PPP), for necessities across the world. According to this classifications 54.5 percent and 58.7 percent of Zambians lived below the poverty lines of 3.20 USD and 1.90 USD respectively in the 2015 (World Bank, 2022). Another indicator of poverty, inequality can also be measured through income distribution between the rich and the poor, with the gini coefficient as the most measure. The gini coefficient measures income gap dispersions with values ranging from 0 to 1, with 1 indicating perfect inequality, and 0 otherwise. The gini coefficient categories are less than 0.2 implying perfect income equality, 0.2-0.3 relative equality, 0.3-0.4 adequate equality, 0.4-0.5 big income gap, and over 0.5 representing severe income inequality (World Bank, 2022). Zambia's gini coefficient for the year 2015 was over 57.1 percent entailing a higher income gap (World Bank, 2022).

2.1.3. Education

Some economists have always noted a relationship between education and sustained economic development (Todaro and Smith, 2015). Literacy rate can be defined as the ability of people to read and write and is computed as the percentage of people from the total population with that ability (World Bank, 2022). As at the year 2018, Zambia's adult literacy rate was over 80 percent (World Bank, 2022). As of 2017, the country's expected, and mean years of schooling were 12.5 and 7 years respectively (UNDP, 2022). Countries with high levels of literacy and education are expected to have higher levels of innovation and development, for example South Korea and the USA, the first and second most innovative countries with expected years of schooling 16.5 and 16.3 years respectively as of 2019 and have respective GDP per capita of 31640.24 and 60836.77 USD, unlike Zambia's a developing country with low GDP per capita and low expected years of schooling of 1414.829 USD and 11.5 years respectively (World Bank, 2022).

2.1.4. Health

Health is deemed to have some relationship with the level of economic development and several measures are used to examine that. Nutrition is deemed as the measure of the percentage of people with insufficient or sufficient food levels. According to the world health organization (WHO), Zambia is regarded as one of the poorer economies with at least 53% of the population undernourished as at the year 2020 (WHO, 2022). This contrasts with other developed countries like the USA and South Korea that had less than 6 and 4 percent of the population respectively undernourished within the same year (WHO, 2022). Health can also be quantified by looking at computing the percentage of the population that accesses safe drinking water. In Zambia, this was 90 and 53 percent for urban and rural population respectively. This is an indication of inadequate health and development, contrary to developed countries like the USA and South Korea, which are deemed healthy and developed and in the same year had over 99 percent of their population accessing safe drinking water (WHO, 2022).

The level of health can be measured by computing the life expectancy at birth, which is the expected number of years a person is expected to live. Developed countries are expected to have a higher life expectancy than developing countries. For example, the USA's, a developed country, life expectancy of 78.9 years in 2020 was higher than Zambia's, a developing country, expectancy of 63.9 years during the same period (World Bank, 2022). However, most countries had higher life expectancies now than in the past, thanks to technology, medical advancements and globalization that had made it possible for medicines and foods to be traded across the world. Also, health as proxy for development can be measured using the infant mortality at birth per 1000 births. In this regard, there are expectations of an inverse relationship between development and the infant mortality rate (Todaro and Smith, 2015). For example, in 2019, developed countries like the USA and South Korea had infant mortality rates of 5.5 and 2.7 respectively, while Zambia, a developing country recorded an infant mortality rate of 42.9 per 1000 births (World Bank, 2022).

2.1.5. HDI

Some economists believed that development should be measured by checking the aggregate of the welfare of the economy and welfare of citizens, as this gives a clearer indication of the standards of living in an economy. This is so because some having a higher GDP growth did not always have favorable living standards, hence underpinning the need for a variety of alternative measurements to improve human welfare. Previously, welfare was measured by computing individual components of level of literacy, health, including national income. The UNDP had used the HDI as a reliable means of measuring welfare, since 1990 when it was computed by Pakistan economist Mahbub Ul Haq, The HDI is a composite statistic (Index) that measures key dimensions of human development. The HDI is measured on a scale of 0 to 1, with 0 indicating low levels of welfare and 1 otherwise. The HDI measure which consists of three indicators namely:

- A long and healthy life: Life expectancy at birth
- Education Index: Mean years of schooling and expected years of schooling
- A decent standard of living: GNI per capita (Purchasing Power Parity US$)

The components of the HDI are summarized in figure 2.1.

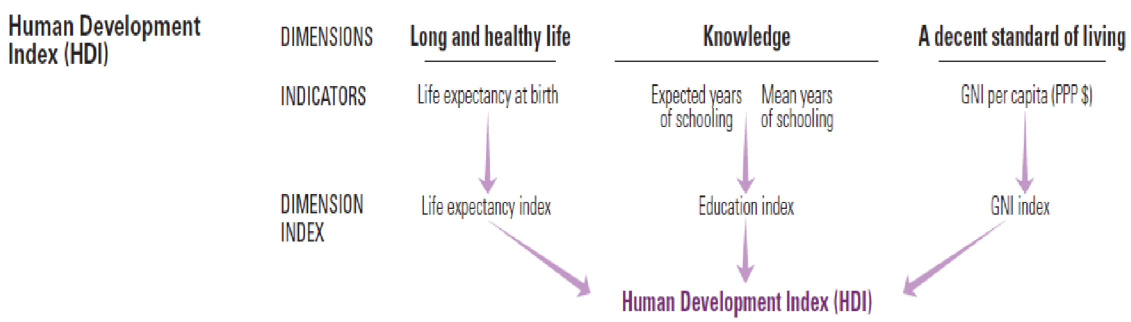

FIGURE 2.1: COMPONENTS OF HDI

Source: UNDP (2022)

Countries with higher HDI values are deemed developed, while developing and underdeveloped nations are expected to have lower HDI values. For example, in 2019, advanced economies like the USA and South Korea had HDI value of 0.926 and 0.916 respectively, while Zambia, a developing economy had an HDI value of 0.584 (UNDP, 2022). So far, this section has looked at several indicators of economic development, which may vary, though in most instances have similar results pertaining to developed as well as developing countries. The methodology will indicate why GDP growth serves as the standard measure of economic development pertaining to this dissertation. Meanwhile, the next sub-section looks at macroeconomic indicators and sectoral contributions to Zambia's GDP.

2.2. MACROECONOMIC INDICATORS AND CONTRIBUTIONS TO GDP

In recent years, the Zambian economy experienced real GDP growth, with rates of 3.40 and 3.79 percentages in 2017 and 2018 respectively (World Bank, 2022). The economy has over the years relied on copper mining, which has been impacted by volatilities in prices with its output having reduced by 4 percent in 2018 (African Development Bank, 2019). The economy also experienced fiscal deficit that was compounded by debt servicing, which culminated to escalations in capital investments and increasing the debt-GDP ratio of 25 and 61 percentages in 2012 and 2016 respectively. According to the World Bank, the percentage of the population that was living the poverty threshold was at least 57.5 percentage in 2015 (2022). Table 2.1 shows some of the country's macroeconomic indicators; GDP per capita constant 2015 USD, unemployment, and inflation for the years 2015, 2016, 2017 and 2018.

TABLE 2.1: MACROECONOMIC INDICATORS

Year	**2015**	**2016**	**2017**	**2018**
GDP per capita (USD)	1641.005	1652.284	1658.823	1672.345
Unemployment (%)	7.45	7.37	7.21	7.21
Inflation (CPI)	10.11	17.87	6.58	7.49

Source: World Bank, 2022

Average unemployment during the focus period was 7.31 percent. As indicated in Table 2.1, the inflation rates in 2015, 2016, 2017 and 2018 were 10.11, 17.87, 6.58, and 7.49 percentages respectively. Within the focus period indicated in the above table, 2016 had the highest inflation, which was 17.87 percent, and it can be attributed to a depreciated currency, increased electricity tariffs, and lower supply of food commodities. GDP per capita was 1641.005, 1652.282, 1658.823, and 1672.345 USD in 2015, 2016, 2017 and 2018 respectively. Different sectors have contributed differently to the country's GDP, with the major ones being agricultural, forestry, and fisheries value-added constant 2015 USD; manufacturing value-added constant 2015 USD; services value-added constant 2015 USD; and mineral rent as a percentage of GDP. Figure 2.2 indicates how the trend of mineral rent and other sectors as a percentage of GDP for the period 1983 to 2019.

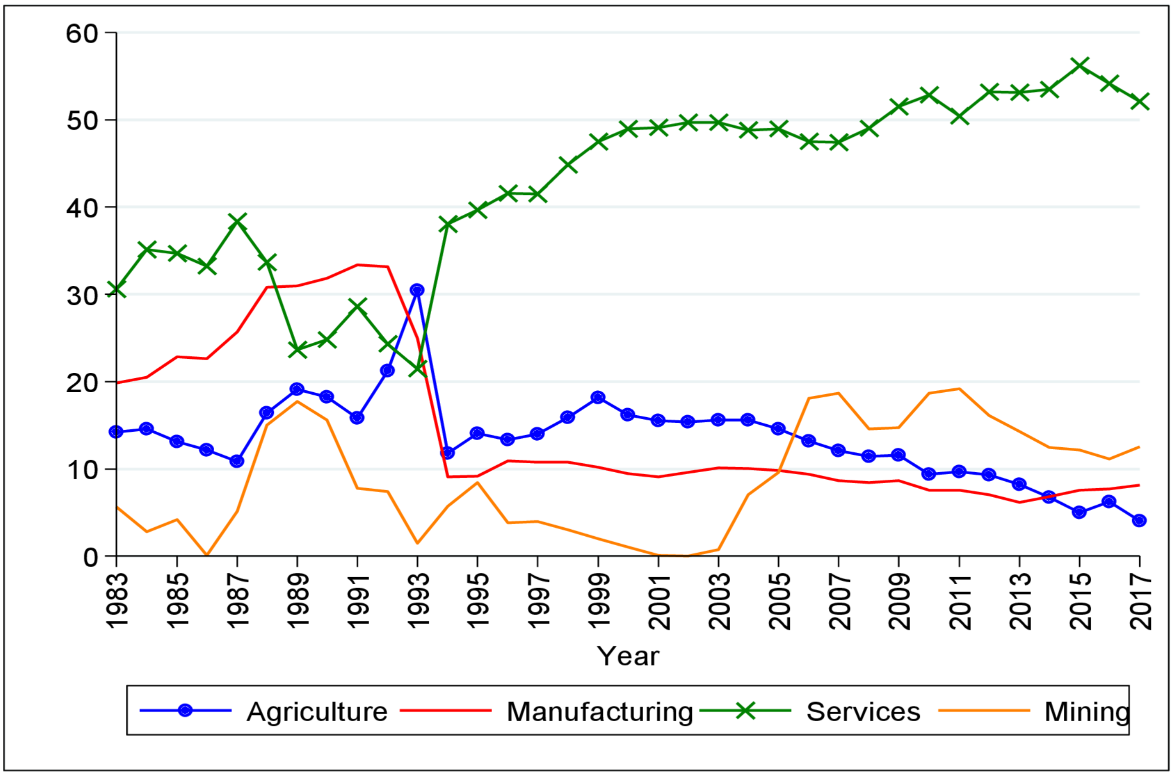

FIGURE 2.2: CONTRIBUTION TO GDP BY SECTORS IN TERMS OF VALUE ADDITION FROM 1983 TO 2017

Source: Phiri et al., 2020

During the focus period, as indicated in Figure 2.2, services had the highest contribution to Zambia's GDP, contributing over 40 percent, while other sectors namely agricultural, forestry, and fisheries value-added constant 2015 USD; manufacturing value-added constant 2015 USD; and mineral rent as a percentage of GDP all contributed averages of ten to thirty percent each, with agriculture playing a fundamental role having contributed well over 20 percent to the economy's total output over the focus period. The following sub-section shows Zambia's agro-ecological zones as well as the food types produced in the country.

2.3. ZAMBIA'S AGRO-ECOLOGICAL ZONES, PROVINCES, AND FOOD PRODUCTION

The estimated land size of Zambia is approximately 75 million hectares (752000 km^2). Zambia being a landlocked SSA country is surrounded by eight countries: Angola, Botswana, Congo DR, Malawi, Mozambique, Namibia, Tanzania, and Zimbabwe. Concerning climate, the country is sub-divided into three agro-ecological zones, Regions 1, 2, and 3 (see figure 2.3 for a map on the agro-ecological zones), which are covered by the country's 10 provinces. The 10 provinces are Central, Copperbelt, Eastern, Luapula, Lusaka, Muchinga, Northern, North- Western, Southern, and Western. Covering 12 percent of the total land area is region 1, which consists of Eastern, Southern, and parts of Western Provinces. Region 2 consists of Central, Eastern, Lusaka, and parts of Western Province, which accounts for 42 percent of the country's total land area. The largest of them is Region 3, accounting for 46 percent of the countries land area and consists of Copperbelt, Luapula, Muchinga, and Northern provinces. The country's rainfall varies across regions ranging from 800 to 1500mm per annum.

Region 1 experiences annual rainfall of around 800mm, while Region 2's rainfall ranges between 800-1200mm, with the highest rainfall experienced in region 3, which ranges between 1000-1500mm. Zambia's annual temperatures range between 7 to 37°C. The suitable crops for region 1 include beans, cassava, cotton, groundnuts, millet, potatoes, sesame, sorghum, and sweet potatoes. Crops grown in Region 2 include cashewnuts, cotton, groundnuts, maize, soybeans, sunflower, tobacco, and wheat. Region 2 is suitable for beef, diary, and poultry production, including the production of flowers, paprika, rice, and vegetables. Region 3, that is made of high-leached acid soils is ideal growing coffee, groundnuts, millet, rice, sugarcane, and pineapples. Most of the country is suitable for growing maize and groundnuts. Figures 2.3 and 2.4 show the Zambian map, indicating the location of provinces and the country's regional position; and Zambia's agro-ecological zones respectively.

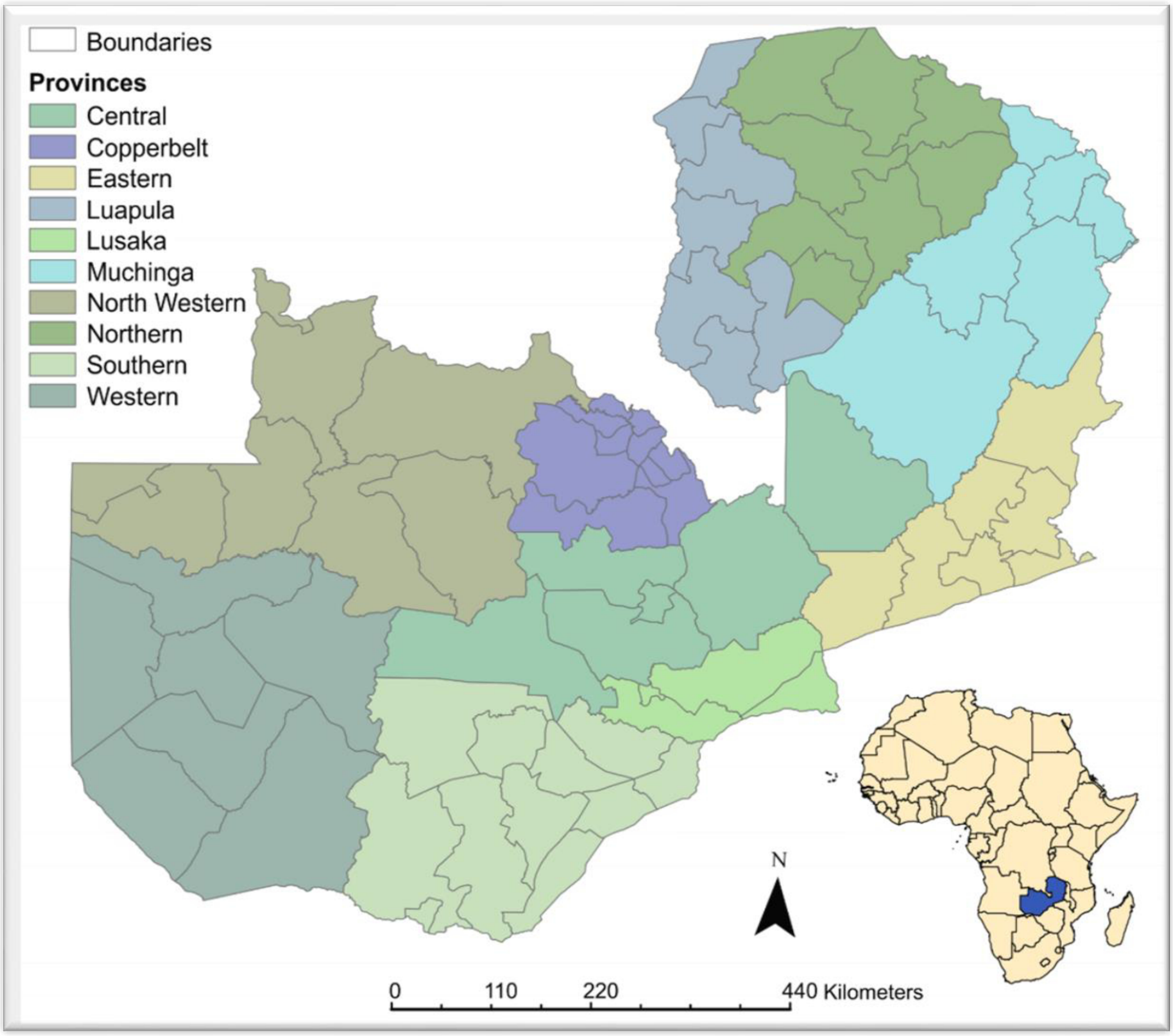

FIGURE 2.3: ZAMBIA'S MAP AND REGIONAL POSITION

Source: Phiri et al., 2021a

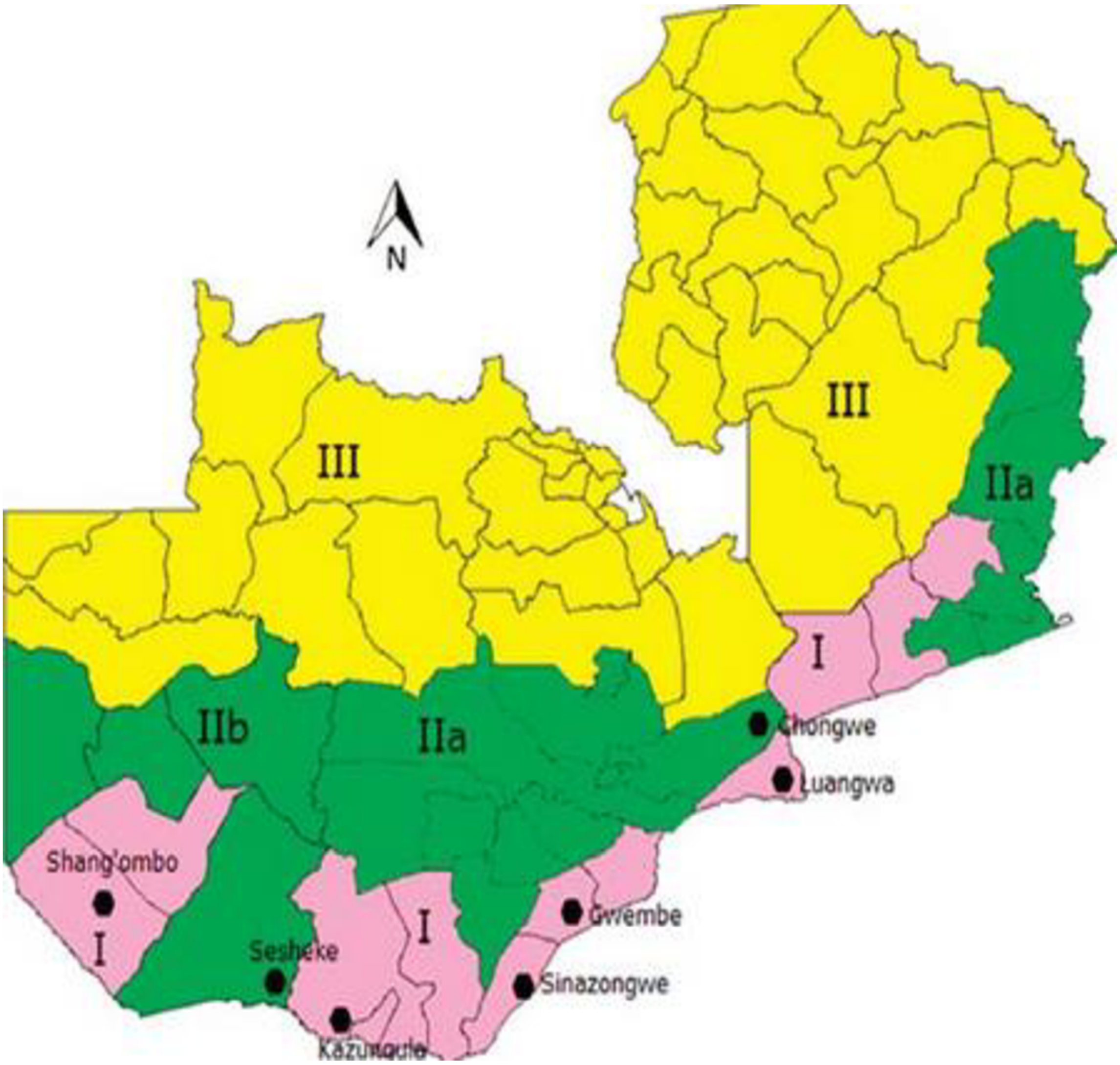

FIGURE 2.4: ZAMBIA'S REGIONAL AGRO-ECOLOGICAL DEMOGRAPHICS

Source: **Zambia Statistics Agency** (Agency, 2022)

Over the years, Zambia has produced a variety of agriculture products some of which include maize, sorghum, rice, millet, soybeans, sugar, groundnuts, tobacco, and cotton. Figure 2.5 shows maize production in Zambia between 1990 and 2015 as recorded by the Zambia Statistics Agency. As observed in figure 2.5, from 1990 to 2008, maize production has been relatively lower as compared to recent times. Overall, over the last two decades, production growth rate has been exhibiting slow growth, largely due to poor rainfall patterns. Zambia's total maize production in 1990, 1991, 1992, 1993, 1994, 1995, 1996, 1997, 1998, 1999, 2000, 2001, 2002, 2003, 2004, 2005, 2006, 2007, 2008, 2009, 2010, 2011, 2012, 2013, 2014, and 2015 were 1119670, 1095908, 483491.8, 1597767, 1020749, 737835.4, 1409585, 960188.5, 638134, 822056.6, 850466, 801888.6, 601605.9, 1157860, 1213202, 866187, 1424439, 1366158, 1211566, 1887010, 2795483, 3020380, 2938295, 2541961, 3250674, and 2916014 metric tonnes respectively. The increase in output in maize production can be attributed to rising population, which has led to increased economic activity, and hence a higher food demand leading to higher productivity using recent technologies. However, climatic change led to reduced rainfalls making the maize production stay below its fullest potential overtime. Figure 2.5 is indicated below.

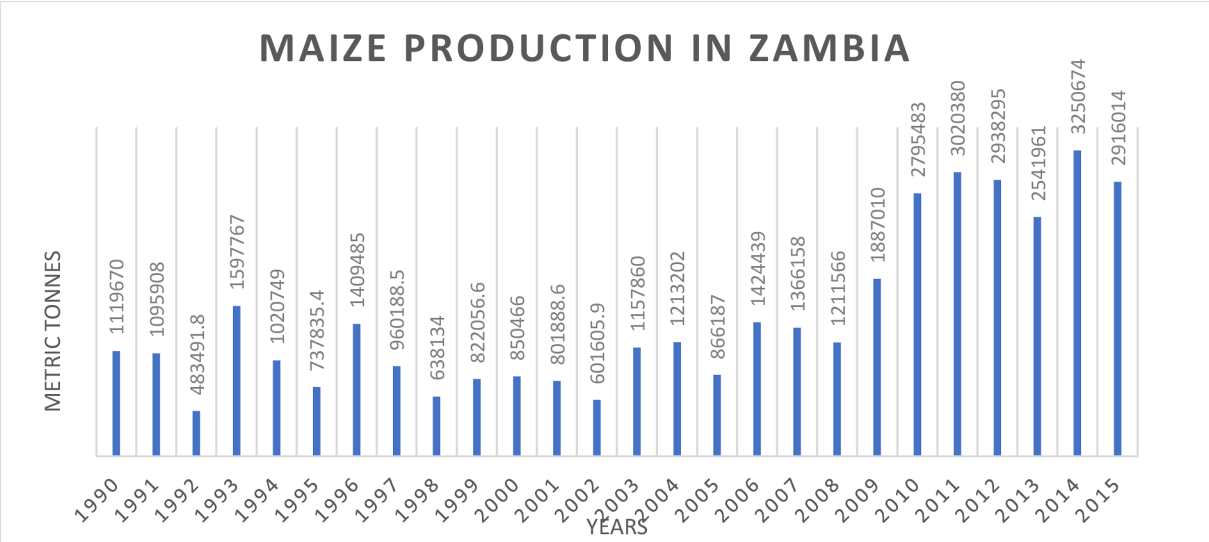

FIGURE 2.5: PRODUCTION OF MAIZE FROM 1990 TO 2015

Source: **Zambia Statistics Agency** (Agency, 2022)

Figure 2.6 indicates the production of the crop's sorghum, rice, millet, and soyabeans between 2000 and 2014.

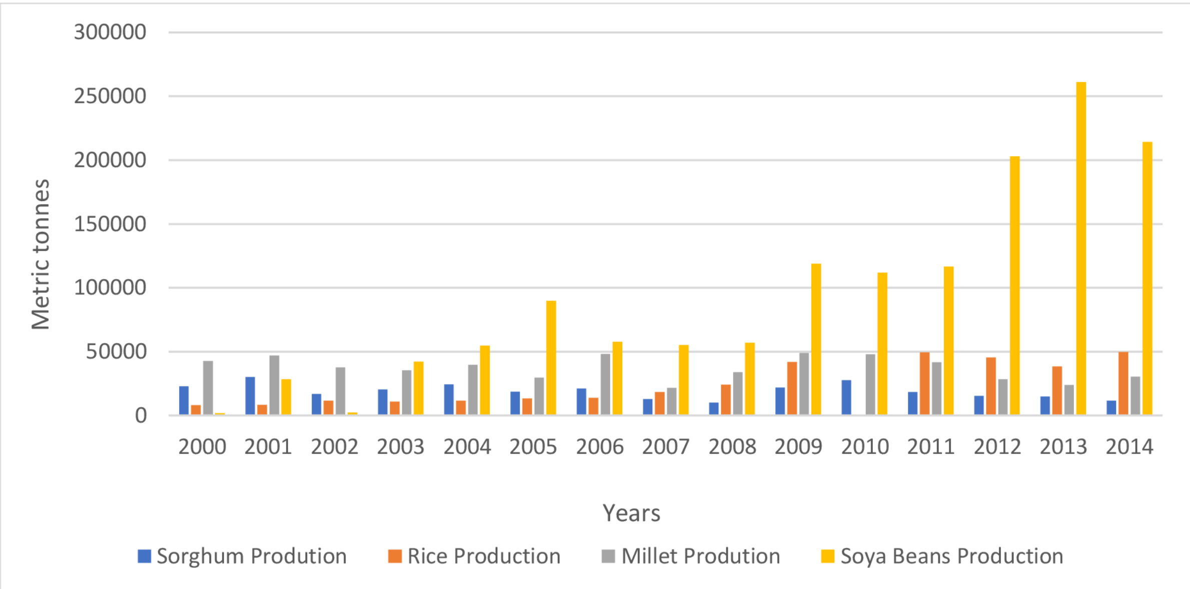

FIGURE 2.6: PRODUCTION OF SELECTED CROPS FROM 2000 TO 2014

Source: **Zambia Statistics Agency** (Agency, 2022)

As indicated in figure 2.6, soybeans have had the highest yield in recent times despite starting off on a poor note in the early 2000s. Millet production has been inconsistent, just like rice and sorghum production with observed trends. Much of the production over the focus period were below 50 000 metric tonnes, except soya beans between the years 2004 to 2014, which was more than at least 200 000 metric tonnes in 2012, 2013, and 2014. Figure 2.7 indicates the graphical illustration of the production of sugar, groundnuts, tobacco, and cotton from 2010 to 2015.

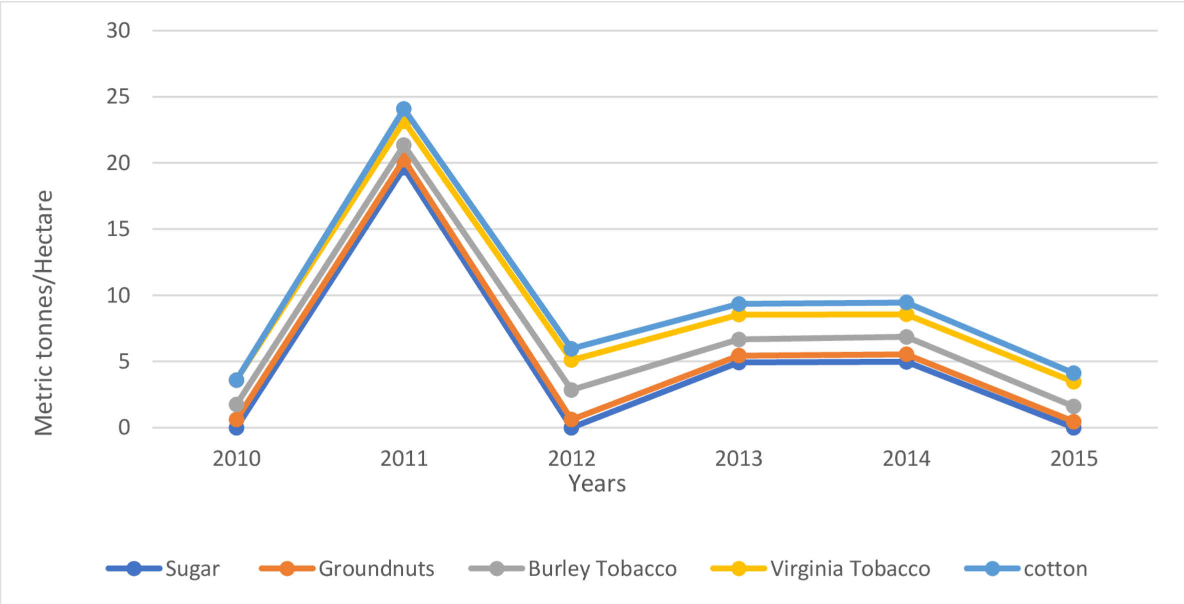

FIGURE 2.7: PRODUCTION OF SUGAR, GROUNDNUTS, COTTON, AND TOBACCO FROM 2010 TO 2015

Source**: Zambia Statistics Agency** (Agency, 2022)

From the above figure, all the crops under study were following an almost similar production growth pattern with cotton having the highest yield between 2010 and 2015. Cotton had the highest output, followed by Virginia tobacco, burley tobacco, groundnuts, and sugar with 2011 as their peak year, while 2000, 2012, and 2015 recorded lower output rates. The next sub-sections focus on Zambia's agricultural exports performance and survival. Factors that impacted maize production from 1990 to present, are like factors that impacted other agriculture products, including sorghum, rice, millet, soyabeans, sugar, groundnuts, cotton, and tobacco.

2.4. ZAMBIA'S AGRICULTURAL EXPORT PERFORMANCE AND SURVIVAL

The Zambian government has tried to promote exports through the Zambia Development Agency (ZDA), and among the major cash crops exported are maize, sugar, cotton, and tobacco (Phiri et al., 2021b). However, the exportation of the product is limited as there was not consistent duration of exporting agriculture products, with the average durability averaging at most two years (Phiri et al., 2021c). Briefly, export duration (also known as export survival) is the likelihood that a product will be exported to a specific destination non-stop for a certain period, usually months or years (Besedeš and Prusa, 2006; Bosco Sabuhoro et al., 2006; Brenton et al., 2010; Nitsch, 2009). It is important to improve export duration as it deepens existing trade relationships and enhances long-term export growth. The last half decade has seen trade research focused on the durability and survival of agriculture products (Asche et al., 2018; Fert\Ho and Szerb, 2018; Lee et al., 2020; Luo and Bano, 2020; Peterson et al., 2015; Phiri et al., 2021c; Wang et al., 2019; Yang et al., 2021; Zhang and Tveterås, 2019). However, focus will on the recent developments from the research on the "durability of Zambia's agricultural exports" (Phiri et al., 2021c). A study, just quoted in the last citation was conducted using annual data recorded by importer countries with data collected from the World Integrated Trade Solutions (WITS) and the period of analysis is from1996 to 2019 (For the full list of importer countries, see Appendix A). The data with 6 digits classifications Harmonized Systems (HS), was sugar 17, cotton 52, tobacco 24, and maize 1005. The average value for the four products was 1.8 million USD, while the mean of each; maize, sugar, cotton, and tobacco is 4273, 1745, 0.965, and 2319 million USD respectively. Detailed descriptive statistics of the exports of these four products are indicated in table 2.2.

TABLE 2.2: DESCRIPTIVE STATISTICS OF EXPORTS (MILLIONS USD)

Variable	Obs.	Mean	Std. Dev.	Min	Max
Total Agricultural Products	4,022	1.812	8.012	0	263.779
Maize	344	4.273	19.175	0	263.779
Sugar	636	1.745	4.541	0	39.857
Cotton	1,732	0.965	3.953	0	64.132
Tobacco	1,310	2.319	8.209	0	133.131

Source: Phiri et al., 2021c

The next two figures (figures 2.8 and 2.9) use the Kaplan Meier graphs to describe the duration of Zambia's agriculture exports (in years) over the focus period. In the two figures that follow, the vertical axis represents the observations, whose numbers exceed a certain period, while the horizontal axis plots the duration (or survival period) of the countries four major agricultural exports namely maize, sugar, cotton, and tobacco.

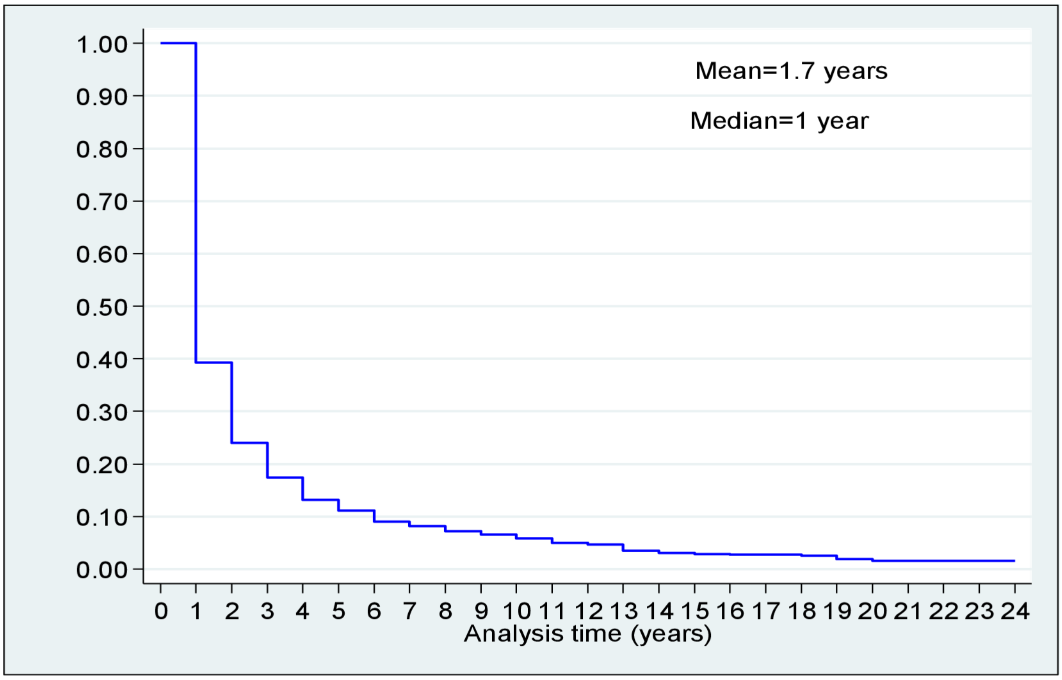

FIGURE 2.8: EXPORT DURATION OF TOTAL AGRICULTURAL PRODUCTS

Source: Phiri et al., 2021c

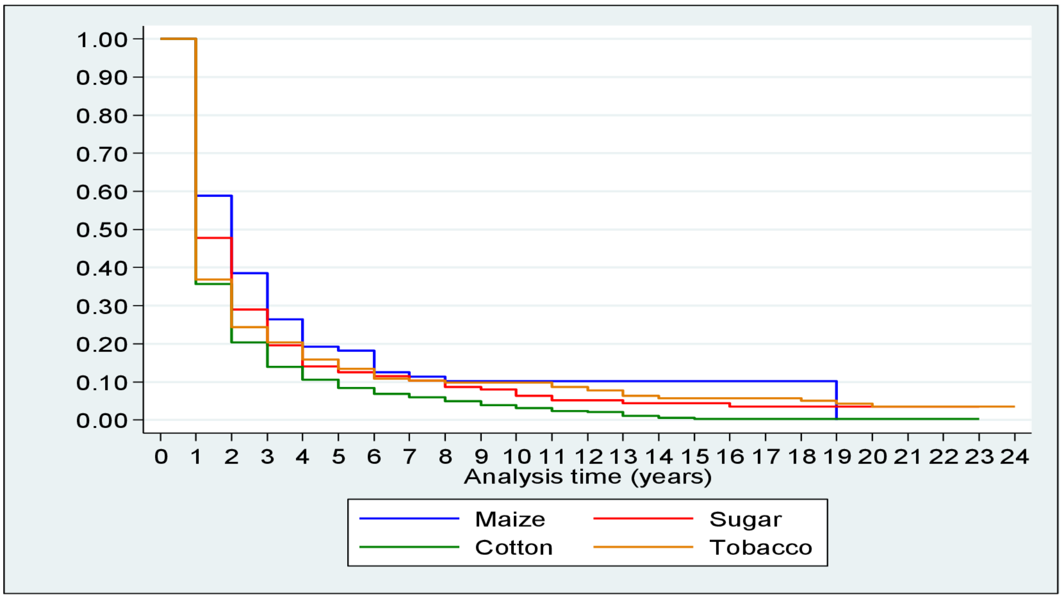

FIGURE 2.9: EXPORT DURATION OF AGRICULTURAL PRODUCTS BY CATEGORY

Source: Phiri et al., 2021c

As noted in figure 2.8, 39 percent of the countries' agricultural products exceed the first year of exportation. The second year, the time after the sixth year, and the final year of exportation constitute at least 24, 10, and 2 percent of export survival respectively. During this period, the respective mean and median years of survival were 1.7, and 1 years.

Figure 2.9 displays the durability of exports by products maize, sugar, cotton, and tobacco. Their first-year survival probabilities for each product were 59, 48, 37, and 36 percentage respectively. The figure also shows that maize dominated the survival likelihood amongst the four major products during the period 1996 to 2019. On other products, tobacco bypassed the duration of sugar exports after two years of trading and the trend remained so, with the least duration of the products been experienced on cotton exports. The median export duration of sugar, cotton, and tobacco were 2.5, 2.1, and 2.7 years respectively. For a complete table on how the Kaplan Meier survival tables are derived, see section with table 5.9 (and the part on Probit and Logistic model, table for results on factors empirically impacting the survival of Zambia's agricultural exports), and see appendix A for the list of countries were Zambia exported agricultural products of interest as indicated in figures 2.8 and 2.9 for the period between 1996 and 2019, and empirical measurements of factors impacting durability of the country's agriculture exports.

The following sub-section looks at the country's agriculture policies that were instituted by different administration from independence to date.

2.5 AGRICULTURAL POLICIES FROM INDEPENDENCE TO PRESENT

Zambia has implemented agricultural policies that provide public support and investment to create an enabling environment for private sector and smallholder interest in farm production, processing, and trade. The National Agricultural Policy (NAP) thrusts are liberalization, commercialization, the promotion of public-private partnerships and the provision of effective agricultural services to ensure long-term agricultural growth. Crop seed multiplication and distribution, conservation farming, promotion of "traditional" food crops such as cassava, sweet potatoes, sorghum, and millet, and research into high yielding drought/pest tolerant food crops such as sorghum, cassava, and sweet potatoes are among the programs that Zambia has been implementing to achieve sustainable food production and improve agricultural productivity, farmers' incomes and as a response to climatic change.

As far as government priorities are concerned, at least 60% of public spending towards agriculture is spent on maize, which is cultivated by 98% of smallholder households, and it has over 54% of agricultural land (Zambia Statistics Agency, 2022). According to the NAP under the purview of the Ministry of Agriculture, livestock contributed 7% to GDP, with 42% and 21% deemed suitable for landmass living and rangeland grazing, respectively (Ministry of Agriculture, 2022). Fisheries also contributed 70,000 metric tons, which constituted 3 of annual GDP (Zambia Statistics Agency, 2022). Zambeef Product Ltd, which is publicly listed on the Lusaka Stock Exchange (LUSE) and London Stock Exchange Alternative Investment Market (AIM), is a leading player in Zambian agribusiness. It also-products, generating over US$ 300 million in revenue across the region. In 2010, over 3,042,000 people, which constituted 65% of the labor force, were directly or indirectly employed by the agricultural sector (Ministry of Agriculture, 2022). Zambia is landlocked bordered by eight countries and has vast endowments like rivers, lakes, and underground water. These represent over 40% of Southern and Central Africa's water bodies, most of which a way for agriculture policy to serve as a catalyst for sustained economic development (Mabhaudhi et al., 2016).

NAP was established on behalf of the Republic of Zambia Government. It establishes policy guidelines for agricultural development. This policy was instituted because of extensive consultations between the Ministry of Agriculture and other agricultural stakeholders. It includes support for agricultural research and extension services, sustainable resource use, irrigation promotion, food and cash crop production, agro-processing, agricultural marketing and trade, livestock development and fisheries development. The policy also addresses the institutional and legislative framework, support for co-operatives and other farmer organizations, and cross-cutting issues such as gender mainstreaming, HIV and AIDS, and climate change mitigation. This was part of the previous fifth, sixth, seventh, and now eighth NDPs. The current national agricultural policy supports the current eighth NDP, which runs from 2021 to 2026. The government has long supported agricultural growth through the Food Reserve Agency (FRA), which was established in 1995. FRA assists domestic farmers by providing credit facilities, relevant farming information, and market access through the purchase of farm products such as maize. This is mandated to ensure national food security, as the state is the custodian of its citizens' well-being. Providing farmers with a market for their products provides them with a source of income.

Below is a summary of agricultural policies enacted over the years during various tenures of Zambian governments from independence to date.

2.5.1. UNIP Government (1964 to 1991)

Following independence, the ruling United Nations Independence Party (UNIP) stated unequivocally that most Zambians should be more actively involved in economic and social development than they had previously been. Cooperative organizations were seen as a clever way to increase Africans' participation in business, industry, and non-subsistence farming; groups of ten or more could apply to be registered as societies and thus receive government funding. President Kenneth Kaunda launched this revitalized post-independence movement in early 1965, urging the unemployed to put their diverse skills to use on envisioned agricultural and construction projects. Zambia implemented a standardized Structural Adjustment Program (SAP) in 1983. This represented a fundamental policy shift from previous attempts at economic reform and was implemented in part as a condition for receiving external financing from international financial institutions, particularly the International Monetary Fund (IMF) and the World Bank (Simutanyi, 1996). Policy reforms were required to implement the SAP. The major reforms implemented in the agricultural sector were price interference and subsidies. The government eliminated maize and fertilizer subsidies, as well as agricultural market liberalization. Not only that, but prices for consumer goods other than maize had risen. The state encouraged the formation of vegetable, egg, beef, milk, and road-building cooperatives in particular (Simutanyi, 1996).

Given the political clout of mine workers unions, which pushed for these in response to urban consumers' preference for maize meal, which was established under colonial-era policy, maize became the primary focus of food and agricultural subsidies beginning in the 1960s. Government support for maize included uniform input prices, uniform crop producer prices, and a price differential subsidy from 1960 to 1990 (Chizuni, n.d,1994). To purchase maize, local marketing stations were established in smallholder farmer areas. Maize subsidies averaged 70% of the retail price from 1967 to 1985. Because not all of Zambia is ecologically suited to maize cultivation, this policy created inefficiencies by biasing production toward maize rather than crops with a comparative advantage, resulting in increased food insecurity in the country. This policy also harmed farmers in areas that were unsuitable for maize cultivation. The establishment of commodity exchanges and other commercial services to reduce marketing risks was discouraged by uniform maize prices (Chizuni,1994).

In 1980, pricing policies aimed at encouraging commercial farm production gave way to policies aimed at smallholder farmer welfare and preventing excessive profits from large-scale commercial farming. In practice, while this policy approach benefited poorer farmers, it also discouraged the growth of medium-scale farmers. Furthermore, the requirement for approach consistency, as was frequently the case at the time, may have come with change costs and deliberate speculation. Zambia's agricultural policy system had extensive controls over the pricing, marketing, and financing of agricultural inputs and outputs from 1974 to 1991. Agriculture in Zambia grew rapidly in comparison to other economic activities during this period because the population was small, vigilant, and willing to work on land.

Agricultural input availability was well coordinated and distributed to genuine farmers across the country. Markets were run by rural cooperatives, and infrastructure was maintained by a functional Ministry of Works and Supply.

Given the political power of mine worker unions that lobbied for these in response to urban consumers' preference for maize meal, which developed under colonial-era policy, food and agricultural subsidies focused heavily on maize from the 1960s onward (Kean and Wood, 1992). Government support for maize included uniform input prices, uniform crop producer prices, and a price differential subsidy from 1960 to 1990 (Chizuni, 1994). Local marketing stations for maize were established in smallholder farmer areas (Jayne et al., 2010).

Maize subsidies averaged 70% of the retail price from 1967 to 1985 (Kean and Wood, 1992). Because not all of Zambia is ecologically suited to maize cultivation, this policy created inefficiencies by biasing production toward maize rather than crops for which there may be a comparative advantage, resulting in increased food insecurity in the country. This policy also disadvantaged farmers who lived in areas unsuitable for maize cultivation. Uniform maize prices stifled the private sector's efforts to establish commodity exchanges and other commercial services to reduce marketing risks (Kean and Wood, 1992) . Subsidies and price controls were significant government expenditures that contributed to Zambia's ongoing debt problems (Jansen and Rukovo, 1992).

In the 1970s and 1980s, donors helped to expand Zambia's research system, particularly the Soils and Crops Research Branch of the Ministry of Agriculture, Food, and Fisheries. From the mid-1970s to the early 1990s, several crop varieties with higher yields were introduced (Elliott et al., 2006; Jayne et al., 2010). Pricing policies aimed at encouraging commercial farm production shifted sharply in 1980 to policies aimed at promoting smallholder farmer welfare and preventing excessive profits from large-scale commercial farming. In practice, while this policy approach may have benefited poorer farmers, it also tended to discourage the expansion of medium-scale farming. Furthermore, the lack of policy consistency, which was common during this period, may have resulted in adjustment costs and discouraged investment(Kean and Wood, 1992).

In the mid-1980s, issues with the maize marketing and support system surfaced. Marketing board costs were rising, while the high costs of fertilizer support subsidies exacerbated macroeconomic issues, particularly hyperinflation (Jayne et al., 2010) . To reduce government deficits, reforms aimed at reducing maize input subsidies and government involvement in marketing began in 1990. In Zambia, these reforms were not politically supported because they contradicted the government's goal of supporting smallholder farmers through crop production subsidies. Although maize input subsidies were reduced, they were not eliminated(Jayne et al., 2010).

2.5.2. MMD Government (1991 to 2001)

Previous agricultural policies were restrictive and heavily regulated by the government. The adopted strategies were also heavily reliant on subsidies, rendering them unsustainable. The industry was underdeveloped and dominated by crop maize in the early 1990s. In 1992, the government began reforming agricultural policy as part of the overall economic reforms pursued under the SAP. The reforms' main policy thrusts were agricultural sector liberalization and promotion of private sector participation in production, marketing, input supply, processing, and credit provision (Antony, 1991).

Within the agricultural sector, structural adjustment entailed the removal of subsidies on fertilizers and other inputs, the decontrol of commodity prices, including maize, and the opening of marketing to attract competing marketing organizations. As a result of liberalization, the government began to privatize all agricultural parastatal companies, allowing new private-sector marketing agencies to enter the market. These changes resulted in the demise of National Agriculture Marketing Board (NAMBOARD), the liquidation of LIMA Bank and the demise of Credit Union and Savings Association of Zambia (CUSA Zambia) and the Zambia Cooperative Finance Services, which were in charge of providing agricultural credit to small-scale farmers (Kajoba, 2022).

The Zambian government that took power in 1991, under the party Movement for Multiparty Democracy (MMD) faced the challenge of liberalizing the economy while also preventing further increases in poverty and consolidating its hold on power. Part of its response was the establishment of the Agricultural Credit Management Program (ACMP) in 1994. This could be viewed as a mechanism for; (a) promoting a network of private traders capable of taking over the business of financing and delivering inputs to small-scale farmers from the government; (b) improving food security during a period of rapid economic development; and (c) retaining political support for the government (Copestake, 1998).In response to the droughts of 1991-1992, the ACMP was established as an ad hoc and temporary policy to serve as an alternate conduit in the short term while enhancing private traders' ability to serve as financial intermediaries.

Dr. Fredrick Chiluba's MMD government also created the conditions for a significant shift in how people understood land in terms of land tenure. As a result, the MMD government enacted, and parliament approved the 1995 Lands Act. During this time, the Food Reserve Agency (FRA) was established in 1996 as a semi-autonomous corporate body charged with managing the National Food Security Reserve, though its impact is limited due to insufficient financial resources (Nolte, 2014).

Overall poverty declined significantly, but overall rural poverty remained high, at 92% in 1993 and 74% in 2003, with a slight increase from 1996 to 1998. GDP per capita remained low throughout the 1990s before rising in the early 2000s to USD 1,018 in 2003 (Jayne et al., 2010; World Bank 2019). The Lands Act of 1995 was enacted in response to donor requests to further privatize and liberalize the land market to stimulate investment and agricultural productivity. In practice, the legislation has increased the advantage and benefits of the elites by providing investors, local governments, and government officials with leverage while excluding local land users (Nolte, 2014) .

According to the NAP 2012-2030, only 3% of the country's 1.5 million smallholder farmers had title deeds as of 2011, which discourages long-term land management approaches and prevents access to loans for which land can be used as collateral (Ministry of Agriculture, 2022). The transition to title deeds appears to be primarily used by urban income earners seeking investment, and it has not been available to smallholder farmers seeking legal security for their land (Sitko and Jayne, 2014). The government returned to marketing boards in 1996 with the establishment of the FRA, which was initially intended to hold a strategic reserve of grain to limit price volatility (Tembo et al., 2010). The FRA's mandate had expanded by the early 2000s, and the agency began to distribute fertilizers and set price floors in the maize market by acting as a buyer of last resort. The FRA has not always been successful in maintaining stable prices, due in part to the difficult logistics of storing large amounts of grain and a lack of agricultural market analysis (Tembo et al., 2010). In 2002, the Fertilizer Support Program took over the role of providing subsidized fertilizer to smallholder farmers (World Bank, 2021).

2.5.3. MMD Government continued (2001 to 2011)

When President Levy Patrick Mwanawasa was elected on an MMD ticket in 2001, he referred to his administration as a New Deal. To achieve economic growth, the government has continued to promote private-sector-led development. However, as part of the New Deal, the government took deliberate steps to rebuild the resilience of small-scale farmers who had been subjected to both policy (SAPs) and environmental shocks (droughts and floods) in the previous ten years (Kajoba, 2010). To reduce poverty, increase food output, and ensure national and household food security, the government encouraged small-scale agricultural producers and livestock restocking. To accomplish this, the government implemented two programs. First, in 2002, a portion of the fertilizer subsidy was reinstated as the Fertilizer Support Program (FSP), which was designed to assist small-scale farmers who were struggling financially because of environmental shocks such as the droughts of 2000-2001. Second, the government unveiled a package aimed at vulnerable but profitable small-scale farmers. If maize was old, the government reinstated a floor price through FRA, which acted as buyer of last resort. The NAP was approved in 2004 by President Mwanawasa and was supposed to last from 2004 to 2015.

Until 2015, the policy aimed to create a favorable environment for agricultural growth. The NAP's main thrusts are increased production, sector liberalization, commercialization, promotion of public-private partnerships, and provision of effective services to ensure sustainable agricultural growth. In doing so, the government will not normally intervene in input distribution or crop marketing in a way that undermines or undercuts private sector participation, particularly if the private sector has the willingness or capacity to do so (Antony, , 2006). The policy addresses all aspects of agriculture, including food and cash crop production, inputs, agro-processing, agricultural marketing, including exports, sustainable resource use, livestock and fisheries development, irrigation, agricultural research and extension services, institutional and legislative arrangements, co-operatives and farmer organizations, biodiversity, emergency preparedness, and cross-cutting issues such as HIV/AIDS, gender, and the environment.

The Agriculture Policy's main goal is to encourage and support the growth of a competitive, sustainable, and national and household food security that maximizes the sector's contribution to the GDP. Rural infrastructure funding has been limited because the majority of government agriculture spending has gone to fertilizer subsidies and the FRA (Govereh et al., 2006). By 2005, the government had re-established itself as a major player in the maize market. Because of the high level of government spending on grain purchases and subsidized fertilizer, a smaller portion of the public budget was spent on rural infrastructure and agricultural research. Government spending on inputs and marketing has not always been beneficial to farmers and consumers. Farmers received most inputs late, which had a costly impact on yields, and marketing boards were not always able to keep foods affordable to consumers (World Bank, 2021; Tembo et al., 2010).

Zambia faced a dark cloud in 2008 when its then-president, Levy Patrick Mwanawasa, died of illness on August 19. As a result, Mr. Rupia Banda was appointed as his successor. The Farmer Input Subsidy Program (FISP) was established in 2009/10 by Banda's government to replace the FSP, that previously existed (World Bank, 2021). The FISP aimed to improve small-scale farmers' food security, increase agricultural output, expand small-scale farmers' access to seed, and encourage private sector involvement in input supply. By 2013, the FISP was providing 51% of fertilizer in the country, up from 19.2% supplied by the FSP in 2002 (Zinnbauer et al., 2018). However, it was noted that the FISP did not achieve its goal of improving the livelihoods of small-scale farmers in some parts of the country. From 2008 to 2014, research spending increased due to a large World Bank loan under the Agricultural Productivity Program for Southern Africa, a program aimed at technological dissemination in the Southern African Development Community (SADC), a regional economic community comprised of 15 countries, including Zambia(World Bank 2019) .

Smallholder farmers in Zambia have historically had limited access to finance. Private credit institutions and smallholder farmers faced obstacles such as the high cost of reaching remote farmers, the high risk of agricultural loans, and low borrower knowledge about credit, which hampered any attempts to resolve these access issues. In 2010, the Zambia National Commercial Bank and the Zambia National Farmers Union jointly launched a scheme to provide seasonal credit for maize to groups of smallholder farmers. The Ministry of Finance and National Planning was working on a plan for a sustainable rural credit institution in 2011. To facilitate and coordinate rural financial services, the government issued the Rural Finance Policy and Strategy in 2012. The policy provides rural finance through a market-based approach (Ministry of Agriculture, 2022).

2.5.4. PF Government (2011-2014)

In 2011, a new government, the Patriotic Party (PF) government assumed office, then under the leadership of the late President, Michael Chilufya Sata. To facilitate and coordinate rural financial services, the government issued the Rural Finance Policy and Strategy in 2012. The policy provides rural finance through a market-based approach (Kasoma & Zulu, 2011) . The Zambia NAP (2012-2030) was also launched during the time (Ministry of Agriculture, 2022). This is a cross-cutting policy with the vision of developing a competitive and diverse agricultural sector through: promoting sustainable increases in agricultural productivity of major crops with comparative advantage; and (ii) continuously improving agricultural input and product markets to reduce marketing costs and increase agribusiness profitability and competitiveness. (iii) Increasing agricultural exports to fully utilize preferential markets (regional and international) and contribute to foreign exchange earnings; (iv) Improving access to productive resources and services for small scale farmers, particularly women and young farmers; and (v) Constantly strengthening public and private sector institutional capabilities to improve agricultural policy implementation, resource mobilization, agriculture research, and technology transfer.

The policy aims to increase the productivity and sustainability of agriculture, forestry, and fisheries. Sustainable productivity increases will be achieved by promoting environmentally friendly farming systems such as conservation farming, afforestation, and the use of green manure and lime; encouraging farmers to use relatively cheaper sources of soil nutrients such as fertilizer blends, inorganic fertilizers, and liquid fertilizers as a way of lowering production costs and encouraging optimal fertilizer application; enhancing small-scale farmers' capacity on appropriate crop husbandry practices to reduce costs, increase production, and reduce post-harvest losses; enhancing farmer organizations' capacity, including cooperatives to provide appropriate agricultural services to their members, such as pooling produce to generate adequate volumes needed by processors and exporters; working with the Ministry of Lands to increase the number of farmers with title deeds as an incentive for them to adopt sustainable land management practices and increase collateral value to enable them to access credit; and promoting the efficient use of available water resources for irrigation in arable land. promoting the expansion of production of oil seed crops (soybeans, sunflowers, and groundnuts) in rotation with food grains to reduce fertilizer costs while increasing farm yield, income, and consumption of protein-rich food crops; and encouraging the production of fruits and vegetables as a means of encouraging balanced diet consumption, increasing income, and diversifying income sources.

The efficiency of agricultural and food systems will be improved through infrastructure upgrades, such as rural roads to reduce the cost of providing agricultural services and rural storage to reduce post-harvest losses; strengthening farmer groups' capacity to provide efficient services; and enhancing market information systems; promoting agro-processing and value addition for major food and industrial crops with consistent surpluses; encouraging decentralized production and marketing of alternative soil nutrient sources such as fertilizer blends, liquid fertilizer, and inorganic fertilizer; and increasing agricultural exports. In terms of governance, the Zambian government recognizes the various agriculture stakeholders' roles and will work to establish strong partnerships with agribusiness, civil society organizations, and development partners. The Agricultural Sector Advisory Group, comprised of all key stakeholders in the agricultural sector, will provide overall coordination and oversight of the revised NAP 2012-2030 implementation.

2.5.5. PF Government continued (2014-2021)

Previous governments implemented policies and programs aimed at improving small-scale farmers' access to agricultural inputs and fostering the expansion of the agricultural sector. However, in the 2015/16 season, the Ministry of Agriculture abandoned the traditional FISP in favor of an Electronic Voucher system, which expanded the target inputs farmers were permitted to purchase beyond maize inputs alone (Sitko et al., 2012).

The NAP (2004-2015) was created to guide the agricultural sector's development. As the period 2004-2015 came to an end, it became critical to develop a second NAP to guide the agriculture sector in the coming years. The NAP 2004-2015 had to be reviewed in order to arrive at this policy, with special attention paid to the concerns raised by various stakeholders regarding the failure to increase rural incomes and reduce poverty, the failure to achieve inclusive growth, the perpetual agricultural financing and marketing challenges, and climate change associated with erratic rainfall patterns, as well as the change of Government, which necessitated new policy guidelines that are in line with the Government (FAO, 2022).

The second NAP was established in 2016 and was scheduled to last until 2020. The second NAP's launch aims to address the challenges encountered during the first NAP's implementation. It also establishes ten objectives to improve the state of agriculture in Zambia, with the government acting as a facilitator of a private-led agriculture sector. The founders are also focused on ensuring profitability and competitiveness, as well as promoting agriculture as a business. The principles also emphasize the importance of cooperatives as a vehicle for sector growth. Its first goal is to increase agricultural production and productivity by promoting improved seed, efficient fertilizer and agrochemical use, efficient water resource use, and mechanization. The second objective was to promote agricultural research and development.

The emphasis is on promoting alternative sources of research funding. There is also an emphasis on building institutional and human capacity to conduct appropriate research. The third goal aims at using different strategies which include the establishment and rehabilitation of existing infrastructure. Staffing levels, training equipment, and training materials have all been targeted for improvement curricula have also been targeted for improvement to adapt to the needs of the sector and ensure the inclusion of climate change, agricultural extension, and food nutrition components.

The fourth goal is to encourage private sector participation in agricultural markets for inputs and outputs. There is also a focus on promoting access to agricultural market information, which is critical in assisting small-scale farmers in making important decisions.

Under this goal, new fisheries marketing systems, as well as crops and livestock, have been targeted for promotion. Finally, there is a focus on the development and upkeep of appropriate agricultural marketing infrastructure to ensure that it is more climate resilient. The fifth goal focuses on the provision of credit and insurance in the agricultural sector. The goal is to promote broad-based small-holder credit and financial delivery systems by establishing Savings & Credit Cooperatives and engaging in farmer training on the use of village/rural banking services.

Furthermore, the establishment of a warehouse licensing authority has been aimed at promoting a warehouse receipt system. Finally, agricultural insurance has been designated for promotion due to its importance in agricultural production. The sixth objective, on the other hand, is to strengthen the legal and regulatory framework that guides the agriculture sector, as well as to strengthen agricultural information management systems and dissemination among all stakeholders in the sector. This goal will also promote the development of agricultural farm blocks. The seventh goal is to improve food and nutrition security through the promotion and diversification of agricultural production and utilization. This will be accomplished through training in food processing and preservation, as well as increased access to bio-fortified seed or vines to produce nutrient-enhanced varieties. On-farm agro processing, value addition, nutrient-rich food preservation, and utilization will also be encouraged.

The eighth goal is to ensure that natural resources are used and managed in a sustainable manner throughout the agricultural sector. This will include promoting sustainable fishing methods as well as appropriate technologies for the long-term use of fisheries resources. This will also include promoting sustainable land management technologies such as conservation agriculture and appropriate fish stock densities. Forestry will also be addressed through afforestation promotion.

The use of renewable energy resources will be encouraged by encouraging energy-efficient agricultural production and processing technologies. The ninth goal is to mainstream environmental and climate change issues in agriculture. This will entail fortifying camps/districts/provinces to collect, process, and transmit early warning information. Efforts will also be made to promote and strengthen climate-resilient agricultural production methods, as well as raise awareness about climate change adaptation. Finally, adaptation measures to climate change will be incorporated into all plans and programs. The tenth and final goal is to mainstream cross-cutting issues such as gender, HIV/AIDS, and governance issues. Gender mainstreaming training, knowledge, and skills in agriculture are among the strategies promoted. Other strategies include facilitating gender mainstreaming in agriculture with other stakeholders and strengthening gender integration at all levels of agricultural development in accordance with national, regional, and international agreements.

Furthermore, the strategies will emphasize strengthening HIV and AIDS prevention activities among agricultural stakeholders and promoting agricultural technologies that reduce the impact of HIV and AIDS. Finally, good governance, transparency, and accountability in the agriculture sector will be prioritized.

The Second NAP's objectives cover a broad range of key areas critical to realizing Zambia's agricultural sector's potential. Capacity building, access to markets and finance, and sustainable production processes are among the issues identified. These areas are consistent with Zambia's medium to long-term goals, as stated in the seventh NDP (2017-2021). The seventh NDP aimed to increase income and create decent jobs through climate smart and organic agriculture, sustainable forestry, sustainable construction, and small-scale mining.

However, the second NAP has flaws as well. Because the policy was developed collaboratively by the Ministries of Fisheries and Livestock and Agriculture, specific interventions in the second NAP indicate that the crop subsector outnumbers the fisheries subsector. In 2015, the new Ministry of Fisheries and Livestock was established with the goal of improving the status of both capture fisheries and aquaculture (Ministry of Fisheries and Livestock, 2022).

The concept of aquaculture is relatively new, and the subsector is still in its infancy; however, Zambia has long been involved in crop farming and livestock production and has extensive experience in both sub-sectors. As a result, the fisheries subsector requires a stand-alone policy to address challenges and develop strategies to maximize opportunities (Ministry of Fisheries and Livestock, 2022).

2.5.6. UPND Government (2021- present)

In August 2021, the United Party for National Development (UPND), under incumbent President Hakainde Hichilema assumed office, and continued the progress of predecessor governments. To increase agricultural productivity, the government aimed to improve extension service delivery and thus replaced FISP with the Comprehensive Agriculture Support Program (CASP). This is because FISP focused on inputs and production while excluding extension services, this was done. CASP will investigate the need for agricultural extension offices. These act as go-betweens for farmers and the government as well as the private sector, providing relevant information, teaching farmers new agricultural practices, emphasizing the importance of diversification to reduce risks, and assisting farmers in finding markets. This means that farmers will have easier access to information and will be able to find materials for whatever they are producing or rearing.

According to the Minister of Finance's budget speech for 2023, in addition to providing input support, FISP will be reformed to include extension service support, irrigation development, access to finance, value addition support, and storage and logistics. The program will also ensure better targeting and equity in the distribution of subsidies and services.

CASP will be the name of the new expanded program. What is true, however, is that the government will scrutinize the beneficiaries in detail to ensure that only the targeted and deserving people receive subsidized fertilizer under this comprehensive agriculture support program (PWC, 2022). Government also proposes to spend over K9.1 Billion (Zambian Kwacha), which is 557.32 Million USD (as at the rate of September 2022) on farming inputs for the fiscal year 2023 (Ministry of Finance and National Planning, 2022).

The Zambian government banned the importation of agricultural products, specifically potatoes and onions, earlier in the year 2022. This was done to encourage local production by local farmers, resulting in a positive repo effect on the economy. However, because the policies of the UPND government are in its infancy stages, a comprehensive review of their success cannot be determined, but the promise is to expect more jobs, income, and investments opportunities culminating from the vast potential of agriculture in Zambia as this thesis proposes. Over the years, Zambia has flows of FDI across different sectors, and the next sub-section address FDI in Zambia by sector.

2.6. FDI IN ZAMBIA BY SECTOR (US$ Millions)

In 2006, the Zambian governnement through an act of parliamnent set up the Zambian Development Agency (ZDA), to stimulate investment and FDI in Zambia. Amongst the functions of the ZDA related to FDI includes the increasing employment in Zambia, formulate investment promotion strategies, facilitate government policies on investment in Zambia, undertake economic and sector studies to preview investment prospects as well as plan, manage, implement and control the privatization of state-owned enterprises and monitor its progress. Some strategies it applied to attract FDI included the following:

- Tax incentives and land provision.
- Extra incentives, exemptions, and promotions for high-cost investments.
- Accelerated immigration assistance including provision of legal guidance and assistance
- Assistance with the quick provision of utility services such as water, electricity, and communication.

These has had an effect on investment pleadges and contribution of FDI to sectors like agriculture and overall economic development in the country. Table 2.3 that follows shows the various FDI inflows by sector (Million US$) between 2009 and 2012. During the stipulated period, the highest investment went to the mining industry with 367.2, 1141.2, 955.6 and 933.7 in 2009, 2010, 2011 and 2012 respectively. The manufacturing industry was second recording 285.7, 373.9 and 469.6 in 2009, 2010 and 2012 though it notably recorded -177.8 in 2011. In the years 2009, 2010, 2011 and 2012, Agriculture, Forestry and Fishing received -14.1, 13.2, 31.7 and 28.3 respectively. Wholesale and retail trade had 65.0, -2.2, 76.6 and 38.3 in the years 2009, 2010, 2011 and 2012. In the same respective period, the Construction industry recorded 44.2, 17.4, 39.2 and 54.6. Real Estate activities received an investment of -0.4, -4.5, 42.8 and 4.9 in the respective years of 2009, 2010, 2011 and 2012. Tourism had an investment of 40.9, 4.3, 13.6 in the years 2009, 2010, and 2011. Deposit-taking corporations inflows were 71.2 and 184.4 in the years 2011 and 2012 respectively. In the same respective period, Electricity Gas and Steam had an estimated investment of 13.3 and 6.5. In the year 2012, information and communication, as well as other financial institutions, had -18.4 and 9.2. The other areas had investments of 0.6, 17.8, 1.0 and 0.8 in the respective years 2009, 2010, 2011 and 2012. The sectors education and health among others had insignificant investment amounts and were under “other expenses” mentioned above, with less than a percentage of the total FDI during the period 2009 and 2012. Unfortunately, data for investment by sector for prolonged time period was unavailable at the time of this dissertation, but this information, which is still revelant was just to indicate the pattern of investment is Zambia. The Zambian government through the Zambia Development Agency (ZDA) instituted several initiatives to stimulate FDI flows and employment creation, and as a result several pledges were made by various MNCs as elaborated in table 2.4 that will follow later.

TABLE 2.5.6 : ZAMBIA'S FOREIGN DIRECT INVESTMENT INFLOWS BY SECTOR (IN US $ MILLION)

	2009	2010	2011	2012
Mining & Quarrying	367.2	1,141.3	955.6	933.7
Agriculture. Forestry & Fishing	-14.1	13.2	31.7	28.3
Manufacturing	285.7	373.9	-177.8	469.6
Wholesale and Retail Trade	65.0	-2.2	76.6	38.3
Tourism	40.9	4.3	13.6	0.0
Transport & Communication	-10.7	179.3	41.6	19.7
Information and Communication	0.0	0.0	0.0	-18.4
Construction	44.2	17.4	39.2	54.6
Real Estate Activities	-0.4	-4.5	42.8	4.9
Finance & Insurance	-83.5	-11.2	-0.2	0.0
Electricity, Gas and Steam	0.0	0.0	13.3	6.5
Deposit Taking Corporations	0.0	0.0	71.1	184.4
Other Financial Institutions				9.2
Other	0.6	17.8	1.0	0.8
Total	694.9	1,729.3	1,108.5	1,731.6

Source: *Foreign Private Investment and Investor Perceptions Surveys 2010, 2011, 2012 and 2013*

In the years 2014 and 2015, a substantial amount of recorded investment applications and pledges were diverted towards the manufacturing industry with a prospective employment generation of at least 3039 and 3624 employees in those respective years. The construction industry recorded employment pledges of 8738 and 1531 in 2014 and 2015 respectively. In the same respective period, the Real estate industry pledged 700 and 4137. Tourism investment pledged to employ 1074 and 1057 person in the same periods as above. The mining and quarrying industries pledged 1643 and 545 respectively. The service industry pledged to generate 1097 and 690 jobs in 2014 and 2015 respectively. In the same respective period, the Agriculture, Forestry and Fishing industries pledged to create jobs of up to 1495 and 1288. In 2014 and 2015, the transport sector pledged to generate 196 and 478 respectively. In the same respective period, the information and communications received minimal employment pledges of 49 and 35. Education and Health were yet again on the lower end of FDI, with the former receiving employment pledges of 0 and 166 in 2014 and 2015 respectively. In the same focus period, the latter received respective pledges of 38 and 69. All the above pledges were inspired by the government through ZDA in there quest to attract across all sectors of the economy. A summary of these pledges is indicated in Table 2.4 below:

Table 2.5.6: Investment and Employment Pledges. January – September 2014 and 2015

	January – September 2014			January – September 2015		
Sector	Number of Applications	Value US$ (Millions)	Pledged Employment	Number of Applications	Value US$ (Millions)	Pledged Employment
Agriculture, Forestry and Fishing	27	114.5	1495	27	82	1288
Construction	15	3172	8738	20	127.4	1531
Education	0	0	0	5	27.2	166
Energy	3	26	175	2	1.2	43
Finance	0	0	0	1	3.4	17
Health	1	1.74	38	2	5.2	69
Information and Communication	2	174	49	3	1.3	35
Manufacturing	68	231.8	3039	66	496	3624
Minning and Quarrying	15	17.8	1643	8	26.4	345
Real Estate	21	181.1	700	40	512.9	4137
Service	34	94.8	1097	22	38	690
Tourism	21	94.5	1074	26	173.2	1057
Transport	9	20.6	196	21	26.1	478
Total	216	4188	18244	243	1520	13680

Source: Zambia Development Agency(2015)

As noted in the last section, some amount of FDI had been directed towards the agriculture sector and contributed to economic development through employment creation and creation of opportunities. Inspite of FDI pleages and contribution, government policies, productivity and trade prospects, the agriculture sector has not gome without challenges as noted in section 2.7 that follows.

2.7. CHALLENGES FACING THE AGRICULTURE SECTOR

Despite government assistance to agriculture through NAP and FRA, the agricultural sector in Zambia faces several challenges and constraints. Overreliance on rain-fed agriculture, compounded by low irrigation levels, low levels of agricultural mechanization among smallholder farmers, low private sector participation in agricultural development, and limited access and availability to agricultural finance and credit facilities are among the challenges confronting the industries. Others include a reduction in investment in agricultural research and development, the unsustainable use of natural resources, and a reduction in resilience to the effects of climate change (IAPRI, 2022). Others included mitigation against the impact of HIV/AIDS on agriculture. Zambia has made strides in HIV response over the last decade. According to UNAIDS, the number of HIV infections in Zambia has decreased from 60,000 in 2010 to 51,000 in 2019. The number of new infections among children aged 0 to 14 years has dropped from an estimated 10,000 in 2010 to 6,000 in 2019. Annual AIDS-related deaths have also decreased significantly, falling from 24,000 in 2010 to 19,000 in 2019, a 30% decrease (UNICEF,2022). Despite progress, the HIV burden remains high and disproportionately affects women. In 2019, it was estimated that 26,000 new HIV infections occurred among women aged 15 and older, compared to 19,000 among men. According to the Zambia Demographic and Health Survey (2018), HIV prevalence among females aged 15-49 years is 14.2%, compared to 7.5% for males of the same age. Copperbelt and Lusaka provinces have the highest HIV prevalence rates of 15.4% and 15.1%, respectively, with Muchinga province having the lowest at 5.4% (UNICEF, 2022). Other concerns include strong early warning mechanism, promoting of good nutritional practices, promotion of research in crops and livestock, non-availability, or poor access to inputs. Other challengers are high dependency on maize. Since 2004, Zambia has consistently cultivated more maize – the national staple – than is consumed domestically. Maize is known as Zambia’s staple crop and from 2004, the country is said to be producing more maize than is being consumed locally, presenting more storage problems and in some instances bring about food wastage and damage, as the FRA does not have capacity to preserve all the food produced in a previous year. Which gives evidence of the high dependency on the commodity (IIED, 2022.; ARI, 2013). Underutilization of land resources was another notable challenge. According to the Food and Agriculture Organization (FAO), Zambia's estimated land area is 75 million hectares (about 72000 km) and about 16.35 million hectares is cultivatable land. Despite having a suitable climate, land and about 40% of water resources in the whole of southern Africa, Zambia has not fully realized its agriculture potential with only about 14% of the land being cultivated that is out of 58% of land available for agricultural production (FAO, 2022). Additionally, the sector had challenges pertaining to high incidences of pests and disease for livestock and crops; inadequate agricultural finance and credit; unfavorable world and regional markets. Zambia is a landlocked country and hence it has a relatively small market which possess as a challenge for its agriculture products (ITA, 2022), including weak market linkages to local and international markets.

On the other hand, some of the major constraints have been low spending on agriculture-related developments, which has resulted in dilapidated agricultural support infrastructure and inadequate delivery of extension services, poor rural infrastructure in many parts of the country, which increases operational costs and cuts off certain areas from many agricultural services, and poor rural infrastructure in rural areas, which causes high distribution cohesion. Despite this, the lessons to be learned are that if prudent measures are implemented, the situation can be reversed, and agricultural growth can be more promising than before. As the national economy expands, more resources are expected to be released to support not only agricultural development but also rural development.

So far, this chapter has helped address research question one, “What is contribution of several agriculture to Zambia’s GDP and economic development?”, and figure 2.2 has indicated that agriculture contributed approximately 20 to 30 percent towards GDP, over the focus period 1983 to 2017, with services having had the largest contribution, as indicated in figure 2.2. Also, this chapter addressed part of research question four, “How has Zambia’s agricultural production been locally, and trade performance been on the global market? ’’, having indicated the productivities of maize (figure 2.5); sorghum, rice, millet, and soyabeans (figure 2.6); including sugar, groundnuts, cotton, and tobacco (figure 2.7), and the durability of Zambia’s agriculture products including maize, sugar, cotton, and tobacco were also addressed, with the mean and medium durability of under 2 years, and over 40 percentage of the countries agricultural products been exported continuously beyond the first year of trading (figures 2.8 and 2.9). This chapter has also showed the contribution of FDI to the agriculture and other sectors (in USD in employment numbers) in the economy over the recent periods, where agriculture was just behind mining and manufacturing. Additionally, this chapter has addressed the challenges impacting the agriculture sector in Zambia?", indicating that some of the limitations on the agriculture sector are agro-ecological, institutional, global, and all need policy direction to improve on the performance of the sector as the final chapter shall suggest. The fourth section, the methodology, which will address the empirical part and justifications of variables used, including the how-to address research question two, "What is the impact of agriculture on GDP and economic development in Zambia?" and four "How has Zambia's agricultural production been locally, and trade performance been on the global market?" will be answered using econometric models. The literature review consisting of the conceptual and theoretical framework on the importance of agriculture for development, and the overview of previous studies on the impact of agriculture on economic development follows in chapter three.

3. LITERATURE REVIEW

This chapter, the review of literature mainly focusses on two sub-sections, it will begin with the conceptual and theoretical framework on the importance of agriculture for development and conclude with the overview of previous studies. The sub-section conceptual and theoretical framework on the importance of agriculture for development follows.

3.1. CONCEPTUAL AND THEORETICAL FRAMEWORK ON THE IMPORTANCE OF AGRICULTURE FOR DEVELOPMENT

Some theories and arguments have been developed over the years emphasizing the role and importance of agriculture as a catalyst for sustained economic development, particularly for developing countries. Some of those theories and arguments that have stood a test of time include Rostow's stages of development, the Johnston-Mellor Model, Schultz's Transformation of Traditional Agriculture, and Kuznet's theory on the role of agriculture on development. Following is an overview of these important theories.

3.1.1. Rostow's stages of development

To reach optimal economic development, nations must undergo five stages of development. These stages first published in his work in 1960, and later revised in a 1990 publication are the traditional, preconditions of take-off, take-off, drive to maturity, and high mass consumption (Rostow, 1960; Rostow and Rostow, 1990). The stages are prescribed by certain characteristics which implies a certain level of income. The preliminary (first two) stages are characterized by a limited manufacturing sector and over reliant on the agriculture sector, having lower income levels as a dominant characteristic. The reliance on agriculture in low-income countries has been verified by many empirical cases suggesting that agriculture is a dominant factor in enabling sustainable economic development (Awokuse and Xie, 2015; Mero et al., 2021; Moussa, 2018; Oyetade and Al, 2021; Phiri et al., 2020; Tahamipour and Mahmoudi, 2018). This is also true for developed countries that previously relied on agriculture in their initial stages of development as was the case during and some decades after the industrial revolution (Fajgelbaum and Redding, 2014; Hausmann, 2011; Herrendorf et al., 2014; Lavopa, A.M. et al., 2015). The reliance on agriculture and the technological advancements for the developing and advanced economies respectively hold true to the theory of Rostow' stages of development. Against this backdrop, agriculture still serves as a catalyst for development in developing countries, emphasizing the need for sustainable economic policies. The primary stages of development (according to Rostow) are linked to a country's level of development and income, which also underline the nation's characteristics and focus areas. According to the 2021 revised World Bank's income classifications, Zambia is a lower-middle income country (income category 1046-4096 USD), with per capita income of 1322 USD in 2018 (World Bank, 2022). The country's agriculture contribution to GDP over the focus period of this dissertation was at least 20 percent, which is way higher than the average of advanced economies. The conclusion on figure 3.1, on developed nations, and including Zambia's and underdeveloped country's reliance on agriculture (through the percentage of people employed in the agriculture sector as seen on the World map on figure) for development resonates with Rostow's theory of development and underlines the objectives of this dissertations in re-emphasizing the call for alignment of agricultural policies so that it catalyzes Zambia's and SSA's economic development. The importance of agriculture as a catalyst for Zambia's economic sustainability in relation to Rostow's traditional and precondition of take stages (where Zambia is), cannot be overemphasized as recent studies have agreed with this proposition (Awokuse and Xie, 2015; Mero et al., 2021; Moussa, 2018; Oyetade and Al, 2021; Phiri et al., 2020; Tahamipour and Mahmoudi, 2018). The figure 3.1 below shows Share of labor employed in agriculture, forestry, and fisheries, 2019, by sector as a cross verification of Rostow's theory of development, through checking a country's contribution of agriculture to GDP as per level of economic development, and national income. As noted, most low-income countries including the SSA region rely more on agriculture with contributions of 20 to 80 as indicated by the darker purple sides of the graphs, which signifies the role of agriculture in ending development in these economies (see figure 3.1 below).

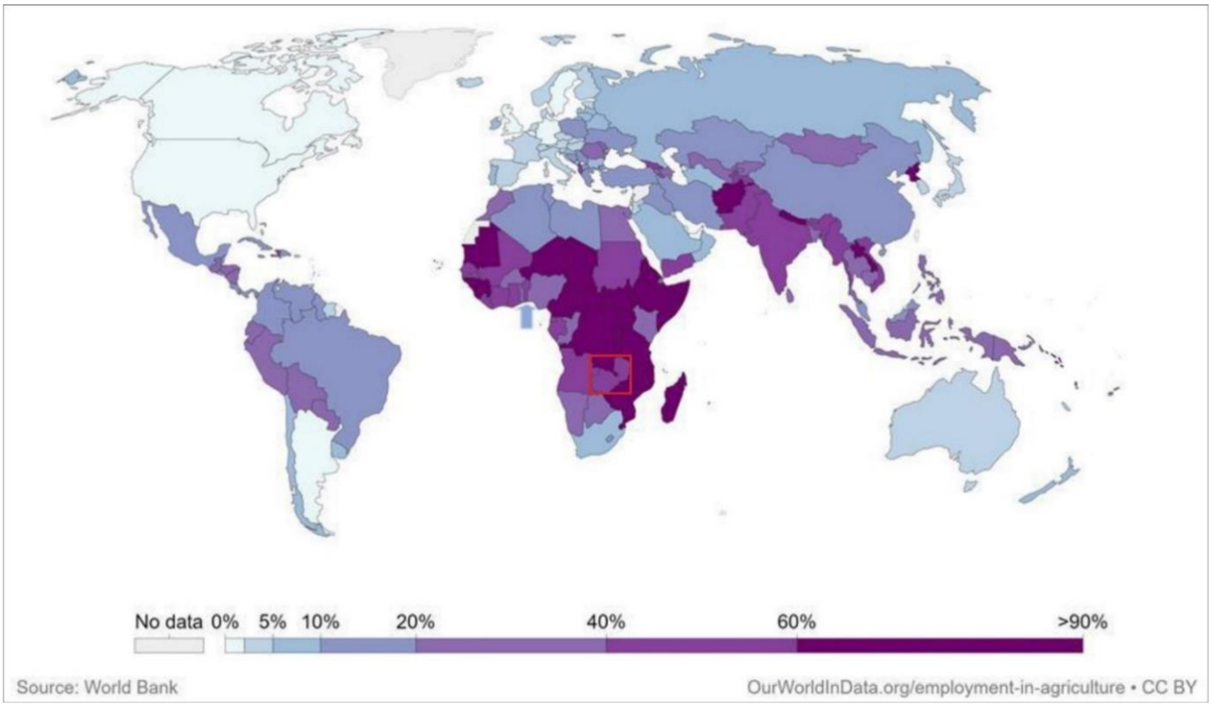

FIGURE 3.1: SHARE OF LABOR EMPLOYED IN AGRICULTURE, FORESTRY, AND FISHERIES, 2019

Note*: In red square is Zambia, which is the focus country.*

Source: World Bank, 2022

3.1.2. Johnston-Mellor Model

The thoughts of Rostow on the importance of agriculture is further built on by acknowledging that increased productivity could lead to higher rural incomes, reduced food prices in urban communities, more savings in rural areas, enabling capital flow for the domestic industry as the market expand (Johnston and Mellor, 1961). This model by Johnston-Mellor provided a narrative on how the role of agriculture is imperative in enabling economic growth, which its basis paved way for agriculture as an important aspect of economic diversification amongst developing nations. Most empirical studies were built on the premise of the Johnston-Mellor model as it created the theoretical basis for most studies that followed. Johnston and Mellor (1961) acknowledged in agreement with Rostow that as nations develop, reliance on agriculture could possibly decline. However, they both acknowledged that nations focused on processing raw food products (which is line with a growing manufacturing sector) are likely to benefit more from a vibrant agriculture sector and its contribution towards economic development.

3.1.3. Schultz's Transformation of Traditional Agriculture

Schultz's (1966) theory of the transformation of traditional agriculture was published first in the Oxford's Journal of Farm economies. The ideas culminated from noticing that agriculture production was stagnant (non-dynamic). He noticed that most farming practices did not have additions in factors of production or improvements in knowledge and farming method, having observed constant and unchanging patterns or production outputs. This was prominent then, as most economies that were reliant on agriculture (in their initial stages of development) did not have the means to increase productivity. However, Schultz was optimistic and proposed developments that have benefited most nations today. Amongst his propositions included investing in capital intensive means of agricultural production, increasing the availability of factors of production and labor, more training, research, and development including advancements in agriculture technology as well as creating agriculture investment opportunities (which served as a basis for investment and current increments of FDI in agriculture). Schultz's Theory of Traditional Agriculture received criticism because it did not acknowledge that countries have different stages and levels of factor endowments, infrastructure, commercialization, monetization, and administrative efficiencies (Dabasi-Schweng, 1965; Dandelar, 1966; Deshpande, 1977). However, it did serve as gateway for investments in better agriculture production techniques and as a catalyst for economic development for all economies, especially developing countries (Phiri et al., 2021a; T. A. et al., 2015; Tahamipour and Mahmoudi, 2018).

3.1.4. Kuznets (1961) on the role of agriculture on development

With a sub-focus on, "Economic Growth and the Contribution of Agriculture: Notes on Measurement", Kuznets concluded that agriculture contributes to development through several means like product, factor, and market contributions (Kuznets, 1961). Through the product contributions many commodities are considered lots of food and raw materials which can be used by the citizens in an economy. By means of factors, the agriculture sector is a contributing factor of production which are essential as supporting inputs from other related industries. Agriculture can also provide employment and serve as a means of employment creation for related industries. The industry also provides a platform for buying and selling of products on the market. Several studies acknowledged the importance of these realizations (Phiri et al., 2020; Steger, 2000; Wichmann, 1995). The next sections show an overview of previous studies on the importance of agriculture for economic development.

3.2. OVERVIEW OF PREVIOUS STUDIES

Several empirical studies on the impact of agriculture on economic growth (development) across the world were conducted. The study on impact of agriculture on economic growth in Ghana found that agriculture impacted GDP much more than services and industry. Using the OLS method during the period 1996 to 2006, this study concluded that a unit increase in the agriculture sector affected GDP growth by 0.354515, with the biggest contribution coming from the production of cocoa (Enu, 2014). Matsuyama acknowledged that agriculture is an important precondition for industrial growth and economic development (1992). He noted that the positive link between agriculture and economic growth is very strong in closed economies as compared to opened economies. The conclusion was that openness of an economy was significant in using agriculture as a catalyst for sustained economic growth, a conclusion that was supported by a recent study in Zambia, that noted that with an export focus, agriculture value addition though food processing, and favorable trade terms can put a nation on the path to economic prosperity (Phiri et al., 2021c).

In the case of Nigeria, a study conducted between 1960 and 2016, using a growth accounting framework for the time series data noted the effect of agriculture on economic growth, using the granger causality test and found a unidirectional impact culminating from agriculture towards economic growth (Odetola and Etumnu, 2013). Another study on Nigeria, this time using time series data from 1981 to 2013 concluded that Real GDP, agriculture output, and oil rents had a long-run equilibrium relationship, with the VECM indicating a lower speed of adjustment, but notably with agriculture having a positive and significant impact on economic growth (Sertoğlu et al., 2017). Another study looked at the impact of agriculture on another component of development, life expectancy in Nigeria for the period 1981 to 2019 using the ARDL model, and concluded that agriculture productivity had a minimal and less significant effect on life expectancy (Olakunle, 2021). Conversely, a related study on the impact of agriculture on economic growth also using the ARDL Bounds Tests, with data analyzed and forecasted between 1981 and 2025 noted the existence of short and long run relationship amongst the variables of interest with agriculture and economic growth converging to long run equilibrium at a speed of 90 percent, and the research also noted the presence of unidirectional granger causality running from agriculture towards economic growth (Oyetade and Al, 2021).

In a European study comparing Albania and other former Balkan states in the year 2018, a positive relationship was observed between agriculture and economic growth with the impact being inelastic (Mero et al., 2021). From a perspective of several developing countries, a study on the role and impact of agriculture on economic development was conducted with a focus on Brazil, Chile, Mexico, China, Cameroon, Thailand, Kenya, South Africa, and Mexico, which the levels and impact of agriculture on growth are more pronounced according to the order of list of countries listed above, and the analysis applied cointegration techniques (Awokuse and Xie, 2015). In the case of Iraq, low agriculture productivity was noted, which was compounded by lack of or poor inputs in labor, and capital, which compelled the authors to recommend stronger investments in capital that would serve as catalyst for economic sustainability through a vibrant agriculture sector (Tahamipour and Mahmoudi, 2018). A study on Benin for the period 1970 to 2016 noted a long run cointegration relationship amongst the variables; agriculture, HDI, and economic growth (Moussa, 2018). Moussa observed a country's natural endowment such as good rainfalls, grazing land, and nutritious soils can make it compete favorable in aspects such as pastoral and arable farming, which supplement economic development, a conclusion that was backed by an earlier study (Matsuyama, 1992).

Using a panel cointegration approach, a study on the impact of export led agriculture on the economic development of developing countries found a positive relationship, and agriculture exports to GDP elasticity of 0.07, with a notable presence of causality running from agriculture to GDP (Sanjuán-López and Dawson, 2010). A study that focused on duo economic system concluded that agriculture contributed to a nation's sustained economic development through increased productivity including helping with the de-escalation of malnutrition in an economy (Wichmann, 1995). A similar World Bank funded research concluded that poor mismanagement of resources including corruption can plunder the economy thorough misappropriation of inputs and resources (Schiff and Valdés, 1992). A study on the impact of agriculture on economic growth in Zimbabwe between 1980 and 2009 using the log-linear regression concluded that spending more on agriculture research and development stimulates development investment mitigating the effects of poverty, while lack of credit facilities for enterprises has hampered development (Mapfumo et al., 2012). According to Gardner, who researched on the causes of rural development, migration of laborers from the agriculture to other sectors like manufacturing and services, which leave a production gap in agriculture leaving it below the standard production levels (2005). This experience, as a country develops, was noted in the Rostow's theory of the development stages, that was earlier alluded too (Rostow and Rostow, 1990), and as a result increasing the calls to have a balance which stage institute the structural transformation policies so as to still maintain a vibrant agrarian sector.

A study was carried out to examine the performance of small-scale and large-scale farmers in the Mwanzini region of Swaziland (Kongolo et al., 2011). The authors used two stage ordinary least square regression model to analyze the elements that have an influence on the output of maize and the general hypothesis was that expected input prices, weather conditions and technology were the main determinants of output responses in agriculture, which the researcher used for estimating own price elasticity of maize, with its coefficients found to be -0.138 and 0.236 for small scale and large-scale farmers respectively. The negative sign in the case of small-scale farmers showed that their outputs were less compared to the production costs. The results indicated that 78% and 87% of the variation in both small-scale and commercial farming respectively was explained by model-independent variables such as input prices, fertilizer and technology, which had coefficients of 0.1387, -0.12930, and -0.00941 respectively (Kongolo et al., 2011). Their findings give proof of the significance of government intervention in the agricultural sector. They however don't clearly indicate whether the said policies lead to either positive or negative contributions but attributed the expected negative signs on the coefficients for fertilizer and technology due to lack of innovation amongst farmers. In examining the determinants of household food security in rural households in the Ada Berga district of Ethiopia, using a survey of 196 farm households while applying logistic regression model, the variables coefficients that are found to be significant in determining household food security were the age of household head, off-farm/non-farm income, use of chemical fertilizer, size of cultivated land, livestock ownership, oxen ownership and soil and water cultivation practice with the unit change positively and significantly impacting food production by 0.041, 0.040, 1.780, 0.304, 0.242, 0.660, and 1.253 units respectively (Beyene and Muche, 2010).

A study was conducted with the support of Zarai Taraqiati Bank Limited on the impact of agricultural credit on agricultural productivity in Pakistan, using a logistic regression model, where increase agricultural productivity from credit took the value 1, and 0 otherwise (Hussain and Taqi, 2014). The results show that variables such as the amount of credit, short-term loan, size of household and education of farmers had a significance level of 10%, and impacted productivity by 1.81, 0.53, 0.11, and 0.54 respectively, which was positive and a contributor to crop yield as was finance which gives farmers access to seed and fertilizers as well as quality of land. A similar study conducted in Pakistan which was analyzing the impact of factors such as cropped area, water availability, credit distribution and fertilizer consumption on agriculture productivity using secondary time series data from 1978-2015 also echoed same sentiments (Rehman et al., 2019). The authors adopted a Cobb Douglas production function model and conducted the Johansen test for cointegration, and their results showed that credit distribution had a positive and significant impact on agriculture production.

Another study in Turkey draws a similar conclusion on the positive association between agricultural credits and agricultural productivity. By doing a cross-country analysis, the author uses a combination of panel data and instrumental variable methods such as the instrumental variable, 2 stage least square and generalized method of moments. These instrumental variable methods help in controlling for potential endogeneity and yields estimates that are statistically significant around 5%, and its results concluded that doubling of agricultural credits generated an increase of 5% in agricultural production in terms of the agricultural component of GDP (Seven and Tumen, 2020). The authors rather made an interesting observation regarding the impact credits have across developing and developed countries, that is the levels of impact change according to the levels of development in countries with developed countries having a higher capacity to provide huge sums regarding agriculture credit finance hence they tend to experience a higher impact which leads to high productivity as compared to developing countries. However, a different conclusion was noted in a study for Nigeria, which adopted the pairwise granger causality model to assess the causal relationship between agricultural financing and agricultural output growth, with results after carrying out the test indicate that government agricultural finance does not granger cause agricultural in increase in output and vice-versa (Orji et al., 2020).

A study on the causal nexus between GDP, household final consumption expenditure, fertility rate, child mortality rate and agriculture production index were conducted in Ghana, which adopted the ARDL model and there was evidence of a long-run equilibrium relationship among the variables notably GDP and agriculture production index (Asumadu-Sarkodie and Owusu, 2016). The results of this study showed that 14% of fluctuations in the agriculture production index were due to shocks in GDP entailing that a unit change in GDP will affect about 14% of agriculture production. A similar study on Malaysia conducted an analysis of food security and macroeconomic variables such as GDP and government expenditure using the VAR econometric model, and the results indicated that GDP was responsible for shocks in agriculture production and the conclusion was that policymakers need to spend more on government expenditure to enhance and improve agriculture productivity (Applanaidu et al., 2014). Using the ordinary least square and generalized least squares estimates a study was conducted on how effective agricultural policies impact productivity, using variables such as agricultural value-added per worker, net entrepreneurial income index deflated with the consumer price index, standard deviation of wheat prices, self-sufficiency ratio and food price index (Arovuori, 2015). This study noted that food price development is found to have a positive influence agricultural production and was statistically significant at 99% confidence level towards agriculture production. The study observed that if prices for commodities are declining, people wouldn't find an incentive to involve themselves in food production activities as low prices imply low-profit margins.

In Zambia a study on the price effect on food production was conducted checking with selected structural adjustment policies in order to assess their impact on food production, using a four-year panel of post-harvest data to estimate a system of six crops, namely sorghum, millet, maize, rice, wheat, and soya beans, by calculating elasticity and using it to conduct simulations so as to look at the impact of the reforms with the findings in this study, were that prices have a high effect on food production, and that output driven interventionists policies like credit support, subsidies and inputs aid production (Simatele, 2006).

In a study conducted in the central region of Vietnam examining different factors influencing farmers decision on adaptation to climate change in their agriculture production, using Binary Logit and Multivariate Probit models, it was observed that attendance of climate change training, including farm size were the most important factors that would influence the farmers decision on adaptation to climate change which would entail a reduction in production losses hence having larger agriculture production units (Trinh et al., 2018). A research focusing on the relationship between poverty, social protection and agriculture in developing countries, using World Bank for year 2014 showed that despite significant progress being made on reducing extreme poverty, little progress has been made in reducing the number of people living between $1.25 and $2 a day, indicating that there is little assistance in social assistance as well as the delivery of agricultural inputs, mostly in countries or parts of the world where poverty is mostly widespread (Lowder et al., 2017).

In SSA region, an empirical study to find the role of agriculture in poverty reduction, using World Bank data for the year 2000 found that the contribution of a sector to poverty reduction will depend on its inter-sectoral performance or rather its own internal performance, its implicit contribution to growth in other sectors, the extent to which poor people participate in that sector and the size of that said sector in the overall economy, (Christiaensen et al., 2011).

The study applied a dynamic panel data estimation technique to find the causal relationship between agricultural and non-agricultural output. The evidence from the study showed that the agricultural sector is most effective at poverty alleviation among the poorest of the poor. In addition, it showed that it is 3.2 times much better at reducing $1/day headcount poverty in low-income countries and resource rich countries assuming no income inequalities in the said country. In another case, it noted that considering a class called the better off poor (as measured by the $2/day measure), non-agricultural sectors are better off at poverty alleviation. A study recently conducted to investigate the nexus between water, poverty and agriculture in Africa, while utilizing data collected from the Living Standards Measurement Survey, concluded and recommended that water meant for agricultural purposes need to be properly managed if it is to significantly contribute to poverty reduction (Balasubramanya and Stifel, 2020).

A policy study investigated how various structural transformations in the economy and/or to be specific, in the agricultural sector from taxations and budget deficits from the government's side can affect the speed of poverty reduction in the economy (Christiaensen and Martin, 2018). The authors also looked at the effect of the subsector and price differential effects on the niche of poverty reduction. The study utilized the econometric procedure of controlling for endogeneity of growth or Computable General Equilibrium (CGE) simulations model to investigate the structural transformations on data collected from 315,000 households from 31 countries. The researchers conclude that a series of structural transformations can affect the speed of poverty reduction in the economy and adopts the view that growth in agriculture is more poverty reducing than any other sector. They also show that different mechanisms to finance investments in various sectors can have enormous implications for poverty reduction.

A study was done to see if rainfed agriculture could be a pathway from poverty. It utilized data collected from SSA surveys and from India and Africa, which were national surveys collecting data on small holder farmers and adopted a pooled data set that fixes a relationship between farm size and the value of crop yield from improved household technology. The results showed that improved technology can substantially improve net returns per hector per cropping season. Further recommendations are that crop production could be a pathway from poverty where small holders are able to increase farm size or where markets improve crop diversification, commercialization and increased farm profitability (Harris and Orr, 2014). In that case, for small holders, improved technology would be trivialized by small land size, thus it would be difficult for the said improved technology alone to lift them above the poverty line.

A study in the Eastern Brazilian Amazon comprehended the interrelationships between ecosystem services, agriculture and rural poverty, as well as took a view on the policy prescriptions, and it utilized field data collected for the development of the bioeconomic model from 270 randomly selected farm households from 3 municipalities for the year 2002/2003 farming season (Boerner et al., 2007). The researchers used the Land Use System (LUS) approach as the method of analysis, and baseline results suggested that smallholder agriculture leads to the gradual loss of ecosystem services, mainly above ground and root carbon provided by secondary forest fallows, and that reduction in fallow age leads to reduced plant biodiversity. With that in mind, the researchers concluded that apart of payment for ecosystem services should be done through attaching biodiversity loss as a cost to community's access these ecosystem services.

A study was done to make explicit the economic importance of agriculture in poverty reduction in Ethiopia, Ghana, Indonesia and Vietnam, and it utilized data from surveys within countries done for International Comparisons Programs which is managed by the World Bank data group, using pooled regression analysis using panel data (Cervantes-Godoy and Dewbre, 2010). This study concluded that countries that were able to successfully attain poverty reduction were of a diverse mix. They showed main macroeconomic improvements that could be seen from the provided indicators, the countries 'own governments were reducing deprotection by lowering export taxes, and the countries` main rich trading partners were reducing the most in terms of production and trade distorting kind offered their farmers. A strategy paper in Ethiopia was written to indicate the policy processes around agriculture, growth, and poverty reduction, using the lens of the poverty reduction strategy (Teshome, 2006). The researcher identified 4 pathways of which agriculture could be prioritized. These are intensification of smallholder agriculture, commercialization, diversification, resettlement, urbanization, and migration.

Research on the impact of organic agriculture on rural poverty in the Asian case by applying data collected from the Asian Development Bank for the year 2005, concluded that organic agriculture plays a major role in poverty reduction by improving income, food security and environmental sustainability, with the latter taking into consideration the green revolution and poverty reduction measures and policies (Setboonsarng, 2006). A project by Peskett et al. (2007) evaluated the impacts of biofuels on agricultural expansions and poverty reduction utilizing data from F.O Licht database 2006, using a descriptive statistic with its focus being on India, USA, China, Indonesia, Brazil, France and the SSA region. The study then concluded that investment in biofuels should be integrated within a broader context as human capital and rural infrastructure. Also, that low-income countries should assess whether the underlying conditions exist for a successful biofuel program which could be implemented near term, including infrastructure and public service.

A study on the Indian economy examined the relationship between agriculture, employment and poverty reduction, and used descriptive statistics and various data sources, and showed that improved agriculture output had an effect on food grain prices as well as led to significant shift in the labor markets, such that improved agricultural outputs caused improved employment levels and better working conditions for workers in terms of better wages and allowances (Dandekar, 1986). The data sources included a) The Ministry of Finance, budget division, Government of India for the year 1986-1987 and b) Poverty alleviation programs “a status paper” government of India. Given the above, the researcher concluded that improved agricultural output that could receive stimulus by more sectoral investment would explicitly cause significant reductions in poverty levels as well as contribute positively to labor markets by providing employment sources for workers in the sector.

A research assessing the relationship between non-agriculture employment and poverty in Pakistan, utilized primary data set generated from the 1996/1997 Household Integrated Economic Survey carried out by Federal Bureau of Statistics, and it employed descriptive statistics and bivariate estimation techniques (Arif et al., 2000). The study showed that there was shift from farm to non-farm sectors in the economy. Because of this, non-farm workers were no longer the worst category in the belt of standard of living, labelling them being at least better off than most agricultural laborers. Thus, the research concluded that a dynamic labor-intensive combination of agriculture with a modernizing non-agriculture sector can lead to rapid growth and a broad spread of employment and income.

A study was done in India to investigate agricultural challenges as well as poverty, social sector, and regional disparities, using data collected from the government of Andhra Pradesh. It identified lack of equitable development or rather lack of inclusive growth in the countries’ growth prospects or observed growth statistics (Sahoo et al., 2021). The researchers thus identified several elements for inclusive growth being agriculture growth, employment creation and poverty reduction, social sector (health and education) and reduction in regional and other disparities. Isolating the agriculture component, the researchers found that the net income from agriculture was not sufficient for the average farmer. Another finding was that farmers spent a major part of an agricultural loan for productive purposes, although allocations would vary across social groups. Sahoo et al.(2021) also showed that there was an increasing number of farmers using electricity and diesel. That is, the number of small scale and marginal farmers doing that was relatively higher than any other. The researcher also disclosed the importance of information for the farmers. That is, most farmers got their information off modern technology and other progressive farmers, radio, and television.

In Canada, a study investigating the impact of retail subsidies on food on the food prices in the Indigenous communities in Canada, using 2019 data collected by the Nanuvut Bureau of statistics, which constituted food price data for 232 food items on average, for each of the 25 communities in Nanuvut. The study employed linear regression analysis to check the pass-through rate for the Nutrition North of Canada, with results of the analysis suggesting that most, if not all of the food subsidy is passed onto the consumer in the form of lower food prices (Naylor et al., 2020).

Atkinson (1995) investigated the actors and approaches to food security in global south countries that include Sri Lanka, Brazil and Africa, using 1986 Word Bank data . He explored some of the policy options available for food security by placing them in each category, and the conclusion noted that policy appropriateness was queried as relying on household as this was mainly in basic unit of decision making or rather the basic planning unit in urban areas. The researcher also emphasized the need to assess the effectiveness of initiatives that attempt to bring together different actors and agencies attempting to plan policies at city level.

A study was done in Singapore investigating the effect of policies that encourage aquaculture in high income countries, which utilized data retrieved from the FAO, and employed partial equilibrium model on the use of supply-demand Asia Fish (Bohnes et al., 2020). The Singaporean government had set up policies aiming to ensure that the aquaculture industry attains self-sufficiency by 2030. Analyzing using the adapted Asia Fish model, the researchers ascertained that there was a scenario under which the said government could attain its goal. The model revealed that a decrease in imports by 28% would lead to self-sufficiency standing at 69% with 90% of aquaculture originating from modern technological sources. That would have improved benefits with the Singaporean environmental, social, and economic constraints as land and aqua-feed scarcity.

A study on Ethiopia by Baye (2017) explored the issues and history of essential features of the Ethiopian agriculture, including the post 1974 rural policy and agricultural developments. The study utilized primary and secondary sources of data. Primary data was collected through interviews, Ethiopian National Archives and Library Agency, Institute of Ethiopian Studies of Addis Ababa University, and traveler accounts. Researcher showed that the agriculture sector has remained static for centuries. That is, people have remained poor while being faced with different but interwoven constraints. These were identified to be the presence of an unproductive class, lack of capital, poor infrastructure, shortage of access to markets, lack of unskilled labor, land degradation, population pressure, religion, culture, deforestation, tenure regimes, poor land management practices and varied but interrelated natural factors could be mentioned as important factors related to rural poverty.

A study was done in Nigeria to assess what led to the decline in urban waste collection by farmers, which before could be a natural way they used to retain the soil compost and density (Lewcock, 1995). The research looked at the waste generating process in Kano, Nigeria, and unmet need for farmer resources. The case study uses descriptive statistics which later showed that Kano has shown the adoption of the in house and animal waste farming system, basically due to the free absorption function provided by the soil. Other factors have lack of information about the availability of waste to be used by near urban farmers, and lack of resources by the near urban farmers to transport the available waste from the urban place to their respective farm plots.

Ninan and Bedamatta (2012) conducted a study to investigate the effects of climate change on the Indian agriculture, poverty, and livelihood. The study utilized data from secondary sources and existing literature to ascertain changes in climatic conditions as well as reaching a cross-crop consensus on adaptability to new climatic conditions. The researchers concluded that the effects of climate change would vary across different crop species, regions, and climatic change scenarios. The study also showed a decrease in production of crops in India as temperatures rise. That is, temperature rises of between 2°C and 3.5°C would cause a projected 3%-23% loss in agriculture revenues. The study also noted that increasing sensitivity of agriculture to climatic conditions would cause instability of India’s food production which will also have an impact on poverty and livelihood.

A study done in South Africa to investigate the role of urban agriculture on supplementing the incomes of households (May and Rogerson, 1995). The objective of the study was to review prospective and policy implications of urban agriculture in the context of national initiatives for post-apartheid reconstruction. The study used primary data from the interview of farmers to ascertain the methods of production, problems and potential with data collected from the 1992 household surveys and field research of 1993. The researchers drew out the conclusion that government needed to view urban agriculture as a resource and not a problem as this had positive effects on the comprehensive land use for food production and socio-economic as well as promotion of a productive urban agricultural that can integrate and promote other informal activities. Using bivariate causality tests, on the causal relationships between economic growth and agricultural value added and the direction of causality for a panel of countries, the findings indicated that developing countries exhibit a strong causal relationship between the two variables, with the impact running from agriculture value added to economic growth per capita in developing countries, while the outcome on developed countries was inconclusive (Tiffin and Irz, 2006).

Awokuse and Xie (2015) investigated the dynamic interaction between economic growth and agricultural productivity, using time series data of fifteen developing and transition countries in Africa, Asia and Latin America to try and find out a relationship between agriculture and economic growth. The study uses a multivariate causality framework to examine the dynamic causal relationship between agriculture and economic growth across a diverse panel of developing countries. Also, both short run and long run causal relationships between the two variables are investigated using the ARDL error correction modelling. The auto lag distributive model and co integration were used to find out the empirical relation among the economic variables. The paper finds that agriculture is the "engine of economic development". Evidence is provided in this paper that supports increasing private and public resource allocation to agriculture and infrastructure development. Furthermore, the result suggest that trade openness has a positive impact on GDP per capita.

In investigating the impact of agricultural productivity in Pakistan, using secondary data for a time of 1972 to 2012, the ARDL Bounds test finds that a unit increase in agriculture value added leads to a 0.23 unit increase in GDP growth (Awan and Aslam, 2015). The results show that economic growth of a country can be increased by a positive trend of agriculture value added, with recommendations are made that the Pakistan government to increase labor force to both the agricultural sector and industrial sector, as well as the provision of new agriculture technologies and good seeds to achieve value added portion need to enhance at higher level.

In a study exploring the interaction between patterns in agricultural development and economic growth post World War 2, covering the time 1961-2010, a panel of 52 African countries is analyzed to unravel the links between economic and agricultural development, applying panel co-integration and causality (Los and Gardebroek, 2015). In this study countries were grouped in 3 parts, firstly, in accordance with income levels (low-income, lower-middle income, upper middle income and high income based on UN-classification). Secondly, in accordance with region (Eastern, Northern, Western, Middle and Southern Africa). And thirdly, landlocked, and non-landlocked countries. Results of the panel co-integration regressions reveal that agricultural sector performs different roles in different stages of economic development. Increases in food production play a vital role in furthering economic growth of low-income countries, whereas in more developed countries, such as upper middle-income countries, outflow of labor to other economic sectors is crucial for understanding economic growth. Bidirectional causal relation between agricultural and economic growth is found to be existent as shown by the panel causality results. In conclusion, the paper advises a cautious approach in copying development strategies that worked for Asia's Green Revolution of 19th century Western Europe into the current context of the African continent to enable economic development. The economic and social contexts in which the agricultural sector is embedded are strongly different.

A separate study was carried out in Nigeria examining empirically the impact of labor force dynamics on economic growth over the period of 1970-2015 using the bounds testing approach to co-integration (Young, 2018). Following empirical results, labor force dynamics has a positive and significant effect on economic growth both in the short run and long run. The paper recommends that the government of Nigeria should implement a set of employment generating policies to help enhance employment. Block (1999) conducted an empirical study designing a model that stimulates economic growth as a function of growth in four sectors (traditional, agriculture, modern industry, and services) and their interactions with one another. Results show that growth in one sector induces growth in GDP directly and indirectly through the growth it induces in other sectors through inter-sectoral linkages specified in the model. This gives a multiplier effect above 1.0. Agriculture and the service sector are found to have the largest multipliers in absolute terms and share the largest portions of the net impact shocks with each other.

A study carried in several countries focusing on three countries which are Zambia, Mozambique, and Malawi to see the true contribution of agriculture to economic growth and poverty reduction. Its objectives stressed the economic and non-economic roles of agriculture; discussed and presented the true contribution of agriculture to the development of the economy of the three countries and lastly to suggest policies and strategies for the socio-economic development of agriculture in this region (Mucavele, 2013). After the study was carried out specifically in Zambia, it was found that as the economy grows and diversifies, the traditional primary agricultural sector loses weight in terms of GDP but develops strong connections with the rest of the economy. Secondly, it was observed that agriculture displays very significant back and forth connections within and outside the sector, also there was a realization that due to agriculture the quality of life in the rural areas was promoted. Lastly, the agricultural sector displays very significant multiplier effects with other economic sectors. This close relationship noted in the study that close relationship between different rates of poverty reduction during the past four decades.

Another study examined the differences in performance particularly the productivity rate of growth in the agricultural sector (De Janvry and Sadoulet, 2010). The writers examine the link between agriculture and poverty alleviation and was conducted through four ‘transmission mechanisms’: the impact of improved performance in agriculture on the incomes of people in rural areas; the effect of cheaper food for the urban and the rural poor; the contribution of agriculture to grow and also the generation of opportunities in the non-farm sector; and lastly the fundamental role of agriculture in the sustaining and stimulating economic transition, as poor people’s livelihoods and countries shift away from being primarily agricultural into a broader base of service and manufacturing. They carefully explained the possibility of future poverty reduction through the above-mentioned transmission mechanisms, which solely depend on the scope through which agricultural productivity can be amplified where it is most desirable.

Bresciani & Valdés (2007) used three channels linking agriculture to poverty which is food prices, labor market, and farm income, and they investigated the quantitative importance of the three sectors. They concluded that, when both direct and indirect effects of agriculture are taken into consideration, this type of growth reduces poverty than it causes non-agricultural sectors to grow. These authors pointed out the contribution of agriculture to poverty reduction are much greater than agriculture’s share of GDP. A study that used comparative statistics determined how a change in one exogenous variable will affect or cause a change in the endogenous variable by explaining the impact of agriculture on poverty reduction in Zambia. The analysis is relevant because about 60% of the Zambian population lives in rural areas and on top of that most of the population earns from agriculture (Nkolola et al., 2016). This makes it of more importance to develop the agricultural sector as this will have the potential to mitigate the extreme hunger and poverty issues that affect 80% of the people living in rural areas. the results show that the agricultural sector is the second largest sector that contributes to GDP, and this is the main strategy that Zambia can use to reduce poverty.

A research used both the cross-sectional data and time series to approximate regression coefficients relating consumer expenditure by decile to non-agricultural and agriculture GDP in Africa, India and parts of Europe, pointed out that improvements in the agricultural sector are more important than improvements in the non-agricultural sectors for the consumers in the lower deciles of the expenditure scattering, that is, the poor group of the population (Ligon and Sadoulet, 2008). They also found out that it's the opposite with rich households whose expenditure elasticity on non-agricultural growth is much higher thus, they concluded that agriculture is pro-poor. A frequent discovering is that agriculture has a decreasing effect on powers of agriculture declines as nations get richer (Christiaensen et al., 2011; Ligon and Sadoulet, 2008). For example, its conclusion was that positive factors in earnings from off-farm sources used to be the foremost reason rural poverty declined in the USA from the 1960s.

Concerning trade and durability of agriculture exports and their impact on economic development through agriculture trade, a few studies have assessed export duration of agricultural and food products. Some notable studies include Wang et al., who studied the duration of seafood exports from the Association of Southeast Asian Nations (ASEAN), applying Cox, Logit and Complementary log-log (Cloglog) models in their analysis for data spanning 1996 to 2014 (2019). They find that the mean duration of seafood exports is 4.42 years. This is determined by the GDP of importers and exporters, initial and total export indicators, importer and exporter's population and Regional Trade Agreements (RTA) all having an incremental probability of the duration of trade, while distance had the reverse effect.

In another study on the duration of fresh fruit and vegetable exports to the US between 1996 and 2018, which applied three sets of discrete-time models namely Probit, Logit and Cloglog. The results showed that prices in the USA and the exporter GDP had the highest impact on duration and this duration was enhanced by proper treatment of fruits and vegetables while exporter experience been on the lower end of the effect (Peterson et al., 2015). A study on the Norwegian cod exports concluded that at least 45 percent of exports fail after the first year of trading, using a Cox model, the authors concluded that distance, GDP, GDP per capita, firm size and the number of shipments significantly influence duration of cod exports GDP, GDP per capita, firm size and the number of shipments significantly influenced duration of cod exports (Asche et al., 2018).

Other studies on the duration of agricultural exports in New Zealand, especially one by Luo and Bano (2020) followed this line of research to establish the duration and determinants of dairy products in New Zealand. This study applied Logit and Clog log models. The mean duration of exporting dairy products is found to be two years, and it is majorly determined by the GDP of the importer, the domestic GDP, population, and distance. A study was conducted to ascertain the fisheries trade patterns between the Organization for Economic Co-operation and Development (OECD) countries major importers and exporters (Lee et al., 2020). Its conclusion was that intra-industry duration was much higher than inter-industry with the former having a higher duration rate in horizontal against the vertical integrated products. Additionally, the duration of trade was impacted by gravity variables such as common boarder, language, and colonial experience which had a positive effect on the probability of duration using the Cox proportional hazard model.

Concerning the duration of shrimp exports from China, a higher probability of the hazard rate was noted especially in Special Economic Zones with the significant aspect culminating from partner GDP, distance, prices, and initial exports (Yang et al., 2021). A study on the exportation of sea food from developing countries to the European Union (EU), Zhang and Tveterås (2019), using the Cox model concluded that the Generalised Scheme Preference (GSP) impacted the export performance with Preferntial Trade Agreements (PTAs) and product types playimg a key role particularly for processed foods coming from the developing world were prices, GDP, and distance had higher hazard rates and were significant to that effect with a median of under 3 years.

Concerning export duration of maize, few studies were conducted (Fert\Ho and Szerb, 2018; Headey and Fan, 2008; Mitchell, 2008). The USA has over the years been the number one exporter of maize and maize products. Mostly, nations export less of maize products increased transportation and production costs and also due to the fact that maize is used for domestic consumption including serving as food for livestock (Headey and Fan, 2008; Mitchell, 2008). Lately, increase in demand for the use of maize as an alternative energy input is contributing to its escalating need on the global platform. Besides agreeing with the statements, Ferto and Szerb (2018) using the Probit, Logit, and Cloglog models observed that gravity variables namely partner population and GDP significantly reduced the hazard rate, while the reverse was significantly noted in the case of distance with maize having a median duration of 2 years with over 72 percent of Hungarian exports ceasing within 3 years. In most cases the duration, impact, and direction of the flow of agriculture products was affected by trade policy, which has a consequential impact on agriculture trade duration (Koo and Karemera, 1991). With regards to food in Asian countries, 2 years was noted for Malaysian food products with its beverages lasting up to 7 years (IDRIS et al., 2020), and another study from low income countries observed an export durability of under 3 years of fish exports from developing countries to the EU (Zhang and Tveterås, 2019).

With regards to agriculture policy, state policies in supporting agriculture entrepreneur education and innovation can pave way for increased exports through its increased value addition (Prus, 2019; Roman et al., 2020; T. A. et al., 2015), and higher market share value (Maitah et al., 2014). Also, improved technology can enable increased water capacity which is a catalyst for health arable and pastoral growth making it possible for nations to export agriculture products which are of international standards (T. A. et al., 2015).

Another area of agriculture towards development are in energy. Studies have looked at how energy affects agriculture and vice versa as well as their relationship as the following sub-sections indicate. The amount of energy needed in agriculture has rapidly expanded, and the agri-food chain now uses 30% of all the energy in the world. Energy analysis analyzes the energy required for agricultural output, making it possible to reduce energy use and increase energy efficiency, further advancing agriculture's sustainable development. (Bayasgalankhuu et al., 2022) did a study on the impact of energy inputs and energy kinds on the agricultural productivity of Mongolia from 2005 to 2018 called Energy Analysis on Wheat Yield of Mongolian Agriculture. The output was determined using the yearly wheat equivalent for all 14 significant provinces. As a function of human labor, machinery, electricity, diesel fuel, fertilizers, pesticides, irrigation water, and seed energy, the output level was specified. The yield and various energy inputs were calculated using the Cobb-Douglas function's ordinary least squares method. While overall production energy increased from 2312.08 Merger Joules/hour 1 to 4562.56 Merger Joules/hour total energy input increased from 2359.50 MJ ha 1 in 2005 to 3047.61 MJ ha1 in 2018. The input-output ratio, energy productivity, and net energy of wheat production were examined during this time. There was statistically significant fertilizer input. Nitrogen, fuel, and irrigation water each contributed 3.52, 3.09, and 2.33 to the output level, respectively. As a result, the data showed that all types of energy—non-renewable, direct, and indirect—had a favorable effect on output. In addition, the use of non-renewable energy in Mongolian agriculture has substantially expanded (Bayasgalankhuu et al., 2022)

To determine whether agriculture was consuming an increasing amount of energy, another study was done in France. Sylvie Bonny's study aims to examine the trend in energy intensity in French agriculture between 1959 and 1989 and for wheat, one of its primary crops, between 1958 and 1990. He contends that between 1959 and 1977, a growing amount of direct energy was required in French agriculture to produce a certain volume of product; since 1977, Nevertheless, this sum has been declining. The total energy content of wheat has decreased across the analyzed period as well. The usage of energy in agriculture so appears to have improved, at least over the past fifteen years. Additionally, these results initially appear to contradict the findings of other studies, therefore the paper also highlights some potential future developments brought on by the technological advancements in agriculture. (Bonny, 1993)

To assess the overall energy input needs and outputs of subsistence agriculture in Nepal's rural areas, (Rijal et al., 1991) use descriptive statistics. According to the study, in the terai paddy, potatoes, oilseeds, and lentils should be grown instead of wheat and jute, while in the hills, paddy, maize, oilseeds, and lentils should be grown instead of wheat, barley, and millet. Instead of barley, maize, and potatoes in the mountains, use uoa and phapar. With the exception of jute cultivation in the Terai, which is mostly planted for cash rather than for energy or food, it is interesting that the crops with better output-input ratios cover a higher percentage of farmed area in all communities (Rijal et al., 1991)

Using panel cointegration techniques and Granger causality tests, (Ben Jebli and Ben Youssef, 2017) investigates the dynamic causal relationships between per capita renewable energy consumption, agricultural value-added, carbon dioxide (CO_2) emissions, and real gross domestic product (GDP) for a panel of five North African nations, namely Tunisia, Egypt, Sudan, Morocco, and Algeria, spanning the years 1980–2011.. Granger causality studies demonstrate that there is a unidirectional causal relationship going from agricultural to GDP, from GDP to renewable energy use, and from renewable energy consumption to agriculture in the short term. The long-term relationship between agricultural and CO_2 emissions is bidirectional; nevertheless, the relationship between renewable energy and agriculture and emissions is unidirectional, as is the relationship between output and agriculture and emissions. Long-run parameter estimations reveal that while an increase in agricultural value added reduces CO_2 emissions, an increase in GDP or renewable energy consumption (including combustible and waste) increases CO_2 emissions (Ben Jebli and Ben Youssef, 2017)

According to most published studies, it appears that there is a general consensus that the energy productivity of modern intensive agriculture is declining and that the main focus should be on reducing the usage of fossil fuels. However, Hans-Erik Uhlin's thorough analysis of three developmental phases in the transition of traditional Swedish agriculture (from 1956 to 1993) suggests that such conclusions need to be taken with a grain of salt. He contends that the ability of traditional agriculture to capture solar energy has a significantly greater impact on energy flows than input cost savings. Furthermore, it is claimed that prior research on energy in agriculture not only failed to properly account for technical advancement but also misjudged the connections between existing technology and the potential for energy crops. The economic opportunity cost principles are used to reassess the energy and environmental performance of high input agriculture in light of the fact that it uses significantly less land per unit of output (Uhlin, 1999)

A multifactor market model is used by (Vandone et al., 2018) to examine how agricultural and energy price trends affect the stock prices of listed companies in Italy's water sector. Evidence shows that water stock returns are sensitive to fluctuations in agriculture and energy prices. Factor sensitivities also exhibit a time-varying pattern when dynamic beta coefficients are estimated using a state space model, particularly during the 2008 financial and economic crisis.(Vandone et al., 2018)

Least square approaches are used by (Karkacier et al., 2006) to look into how energy use affects agricultural output in Turkey. The findings of a regression analysis of the connection between energy use and agricultural productivity are presented. The analysis of the yearbook data for the years 1971 to 2003 served as the study's foundation. Agriculture's energy consumption (TOE) and the gross additions of fixed assets for the year were used to determine its productivity. The State Institute of Statistics (SIS) and the Turkish Ministry of Energy provided the data for this study (Karkacier et al., 2006). A very substantial correlation between energy use and agricultural productivity has been asserted. For the specified study period, the elasticity for energy consumption and gross additions to fixed assets was 0.167 and 0.083, respectively. The elasticity of energy consumption was significantly higher than zero, indicating that energy use is influenced by agricultural productivity (Karkacier et al., 2006)

Similar research was done in Turkey by (Hatirli et al., 2005), who used co-integration and error correction (ECM) analysis to evaluate the long- and short-run relationships between energy consumption, agricultural GDP, and energy prices. The consumption of diesel and electricity on an annual basis from 1970 to 2008 is used to calculate the long- and short-term elasticities. The long-run income and price elasticities for the diesel demand model were determined to be 1.47 and 0.38, respectively, according to ECM analysis. Income and price elasticities were determined to be 0.19 and 0.72 over the long run, respectively, for the electricity demand model. To put it briefly, Turkey should continue to support energy use in agriculture in order to assure sustainability, boost competitiveness in global markets, and balance farmers' income (Hatirli et al., 2005). It was believed that energy prices significantly affect how much energy is used. Furthermore, it is believed that energy costs in Turkish agriculture are considerable. As a result, energy costs are becoming a powerful instrument for influencing energy use, and any future expansion of the agricultural industry will result in greater demand for diesel. Additionally, a causal association between power use and agricultural GDP can be seen.(Hatirli et al., 2005)

Sebri and Abid (2012) employ Granger's method to This study investigates the 1980–2007 Tunisian period's energy usage and agricultural value addition while controlling for trade openness. Investigations on the link are conducted for both aggregated and broken-down energy consumption components, such as oil and electricity. They contend that increased agricultural value is a result of trade openness and aggregated and disaggregated energy usage. Therefore, the Tunisian agricultural sector supports both the energy-led development and trade-led growth hypotheses. Energy, according to Maamar Sebrin and Mehdi Abid, can be seen of as a limiting factor to the value added of agriculture. As a result, shocks to the energy supply would be detrimental to the performance of agricultural. Additionally, trade liberalization appears to be a driving force behind the success of Tunisian agriculture(Sebri and Abid, 2012)

Using an economic model, (White et al., 2013) analyze how the agriculture and forestry sectors can work together to meet rising bioelectricity demand under hypothetical future national-level renewable electricity standards. They contend that increasing the production of bioelectricity at the national level may be accomplished through the forest and agricultural sectors, with only little effects on GHG flux, land use change, and commodity pricing. The main biomass feedstock is anticipated to be energy crops. Perennial energy crops, such as switchgrass, may provide environmental advantages to the extent that they replace conventional agricultural crops.(White et al., 2013).

In order to analyze the agricultural energy decomposition and its decoupling from economic output in Pakistan from 1981 to 2020 and to demonstrate the impact of four key driving factors, including agriculture energy intensity, agriculture economic output, agriculture labor intensity, and total agriculture land,(Raza et al., 2023) use the logarithmic mean Divisia index method. The findings indicate that AEO is the primary cause of the increase in energy usage. While ALI displays mixed impacts throughout the intervals. The strong negative decoupling condition could therefore be replaced with the strong decoupling employing energy technologies based on additional regulations. Given that energy demand is accelerating, it implies that the agricultural industry can achieve mixed energy, energy management, increased capital investment, and skilled labor(Raza et al., 2023)

In a different study, (Yan et al., 2017) used the Generalized Divisia Index to analyze the key factors (carbon factor of energy consumed in agriculture, energy intensity of agricultural production, and growth in agricultural production) and their effects on the energy-related GHG emissions in agriculture for selected countries, namely: Belgium, France, and Latvia. They contend that from 1995 to 2012, the only countries with rising GHG emissions were France, Latvia, and Belgium. In the case of France, the growth in the scale of agricultural production was accompanied by an increase in energy intensity. A rise in carbon factor revealed to be the main cause of an increase in GHG emissions in Latvia and Belgium. Additionally, it was suggested that jobs should be created in these nations to lower GHG emissions from agricultural energy use. Energy efficiency improvements seem to be a more practical way to guarantee ongoing reductions in GHG emissions(Yan et al., 2017)

The ARDL model is used by (Waheed et al., 2018) to examine how carbon dioxide (CO2) emissions in Pakistan are impacted by the usage of renewable energy, agricultural productivity, and forestry. They make use of annual data from 1990 to 2014. The use of forests and renewable energy have been found to have negative and significant long-term effects on CO2 emissions, suggesting that CO2 emissions can be decreased by expanding the use of forests and renewable energy. Contrarily, agricultural output has a long-term, positive impact on CO2 emissions, suggesting that agriculture production also contributes significantly to Pakistan's carbon emissions. Additionally, in the short term, use of renewable energy and forest have produced results that are comparable, while the effects of agriculture become statistically insignificant. In addition, we demonstrate that compared to agriculture and renewable energy, planting forests reduces CO_2 emissions more effectively. Our findings hold up to different model requirements (Waheed et al., 2018)

In order to examine energy-related CO_2 emissions and structural emissions reduction in China's agricultural from 2007 to 2017, (Yu et al., 2020) employ the input-output technique, an energy consumption model, and structural decomposition analysis. (1) The input structure effect and the energy intensity effect in 2007 inhibited the growth of energy-related CO_2 emissions in China's agriculture, with the reduction effect of energy intensity effect being the more noticeable. In contrast, the final demand effect and the energy structure effect contributed to promoting the growth of energy-related CO_2 emissions in China's agriculture, with the final demand effect being the greater promoting factor (2) The energy structure impact did not successfully lower energy-related CO_2 emissions in China's agriculture because the supply-side optimization of the consumption structure is still not clear. The proportion of energy coming from high-carbon fuels like raw coal, coke, and other washed coal has increased rather than decreased, while natural gas is still being optimized slowly, which limits the impact of reduced emissions on the energy structure. (3) The growing need for agriculture throughout the entire industrial system is the cause of the final demand impact, which has fueled an increase in energy-related CO_2 emissions in China's agriculture. About each industry individually, the secondary industry, which accounts for more than 50% of the final demand effect, has played a significant role. It is followed by the primary and tertiary industries. Finally, from the perspectives of the industrial system on the demand-side, the energy system on the supply-side, as well as in China's agriculture, they offer a theoretical and practical basis for precisely and efficiently executing emissions reduction (Yu et al., 2020).

Using annual data from 1981 to 2015, (Khan et al., 2018) investigate the relationship between agriculture value added, coal electricity, hydroelectricity, renewable energy, forest area, vegetable area, and greenhouse gas (GHG) emission in Pakistan. All the explanatory variables, according to the argument, demonstrated a causal relationship with GHG emissions, agriculture value added, coal electricity, hydroelectricity, renewable energy, and forest area. From hydroelectricity to GHG emissions, renewable energy to GHG emissions, forests to GHG emissions, forests to coal electricity, hydroelectricity to forests, and vegetable areas to forests, the unidirectional causality was observed. There is a two-way causal relationship between the value added to agriculture and the amount of forests(Khan et al., 2018)

Investigating the use of renewable energies for agricultural activities in both developing and developed countries, (Rahman et al., 2022)reveal the current status, future potential, as well as challenges to be faced in this sector. It was said that industrialized nations have a high adoption rate for the use of renewable energy in agriculture. The use of RE in agriculture could be the key to the creation of a sustainable agriculture sector, however poor nations are still having difficulty doing so due to issues including technical and economic ones.(Rahman et al., 2022)

Hatirli et al. (2005) used ordinary least squares to assess energy use and investigate the effects of energy inputs and energy types on output levels in Turkish agriculture from 1975 to 2000. It was discovered that direct and indirect non-renewable energy sources had a favorable effect on output level. Furthermore, the amount of non-renewable energy used in Turkish agriculture has also increased. This inefficient energy use pattern in Turkish agriculture has the potential to cause several environmental issues, including an increase in CO2 emissions and non-sustainability. Therefore, new policy mechanisms should be implemented by decision-makers to ensure sustainability and effective energy use (Hatirli et al., 2005)

Based on data on the energy consumption of Chinese agricultural from 1991 to 2008, (Lu et al., 2011) apply the DoseResp growth curve for the energy scenario analysis of the future trend of the energy consumption of Chinese agriculture. First, he makes the case that Chinese agriculture's energy use follows the DoseResp growth curve. Second, the energy scenario A estimates that Chinese agriculture will need 148.73948 million tons of energy at its peak in 2065. Thirdly, the energy scenario B estimates that Chinese agriculture will reach its peak energy consumption of 205.52559 million tons TCE in 2067. (Lu et al., 2011)

Using the Solow residual approach, Reza Moghaddasi and Amene Anoushe Pour examined the relationship between energy consumption and growth in total factor productivity of agriculture in Iran from 1974 to 2012. According to the predicted aggregate Cobb-Douglas production function, a 1% change in the cost of labor, capital, and energy will result in a 4.07, 0.09, and 0.49 % change in the value added to agriculture, respectively. According to the Johansen cointegration test, there is a negative relationship between TFP growth and energy consumption in Iranian agriculture over the long term, which may be because this industry uses cheap and ineffective energy. It is advised to gradually liberalize energy prices and implement so-called "green box" assistance schemes.(Moghaddasi and Pour, 2016)

In their study of energy use in Ghana before and after the Economic Recovery Programme/Structural Adjustment Programme (ERP)/(SAP), (Amoako et al., 2022) pay particular attention to the degree to which the regime change moderates energy use in the agriculture and manufacturing sectors, two important economic sectors. The study discovers that the structural change policy is positively connected with energy use using the Ordinary Least Squares (OLS) and Fully Modified Ordinary Least Squares (FMOLS) on data spanning 1971–2014. Manufacturing and agriculture both have favorable effects on energy use. The required energy consumption plan must be implemented in tandem with following structural change policies that prioritize growing output, particularly in the private sector. The industry and agricultural industries should concentrate on energy-efficient production systems and blends. (Amoako et al., 2022)

Wysokiński et al. (2020) study the economic and energy efficiency of agriculture in European Union nations using the CCR (Charnes, Cooper and Rhodes) model, which is input-oriented minimization-focused. They suggested that agriculture's economic and energy efficiency is rising along with socioeconomic development in the EU member states.(Wysokiński et al., 2020)

In an analysis of how agriculture functions in India as both a producer and a consumer of energy, (Praveen et al., 2021) discovered that the total commercial energy input in agriculture has grown. Producing biofuels, which are thought of as a backup technology to energy sources based on fossil fuels, is part of the agriculture sector's role as an energy generator. However, there are challenges with sustainability because food and biofuel crops compete for the same resources.(Praveen et al., 2021)

To assess the biomass utilization potential from agricultural residue in Lithuania, Astrida Miceikien and Rita Buinskien used mathematical equations, analysis, synthesis, and other methods to discuss biomass potential utilization for energy production from primary and secondary agriculture residue assessment. They found that the potential energy yield from primary agriculture residue is higher than secondary agri-residue. (Bužinskienė and Miceikienė, 2021)

Popescu (2015) conducted yet another investigation in Romania. Identifying and analyzing the evolution of technical progress, energy consumption, and agricultural value addition revealed that using conventional least square approaches. relationships exist between the use of fertilizers and pesticides, energy in agriculture, value added in agriculture, forestry, and fishing that may reveal the flaws and strengths of Romanian agriculture when compared to that of Europe (Popescu, 2015)

To determine the extent and factors affecting the consumption of bioenergy of agricultural origin in agriculture in the EU, (Rokicki et al., 2021) using descriptive, tabular, graphical, Gini concentration coefficient, Lorenz concentration curve, descriptive statistics, Kendall's tau correlation, They came to the conclusion that there was a correlation between the consumption of bioenergy with agricultural origin in agriculture across the EU and specific economic indicators related to agriculture and energy. Additionally, it must be noted that this sector's use of bioenergy with agricultural origin in agriculture was low and very slowly increasing. This is a result of the agricultural industry's weak innovation potential. Additionally, it might be said that agriculture's potential for producing renewable energy for farm usage is underutilized (Rokicki et al., 2021)

Based on 2000 data from peer-reviewed journals, Bibliometrix analysis was carried out using a R program to assess how Agriculture 5.0 contributed to farmers' prosperity in the post-pandemic era and the progressive conversion to an energy-smart farm. The first records on smart farming, according to arguments made by (Ragazou et al., 2022), surfaced in 2017. As a result, Agriculture 5.0 is moving in the correct direction to transform from a normal smart farm to an energy-smart farm when combined with green energy sources and smart equipment.

For the OBORI economies from 1980 to 2017, the impact of agriculture and forestry on environmental degradation was assessed using Fully Modified Ordinary Least Square (FMOLS) and Dynamic Ordinary Least Square (DOLS) by (Mahmood et al., 2019). They suggested that increased energy demand and agriculture are to blame for the worsening of the environment. The quality of the environment is being improved by the forest. In addition, it was proposed that authorities take into account eco-friendly and effective energy-using strategies to counteract the negatively impacting consequences of agricultural and energy use on the environment, respectively.(Mahmood et al., 2019)

For each of the five historical periods (1871, 1931, 1951, 1981, and 2011), Lluis Parcerisas1 and Jérôme Dupras calculated the various energy flows and their corresponding Energy Return on Investment (EROI) in Quebec, Canada. They contend that the current emphasis on intense monocultures and animal production is inefficient and uses a lot more energy than it contributes to society (Parcerisas and Dupras, 2018).

A Cuckoo Search Algorithm was developed by (Pathak et al., 2019) that enables water to be distributed for farms in any situation. Thermostats, surface water, PH, and precipitation were all measured and wirelessly communicated using an Internet of Things (IoT) device. The IoT devices in this IoT ecosystem were used to present the detection data on the public cloud. The theoretical Cuckoo Search Algorithm, which identifies the appropriate crops for a given soil, has been developed using the data from Thing Speak.(Pathak et al., 2019)

Using the recommended reviewing items for observational studies Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) technique, (Navarro et al., 2020) present a thorough analysis of the existing documentation on precision grid with IoT, identifying the key devices, applications, security mechanisms, process control capabilities, and the validity of agricultural production with IoT to cultivation. The way that data is employed in traditional approaches is frequently dynamic. On the other hand, new technologies have made it possible to use databases to identify crop mistakes and increase crop categorization accuracy in more significant developments (Navarro et al., 2020)

An improved version of smart water management platform (SWAMP)dubbed the water management model, which is a ground-based IoT-based precision agricultural tool that uses completely accessible reservoirs, sinks, and diffusion hubs, was proposed by (Ullah et al., 2021)with the goal of lowering energy usage. When analyzing the results, electricity demand, the proper model time, the package sent to the recipient, and the delivery ratio all appear to be considered. According to the results of the trials, energy-efficient water management platform (EEWMP) generates twice as much power quality as SWAMP while absorbing less energy. Several groundwater models, including irrigation, animal watering, surface irrigation, and gesture control irrigation, use EEWMP with very modest modifications. Smallholder farmers can also utilize it in foreign countries where 2G or 3G internet networks are already available (Ullah et al., 2021)

A precision agricultural ontology, an OWL-based epistemological model that aids in a greater understanding of the relationships between the context concerns, was created by (Sivamani et al., 2013). The established framework is used to re-sample the Internet of Things (IoT) knowledge as background knowledge and make it recognizable for those extra schemes. For the benefit of farmland, the suggested framework has evolved into the ideal method for developing clever and talented agricultural operations (Sivamani et al., 2013). The efficiency of tools as well as current IoT innovations in the agricultural sector were improved. There will also be a discussion on global initiatives and inventions, both public and private, that have been made to offer smarter, safer, and better agricultural solutions. It is suggested an improved agricultural system based on IoT principles and a brief overview of the current state of affairs, developments, development prospects, weaknesses, and potential difficulties is provided (Sivamani et al., 2013)

The role of unmanned aerial vehicle expertise in agricultural development was described by (Boursianis et al., 2022) by evaluating unmanded aerial vehicle (UAV)applications in a variety of situations, including cultivation, fertilization, chemical use, weed control, seed germination tracking, crop preventative medicine, and epigenetic modification at concession stands. They also reviewed the most recent studies on IoT and UAV technologies in construction. Additionally, the employment of UAV systems in challenging agricultural circumstances is also covered. Only the IoT and UAV are among the most common, according to the findings. Relevant advances that are developing agricultural development into a new intellectual ability from traditional farming approaches.(Boursianis et al., 2022)

Kaur et al. (2020) examined the recent accomplishments of various researchers and academic institutes. Aside from that, new issues that have emerged during agricultural operations have been highlighted, along with prospective answers, in order to give future researchers in this field the resources they need to assess the state of IoT and create more intriguing and original ideas (Kaur et al., 2020)

A thorough analysis of all relevant studies on IoT precision farming, sensor equipment, programming interfaces, and service forms was presented by (Farooq et al., 2019). Additionally, it discussed the main issues and worries being investigated in the field of agriculture. Additionally, a proposed IoT cultivation system highlights the depiction of a variety of existing agricultural explanations. Additionally, community projects for IoT-based farms have been put out. Finally, IoT farmland-related open issues and current developments have been brought up to give researchers promising new developments.(Farooq et al., 2019)

In order to raise awareness about the significance of technical assistance and modification for a quick recovery in urban agriculture,(Shamshiri et al., 2018)assessed a number of current developments in renewable energy and controlled environment agriculture (CEA). A number of components of a contemporary CEA system were looked at, such as modifications to the framework and supporting products, environmental awareness and intelligence collecting, and integrated frameworks for reducing climate change and electricity use (Shamshiri et al., 2018).

Due to its high energy consumption and few distinct patterns, (Lee et al., 2010) determined that the sensor network Authentication scheme was best suited for agricultural settings. S-MAC and X-MAC, among other necessary interfaces, were set up in the installation environment. A method for selecting the ideal protocol for an agriculture site was suggested after they had been evaluated.(Lee et al., 2010)

Batch processing and its dynamic resource data gathering approach in wireless sensor networks (WSN) were addressed by (Nandal and Dahiya, 2021). The study established their overview, carried out a similar evaluation of the approaches addressed, and highlighted the complexity and drawbacks of WSNs in the context of farmland. It also employed the phraseology of energy efficiency and cultivation techniques used in wind resource assessment.(Nandal and Dahiya, 2021)

The Security Analysis of a Park-level Agricultural Energy Network Considering Agrometeorology and Energy Meteorology in China is carried out by (Fu et al., 2020) using the Monte Carlo approach. They conclude that severe weather, such as freezing temperatures and protracted cloud cover, frequently causes significant harm to agricultural production and energy infrastructure. A significant percentage of new energy technologies are available in a park-level agricultural energy network, which amplifies the effects of the weather. The safety and efficiency of the park-level agricultural energy network depend on an analysis of the twin effects of energy meteorology and agrometeorology (Fu et al., 2020).

In order to determine if agriculture in France balances its energy use and continues to produce food, (Harchaoui and Chatzimpiros, 2018) used conventional least square methods. They contend that modern agriculture has such severe structural energy deficiencies that its functional energy needs are practically equivalent to its output. At most, the primary biomass equivalent of the external energy inputs to agriculture may be covered by the energy recovery potential from crop leftovers and manure. Agriculture can only become a net energy provider to society by suppressing feed from crops and recovering a very high amount of energy from agricultural residues.(Harchaoui and Chatzimpiros, 2018)

Al-Mulali, (2015) uses a panel model to examine the effects of biofuel energy on economic growth, pollution, the price of agricultural products, and total agricultural production in 16 of the world's largest consumers of biofuel energy, including Canada, the United States, China, Argentina, Brazil, the Czech Republic, Finland, France, Germany, Italy, the Netherlands, Poland, Portugal, Spain, Sweden, and the United Kingdom. He concluded that biofuel energy boosts GDP growth and lowers pollution. Additionally, there is a long-term correlation between the production and consumption of biofuel energy, GDP expansion, CO_2 emissions, agricultural prices, and agricultural output. Additionally, the FMOLS test findings amply demonstrated that the use of biofuels has a long-term favorable association with economic expansion, agricultural price levels, and overall agricultural output. Additionally, there is a long-term inverse link between the usage of biofuels and CO_2 emissions. Furthermore, the Ganger casualty test results demonstrated that, while there is no causative association between the level of CO_2 emissions in the analyzed nations and the consumption and production of biofuel energy, there is a positive causal relationship between the two and GDP growth. Additionally, the development and consumption of biofuels both raise agricultural output and prices in the countries under study. However, it raises agricultural crop prices as well as output. It is advised that these nations use measures to expand their biofuel energy without raising the price of agriculture because biofuel energy encourages GDP growth and lowers the level of pollution (Al-Mulali, 2015)

Using data from 31 Chinese provinces from 1993 to 2016, (Zang and Zhang, 2019) intend to calculate the biomass energy potential from agriculture, examine composition, and study evolutionary tendency. The findings demonstrate that: (1) Over a 24-year period, China's biomass energy potential from agriculture increased from 139.42 million metric tons of coal equivalent (Mtce) in 1993 to 196.51 Mtce in 2016 (2) In terms of resource composition, the majority of the biomass energy potential from agriculture was derived from the straws of rice, wheat, and maize, which accounted for up to 60.97% of all types of biomass energy; (3) In terms of evolutionary trend, the biomass energy potential from agriculture displayed an increasing trend, but gaps between the provinces gradually grew wider (Ben Jebli and Ben Youssef, 2017).

(Chebbi, 2010) gives some understanding of the connections between energy consumption, carbon emissions, and the sectoral components of output growth for Tunisia (agriculture, industry, and services). The results of the long-run estimations show that there is a bidirectional causal relationship between energy use and both output growth and CO2 emissions. The short-run results, however, imply that the relationship between GDP and CO2 emissions and between GDP and energy consumption is not constant across sectors (Chebbi, 2010)

Despite the many benefits that agriculture has for the economy that have already been mentioned, as the following paragraphs will show, researchers have differing views on the environmental benefits and drawbacks of agriculture.

Isermann (1994) addresses the contribution of agriculture to global emissions of climate-changing gases and to the potential for global warming using a cause-oriented approach . Additionally, suggestions for appropriately reducing these pollutants are offered.

Model From 1968 to 2016, (Rauf et al., 2018) examine the relationship between energy consumption, economic growth, the value added to agriculture, industry, and services, trade openness, financial development, urbanization, and environmental degradation (CO2 emission) in China. The short-run and long-run estimate fundamentals are captured by the ARDL bound testing model. The environment is predicted to get worse over time due to industry, agriculture, services, energy use, and trade openness, although growth and urbanization are predicted to maintain a clean and responsible environment quality. Furthermore, studies with Granger causality aligned results with ARDL show directional connected-ness. It is advised that generating energy from renewable sources will help to minimize greenhouse emissions (CO2). In the meanwhile, the government must enact strict laws and regulations to impose carbon taxes on key economic sectors, with a specific focus on the green economy.

Numerous diogenitic tests support the validity of the model and estimations, which show that trade openness, industry, agriculture, and services have a positive and significant impact on carbon emissions while growth and urbanization have a negative but significant impact on the quality of the environment. In the case of China, only financial development was shown to be negligible in terms of carbon emissions over the short and long terms(Rauf et al., 2018).

The consequences of abundant natural resources on carbon dioxide (CO_2) emissions are examined by (Danish et al., 2019). The study makes use of annual panel data from the BRICS countries from 1990 to 2015. The augmented mean group (AMG) panel method infers the heterogeneous effect of natural resources on CO_2 emissions among the BRICS countries. It is robust to cross sectional dependence and heterogeneity. In Russia, the abundance of natural resources reduces CO_2 emissions, yet in South Africa, it increases pollution. Additionally, in Brazil, China, Russia, and South Africa, natural resources contribute to the formation of the Environmental Kuznets Curve (EKC) theory. Finally, causality analysis proposed a feedback relationship between CO_2 emissions and natural resources demonstrate that natural resources of Brazil, China, and India have no effect on CO_2 emissions. However, because there are so many natural resources available, their richness aids in reducing pollution in Russia. Because of the unsustainable exploitation of natural resources, South Africa's natural resources are not environmentally friendly. In addition, renewable energy sources, except for South Africa, help BRICS nations reduce environmental pollution. In addition, the EKC hypothesis is supported in all BRICS nations except for India, where it cannot be supported. In this study, we also discovered that the quantity of natural resources is a crucial factor in forming the EKC hypothesis. Since natural resources do not appear to contribute to environmental degradation, it is possible that this is another factor in the lack of EKC in the nation.(Danish et al., 2019)

Olanipekun et al. (2019) use the pooled mean group (PMG), mean group (MG), and augmented mean group (AMG) techniques to study the impact of agriculture on the environment, conditional upon the level of income, in a panel of eleven Central and West African countries from 1996 to 2015. According to our research, agriculture, and income both contribute to environmental degradation. Rising income levels mitigate the damaging effects of agriculture on the environment, according to the interaction effect. Additionally, while greater reliance on renewable energy sources and tighter laws slow environmental deterioration, population growth worsens the situation. According to this study's findings, unsustainable farming practices harm the environment, but they can be counteracted by reducing poverty. Poverty must be addressed, and income levels must be increased in an environmentally sustainable way, to stop the problem of environmental degradation.(Olanipekun et al., 2019)

A completely integrated approach is used by (Dodder et al., 2015) to study the effects of energy costs and the availability of cellulosic biomass on agriculture, energy, and the environment. The outcomes of this integrated agriculture-energy modeling framework in terms of biofuels can be divided into two categories. First, the scenarios show how significant changes in the price of crude oil and natural gas will be for the production and usage of biofuels as well as for the agricultural markets (i.e., the impact of energy on agriculture). Second, the results show that while the effects on the overall energy markets are less significant in the no cellulosic scenario than in scenarios 1 and 2, the effects on the demand for corn-based ethanol and corn prices are comparable.(Dodder et al., 2015)

In their study over the years 1996–2017, (Wang et al., 2020). Looking at how natural resources, agricultural value-added, and financial development relate to CO_2 emissions and economic globalization. By adding fresh empirical data on how economic globalization, financial development, agriculture value-added, and natural resources affect CO_2 emissions in G7 economies, this study adds to the body of previous work. For the short-run and long-run outcomes of the empirical analysis, this study uses cutting-edge econometric methods like Cross sectional Autoregressive lag model CS-ARDL. The actual data demonstrates that the exploitation of natural resources, financial innovation, and economic globalization all lead to an increase in carbon emissions. In contrast, adding value to agriculture reduces carbon emissions. According to this analysis, initiatives intended to reduce carbon emissions should take more than a year to take effect (Wang et al., 2020)

Researchers (Liu et al., 2017) look at the relationship between per capita renewable energy, agriculture, and CO_2 emissions, as well as output and non-renewable energy, in a sample of BRICS nations from 1992 to 2013. All-time series data are shown to be stationary in first difference by panel unit root tests, and panel co-integration tests demonstrate the presence of a co-integration connection between the variables. The three panel long-run elasticities show that while per capita nonrenewable energy and agriculture have a positive impact on emissions, per capita renewable energy and production have a negative impact. Additionally, there are unidirectional linkages between renewable energy and both emissions and non-renewable energy, as well as relationships between agricultural value added and output and output and non-renewable energy in the short term. Long-term causal relationships between emissions and the usage of non-renewable energy are discovered. In order to stop global warming, officials in the BRICS nations should promote the use of renewable energy sources and improve agricultural management.(Liu et al., 2017)

Researchers (Ikram et al., 2020) analyze the country-level connections between international organization for standards (ISO) 14001 certification, renewable energy use, access to electricity, agriculture, and CO_2 emissions in the South Asian Association for Regional

Cooperation (SAARC) nations. These nations merit careful consideration since they are home to 20% of the world's population, are making infrastructure investments, and are at risk from the effects of CO_2 emissions. While employing innovative modeling to try and understand dynamic linkages among countries, there is a void in the literature that addresses all of these countries. The data in this study is examined using a variety of models, starting with unique Grey Relational Analysis (GRA) models to rank and weight the countries according to their CO_2 emissions. Next, based on weights generated by Second Synthetic Grey Relational Analysis, we assess which country among all countries has the largest CO_2 emission problems using a Conservative (maximin) model Second Synthetic Degree of Grey Relational Analysis (SSGRA). Finally, the elements that have a greater impact on CO_2 emissions are given priority using the grey preference by similarity to ideal solution (G-TOPSIS) methodology. The findings show that among all SAARC nations, India has serious CO_2 emission problems. Additionally, we observe emissions declines from the use of renewable energy sources and the adoption of ISO 14001 certification in these nations. The findings of this study can help businesses and policymakers in their choices and investments for reducing CO_2 while also enhancing environmental sustainability practices.(Ikram et al., 2020)

For 115 nations between 1990 and 2016, (Uddin, 2020) examined the causal relationship between the sectoral growth of agriculture and manufacturing using the Environmental Kuznets Curve (EKC) paradigm. According to the findings, there is a long-run equilibrium link between CO_2, CH_4, and PM2.5 emissions and their macroeconomic drivers, including GDP growth in manufacturing and agriculture, energy use, urbanization, trade openness, and transportation. Further agricultural GDP development (YA^2) has a considerable positive effect on low-income groups while having little effect on lower middle, upper middle-, and high-income groups in terms of CO_2 emissions. For low, lower-middle-, and high-income groups, the agriculture sector exhibits an inverted U-shaped EKC for CH_4 emission, and for all income groups for PM2.5 emission. However, for all income categories, industrial GDP growth exhibits a U-shaped EKC on CO_2 emissions and an inverted U-shaped EKC on CH_4 emissions. The variables have bidirectional and/or unidirectional causality for all the income panels, according to the pair-wise Granger causality test that follows. Our findings imply that the government can prevent environmental degradation in the nation by encouraging sectoral energy efficiency policies, greener technologies, and strict regulation.(Uddin, 2020)

Emam (2022) revealed how agricultural output (date production) affects the environment and agricultural gross domestic product (AGDP) (CO_2 emissions). From 1990 to 2019, we gathered information on date production, AGDP, and CO_2 emissions from several sources. The Engle-Granger two-step process, autoregressive distributed lag (ARDL) boundaries methods of analysis, regression analysis, and forecasting tests were all employed to evaluate the data. The outcomes of the ARDL model were supported by findings from analyses using completely modified ordinary least squares (FMOLS) and dynamic ordinary least squares (DOLS). According to the findings, there are long-term correlations between date output and both CO_2 emissions and AGDP. While the second result shows a detrimental impact on the environment, the first result is consistent with theory and promotes economic growth. We conducted a regression analysis to identify the production elements that led to this unfavorable result, and the results showed that the coefficient of power consumption (an independent variable) was positive and very significant in explaining the variation of CO_2 emissions. As a result of rising CO_2 emissions over the study period, agriculture had a detrimental impact on the environment, according to the regression analysis's findings. The findings of the forecasting research indicated a decrease in CO_2 emissions for the years 2020 to 2026. The findings of the study prompt us to suggest that, to boost economic growth, date production should be enhanced along with the coordinated use of renewable electricity sources. The proportion of renewable electricity in overall electricity consumption should be increased and kept up in order to support the government's efforts to preserve the environment.(Emam, 2022)

Researchers (Shaari et al., 2021) use data from Malaysia to examine how energy use in the country's agriculture sector affects CO_2 emissions. The Autoregressive Distributed Lag (ARDL) approach using annual data from 1981 to 2018 reveal that there is a long-term inverse link between energy use in the agricultural sector and CO_2 emissions. However, in the near term, there is no connection between energy use in the agricultural sector and CO_2 emissions. Other than that, population and economic expansion can have both short- and long-term effects on CO_2 emissions. As a result, the results suggest that increasing energy use in the agricultural sector can lower CO_2 emissions. The current condition is regarded as favorable for the environment. As a result, by lowering CO_2 emissions, the agricultural industry can indirectly enhance the environment.(Shaari et al., 2021)

The effect of foreign direct investment on greenhouse gas emissions in the agriculture sector of emerging nations is examined by (Kastratović, 2019). A dynamic econometric model was estimated using panel data from 63 developing nations for the years 2005 to 2014 by using the system-generalized method of moments. Empirical findings show that foreign direct investment has a favorable effect on the intensity of carbon dioxide equivalent emissions in developing nations. The findings offer shaky support for the theory of pollution havens and highlight the significance of coordinating foreign direct investment with environmental policies.(Kastratović, 2019)

Ngarava et al., (2019) looked at the validity of environmental Kuznets curves (EKC), which look at the relationship between income and environmental degradation, to investigate the trade-offs between SDGs 1 (poverty reduction), 2 (food security), and 13 (climate change action). Real agricultural revenue (2004 constant levels) was used as the study's measure of income for the agricultural sector in South Africa from 1990 to 2012, while agricultural CO2 emissions served as the indicator for environmental deterioration. Agriculture-related CO2 variables utilized in the study include agricultural income, income squared, income cubic, consumption of coal and electricity, and agricultural income. The approach of boundaries testing was utilized to look at the long-term relationship between the variables. In the three models, the investigation discovers cointegration between the series (linear, squared and cubic). Additionally, South Africa's agricultural CO2 emissions tend to rise because of the consumption of power and coal in the sector. Due to the U-shaped EKC in the squared model and the absence of a relationship in the cubic model, the EKC hypothesis is not supported in the South African agricultural industry. As a result, CO2 emissions in the South African agriculture industry rise along with agricultural income. This suggests that for South Africa to fulfill SDG 13 and cut its CO2 emissions, agricultural expansion must be sacrificed. This is impossible because agriculture is necessary for food security, reducing hunger (SDG 2), and eradicating poverty (SDG 1).

Chandio et al., (2021) examine the long-term effects of population growth, FDI, electricity consumption in the agricultural sector, and financial development on the environmental quality in Pakistan from 1980 to 2016. We use agricultural CO2 emissions as a stand-in for other environmental quality indicators. To examine the stationarity and structural break in the data series, we use a variety of unit root tests (such as ADF, PP, ERS, KPSS, and structural break unit root tests; Z&A, CMR). To ensure their robustness, cointegration tests, including as the Johansen, Engle-Granger, and ARDL cointegration techniques, are applied. The findings demonstrated that there is strong long-term cointegration among the variables. Findings also showed that while an increase in economic growth and power use in the agriculture sector worsen Pakistan's environment, an increase in financial development and foreign direct investment (FDI) enhances it. We recommend that governments create a favorable climate for foreign investment considering the findings. To further minimize environmental pollution in the nation, it is recommended that reliance on fossil fuels be lessened and a shift to renewable energy sources be promoted.(Chandio et al., 2021)

Altouma et al. (2022) set out to determine how CO_2 emissions were impacted by energy consumption and economic growth in the Czech Republic. Econometric analysis, specifically the Johansen, Vector Error Correction Model, and Granger Causality, was used to examine the relationship between CO_2 emissions, economic growth, agriculture, and energy use. The results showed that every variable is cointegrated. Agriculture, energy use, and economic expansion all have positive relationships with CO_2 emissions. Economic expansion and agricultural production have a unidirectional Granger causal relationship with respect to carbon dioxide emissions. Agricultural production has a single-direction Granger causal relationship with economic expansion and energy use. Additionally, there is no Granger Causality between rising economic activity and CO_2 emissions from energy use. This is the first study to scientifically assess the environmental effects of economic growth and energy use in the Czech Republic using the most recent data. This study offers useful guidance on how to increase the use of renewable energy sources, protect the environment, and follow the environmental policy of the Czech Republic.(Altouma et al., 2022)

In order to test the environmental Kuznets curve (EKC) hypothesis, researchers (Mahmood et al., 2019) examined the effects of energy consumption and agriculture's share of income on Saudi Arabia's CO_2 emissions per capita. We investigate the effects of the agricultural sector on CO_2 emissions from symmetrical, asymmetrical, and quadratic angles. Gross domestic product (GDP) per capita and CO_2 emissions per capita are found to have an inverted U-shaped connection. Thus, with a turning point at GDP per capita of 77,068 constant Saudi Riyals, the EKC theory is supported. In both symmetrical and asymmetrical analysis, the agriculture sector has been shown to have a negative and considerable impact on CO_2 emissions per person. The magnitudes of the effects of rising and falling agricultural GDP shares are statistically found to have differing effects on CO_2 emissions, with rising agricultural GDP shares having a bigger impact than declining agricultural shares. The link between the GDP proportion of agricultural and CO_2 emissions per person is also inverted U-shaped, with the GDP share of agriculture turning at 3.22%.

The effects of globalization, renewable energy (RE), and value-added agriculture (AG) on ecological footprints (EF) and CO2 emissions are studied by (Wang et al., 2022). This research paper covers annual data for Bangladesh, India, Pakistan, and Sri Lanka from 1990 to 2018 for quantitative analysis. These nations are particularly at risk from climate dangers and swift economic change. The panel data show a clear relationship thanks to the Westerlund test. The results of fully modified ordinary least squares (FMOLS) and ordinary least squares (DOLS) models demonstrate that RE reduces EF and CO2 emissions over time. Emissions and EF both fall by 10.55% and 2.08% CO2 for every 1% increase in renewable energy, respectively. In a few South Asian nations, environmental degradation is being exacerbated by globalization and AG. As a result, these nations must utilize solar energy to its greatest potential. Additionally, to lessen their reliance on non-RE sources, these nations must explore more renewable energy resources resources. By using effective farming methods, these nations may create a sustainable agricultural industry. Farmers should be more environmentally conscious. Farmers can obtain sustainable agricultural products by using clean inputs and animal fertilizers in agriculture. Overall, this research implies that these nations may implement RE and promote efficient technology through globalization to create a cleaner environment.(Wang et al., 2022)

Authors (Doran et al., 2022) discussed the effects of agri-environmental policy implementation on environmental quality and economic growth, which are the two primary goals of sustainable agriculture. The study's methodology is based on the Agri environment indicators for Romania between 1997 and 2019. We conducted stationarity tests, a cointegration test, and used the Fully Modified Least Squares (FMOLS) approach to estimate the relationships between the variables contained in the three proposed models to address the goals of the entire research. The results showed both the beneficial effects on GDP of agricultural areas set aside for irrigation and those set aside for drainage work, as well as the detrimental effects of the quantity of natural fertilizers used in farming. While using chemical fertilizers and pesticides increases CO2 emissions and environmental degradation, expanding agricultural land with erosion control and land-improvement projects results in lessening these effects.(Doran et al., 2022)

It was the goal of (Assamoi et al., 2020) to look into the pollution haven hypothesis (PHH's) validity in Cote d'Ivoire. For this reason, the function of carbon dioxide emissions includes FDI, real gross domestic product (GDP) per capita, energy consumption, and agriculture value added. The study used the autoregressive distributed lag (ARDL) method with time series data from 1980 to 2014. This work adds to the body of literature by focusing on a typical developing nation that is now experiencing increases in both FDI inflows and CO2 emissions, as well as by introducing structural breaks in the estimating approaches. The results showed that the variables had a cointegration relationship. Additionally, we discover a significant correlation between FDI and CO2 emissions, which supports the PHH in Cote d'Ivoire based on the ARDL data. The findings also indicated that CO2 emissions are positively impacted by GDP per capita, energy consumption, and agricultural value added. Based on the findings, we recommend that Ivorian governments tighten environmental restrictions and concentrate on luring clean FDI. The Ivorian government should also promote the use of environmentally friendly practices in agriculture and establish energy-saving policies (Assamoi et al., 2020)

The emerging seven nations of China, India, Brazil, Mexico, Russia, Indonesia, and Turkey were studied for an annual time frequency from 1990 to 2016. (Adedoyin et al., 2021) looked at the effects of agricultural development, energy use, and economic growth on CO2 emissions in these nations. The study used a variety of econometric methods to ensure the accuracy of its analysis, including the Dumitrescu and Hurlin causality test for the direction of causality analysis, dynamic ordinary least squares, and completely modified ordinary least squares as estimate methods. According to empirical findings, economic expansion and value-added agriculture are the main causes of CO2 emissions in the E7 nations, whereas the growth of renewable energy reduces CO2 emissions in the near term and has a beneficial effect on emissions in the target countries. According to a causality study, there is a feedback causal relationship between economic growth and emissions, energy use in agriculture with added value and emissions, as well as between economic growth and agricultural development. In addition, while energy consumption does contribute to emissions indirectly through economic expansion and value-added agriculture. This stance is in line with the promotion of UN-SDG Targets 7 and 13 regarding access to clean energy and issues related to climate change mitigation.(Adedoyin et al., 2021)

The use of renewable and non-renewable energy, economic development, agricultural value-added, and forestry area on environmental quality in China from 1990 to 2015 were examined by (Chandio et al., 2021). Empirical estimates are generated using the Johansen cointegration strategy and the ARDL bound testing method. According to the empirical findings of the ARDL and fully modified ordinary least square (FMOLS) estimators, China's use of renewable energy and forest area lower CO2 emissions and improve environmental quality, while the country's use of non-renewable energy, economic growth, and agricultural output raise CO_2 emissions. The Granger causality test, impulse response function, and variance decomposition technique are used to assess the reliability of the results, which point to fossil fuel use in agriculture production as the primary cause of China's CO_2 emissions. The "Conclusions" section demonstrates how these findings have intrinsic policy implications for the national and local governments of China (Chandio et al., 2021)

Shah et al., (2022) experimentally investigates the influences of energy, natural resources, agriculture, political restraint, and regional integration on CO_2 emissions in Cambodia, Malaysia, Indonesia, and Thailand, the four ASEAN nations. We make a distinction between the use of fossil fuels and renewable energy to examine how each one affects CO_2 emissions. The study used panel data spanning the years 1990 to 2019 that were gathered from sources including the World Development Indicators and then analyzed using the Common-Correlated Effect Mean Group (CCEMG) and Augmented Mean Group (AMG) estimates. The results demonstrate that while the use of fossil fuels damages the environment, the use of renewable energy has a negative influence on CO_2 emissions. The impact of agriculture was determined to be deleterious, while the role of natural resources was judged to be good for environmental quality. Its impact on regional trade integration was insufficient to compensate for CO_2 emissions. Additionally, we found that political restrictions cause CO_2 emissions. According to the findings, it is advised that the chosen ASEAN countries encourage the use of clean technologies and renewable energy in their manufacturing processes, protect natural resources, adopt eco-friendly governmental practices, and step up regional integration to hasten the achievement of the SDGs.(Shah et al., 2022)

By employing quarterly data, (Rahman et al., 2022) examine the effects of agriculture and industrial production on the carbon emission function, respectively. To find evidence of cointegration among the study's variables, the study utilized the innovative FARDL. The Bayer-Hanck combine cointegration and ARDL limits test were used to examine the FARDL's robustness. The results of both tests support those from the FARDL Additionally, the ARDL framework enabled the identification of the long-term elasticity. Utilizing industry value added and agricultural output in the carbon emission functions, the evidence of inverted N-shaped and N-shaped EKC has been located. Carbon emissions are positively and significantly impacted by financial development. Only in the CO_2-agricultural production nexus model does inflation have a positive and large impact on carbon emissions. The spectral Granger causality proposed by Breitung and Candelon had also been used to examine the causal outcomes. It was discovered that forestry and agriculture have short-, medium-, and long-term effects on CO_2 emissions. The study suggested that Pakistan's government concentrate on environmentally friendly crop and fertilizer producing to decrease food scarcity and enhance sustainable development. Additionally, the government must levy a carbon tax on the industries, which can be used to fund forestation and renewable energy-related projects.(Rahman et al., 2022)

Through the use of panel FMOLS data from the United Nations Development Program, (Zhang et al., 2022) investigate the causal relationship between aggregate energy consumption resources, trade liberalization, CO_2 emissions, and modern agriculture in selected ASEAN nations from 2000 to 2020. (Fully modified ordinary least square). Scientific studies show that the value addition of agricultural products reduces CO_2 emissions in polluted nations like the United States. It was also discovered that there was a positive correlation between the amount of energy consumed and the amount of CO_2 emitted per unit of energy used. In countries where environmental contamination is declining because of trade liberalization, CO_2 emissions can be reduced. Though the use of fossil fuels has led to an increase in CO_2 emissions, research has shown that switching to renewable energy can help lessen the harm done to the environment. Climate-smart agriculturally favored institutions boost revenues and production in agriculture while lowering greenhouse gas emissions. New energy sources are one type of renewable energy that could help keep the environment clean and safe Farmers benefit when they employ renewable energy in agriculture because it lessens their reliance on fossil fuels. On the other hand, trade policy might encourage the flow of capital and technology to focus on manufacturing and economies of scale. It is crucial that ASEAN nations investigate measures that will raise living standards while safeguarding the environment. This includes steps that will increase agricultural sector productivity and foster vibrant international trade markets.(Zhang et al., 2022)

So far, this chapter has helped build the theoretical and empirical framework for this research (and helped created a background for answering research questions two and three) by reviewing on the relationship between and the impact of agriculture on agriculture on economic development across different countries around the world. Though laying the foundation for answering those research questions two, ‘’What is the impact of agriculture on GDP and economic development in Zambia?’’, and four, “How has Zambia’s agricultural production been locally, and trade performance been on the global market?”. This chapter has indicated how the theories that lay a basis for agriculture to be deemed as a catalyst for economic development. These theories included, Rostow’s stages of development; Johnston-

Mellor model; Schultz's transformation of traditional agriculture; and Kuznets on the role of agriculture on development. These theories served as basis indicating the relevance of the topic and reason as to why agriculture is still fundamental for the growth and prosperity of developing countries including Zambia. The next chapter considers the data and methodology.

4. DATA AND METHODOLOGY

This chapter considers the data and sources used, and it includes the empirical and econometric steps applied in arriving at the objectives of this dissertation. This first section presents data used and its sources.

4.1. DATA

Data from the World Bank's World Development Indicators for the period 1983 to 2020 was analyzed annually for entire focus period (World Bank, 2022). The variables of interest included real GDP growth constant 2015 USD; agricultural, forestry, and fisheries value-added constant 2015 as a percentage of GDP; manufacturing value-added constant 2015 as a percentage of GDP; services value-added constant 2015 as a percentage of GDP; and mineral rent as a percentage of GDP (which was a proxy for mining output). Throughout this thesis agriculture, forestry, and fisheries will be used interchangeably with the term agriculture, so will be mining and mineral rent. The variable real GDP growth was chosen as an indicator for economic development, since it incorporates all activities (including the independent variables) pertaining to economic development and growth in a nation overtime, and the data was readily available unlike the other indicators of development (described in section 2.1), which were scanty. For the analysis of the results, EVIEWS 12 software was used.

4.2. ECONOMETRIC PROCEDURE OF EMPIRICAL ANALYSIS

This dissertation applied statistical and time series econometric procedure. The steps of each econometric procedure are as indicated. The general formulation of the model is indicated below:

$$\mathrm{GDP} = \mathrm{f}\,(\mathrm{AG}, \mathrm{MANU}, \mathrm{SER}, \mathrm{MIN}) \qquad (1)$$

where GDP, AG, MANU, SER, and MIN represents real GDP constant 2015 as a percentage of GDP; agricultural, forestry, and fisheries value-added constant 2015 as a percentage of GDP; manufacturing value-added constant 2015 as a percentage of GDP; services value-added constant 2015 constant as a percentage of GDP; and mineral rent as a percentage of GDP respectively. The stochastic form of the model is:

$$\mathrm{GDP_t} = \mathrm{a_0} + \mathrm{a_1AG_t} + \mathrm{a_2MANU_t} + \mathrm{a_3SER_t} + \mathrm{a_4MIN_t} + \mathrm{U_t} \qquad (2)$$

Where; $\mathrm{a_0}$ is the Intercept $\mathrm{a_1}$, $\mathrm{a_2}$, $\mathrm{a_3}$, and $\mathrm{a_4}$ are coefficients for agriculture, manufacturing, services, and mining respectively. $\mathrm{U_t}$ is the Stochastic term (unobserved). The coefficients for the variables of interest agricultural; manufacturing; services; and mineral rent are expected to have a positive sign over the long run and impact on GDP growth as suggested by economic theory (Cowen and Tabarrok, 2021; Johnston and Mellor, 1961; Kuznets, 1961; Mankiw, 2016; Rostow and Rostow, 1990; Schultz, 1966; Stiglitz and Walsh, 2006; Todaro and Smith, 2015). Table 4.1 presents the meaning and definitions of variables as defined in their sources, and as they will be used in the econometric analysis of this dissertation.

TABLE 4.1: DEFINITIONS OF VARIABLES USED

Variable	Interpretation and meaning
GDP	GDP at purchaser's prices is the sum of gross value added by all resident producers in the economy plus any product taxes and minus any subsidies not included in the value of the products. It is calculated without making deductions for depreciation of fabricated assets or for depletion and degradation of natural resources. Data are in constant 2015 prices, expressed in U.S. dollars. Dollar figures for GDP are converted from domestic currencies using 2015 official exchange rates. For a few countries where the official exchange rate does not reflect the rate effectively applied to actual foreign exchange transactions, an alternative conversion factor is used.
Agriculture, forestry, and fisheries	Agriculture, forestry, and fishing corresponds to ISIC divisions 01-03 and includes forestry, hunting, and fishing, as well as cultivation of crops and livestock production. Value added is the net output of a sector after adding up all outputs and subtracting intermediate inputs. It is calculated without making deductions for depreciation of fabricated assets or depletion and degradation of natural resources. The origin of value added is determined by the International Standard Industrial Classification (ISIC), revision 4. Data are in constant 2015 prices, as a percentage contribution to GDP.

Manufacturing	Manufacturing refers to industries belonging to ISIC divisions 10-33. Value added is the net output of a sector after adding up all outputs and subtracting intermediate inputs. It is calculated without making deductions for depreciation of fabricated assets or depletion and degradation of natural resources. The origin of value added is determined by the International Standard Industrial Classification (ISIC), revision 4. Data are in constant 2015 prices, expressed in U.S. dollars, as a percentage contribution to GDP.
Services	Services correspond to ISIC divisions 45-99. They include value added in wholesale and retail trade (including hotels and restaurants), transport, and government, financial, professional, and personal services such as education, health care, and real estate services. Also included are imputed bank service charges, import duties, and any statistical discrepancies noted by national compilers as well as discrepancies arising from rescaling. Value added is the net output of a sector after adding up all outputs and subtracting intermediate inputs. It is calculated without making deductions for depreciation of fabricated assets or depletion and degradation of natural resources. The industrial origin of value added is determined by the International Standard Industrial Classification (ISIC), revision 4. Data are in constant 2015 prices, expressed in U.S. dollars, as a percentage contribution to GDP.
Mineral Rent	Mineral rents are the difference between the value of production for a stock of minerals at world prices and their total costs of production. Minerals included in the calculation are tin, gold, lead, zinc, iron, copper, nickel, silver, bauxite, and phosphate. Data is computed as a percentage contribution to GDP.

Note: The ISIC classification is available at the source indicated below.

Source: World Bank, 2022

The econometric procedure for this dissertation is indicated as follows.

4.2.1. Unit Root Test

The research first did some pre-estimation tests by checking for the presence of unit root in all the variables (Enders, 2014; Engle and Granger, 1987; Green, 2017; Nelson and Plosser, 1982; Woodridge, 2018). This stage is very cardinal knowing that variables with a unit root (non-stationary data) are less precise in larger fractions, which makes the interpretation of results misleading (Engle and Granger, 1987; Nelson and Plosser, 1982). When testing for stationarity with the unit root test, we have the stochastic unit root process:

$Y_t = \rho Y_{t-1} + u_t$, where ρ lies between -1 and 1 (1)

p = 1, where U_t is the white noise error term. Equation 1 becomes a random walk without drift. We regress Y_t on its (one - period) lagged values of Y_{t-1} to find out if $\rho = 1$. The manipulated equation is rewritten as:

$\Delta Y_t = \delta Y_{t-1} + u_t$ (2)

Where: $\delta = (\rho - 1)$ and Δ is the first difference. We estimate equation 2 and test the Null Hypothesis that $\delta = 0$. If $\delta = 0$, $\rho = 1$, we have a unit root (the time series is non - stationary). Before proceeding to estimate equation 2, $\delta = 0$ become:

$\Delta Y_t = (Y_t - Y_{t-1}) = u_t$ (3)

We estimate (2), take ΔY_t, and regress Y_{t-1}, and see if the estimated coefficient in this regression is zero or not. If it is zero, we conclude that Y_t is non – stationery and vice – versa. This test can also have various possibilities. To allow the test of various possibilities, we use the Dickey – Fuller test which follows a tau statistic and can be in three different forms namely:

$\Delta Y_t = \delta Y_{t-1} + u_t$ Y_t is a random walk (2)

$\Delta Y_t = \beta_1 + \delta Y_{t-1} + u_t$ Y_t is a random walk with drift (4)

$\Delta Y_t = \beta_1 + \beta_2 t + \delta Y_{t-1} + u_t$ Y_t is random walk with drift around a stochastic trend (5)

Where t is the time trend variable. In each case the Null Hypothesis is $\delta = 0$ (there is no unit root). If the Null Hypothesis is rejected, the data are stationary. Equation 2 is a random walk without drift.

Equation 4, $(= \beta_1/(1 - \rho))$ is a random walk with drift and equation 5 is a random walk with drift around a deterministic trend.

The actual estimation procedure of the Dickey – Fuller test is as follows:

1. We estimate equations 2, 4 and 5 using the Ordinary Least Square (OLS).
2. We then divide the estimated coefficients of Y_{t-1} in each case by its standard error to compute the tau statistic.

If the computed tau statistic value exceeds the DF value, we reject the Null Hypothesis that $\delta = 0$ (there is stationarity in the time series).

When conducting the DF test, it is assumed that error terms are uncorrelated. But in the instance where the error terms are correlated, we use the augmented Dickey – Fuller (ADF) test.

It is imperative to use an appropriate lag length based on confirmation of the selection of the maximum lag length.

The number of lagged terms is determined empirically, the idea is to include enough terms so that the error term is serially uncorrelated. In the ADF we still test whether $\delta = 0$. The ADF follows the same asymptotic distribution as the DF test statistic, the same critical values can be used. If the null Hypothesis is rejected, it implies that the data is stationary.

To check for the presence of stationary, the widely used Augmented Dickey–Fuller (ADF) is used. The test for the presence of a unit root using the ADF test is preferred because of its ability to account for serial autocorrelation in the computation (Dickey and Fuller, 1981). The general form of the ADF is indicated below:

$$\Delta Yt = \beta_1 + \beta_2 + \delta Y_{t-1} \sum_{i=1}^{m} \alpha \Delta Y_{t-1} + E_t \qquad (6)$$

where ΔYt = represents the related variable, $\beta_1, \beta_2, \delta, \alpha$ = represent parameters in the model, t = represents the time trend, Et = Gaussians white nose with zero mean and possible auto correlation represented by time t.

For this research, the unit root test was tested with random walk and drift. The performance of the ADF is like that of the Phillips–Perron (PP) test (Phillips And Perron, 1988). Both tests have the null hypothesis of the unit root indicating non-stationarity with the alternative hypothesis indicating otherwise (Enders, 2014; Green, 2017; Phillips And Perron, 1988; Woodridge, 2018). However, the limitations of the ADF and the PP are the inability to account for shocks and structural breaks in time series data. In such cases, these two tests (the ADF and PP) usually mistake a structural break as a unit root. To address these defects and account for the presence of structural breaks in time series data, the Zivot–Andrew (Z–A) test was used to confirm stationarity test for the results computed by both the ADF and PP tests (Zivot and Andrews, 2002). This dissertation computed all the three results of ADF, PP and Z–A tests to have a strong conclusion on the realization of the time-series pre-estimation tests, giving a better gist and the best estimation and post-estimation procedures as supported by economics and econometric theory.

4.2.2. ARDL Bounds Test

Having tested for the existence of a unit root, the levels of integration for the variables of interest where known, which were a combination of both I(0), and I(1), depending on the unit root test applied making the ARDL Bounds Tests appropriate when analyzing variables that have multiple combinations of order of integration (Pesaran et al., 2001). The advantage of the ARDL Bounds Test is that it addresses the limitations of Engle and Granger (1987) and Johansen and Jeselius (1990), which limit the cointegration steps to variables of the same order of integration I(1). The optimal lags for each of the variables were determined, in the case of this dissertation using the Akaike Information Criterion (AIC), which is preferred in less sample sizes (for example 60 years or less) because of its ability to minimize underestimation while recovering the true lag length, giving it an edge over Hana-quinn and Schwartz criterions (Enders, 2014; Green, 2017; Liew, 2006; Woodridge, 2018). The long-run relationships between the variables were tested, including the short-run impact of agriculture on economic GDP, which were done using both the Wald Test and interpretation of the ARDL short-run coefficients, as necessitated by the objectives of the dissertation (Enders, 2014; Green, 2017; Pesaran et al., 2001; Woodridge, 2018). The model representation for the ARDL is represented below:

$$\Delta GDP_t = \sigma_0 + \sum_{i=1}^{p} \sigma_{1i} \Delta GDP_{t-p} + \sum_{t=1}^{p} \sigma_{2i} \Delta AG_{t-p} + \sum_{i=0}^{p} \sigma_{3i} \Delta MANU_{t-p} + \sum_{i-0}^{p} \sigma_{4i} \Delta SER_{t-p} + \sum_{I=0}^{P} \sigma_{5i} \Delta MIN_{t-p} + \lambda_1 GDP_{t-p} + \lambda_2 AG_{t-p} + \lambda_3 MANU_{t-p} + \lambda_4 SER_{t-p} + \lambda_5 MIN_{t-p} + E_t \tag{7}$$

Δ is the difference operator: p denotes lag length; σ_0 is the constant term; σ_{1i} , σ_{2i} , σ_{3i} , σ_{4i} are error correction dynamics; λ_1, λ_2, λ_3, λ_4, λ_5 are long-term coefficients; E_t is the white noise disturbance term.

The Wald F statistic is used for determining and checking for the presence of cointegration amongst the variables, using the ARDL bounds test (Enders, 2014; Green, 2017; Pesaran et al., 2001; Woodridge, 2018). The null hypothesis indicates the absence of cointegration against the alternative hypothesis which indicates otherwise. Two bounds are used in examining against this step for cointegration, the lower bound and the upper bound. Higher Wald F statistic, greater the higher I(1) and lower I(0) indicates the presence of cointegration amongst the variables, while the existence of a Wald F statistic lower than the lower and higher bound indicates otherwise. The results are inclusive when the Wald F test lies in between the I(0) and I(1) lower and higher bounds respectively (Enders, 2014; Green, 2017; Pesaran et al., 2001; Woodridge, 2018). The finding of this research as the next chapter shall indicate illustrates agreements with the selected method and model.

4.2.3. Post-estimation and Stability Tests

The estimation model, including its stochastic disturbance term, had to undergo some post-estimation tests to examine the precision of the model. The tests included checking for the presence of autocorrelation in the error term, homoskedasticity (which means constant variance around the error term), and for normality in the model and residues (Enders, 2014; Green, 2017; Woodridge, 2018). The null hypothesis, which indicates the absence of serial correlation, heteroskedasticity, and the presence of normality, is desirable (Enders, 2014; Green, 2017; Pesaran et al., 2001; Woodridge, 2018). The model's level of stability was also checked using the CUSUM squares test to verify the absence or presence of (or no structural breaks) having an impact on the model (Enders, 2014; Green, 2017; Pesaran et al., 2001; Woodridge, 2018). All these diagnostic tests are essential, and they reaffirm the reliability of the model. If all these steps are right, we conclude that the selected model is reliable. A summary of the above explained empirical procedure is indicated on the flow chart (figure 4.1) below.

Theory/hypothesis: Agriculture is importance and significantly contributes to economic development and GDP growth in Zambia (Rostow's stages of development; Johnston-Mellor Model; Schultz's Transformation of Traditional Agriculture; Kuznets theory on the role of agriculture on development)

Econometric procedure:

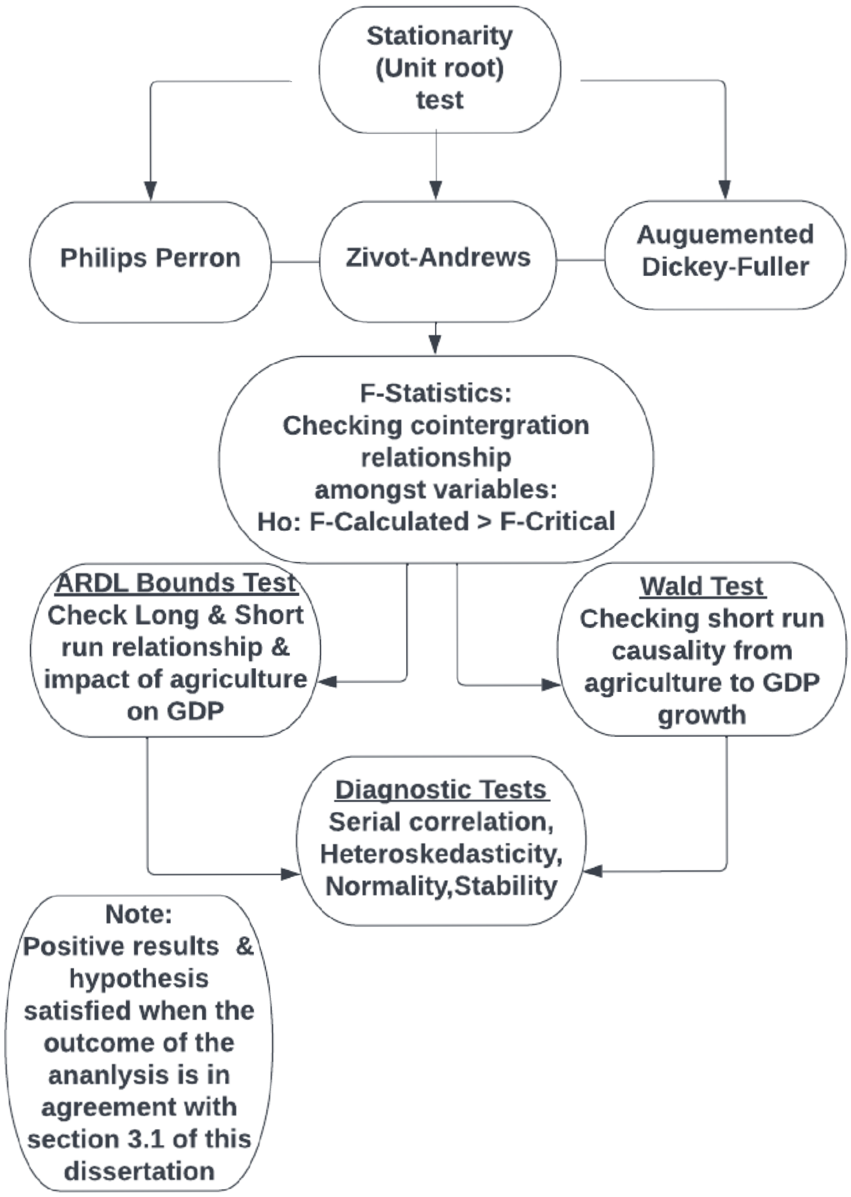

Figure 4.1: Flow chart on econometric procedure

Part of the research question 4, “What has been Zambia’s agricultural food productivity and performance on export market?”, was answered using the auxiliary model, which is indicated in sub-section 4.3.

4.2.4. Justification of using ARDL Bounds Test

As previously mentioned, the ARDL Bounds test was first attributed to Peseran et al. (2001), who showed the flows of always estimating regression with levels (ordinary least squares), in a situation where some variables of interest (in a model) exhibit trending, and seemed to having level of integration either I(0), for example I(1) or a combination of all but I(2), ARDL Bounds test addresses these, a superiority to (Engel) and (Johansen), which limit their combination to a specific level of integration as mentioned in section 4.2.2. All these attributes have made ARDL bounds test quite popular and used my scholars who had time series data with similar characteristics, in situation were models contained the long run dynamics, as well as the short error correction dynamics with respective error correction (cointegration) equations (Adebayo and Odugbesan, 2021; Ahmad et al., 2020; Ahmadi, 2021; Alola and Onifade, 2022; Chin and Hoang, 2017; Demirhan, 2020; Menegaki, 2019; Onifade et al., 2022; Pesaran et al., 2001; Phiri et al., 2021; Srinivasan et al., 2012). In a like manner, tables 5.3. and 5.4 under section 5.3 will demonstrate this with outcome of the results.

4.3. AUXILLARY MODEL

This research also had a research question which examined the factors affecting the performance and durability of the country’s agriculture exports, and the section below explains background of the econometric computations for that.

4.3.1. Method for the derivation of the Kaplan Meier computations

To create the Kaplan Meier graphs and regression model indicated in table 5.9, the dissertation applied a discrete-time model. These models have three advantages over continuous-time models as per (Hess and Persson, 2012). That is, they efficiently deal with ties in duration, control for unobserved heterogeneity, and do not assume a proportional hazard, meaning that the assumption of the hazard rate depending on the covariate and constant overtime is not made.

To understand discrete-time duration models, the computation starts with a life table estimator duration function as follows:

$$\hat{S}(j) = Pr(T > j) = \prod_{m=1}^{j}\left(1 - \frac{d_m}{r_m}\right) = \prod_{m=1}^{j}(1 - h_m)$$

(8)

Where T is the number of consecutive years a product is exported between countries (spell). The failure (hazard) rate is h_m which occurs after a spell has ended. d_m is the time interval of a spell whereby $d_m = (t_m, t_{m+1})$, for $m = 1, \dots, J$. t_m and t_{m+1} are the start and end of the time interval. r_m is the adjusted number of spells at risk of failure at the midpoint of the time interval. It is written as: $r_m = R_m - \frac{c_m}{2}$ where R_m is the number of relationships likely to fail at the beginning of the interval. Estimating equation 1 will establish the duration rate of an exporting firm beyond year j. To assess the impact of covariates on the failure rate of exporting a product, we define the hazard function as follows:

$$h(x_{im}) = Pr(T_i < t_{m+1} | T_i > t_m) = F(x'_{im}\delta + \gamma_m + v_i)$$

(9)

Where $h(x_{im})$ is the hazard rate, x_{im} is a vector of time-varying covariates defined in Table 4.2, δ is the vector of coefficients to be estimated, and γ_m is the baseline hazard rate that is a function of (interval) time that allows the hazard rate to vary across periods. It is presented as several dummy variables which vary according to the length of spells. Frailty (unobserved heterogeneity) is addressed by v_i which follows a Gaussian distribution. $F(.)$ is an appropriate distribution function which can be estimated by maximizing the following log-likelihood function:

$$ln\, L = \sum_{i=1}^{n} \sum_{m=1}^{j} [y_{im}\, log(h_{im}) + (1 - y_{im}) log(1 - h_{im})]$$

(10)

Where L is an expression of likelihood for the whole sample, that is countries from i=1, n. m represents the time interval of the spell from m=1,…, J. y_{im} is a binary dependent variable, which takes the value 1 if the spell i is observed to cease in year m and 0 otherwise. h_{im} is the hazard rate which is specified in equation 2.

To estimate equation 10, the functional form of the hazard rate (h_{im}) must be specified. In our case, we consider the logit and probit, which are the most commonly used specifications for models with a binary dependent variable (Jenkins, 2005).

The thesis overcomes the problem of left-censoring by excluding trading relations before 1996, which is our first of year trading. The main reason is the lack of clarification on whether the trade relationship began in 1996 or earlier. The last year of trading, 2019, is the right censoring. It is included as it has been done by related studies (Asche et al., 2018; Yang et al., 2021; Zhang and Tveterås, 2019). Multiple spells are included as a dummy in line with similar studies (Besedeš and Prusa, 2006; Socrates et al., 2020). Multiple spells arise when an export relationship stops and then recurs during the study period. The variables used in analyzing the auxiliary, using the logit and probit model which addresses research question four, “What has been Zambian agriculture performance on the export market?”, are indicated in table 4.2.

Table 4.2: Variable description and source of data

Variable	Description	Sources
Dependant variable (Dummy)	is a binary dependent variable, which takes the value 1 if spell *i* is observed to cease in year m and 0 otherwise	CEPII database
Distance	Log of simple distance between capitals of the exporter and partner countries	CEPII database
Contiguity	Dummy, 1 for contiguity and 0 otherwise	CEPII database
Common language	Dummy. 1 if the partner has the same common official language and 0 otherwise	CEPII database
Colony	Dummy, 1 if pairs ever in a colonial relationship and 0 otherwise	CEPII database
Zambia's GDP	Log of real GDP for Zambia	World Development Indicators
Partner's GDP	Log of real GDP of the partner country	World Development Indicators
Real exchange rate	Real exchange rate	World Development Indicators
Initial export value	Log of value of export for the previous year	WITS
Total exports	Log of total value of exports per product and destination	WITS
RTA	Dummy if a country is in a similar RTA with a Zambia	Baier and Bergstrand's website: www.nd.edu/jbergstr and WTO's RTA-IS database.

The next chapter, the results and discussion section, which will help in addressing the outcome of research questions two, three, and four, and create a premise for answering research question five in the conclusion chapter.

5. RESULTS AND DISCUSSION

5.1. DESCRIPTIVE STATISTICS

Table 5.1 shows descriptive statistics for the original Zambian data of real GDP constant 2015 USD; agricultural, forestry, and fisheries value-added constant 2015 USD; manufacturing value-added constant 2015 USD; services value-added constant 2015 USD; and mineral rent as a percentage of GDP, all for the period 1971 to 2020.

Table 5.1: DESCRIPTIVE STATISTICS OF GDP AND SECTORS CONTRIBUTING TO GDP

Statistic	GDP	Agriculture	Manufacturing	Services	Minerals
Max	24089861649	1302725857	1812741483	13867728624	36.8531105
Min	5287686297	680840621	301953518.3	2421695254	0.00376025
MEAN	10215943027	1023670228	793992152.9	4958374660	8.16959437
SD	5788879946	191492567.8	431180543.5	3560662103	8.94524389

Source: Author's computations (2022).

As indicated in the table above, the maximum, minimum, mean, and standard deviation values of GDP where 24 089 861 649, 5 287 686 297, 10 215 943 027, and 5 788 879 946 USD respectively. Concerning agricultural, the respective maximum, minimum, mean, and standard deviations where 1 302 725 857, 680 840 621, 1 023 670 228, and 191 492 567.8 USD. With regards to manufacturing, the values 1 812 741 483, 301 953 518.3, 793 992 152.9, and 431 180 543.5 USD where the maximum, minimum, mean, and standard deviation respectively. The respective maximum, minimum, mean, and standard deviations for services where 13 867 728 624, 2 421 695 254, 4 958 374 660, and 3 560 662 103 USD. And finally, mineral rent which was measured as a percentage of GDP had the values 36.8531105, 0.00376025, 8.16959437, and 8.94524389 for the maximum, minimum, mean, and standard deviation respectively. The following table 5.2, shows the descriptive statistics for the similar variables (used in the econometrics model) as a percentage of GDP including economic growth.

Table 5.2: DESCRIPTIVE STATISTICS OF THE VARIABLES USED IN THE EMPIRICAL ANALYSIS

	GDP	AGRICULTURE	MANUFACTURING	SERVICES	MINERALS
Mean	3.562586	12.69462	13.96805	43.69654	5.367060
Median	3.965908	13.25226	9.519588	48.16270	4.546588
Maximum	10.29822	30.47873	33.34589	56.22041	17.69106
Minimum	-8.625442	2.860775	6.023735	21.45483	0.003760
Std. Dev.	3.941271	5.531094	8.909604	10.21820	5.444598
Skewness	-0.766255	0.428355	1.152863	-0.768154	0.737464
Kurtosis	3.694086	4.408399	2.742979	2.324453	2.370289
Jarque-Bera	4.481376	4.302771	8.522180	4.459626	4.072249
Probability	0.106385	0.116323	0.014107	0.107549	0.130534
Sum	135.3783	482.3957	530.7861	1660.469	203.9483
Sum Sq. Dev.	574.7438	1131.941	2937.098	3863.227	1096.815
Observations	38	38	38	38	38

Source: Author’s computations (2022)

As indicated in table 5.2 above, the maximum, minimum, mean, and standard deviation values of GDP growth where 10.29822, -8.625442, 3.562586, and 3.941271 percentages respectively. Concerning agriculture, the respective maximum, minimum, mean, and standard deviations where 30.478, 2.860, 12.694, and 5.531 percentages. With regards to manufacturing, the values 33.345, 6.023, 13.968, and 5.909 percentages where the maximum, minimum, mean, and standard deviation respectively. The respective maximum, minimum, mean, and standard deviations for services where 56.270, 21.454, 43.696, and 10.218 percentages. And finally, mineral rent which was measured as a percentage of GDP had the values 17.691, 0.003, 5.567, and 5.444 percentages for the maximum, minimum, mean, and standard deviation respectively. All the variables were normally distributed with the skewness and kurtosis values in the number ranges of within normal ranges of close to 3 and 0 respectively.

5.2. UNIT ROOT RESULTS

The next table 5.3, shows a summary of the unit root test for the variables used in empirical analysis. As noted in table 5.3 below, the unit root test for GDP using the ADF and Z-A was integrated of order I(1) with statistically significant absolute t-calculated statistic values of 5.482 and 10.984 respectively, with the latter having 1994 as its break year. The GDP unit root test, using the PP test was integrated of order I(0) with statistically significant absolute t-calculated statistic values of 4.284. The unit root test for agriculture was integrated of order

I(1) with ADF and PP tests statistically significant at five percent probability, with absolute t-statistic calculated values of 9.337 and 24.097 respectively, while its Z-A test was integrated of order I(0) with a statistically significant absolute t-statistics calculated having a value 14.617, with 2002 as its break year. Concerning manufacturing, the variable was integrated of order I(1) with ADF and PP tests statistically significant at five percent probability, with absolute t-statistic calculated values of 4.186 and 3.598 respectively, while its Z-A test was integrated of order I(0) with a statistically significant absolute t-statistics calculated having a value 11.243 with 1999 as its break year. Pertaining to services, the variable was integrated of order I(1) with ADF and PP tests statistically significant at five percent probability, with absolute t-statistic calculated values of 5.597 and 6.051 respectively, while its Z-A test was integrated of order I(0) with a statistically significant absolute t-statistics calculated having a value 7.985 with 1998 as its break year. Lastly, the ADF and PP test for the mineral was integrated of order I(1), statistically significant at 5 percent, with its absolute t-statistic calculated value of 4.595 and 5.232, while its Z-A test was integrated of order I(0) with a statistically significant absolute t-statistics calculated having a value 7.673 with 2005 as its break year. Table 5.3 that explains these stationarity results follows.

Table 5.3: TESTS FOR STATIONARITY (Unit Root Tests)

Variable	**Test**	**Level**		**1st difference**	
		Statistic	5% critical	Statistic	5% critical
GDP	ADF	-0.249273	-3.548490	-5.482528*	-3.548490
	PP	-4.284910*	-3.536601		
	Z-A	-4.140148 (1992)	-4.859812	-10.98435* (1994)	-4.859812
Agriculture	ADF	-3.398632	-3.536601	-9.337344*	-3.587527
	PP	-3.398632	-3.536601	-24.09789*	-3.540328
	Z-A	-14.61738* (2002)	-4.859812		
Manufacturing	ADF	-2.763712	-3.540328	-4.186142*	-3.544284
	PP	-2.048098	-3.536601	-3.598890*	-3.540328
	Z-A	-11.24308*(1999)	-4.859812		-4.859812
Services	ADF	-2.272140	-3.536601	-5.597885*	-3.544282
	PP	-2.328404	-3.536601	-6.051935*	-3.540328
	Z-A	-7.985761* (1998)	-4.859812		-4.859812
Minerals	ADF	-3.093159	-3.540328	-4.595748*	-3.506374
	PP	-2.380858	-3.536601	-5.232076*	-3.506374
	Z-A	-7.673898* (2005)	-4.859812		-4.859812

Note: ADF is tested with constant and trend. * Indicates less than 5% levels of significance. The Year of structural break is indicated in brackets for the Z-A test (see full tables of all the unit root results at the appendixes B).

Source: Author's computation (2022)

Based the tests for variables' stationarity, with variables being a mixture of I(0) and I(1) orders of integration, ARDL and Bounds Test was the appropriate next step as suggested by the previous sections, where AIC criterion established the optimal lags of 4, 3, 0, 4, and 3 for the variables GDP growth, agriculture, manufacturing, services, and minerals respectively in the model in table 5.4. Table 5.4 below is a representation of the ARDL Error Correction Regression Results.

5.3. ARDL, LONG RUN AND WALD TEST RESULTS

Table 5.4 contains the ARDL bounds test results and the long-run cointegration results using the F-statistic.

TABLE 5.4: FOR RESULTS FOR ARDL AND COINTEGRATION MODELS

ARDL Error Correction Regression
Dependent Variable: D(GDP)
Selected Model: ARDL(4, 3, 0, 4, 3)
Case 3: Unrestricted Constant and No Trend
Date: 09/25/22 Time: 12:19
Sample: 1983 2020
Included observations: 34

ECM Regression
Case 3: Unrestricted Constant and No Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-34.26987	6.020867	-5.691849	0.0000
D(GDP(-1))	-0.187958	0.161983	-1.160357	0.2640
D(GDP(-2))	-0.243679	0.170071	-1.432804	0.1724
D(GDP(-3))	-0.328351	0.111630	-2.941438	0.0101
D(AGRICULTURE)	0.698104	0.190805	3.658733	0.0023
D(AGRICULTURE(-1))	-0.684644	0.179227	-3.819977	0.0017
D(AGRICULTURE(-2))	-0.834335	0.232541	-3.587897	0.0027
D(SERVICES)	0.587919	0.182852	3.215273	0.0058
D(SERVICES(-1))	-0.172354	0.150630	-1.144221	0.2705
D(SERVICES(-2))	-0.339287	0.148588	-2.283402	0.0374
D(SERVICES(-3))	0.253238	0.105031	2.411065	0.0292
D(MINERALS)	0.366255	0.087795	4.171699	0.0008
D(MINERALS(-1))	0.054861	0.099351	0.552195	0.5889
D(MINERALS(-2))	-0.302210	0.094805	-3.187697	0.0061
CointEq(-1)*	-0.974026	0.172661	-5.641266	0.0000

R-squared	0.933769	Mean dependent var	-0.103204
Adjusted R-squared	0.884968	S.D. dependent var	4.444175
S.E. of regression	1.507305	Akaike info criterion	3.958954
Sum squared resid	43.16737	Schwarz criterion	4.632349
Log likelihood	-52.30223	Hannan-Quinn criter.	4.188601
F-statistic	19.13400	Durbin-Watson stat	1.999041
Prob(F-statistic)	0.000000		

* p-value incompatible with t-Bounds distribution.

F-Bounds Test		Null Hypothesis: No levels relationship		
Test Statistic	Value	Signif.	I(0)	I(1)
F-statistic	5.024824	10%	2.45	3.52
k	4	5%	2.86	4.01
		2.5%	3.25	4.49
		1%	3.74	5.06

t-Bounds Test		Null Hypothesis: No levels relationship		
Test Statistic	Value	Signif.	I(0)	I(1)
t-statistic	-5.641266	10%	-2.57	-3.66
		5%	-2.86	-3.99
		2.5%	-3.13	-4.26
		1%	-3.43	-4.6

NOTE: For initial ARDL, see Appendix C.

Source: Author's computations (2022)

The variables of interest namely real GDP growth; agricultural; manufacturing; services; and mineral rent as a percentage of GDP seemed to exhibit the presence of a long-run relationship (cointegration) amongst them. This was indicated by a higher F-statistic, that is higher than both the I(0) and I(1) values. As noted in table 5.4, the null hypothesis of no-cointegration amongst the variables was rejected thanks to a higher F-statistics value of 5.024, that was higher than all I(0) values at 10, 5, 2.5, and 1 percent, which had critical values of 2.45, 2.86, 3.25, and 3.74 respectively. The F-statistics were also higher than the I(1) values, that were 3.52, 4.01, and 4.49 at 10, 5, and 2.5 percent respectively. Concerning cointegration, the variables real GDP growth; agricultural; manufacturing; services; and mineral rent converged to equilibrium at a speed of 97.4 percent. Put plainly, it takes up to 1.026 years for these variables to converge to equilibrium, and impact GDP growth over the long run.

Concerning, the impact of agriculture on GDP over the short run, a one unit increase in agriculture growth increases GDP growth by 0.684 percent, with the agriculture coefficient having a significant impact on economic development. The model of interest was well-fitted as depicted by a significant F-statistic of 19.134, with a probability value less than 5 percent as desired. Also, the variables agricultural; manufacturing; services; and mineral rent explained 93.37 percent of the variation as changes and impact on economic growth as indicated by the R-squared. The model selection for the adopted ARDL model with its lags for the variables real GDP growth; agricultural; manufacturing; services; and mineral rent was model 4,3,0,4, and 0 respectively using the Akaike Information Criterion, however, inference was only made on the impact of the present one unit change on agriculture against economic growth. The long run impacts of the variables on GDP were positive and statistically significant (except for manufacturing whose coefficients had a corresponding higher probability value) as indicated in table 5.5 that follows.

TABLE 5.5: LONG-RUN IMPACTS OF OTHER VARIABLES AND AGRICULTURE TO GDP

Levels Equation
Case 3: Unrestricted Constant and No Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
AGRICULTURE	0.900511	0.335250	2.686093	0.0169
MANUFACTURING	0.093078	0.138310	0.672968	0.5112
SERVICES	0.527349	0.162768	3.239887	0.0055
MINERALS	0.462926	0.097680	4.739193	0.0003

NOTE: For initial ARDL, see Appendix C.

Source: Author's computations (2022).

As noted on table 5.5, concerning the long run impact of agriculture on GDP growth, a one unit increase in agriculture growth culminates into a positive 0.90 contribution to Zambia's GDP growth. Also, short run causality on GDP growth culminating from a vibrant agriculture sector was evident as supported by the results of the Wald test as shown in table 5.6 below.

TABLE 5.6: WALD TEST FOR SHORT-RUN CAUSALITY OF AGRICULTURE TO GDP

Wald Test:
Equation: EQ01

Test Statistic	Value	df	Probability
F-statistic	13.04571	(4, 15)	0.0001
Chi-square	52.18285	4	0.0000

Null Hypothesis: C(5)=C(6)=C(7)=C(8)=0
Null Hypothesis Summary:

Normalized Restriction (= 0)	Value	Std. Err.
C(5)	0.698104	0.241688
C(6)	-0.505627	0.410277
C(7)	-0.149691	0.364382
C(8)	0.834335	0.269629

Restrictions are linear in coefficients.

Source: Author's computations (2022).

The Wald test results indicate a rejection of the null hypothesis that agricultural, forestry, and fisheries do not jointly impact or cause changes in the GDP growth. This is noted by the corresponding higher F-statistic and other related values, that have a statistically significant probability value of less than 5 percent, which implies that agricultural, forestry, and fisheries can be used to infer causality on GDP in predicting economic outcome.

5.4. POST-ESTIMATION TEST

The model and results of this dissertation's analysis were reliable as depicted by the post-estimation tests, namely, autocorrelation, heteroskedasticity, normality, cusum, and cusum of squares test, which are in table 5.7, table 5.8, figure 5.1, figure 5.2, and figure 5.3 respectively. Table 5.7 presents tests for serial correlation using the Breusch-Godfrey LM. As noted in table 5.7 below, the null hypothesis of no serial autocorrelation in the model's residuals was accepted, with the F-statistic having a probability of 54.99 percent, which is over 5 percent, enabling the acceptance of the null hypothesis.

TABLE 5.7: TESTS FOR SERIAL CORRELATION

Breusch-Godfrey Serial Correlation LM Test:
Null hypothesis: No serial correlation at up to 2 lags

F-statistic	0.626303	Prob. F(2,13)	0.5499
Obs*R-squared	2.988126	Prob. Chi-Square(2)	0.2245

Test Equation:
Dependent Variable: RESID
Method: ARDL
Date: 09/20/22 Time: 21:47
Sample: 1987 2020
Included observations: 34
Presample missing value lagged residuals set to zero.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
GDP(-1)	0.023526	0.269138	0.087412	0.9317
GDP(-2)	-0.055224	0.310208	-0.178021	0.8615
GDP(-3)	-0.102273	0.276120	-0.370394	0.7171
GDP(-4)	-0.050839	0.184367	-0.275750	0.7871
AGRICULTURE	0.054185	0.265211	0.204309	0.8413
AGRICULTURE(-1)	-0.033402	0.464827	-0.071858	0.9438
AGRICULTURE(-2)	0.017803	0.446920	0.039835	0.9688
AGRICULTURE(-3)	-0.022023	0.310502	-0.070926	0.9445
MANUFACTURING	0.016448	0.125666	0.130890	0.8979
SERVICES	0.100163	0.301963	0.331706	0.7454
SERVICES(-1)	-0.016313	0.410524	-0.039736	0.9689
SERVICES(-2)	-0.000218	0.319632	-0.000681	0.9995
SERVICES(-3)	-0.039388	0.258001	-0.152665	0.8810
SERVICES(-4)	0.023494	0.133574	0.175891	0.8631
MINERALS	0.021633	0.143327	0.150938	0.8823
MINERALS(-1)	0.076699	0.185240	0.414054	0.6856
MINERALS(-2)	-0.020171	0.165056	-0.122208	0.9046
MINERALS(-3)	0.029491	0.140659	0.209664	0.8372
C	-3.269842	13.09764	-0.249651	0.8068
RESID(-1)	-0.307569	0.421865	-0.729071	0.4789
RESID(-2)	-0.332662	0.386203	-0.861366	0.4046

R-squared	0.087886	Mean dependent var	5.02E-15
Adjusted R-squared	-1.315366	S.D. dependent var	1.143723
S.E. of regression	1.740326	Akaike info criterion	4.219905
Sum squared resid	39.37356	Schwarz criterion	5.162657
Log likelihood	-50.73839	Hannan-Quinn criter.	4.541411
F-statistic	0.062630	Durbin-Watson stat	2.014152
Prob(F-statistic)	1.000000		

Source: Author's computation (2022)

Table 5.8 that will follow on next page shows the test for heteroskedasticity using the Breusch-Pagan-Godfrey test. As noted in table 5.8, the null hypothesis of no heteroskedasticity in the model's residuals was accepted, with the F-statistic having a probability of 57.92 percent, which is over 5 percent.

TABLE 5.8: TESTS FOR HETEROSKEDASTICITY

Heteroskedasticity Test: Breusch-Pagan-Godfrey
Null hypothesis: Homoskedasticity

F-statistic	0.911506	Prob. F(18,15)	0.5792
Obs*R-squared	17.76164	Prob. Chi-Square(18)	0.4715
Scaled explained SS	5.033686	Prob. Chi-Square(18)	0.9988

Test Equation:
Dependent Variable: RESID^2
Method: Least Squares
Date: 09/20/22 Time: 21:48
Sample: 1987 2020
Included observations: 34

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-12.67585	16.53132	-0.766778	0.4551
GDP(-1)	-0.353861	0.323974	-1.092250	0.2920
GDP(-2)	-0.316195	0.327927	-0.964223	0.3502
GDP(-3)	-0.227358	0.331800	-0.685227	0.5037
GDP(-4)	-0.377706	0.230736	-1.636960	0.1224
AGRICULTURE	-0.338303	0.321166	-1.053357	0.3089
AGRICULTURE(-1)	0.486365	0.545195	0.892094	0.3864
AGRICULTURE(-2)	0.176724	0.484207	0.364977	0.7202
AGRICULTURE(-3)	-0.173184	0.358296	-0.483356	0.6358
MANUFACTURING	-0.072262	0.161640	-0.447052	0.6612
SERVICES	-0.235957	0.352557	-0.669274	0.5135
SERVICES(-1)	0.418310	0.479163	0.873001	0.3964
SERVICES(-2)	0.254197	0.363795	0.698736	0.4954
SERVICES(-3)	-0.085976	0.319974	-0.268697	0.7918
SERVICES(-4)	-0.009694	0.170686	-0.056792	0.9555
MINERALS	0.220884	0.167887	1.315674	0.2080
MINERALS(-1)	-0.106470	0.213191	-0.499413	0.6247
MINERALS(-2)	0.222847	0.211278	1.054754	0.3082
MINERALS(-3)	0.229701	0.178301	1.288275	0.2172

R-squared	0.522401	Mean dependent var	1.269629
Adjusted R-squared	-0.050718	S.D. dependent var	2.199193
S.E. of regression	2.254272	Akaike info criterion	4.762868
Sum squared resid	76.22616	Schwarz criterion	5.615835
Log likelihood	-61.96876	Hannan-Quinn criter.	5.053754
F-statistic	0.911506	Durbin-Watson stat	2.555345
Prob(F-statistic)	0.579227		

Source: Author's computations (2022)

Figure 5.1 shows the output of the normal distribution for the model output, with the results having indicated the acceptance of the null hypothesis for normal distribution of the residues for the regressor with a probability of 50.619 percent. Also, the kurtosis and skewness for normality were within the acceptable range with values of skewness and kurtosis been close to 0, and 3 respectively, having respective value of -0.179 and 3.912, entailing that the variable GDP had a normal distribution as seen in figure 5.1 below.

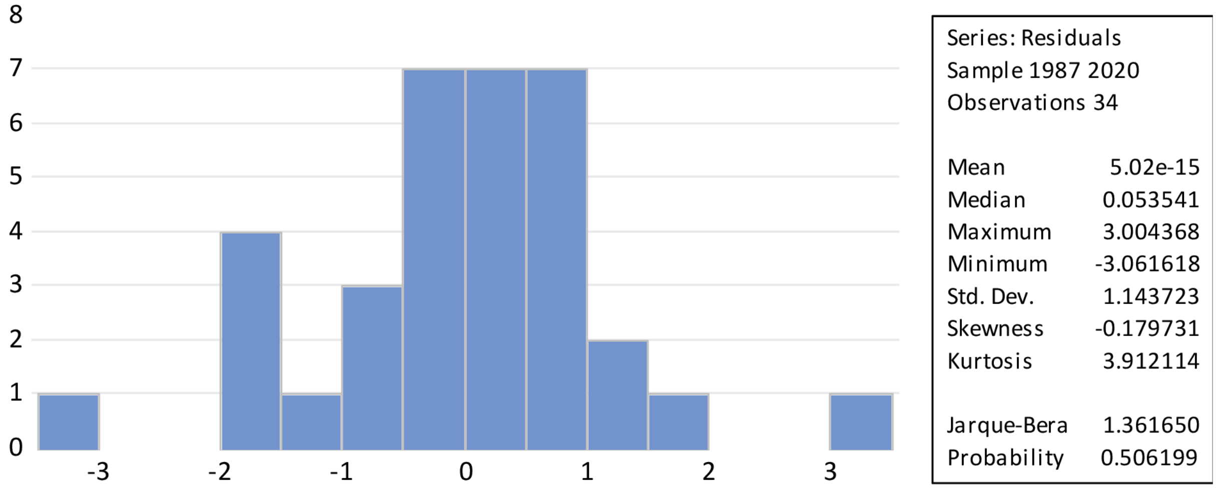

FIGURE 5.1: NORMALITY TEST

Source: Author's computations (2022)

Figures 5.2 and 5.3 show the results of the tests for the stability of the model using the CUSUM test and CUSUM squares test respectively. Figure 5.3 indicated the ability of the model, and it was not impacted by structural breaks, with the dotted line lying between 2 standard deviations.

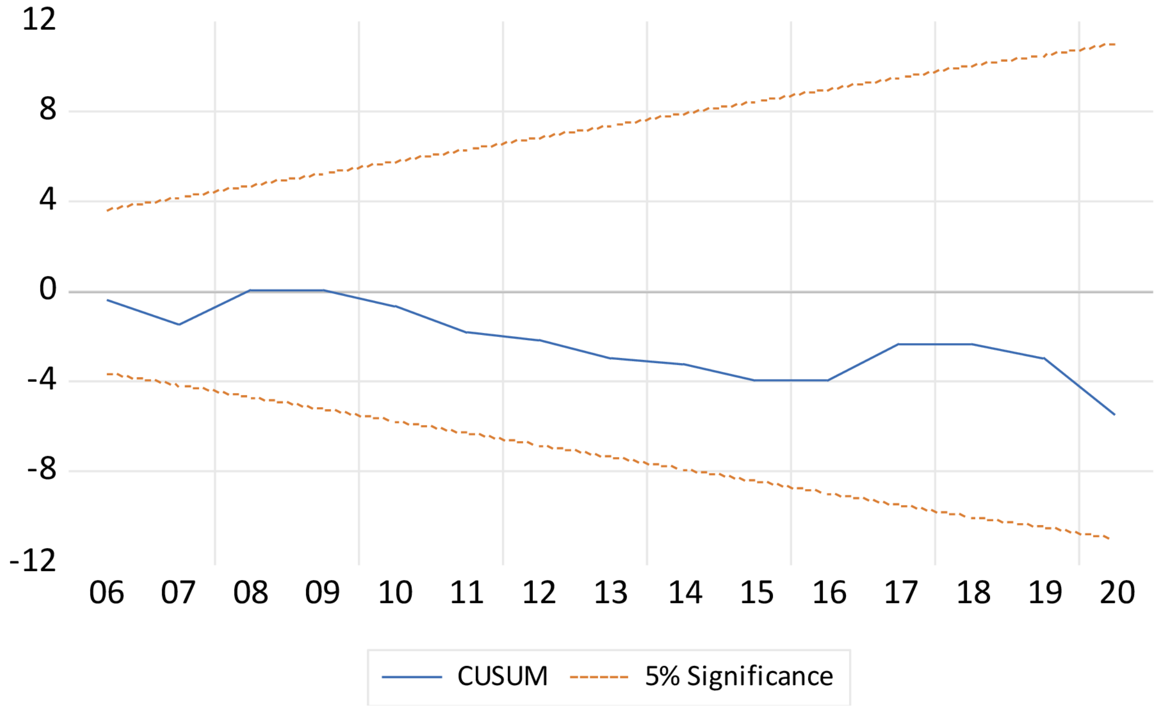

FIGURE 5.2: STABILITY TEST (CUSUM TEST)

Source: Author's computations (2022)

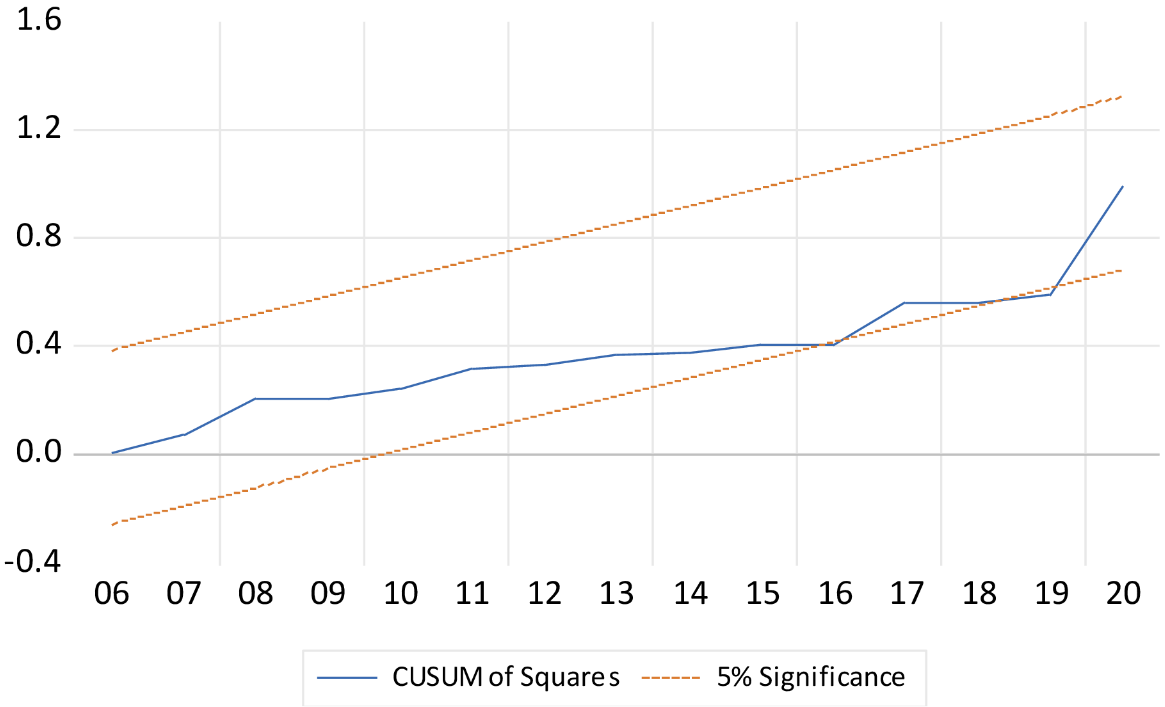

FIGURE 5.3: STABILITY TEST (CUSUM OF SQUARES TEST)

Source: Author's computations (2022)

As shown in figure 5.2, the model was stable with the output line within the 10% boundaries as indicated by the dotted line in between the parallel lines in the output figure. In a similar light, figure 5.3 showed that the model was also well-fitted and not impacted by the presence of structural breaks with its output line within the 10% boundaries as indicated by the dotted line in between the parallel lines in the output figure. The diagnostic tests in table 5.7, 5.8, and figures 5.1, 5.2 and 5.3 have indicated that this model is well-fitted and reliable for inferencing. The following last section of the results focuses on the outcome in table 5.9. The empirical outcome of the analysis carried out in determining the factors impacting the durability of Zambia's agricultural exports maize, sugar, cotton, and tobacco, which were computed using Logit and probit regression (for list of Zambia's agricultural importer countries, see appendix A). A positive sign on a coefficient indicates failure of an export relationship (increase in the hazard rate) while a negative coefficient signifies an increase in duration of an export relationship. Year fixed effects, spell fixed effects, period and destination fixed effects were included to account for possible endogeneity as done by related studies (Majune et al., 2020; Türkcan, K., & Saygılı, 2018).

On table 5.9, results in Model 1, reveal that duration of total agricultural products from Zambia is significantly determined by the following factors (and in parenthesis are the findings of related studies) colonial history, contiguity (Lee et al., 2020), partner's GDP (Asche et al., 2018; Luo and Bano, 2020; Zhang and Tveterås, 2019) domestic country's GDP (Asche et al., 2018; Luo and Bano, 2020; Zhang and Tveterås, 2019), initial export value (Wang et al., 2019; Yang et al., 2021), and total exports (Asche et al., 2018; Luo and Bano, 2020; Wang et al., 2019; Zhang and Tveterås, 2019). These results are confirmed by Model 6 which follows the probit model. Having a colonial relationship with a trading partner reduces the chances of export duration in Zambia centrally to expectation, because Zambia did not only export to its fellow former British colonies but also emerging economies like Turkey, China, the EU, and USA. Contiguity increases export duration of agricultural products in Zambia, implying that countries which share a border or are geographically close have low trade costs. An increase in a partner's GDP increases export duration as it increases the market diversity and demand for Zambia's agricultural products. Exporter's GDP, which in the case of Zambia implied a decrease in the chances of continued duration and increased the probability of failure. This possibly implies that growth in Zambia's GDP improves production capacity of other sectors of the economy, away from agriculture. Initial export value is included to evaluate the existence of ex-ante trust between trading partners, which is expected to reduce export hazard. The findings indicate that initial export increases export duration in Zambia. Total value of the exports of a product is included in the analysis to account for the effects of Zambia's experience on duration. Also, total exports enhance exports duration, thus, experience enhances duration of Zambia's agricultural exports.

Concerning the individual components of agriculture, the GDP of Zambia significantly affected export duration of all products as shown by both logit and probit models (Model 2 to 5 and Model 7 to 10). Nonetheless, the effect is contrary to expectation as an improvement in Zambia's GDP reduces duration of categories of agricultural exports. The result on maize can be influenced by the fact that it is the country's stable food. The result of other products means that their production is substituted for other sectors when Zambia's GDP increases. Export duration of sugar products was also affected by total exports. The dissertation specifically found that a rise in total exports increased export duration of sugar products. Hence, Zambia's experience of exporting sugar also improves duration of sugar products. Exporting under a Regional Trade Agreement (RTA) increases duration of cotton exports from Zambia. Duration of sugar exports is also enhnaced by total exports, suggesting that experience is important in exporting sugar products. Sharing a common border, a rise in importer's GDP and total exports significantly enhance duration of Tobacco exports. Distance, which signifies cost of trading in gravity literature reduces export duration of Tobacco. The results of the auxillary model follows on the next page (table 5.9), after which the discussion section follows.

TABLE 5.9: REGRESSION RESULTS FOR AGRICULTURAL PRODUCTS (TOTAL AND CATEGORIES)

	Logit					Probit				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	Total	**Maize**	**Sugar**	**Cotton**	**Tobacco**	**Total**	**Maize**	**Sugar**	**Cotton**	**Tobacco**
Distance	0.131	-0.568	2.267	-0.288	0.690*	0.079	-0.339	1.307	-0.154	0.407*
	(0.179)	(1.511)	(1.866)	(0.294)	(0.383)	(0.105)	(0.862)	(1.130)	(0.172)	(0.224)
Common language	-0.269	0.191	-0.176	-0.642	0.307	-0.166	0.103	-0.065	-0.379	0.172
	(0.206)	(1.393)	(2.978)	(0.401)	(0.367)	(0.122)	(0.796)	(1.784)	(0.236)	(0.217)
Colony	0.648*	-	0.830	0.623	-0.238	0.391*	-	0.451	0.374	-0.134
	(0.385)	-	(2.999)	(0.570)	(0.853)	(0.228)	-	(1.782)	(0.334)	(0.497)
Contiguity	-0.576**	-0.711	0.455	-0.537	-1.337**	-0.344**	-0.415	0.245	-0.290	-0.820**
	(0.239)	(1.600)	(1.333)	(0.453)	(0.668)	(0.141)	(0.914)	(0.812)	(0.265)	(0.390)
Partner's GDP	-0.157***	0.394	-0.893	-0.096	-0.423***	-0.093***	0.230	-0.516	-0.056	-0.251***
	(0.052)	(0.528)	(0.924)	(0.087)	(0.103)	(0.031)	(0.300)	(0.554)	(0.051)	(0.060)
Zambia's GDP	1.320***	6.575***	2.009*	0.899*	1.455**	0.777***	3.767***	1.203*	0.544*	0.861**
	(0.250)	(2.190)	(1.083)	(0.502)	(0.634)	(0.148)	(1.213)	(0.630)	(0.280)	(0.383)
Real exchange rate	-0.007	-0.073	-0.098	-0.044	0.029	-0.004	-0.043	-0.061	-0.024	0.016
	(0.024)	(0.159)	(0.088)	(0.040)	(0.048)	(0.014)	(0.091)	(0.053)	(0.024)	(0.028)
RTA	-0.325	-0.166	0.964	-1.065**	0.276	-0.180	-0.096	0.575	-0.606**	0.187
	(0.276)	(1.737)	(1.061)	(0.525)	(0.513)	(0.161)	(0.998)	(0.597)	(0.302)	(0.299)
Initial export value	-0.050**	-0.155	-0.072	-0.017	-0.057	-0.029**	-0.090	-0.044	-0.009	-0.035
	(0.022)	(0.105)	(0.054)	(0.051)	(0.039)	(0.013)	(0.059)	(0.032)	(0.030)	(0.023)
Total exports	-0.153***	-0.099	-0.088*	-0.166***	-0.195***	-0.091***	-0.053	-0.052*	-0.097***	-0.114***
	(0.022)	(0.295)	(0.050)	(0.043)	(0.050)	(0.013)	(0.164)	(0.030)	(0.025)	(0.029)
Constant	-24.728***	-152.295***	-39.840*	-12.970	-26.046*	-14.557***	-87.277***	-23.917*	-8.136	-15.388*
	(5.984)	(50.771)	(22.453)	(11.596)	(15.218)	(3.546)	(28.157)	(13.058)	(6.566)	(9.203)
Year effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Spell effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Period effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Destination effects	No	No	Yes	No	No	No	No	Yes	No	No
Observations	2,589	212	400	966	832	2,589	212	400	966	832
Log likelihood ratio	-1392.932	-101.631	-213.859	-523.881	-417.44681	-1392.626	-101.315	-213.675	-523.915	-417.543

Note: Standard errors in parentheses. Asterisk (*) represents level of significance whereby * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Source: Author's computations from Phiri et al., 2021c

.

5.5. DISCUSSION

The ARDL results, which are indicated in Table 5.4, show that there is a long-run relationship amongst the variables namely real GDP; agricultural, forestry, and fisheries value-added; manufacturing value-added; services value-added; and mineral rent. The error correction model (ECM) term is as expected with a negative sign and statistically significant, with a probability value less than 5 percent, which is below 1, meaning that our model converges to the long run. The speed of adjustment is 97.4 percent. More intuitively, this result means that a shock on economic growth culminating from the effect of independent in the short run takes about 1,026 years to clear. In the both the short and long run, the impact of agriculture on economic growth is positive and significant at 5 percent. The results agree with this dissertation's null hypothesis that, "agriculture is importance and significantly contributes to economic development and GDP growth in Zambia. ", and its conclusions are similar to studies pertaining to the fact that agriculture was related to and impacted GDP (Asumadu-Sarkodie and Owusu, 2016; Awokuse and Xie, 2015; Block, 1999; Enu, 2014; Los and Gardebroek, 2015; Mapfumo et al., 2012; Matsuyama, 1992; Mero et al., 2021; Moussa, 2018; Oyetade and Al, 2021; Sanjuán-López and Dawson, 2010; Sertoğlu et al., 2017; Young, 2018). Zambia is like any other developing country in SSA in its initial stages of development, where agriculture still plays an essential role in accelerating economic growth. These research findings indicate that, in the long run, the impact of agriculture on economic growth and all other sectors is positive though insignificant, while the impacts of services and manufacturing had a long run significance.

The postulated hypothesis and the findings of this dissertation indicate some form of consensus with most studies in both the short run and short long (Asumadu-Sarkodie and Owusu, 2016; Awokuse and Xie, 2015; Block, 1999; Enu, 2014; Los and Gardebroek, 2015; Mapfumo et al., 2012; Matsuyama, 1992; Mero et al., 2021; Moussa, 2018; Odetola and Etumnu, 2013; Orji et al., 2020; Oyetade and Al, 2021; Sanjuán-López and Dawson, 2010; Sertoğlu et al., 2017; Tiffin and Irz, 2006; Young, 2018), in the sense that agriculture is an important ingredient for the economy, and it could help to improve the standard of living and help to supplement economic growth if properly managed. Economic history has shown that countries that capitalize on their agricultural comparative advantages, taking advantage of their good rainfall, nutritious soils and grazelands can escalate growth of arable and pastoral farming and are likely to have a larger agricultural contribution and affect economic growth. For example, in the case of Ghana, and Benin that focused on cocoa production and favorable climate conditions respectively, a lesson that Zambia can draw being surrounded by eight neighboring countries and a region that wants to rely on Zambia's production potential enhanced by good resources endowment, having over 40 percent of the region's fresh waters (Mabhaudi et al., 2016; Phiri et al., 2020). The abundance in water does not always manifest into increased production outcome as most farmers do not have access to water, which limits their irrigation and potential to increase output capacity. This creates concerns for policy makers and other stakeholder on how the benefits from the pronounced water endowments can be realized, with concerns of the capital and knowhow amongst farmers on how crop irrigation can be improved to have abundance crop and farming harvest throughout the year and not just during the rainy season.

Pertaining to agriculture causality on GDP, agriculture was found to cause an increase in GDP, as indicated by the outcome of the Wald Test (Table 5.6), similar to other related studies (Block, 1999; Matsuyama, 1992; Odetola and Etumnu, 2013; Orji et al., 2020; Sanjuán-López and Dawson, 2010; Tiffin and Irz, 2006) but contrary to the outcome of related study in Iran (Tahamipour and Mahmoudi, 2018). This impact was spearheaded by government support to the sector, with over 60 percent of public spending going towards maize production, which is cultivated by over 90 percent of smallholder households who occupy 54 percent of the total agricultural land. Other sectors and products such as fisheries, poultry and livestock, horticulture, vegetable, and flower farming, including crops like sorghum, rice, millet, soyabeans, cassava, sugar, groundnuts, cotton, and tobacco all contribute to total agriculture output and can help agriculture diversity and end over reliance on maize. Even some notable transitional economies, such as Brazil and China, once diverted their capital and labor towards agriculture, giving developing countries a model to follow. Brazil advanced on its geographical comparative advantage by investing in its irrigation, agriculture technology and machinery, building capacity, and food processing, leading to exports of nearly US$ 80 million per year by exporting soybeans, oilseeds, beef, broilers, and by being a top global exporter of coffee, sugar, and sugar-based ethanol, with exports constituting over 45% of its total exports (OEC Brazil, 2020). Extension services can increase productivity, as was the empirical case with China. China's reforms were two-fold, aimed at domestic support and global expansion. These were instituted by providing producers with incentives and providing them with a legal framework, such as property rights and later the liberalization of the agro-system, which led to increased agricultural exports, especially after China became part of the World Trade Organization (WTO) in 2001 and beyond (Pingle and

Mahmoudi, 2016). China supports firms with enabling food-processing industries such as canned fish, beef, pork, and vegetables, which have escalated their export values and revenues, something that the Zambian government can emulate, considering its abundance in food options as alluded to earlier.

Furthermore, agriculture-focused companies, such as Lucky Star and Nestle, which sell their produce to Zambia, should be allowed to make partnerships with the state by setting up their food-processing factories to support government and domestic farmers, including entrepreneurs, which have increased revenue and helped escalate economic development. Effective agricultural policy will stimulate development and improve Zambia's global innovation (which proliferates sustainable economic growth), where Zambia was ranked 120 out of 140 countries (The Global Competitive Report, 2019). This research, as noted in the outcome of figure 2.1 has shown that several sectors such as services, industry, and mining all support the agriculture sector in contribution to economic development and growth. Most often, these sectors have operated in a vacuum, and a luck of synergy amongst these industries is a challenge that is present up to this day. Spreading the benefits across different sectors and having one industry generate employment and business for another could have made the benefit and impact from agriculture to other sectors and GDP more pronounced as was the case with countries like Brazil and China (OEC Brazil, 2020; Pingle and Mahmoudi, 2016).

On the global platform, the Zambian government has tried to promote the exportation of agricultural products, with the export duration of maize, sugar, cotton, and tobacco being impacted by colonial history, contiguity, Zambia's and trade partner's GDP, initial and total exports. The results on table 5.9 (which helped in addressing the fourth research question: How has Zambia's agricultural production been locally, and trade performance been on the global market?), with the results revealing that duration of total agricultural products from Zambia is significantly determined by colonial history, contiguity, partner's GDP domestic country's GDP, initial export value, and total exports. These results have indicated that having a colonial relationship with a trading partner reduces the chances of export duration for Zambia contrary to expectation, because Zambia did not only export to its fellow former British colonies but also emerging economies like Turkey, China, Japan, Middle East, the EU, and USA, and also regional powerhouses such as SADC and COMESA, SACU, and the AU countries (which currently promotes that continental free trade areas with over 40 countries having agreed to this). All these countries, regional, and global trade players didn't limit themselves to Britain colonial history but looked at international trade from a global perspective. Contiguity increases export duration of agricultural products in Zambia, implying that countries which share a border or are geographically close have low trade costs. An increase in a partner's GDP increases export duration as it increases the market diversity and demand for Zambia's agricultural products. Also, transportation costs and easiness within Southern and Central Africa, especially Zambia's neighboring countries makes it possible to transport agriculture products by road and at times rail, with countries like Congo DR, Tanzania, Malawi, Botswana, Zimbabwe, Angola, and Namibia including South Africa, the country's biggest regional trade partner. All these countries play a key role as importers of the country's agriculture products, from Zambia's agriculture exports produce and exports (especially maize), which increased fourfold in 2020 up over a million metric tonnes, were Zambia and South Africa become the regions number one players in exporting agricultural produce in Southern Africa replacing global exporters within the region (Sihlobo, 2020). Exporters' GDP, which in the case of Zambia implied a decrease in the chances of continued duration and increased the probability of failure, as developed economies become more self-sustainable, making it possible for Zambia to export to countries with low levels of productivity and countries that increased demand of the country's agriculture products due to rising population. However, this was not always easy as the Zambian farmers and the state first had to satisfy domestic demand.

Some countries within the region that benefitted from Zambia's agricultural exporting pedigree included Malawi, Mozambique, Congo DR, and Zimbabwe, as they were most impacted by low output, including the effects of climatic change, which were more pronounced in those states. Concerning the individual components of agriculture, the GDP of Zambia significantly affected export duration of all products as shown by both logit and probit models (Model 2 to 5 and Model 7 to 10 from table 5.9). The result on maize can be influenced by the fact that it is the country's stable food, and over the past decade Zambia has replaced Zimbabwe as Southern Africa's food basket, with all produce maize, sugar, cotton, tobacco, and other food products including poultry and livestock helping in mitigating the effects of food shortages within the region, and some countries around the globe. Exporting under an RTA increases duration of cotton exports from Zambia and other products increased calls to promote trade regionally and globally including call for the free trade across the AU so that Zambia can cement its place as regional and subsequently a continental food basket. On penetration the global market, several countries have indicated interest in importing Zambia's agricultural products. For example, the Saudi Arabian government has shown interest in importing Zambian goats, the Chinese government has indicated interest in importing the country's cassava for use in the production of biofuel, while the EU is interested in Zambia's honey, sugar, flowers, and citrus fruits. All these prospects present the Zambian farmers, entrepreneurs, and government an opportunity to increase production and penetrate the regional and global markets, increase the limited durability and capacity of total exports, and ultimately contribute to higher GDP.

So far, this chapter has addressed, research questions two and four, which were, "What is the impact of agriculture on GDP and economic development in Zambia?", and "How has Zambia's agricultural production been locally, and trade performance been on the global market?" respectively. The outcome indicated in this chapter has showed that agriculture and GDP had a positive relationship with agriculture impacting and having a causal effect on changes in GDP as noticed by the results in tables 5.4, 5.5, and 5.6, a proposition that was backed by economic theories: Rostow's stages of development; Johnston-Mellor Model; Schultz's Transformation of Traditional Agriculture; Kuznets theory on the role of agriculture on development, and in agreement with the thesis hypothesis that agriculture is a catalyst for sustained economic development in Zambia. Section 2.6, FDI by sector, has indicated that agriculture receives a substantial amount of FDI inflow, though not as much compared to sectors such as mining and manufacturing. Despite this, is impact on GDP growth is more pronounced that the that of mining and manufacturing (as indicated by the empirical results on illustrated in this chapter), which institutes a proposition that more foreign investment should be directed towards agriculture, as this will help address the problems facing this sector and economic development.

This chapter (from the auxiliary model, table 5.9) has supported the views of the research hypothesis and has indicated that Zambia's agricultural produce can be essential for development and improvement of the standards of living in Zambia and its importer countries, with the findings having indicated that the government has tried to promote the exportation of agricultural products, with the export duration of maize, sugar, cotton, and tobacco being impacted by colonial history, contiguity, Zambia's and trade partner's GDP, initial and total exports. The benefits of the country's agriculture sector have been undermined by several challenges, especially poor rainfall and irrigation culminated from climate change which has impacted yield output in the last decade; low production output culminating from limited technologies, limited irrigations, including lack of innovation and capital; lack of market access (locally and globally) hampered by poor infrastructure and technology which has hampered the ability of farmers to reinvest and innovate, diseases, and limited institutional and stakeholder support, which has made it difficult for farmers to access inputs, and expand their businesses regionally, and globally. Against this backdrop, the last section will conclude by summarizing the key outcomes of this dissertation by deriving lessons from the research findings and making some policy recommendations on how the Zambian government can help improve agriculture productivity (especially over the medium and long term) and consequently lead to increased GDP in line with the country's development agenda.

6. CONCLUSIONS AND RECOMMENDATIONS

The implementation of well-structured agricultural and development policies will help the country in attaining some SDGs, such as the complete eradication of poverty and hunger, improved health and wellbeing, decent work, and economic growth. These policies are necessary as they help to enable food security, which helps in improving the standards of living in the country and in securing Zambia's place as a regional food basket, particularly in view of the food crisis in neighboring countries, such Malawi, Mozambique, and Zimbabwe. In the past, the government has tried to provide a market for farmers by buying some of their products through the FRA. Despite having a positive effect on and contributing to increases in GDP, the agricultural industry has experienced challenges. The reliance on mining, as well as the growing of the services sector have led to the migration of the labor force, particularly the educated labor force, towards those sectors. This has contributed to the decline in agriculture's contribution to GDP, and consequently economic growth. In the past few years, droughts have greatly affected the economy, with poor rainfall leaving farmers, particularly small-scale farmers at a disadvantage. Other challenges that have led to the declining share of agricultural contribution to GDP include but not limited too low production output culminating from limited technologies, limited irrigations, including lack of innovation and capital; lack of market access (locally and globally) hampered by poor infrastructure and technology which has hampered the ability of farmers to reinvest and innovate; diseases; limited institutional and stakeholder support, which has made it difficult for farmers to access inputs, and expand their businesses regionally, and globally; and delay in the delivery of farming inputs from the FRA making farmers delay in planting their seed and as a result, slowing down harvesting.

Noting that agriculture is a key ingredient that contributes to economic diversification through creating employment and enabling food security, the main objective of this dissertation was to examine the impact of agriculture on economic growth, which was positive and significant. In meeting the thesis objectives and the following research questions were addressed as follows: Research question one, "What is contribution of agriculture and several sectors to Zambia's GDP and economic development?", was addressed in chapter 2, and this showed that agriculture contributed approximately 20 to 40 percent to Zambia's GDP between 1983 to date, and this was thanks to increased productions in both arable and pastoral farming, a realization that can further be enhanced by all stakeholders including government as this conclusion proposes. The contribution of agriculture to GDP and amounts of agriculture production outputs were graphically illustrated in figures 2.3, and from figures 2.5 to 2.5 respectively, with all speaking to relevant of agriculture as a leeway to the country's economic prosperity as noted by the outcome in chapter 5. Concerning research question two, "What is the impact of agriculture on GDP and economic development in Zambia?", on the impact in the short run (table 5.4) and long run (table 5.5), a percentage increase in agriculture value addition impacted GDP growth by 0.698 and 0.90 percent increment respectively. This was examined using the ARDL Bounds Test and its outcome emphasized the importance of agriculture in influencing the country's economic sustainability through diversification as this chapter shall recommend. Also, the Wald test (table 5.6) results indicated that agriculture causes an increase in GDP growth, while the ARDL Bounds test indicates convergence to long run equilibrium of the variables agricultural, forestry, and fisheries; manufacturing; services; and mineral rent against GDP growth at a speed of 97.4 percent. The outcome of these results are in agreement with the postulated hypothesis that agriculture significantly contributes to and leads to increases in GDP growth, an agreement with the theoretical framework culminated from the ideals of Rostow's stages of development (Rostow , 1960; Rostow and Rostow, 1990); Johnston-Mellor Model (Johnston and Mellor, 1961); Schultz's Transformation of Traditional Agriculture (Schultz, 1966); Kuznets theory on the role of agriculture on development (Kuznets, 1961). The finding thus far has indicated how the governments polices on the eighth NDP, Africa's agenda 2063, and the UN vision 2030 can led to increased economic development supported by a growing agriculture sector as the concluding policy recommendations will indicate.

The other research question four "How has Zambia's agricultural production been locally, and trade performance been on the global market? was addressed in chapters two and five, with chapter two having laid a foundation for the outcome of the results. On the global platform, the Zambian government has tried to promote the exportation of agricultural products, with the export duration of maize, sugar, cotton, and tobacco being impacted by colonial history, contiguity, Zambia's and trade partner's GDP, initial and total exports (see the results on table 5.9, which helped in addressing the fourth research question). The outcome of these results revealed that the duration of total agricultural products from Zambia is significantly determined by colonial history, contiguity, partner's GDP domestic country's GDP, initial export value, and total exports. Concerning the empirical effects of factors that affect export duration of total agricultural products (table 5.9), the research found that colonial history, contiguity, partners GDP, Zambia's GDP, initial exports, and total exports had a significant effect.

Surprisingly Zambia's GDP reduced export duration of agricultural products, implying a deviation effect in terms of domestic capacity as a growth in GDP shifts production to other sectors of the economy. This result was uniform across all categories of agriculture products. Other factors had a heterogenous effect on export duration of categories of agricultural products. For instance, maize was only affected by Zambia's GDP, sugar was affected by Zambia's GDP and total exports, cotton was affected by Zambia's GDP, RTA, and total exports while tobacco was affected by distance, contiguity, partner's GDP, Zambia's GDP, and total exports.

It is worth noting that the odds of improvements in agriculture and economic wellbeing are in Zambia's favor. This is because the economy has a geographical comparative advantage with an abundance of natural wealth, such as over 40% of the fresh waters in Southern and Central African regions, and over two-thirds of underutilized fertile and grazing lands, supported by communities that are passionate about farming. This dissertation has indicated that the agriculture sector is compounded by challenges mentioned earlier, which can be deescalated by government putting agriculture as its number one priority on its development agenda. The discussion in the previous section has shown how countries, such as China and Brazil, invested in a similar comparative advantage and, as a result, escalated their economic potential. This dissertation wishes to conclude by addressing the fifth research question (policy recommendations) by indicating how and what policies can be instituted to ensure that agriculture plays a fundamental role in improving economic development in Zambia. Zambia can draw lessons from countries like Brazil and China, which were mentioned in the previous chapter, and including other examples mentioned earlier in overview of previous studies, by addressing its challenges, and improve its agriculture and economic growth by directing policy in at least six essential ways:

1. Provide resources that enable research and development and ensure the availability of a legal framework which protects property rights for farmers and ensuring support for their investments.
2. Develop infrastructure and direct investment towards growing food-processing zones, including the promotion of exports through incentives, credit and farming inputs support, and subsidies, will help them access markets locally and globally.

3. Develop irrigation techniques and the use of solar and other renewable energy sources which will ensure a continued supply of farm produce, water, and energy despite changing climate dynamics.
4. Negotiate trade partnerships, regionally and globally will provide an international market for farmers to export their produces on the international market at a favorable price, and without any challenges.
5. Institute policies (through the ZDA) that will channel and direct FDI toward the agriculture sector to stimulate employment creation and enable diversification.
6. To proliferate products and international trade competitiveness, Zambia can process more agriculture products to export finished products to this effect for example clothes, cigarettes, medicines, canned sugar, and maize products. This is because they command higher market value but most importantly last longer. This could impact on duration as both Zambia and partner countries could benefit from a prolonged trade relationship. This will also benefit and support the countries newly launched eighth NDP, which seeks to diversify the economy with agriculture amongst its pillars.

Recently, the effect of the COVID-19 global pandemic and the Russia-Ukraine war (which has led to a decline in availability of food products) have emphasized the need for a sustained agricultural sector and its importance in food security and sustainable economic growth. This research has shown that, with the vast potential of agriculture in Zambia, its economic and social benefits on the country and region at large can be more profound and help towards attainment of higher income in a diversified economy supported by vibrant agricultural sector in line the countries eighth NDP, the UN vision 2030, and AU's Agenda 2063.

The main limitation of this study is that some sections of data used, for example agriculture crop outputs (Figures 2.5, 2.6, and 2.7) were only available for a limited time 1990 to 2015, as the state could not provide data up to the present time. The same can be said of FDI by sector in USD millions and FDI employment creation pledges by sector, tables 2.3 and 2.5 respectively, where the availed data did not go beyond 2015. Another limitation was that the state was not able to provide statistics for poultry, fisheries, and pastoral farming creating data gaps in the computations of output of each individual component of agriculture. However, the agriculture, forestry, and fisheries data used in the econometric computation was total of all agriculture output, and hence making the conclusion representative of agricultural components in the empirical outcome. Recommendations on future research are on how

Zambia's emerging agriculture dominance can benefit other neighbors and regional countries in view of food shortages culminating from climate change, the impact of covid 19, and recent wars in Ukraine in other countries.

REFERENCES

Adebayo, T.S., Odugbesan, J.A., 2021. Modeling CO2 emissions in South Africa: empirical evidence from ARDL based bounds and wavelet coherence techniques. Environ Sci Pollut Res 28, 9377–9389. https://doi.org/10.1007/s11356-020-11442-3

Adedoyin, F.F., Bein, M.A., Gyamfi, B.A., Bekun, F.V., 2021. Does agricultural development induce environmental pollution in E7? A myth or reality. Environ Sci Pollut Res 28, 41869–41880. https://doi.org/10.1007/s11356-021-13586-2

Adeel, M., Zain, M., Shafi, J., Ahmad, M.A., Rizwan, M., Shafiq, M., Rui, Y., n.d. CONSERVATION AGRICULTURE, A WAY TO CONSERVE SOIL CARBON FOR SUSTAINABLE AGRICULTURE PRODUCTIVITY AND MITIGATING CLIMATE CHANGE: A REVIEW. Fresenius Environmental Bulletin 27.

Al-Ali, A., Nabulsi, A.A., Mukhopadhyay, S., Awal, M.S., Fernandes, S., Ailabouni, K., 2019. IoT-solar energy powered smart farm irrigation system. Journal of Electronic Science and Technology.

Al-Mulali, U., 2015. The Impact of Biofuel Energy Consumption on GDP Growth, Co_2 Emission, Agricultural Crop Prices, and Agricultural Production. International Journal of Green Energy 12, 1100–1106. https://doi.org/10.1080/15435075.2014.892878

Altouma, A., Krepl, V., Bashir, B., Bachir, H., 2022. Impact of Economic Growth, Agriculture, and Primary Energy Consumption on Carbon Dioxide Emissions in the Czech Republic. Energies 15, 7887. https://doi.org/10.3390/en15217887

Amoako, S., Andoh, F.K., Asmah, E.E., 2022. Structural change and energy use in Ghana's manufacturing and agriculture sectors. Energy Reports 8, 11112–11121. https://doi.org/10.1016/j.egyr.2022.08.241

Assamoi, G.R., Wang, S., Liu, Y., Gnangoin, Y.T.B., 2020. Investigating the pollution haven hypothesis in Cote d'Ivoire: evidence from autoregressive distributed lag (ARDL) approach with structural breaks. Environ Sci Pollut Res 27, 16886–16899. https://doi.org/10.1007/s11356-020-08246-w

African Development Bank, 2019. Zambia Economic Outlook [WWW Document]. African Development Bank - Building today, a better Africa tomorrow. URL https://www.afdb.org/en/countries-southern-africa-zambia/zambia-economic-outlook (accessed 3.8.22).

Ahmad, M., Khattak, S.I., Khan, S., Rahman, Z.U., 2020. Do aggregate domestic consumption spending & technological innovation affect industrialization in South Africa? An application of linear & non-linear ARDL models. Journal of Applied Economics 23, 44–65. https://doi.org/10.1080/15140326.2019.1683368

Ahmadi, M., 2021. Social and Economic Impacts of Elimination of Energy Price Distortion in Indonesia (PhD Thesis). 横浜国立大学.

Alola, A.A., Onifade, S.T., 2022. Energy innovations and pathway to carbon neutrality in Finland. Sustainable Energy Technologies and Assessments 52, 102272. https://doi.org/10.1016/j.seta.2022.102272

Applanaidu, S.D., Bakar, N.A., Baharudin, A.H., 2014. An Econometric Analysis of Food Security and Related Macroeconomic Variables in Malaysia: A Vector Autoregressive Approach (VAR). UMK Procedia, International Agribusiness Marketing Conference 2013 1, 93–102. https://doi.org/10.1016/j.umkpro.2014.07.012

Arif, G.M., Nazli, H., Haq, R., Qureshi, S.K., 2000. Rural Non-agriculture employment and poverty in Pakistan [with Comments]. The Pakistan Development Review 1089–1110.

Arovuori, K., 2015. Political effectiveness of agricultural policies: an empirical analysis. PTT julkaisuja.

Asche, F., Cojocaru, A.L., Gaasland, I., Straume, H.-M., 2018. Cod stories: Trade dynamics and duration for Norwegian cod exports. Journal of Commodity Markets 12, 71–79.

Asumadu-Sarkodie, S., Owusu, P.A., 2016. The casual nexus between child mortality rate, fertility rate, GDP, household final consumption expenditure, and food production index. Cogent Economics & Finance 4, 1191985.

Atkinson, S.J., 1995. Approaches and actors in urban food security in developing countries. Habitat international 19, 151–163.

Auty, R.M., 1991. Mismanaged mineral dependence: Zambia 1970–90. Resources Policy 17, 170–183. https://doi.org/10.1016/0301-4207(91)90001-C

Awan, A.G., Aslam, A., 2015. Impact of agriculture productivity on economic growth: A case study of Pakistan. Global Journal of Management and Social Sciences 1, 57–71.

Awokuse, T.O., Xie, R., 2015a. Does Agriculture Really Matter for Economic Growth in Developing Countries? Canadian Journal of Agricultural Economics/Revue canadienne d’agroeconomie 63, 77–99. https://doi.org/10.1111/cjag.12038

Awokuse, T.O., Xie, R., 2015b. Does agriculture really matter for economic growth in developing countries? Canadian Journal of Agricultural Economics/Revue canadienne d'agroeconomie 63, 77–99.

Balci, P., 2016. Can Biomass Energy Be a Potential for Rural Development? A Roadmap for Karacabey (Bursa). Planning. https://doi.org/10.5505/planlama.2016.85047

Bayasgalankhuu, L., Ilahi, S., Wei, W., Wu, Y., 2022. Energy Analysis on Wheat Yield of Mongolian Agriculture. Processes 10, 190. https://doi.org/10.3390/pr10020190

Balasubramanya, S., Stifel, D., 2020. Viewpoint: Water, agriculture & poverty in an era of climate change: Why do we know so little? Food Policy 93, 101905. https://doi.org/10.1016/j.foodpol.2020.101905

Baye, T.G., 2017. Poverty, peasantry, and agriculture in Ethiopia. Annals of Agrarian Science 15, 420–430.

Ben Jebli, M., Ben Youssef, S., 2017. The role of renewable energy and agriculture in reducing CO 2 emissions: Evidence for North Africa countries. Ecological Indicators 74, 295–301. https://doi.org/10.1016/j.ecolind.2016.11.032

Besedeš, T., Prusa, T.J., 2006. Ins, outs, and the duration of trade. Canadian Journal of Economics/Revue canadienne d'économique 39, 266–295. https://doi.org/10.1111/j.0008-4085.2006.00347.x

Beyene, F., Muche, M., 2010. Determinants of food security among rural households of Central Ethiopia: An empirical analysis. Quarterly Journal of International Agriculture 49, 299–318.

Block, S.A., 1999. Agriculture and economic growth in Ethiopia: growth multipliers from a four-sector simulation model. Agricultural Economics 20, 241–252. https://doi.org/10.1111/j.1574-0862.1999.tb00570.x

Boerner, J., Mendoza, A., Vosti, S.A., 2007. Ecosystem services, agriculture, and rural poverty in the Eastern Brazilian Amazon: Interrelationships and policy prescriptions. Ecological economics 64, 356–373.

Bonny, S., 1993. Is agriculture using more and more energy? A French case study. Agricultural Systems 43, 51–66. https://doi.org/10.1016/0308-521X(93)90092-G

Bosco, S., Volpi, I., Antichi, D., Ragaglini, G., Frasconi, C., 2019. Greenhouse Gas Emissions from Soil Cultivated with Vegetables in Crop Rotation under Integrated, Organic and Organic Conservation Management in a Mediterranean Environment. Agronomy 9, 446. https://doi.org/10.3390/agronomy9080446

Boursianis, A., Papadopoulou, M., Diamantoulakis, P., Liopa-Tsakalidi, A., Barouchas, P., Salahas, G., Karagiannidis, G., Wan, S., Goudos, S., 2022. Internet of Things (IoT) and Agricultural Unmanned Aerial Vehicles (UAVs) in smart farming: A comprehensive review. Internet Things.

Bohnes, F.A., Rodriguez, U.-P., Nielsen, M., Laurent, A., 2020. Are aquaculture growth policies in high-income countries due diligence or illusionary dreams? Foreseeing policy implications on seafood production in Singapore. Food Policy 93, 101885.

Bosco Sabuhoro, J., Larue, B., Gervais, Y., 2006. Factors Determining the Success or Failure of Canadian Establishments on Foreign Markets: A Survival Analysis Approach. The International Trade Journal 20, 33–73. https://doi.org/10.1080/08853900500467974

Brenton, P., Saborowski, C., von Uexkull, E., 2010. What Explains the Low Survival Rate of Developing Country Export Flows? The World Bank Economic Review 24, 474–499. https://doi.org/10.1093/wber/lhq015

Brăileanu, A.-L., n.d. INTENSIVE FARMING VERSUS-AGRICULTURE ENVIRONMENTALLY SUSTAINABLE.

Bresciani, F., Valdés, A., 2007. Beyond Food Production: The Role of Agriculture in Poverty Reduction. Food & Agriculture Org.

Bužinskienė, R., Miceikienė, A., 2021. ASSESSMENT OF BIOMASS UTILIZATION FOR ENERGY PRODUCTION FROM AGRICULTURAL RESIDUE. Management Theory and Studies for Rural Business and Infrastructure Development 42, 549–560. https://doi.org/10.15544/mts.2020.56

Castelão, R.A., de Souza, C.C., Frainer, D.M., 2021. Southern Mato Grosso state (Brazil) productive system and its impact on emissions of carbon dioxide (CO2). Environ Dev Sustain 23, 4134–4148. https://doi.org/10.1007/s10668-020-00760-8

Cervantes-Godoy, D., Dewbre, J., 2010. Economic importance of agriculture for poverty reduction.

Chapoto, A., Chisanga, B., Kabisa, M., 2018. Zambia Agriculture Status Report 2017.

Chandio, A.A., Akram, W., Ozturk, I., Ahmad, M., Ahmad, F., 2021. Towards long-term sustainable environment: does agriculture and renewable energy consumption matter? Environ Sci Pollut Res 28, 53141–53160. https://doi.org/10.1007/s11356-021-14540-y

Chandio, A.A., Jiang, Y., Rauf, A., Mirani, A.A., Shar, R.U., Ahmad, F., Shehzad, K., 2019. Does Energy-Growth and Environment Quality Matter for Agriculture Sector in Pakistan or not? An Application of Cointegration Approach. Energies 12, 1879. https://doi.org/10.3390/en12101879

Chebbi, H.E., 2010. Long and Short–Run Linkages between Economic Growth, Energy Consumption and CO2 Emissions in Tunisia.

Chilufya, W., and Mulendema, N., 2019. Beyond maize: exploring agricultural diversification in Zambia | International Institute for Environment and Development https://www.iied.org/beyond-maize-exploring-agricultural-diversification-zambia

Chin, L.C., Hoang, T.C., 2017. Effects of Us Economic Policy Uncertainty on Stock Price in Vietnam: An Ardl Bound Test Approach, in: Novak, P., Jurigova, Z., Kozubikova, L., Zlamalova, J. (Eds.), Finance and Performance of Firms in Science, Education, and Practice. Tomas Bata Univ Zlin, Zlin, pp. 574–581.

Chizuni, J.M., 1994. Food Policies and Food Security in Zambia. Nordic Journal of African Studies 3, 46–52. https://www.iied.org/beyond-maize-exploring-agricultural-diversification-zambia

Christiaensen, L., Demery, L., Kuhl, J., 2011a. The (evolving) role of agriculture in poverty reduction—An empirical perspective. Journal of Development Economics 96, 239–254. https://doi.org/10.1016/j.jdeveco.2010.10.006

Christiaensen, L., Demery, L., Kuhl, J., 2011b. The (evolving) role of agriculture in poverty reduction—An empirical perspective. Journal of Development Economics 96, 239–254. https://doi.org/10.1016/j.jdeveco.2010.10.006

Christiaensen, L., Martin, W., 2018. Agriculture, structural transformation and poverty reduction: Eight new insights. World Development.

Copestake, J.G., 1998. Agricultural Credit Management in Zambia: Business Development, Social Security or Patronage? Development Policy Review 16, 5–28. https://doi.org/10.1111/1467-7679.00047

Cowen, T., Tabarrok, A., 2021. Modern Principles of Economics, Fourth Edition. ed. Macmillan Learning, USA.

Dabasi-Schweng, L., 1965. The Problem of Transforming Traditional Agriculture. World Politics 17, 503–521. https://doi.org/10.2307/2009292

Dandekar, V.M., 1986. Agriculture, Employment and Poverty. Economic and Political Weekly 21, A90–A100.

Dandelar, V.M., 1966. Transforming Traditional Agriculture: A Critique of Professor Schultz. Economic and Political Weekly 1, 25–36.

Danish, Baloch, M.A., Mahmood, N., Zhang, J.W., 2019. Effect of natural resources, renewable energy and economic development on CO2 emissions in BRICS countries. Science of The Total Environment 678, 632–638. https://doi.org/10.1016/j.scitotenv.2019.05.028

de Figueiredo Silva, F., Fulginiti, L.E., Perrin, R.K., Braga, M.J., 2022. The increasing opportunity cost of sequestering CO2 in the Brazilian Amazon forest. Empir Econ 62, 439–460. https://doi.org/10.1007/s00181-021-02031-5

Dhaya, R., Kanthavel, R., 2022. Energy Efficient Resource Allocation Algorithm for Agriculture IoT. Wireless Pers Commun 125, 1361–1383. https://doi.org/10.1007/s11277-022-09607-z

Dodder, R.S., Kaplan, P.O., Elobeid, A., Tokgoz, S., Secchi, S., Kurkalova, L.A., 2015. Impact of energy prices and cellulosic biomass supply on agriculture, energy, and the environment: An integrated modeling approach. Energy Economics 51, 77–87. https://doi.org/10.1016/j.eneco.2015.06.008

Doran, N.M., Bădîrcea, R.M., Doran, M.D., 2022. Financing the Agri-Environmental Policy: Consequences on the Economic Growth and Environmental Quality in Romania. IJERPH 19, 13908. https://doi.org/10.3390/ijerph192113908

Dorneanu, M., n.d. INTENSIVE FARMING VERSUS-AGRICULTURE ENVIRONMENTALLY SUSTAINABLE.

De Janvry, A., Sadoulet, E., 2010. Agricultural growth and poverty reduction: Additional evidence. The World Bank Research Observer 25, 1–20.

Demirhan, H., 2020. dLagM: An R package for distributed lag models and ARDL bounds testing. PLoS One 15, e0228812. https://doi.org/10.1371/journal.pone.0228812

Deshpande, S.H., 1977. Transforming Traditional Agriculture: A Delayed Critique of Theodore Schultz. Economic and Political Weekly 12, A127–A132.

Dickey, D.A., Fuller, W.A., 1981. Likelihood Ratio Statistics for Autoregressive Time Series with a Unit Root. Econometrica 49, 1057–1072. https://doi.org/10.2307/1912517

Elliott, H., Perrault, P., Pardey, P., Alston, J., Piggott, R., 2006, Zambia: a quiet crisis in African research and development. | Semantic Scholar [WWW Document],URL:https://www.semanticscholar.org/paper/Zambia%3A-a-quiet-crisis-in-African-research-and-Elliott-Perrault/de40802156193c63af33c39e700992f76ea71323 (accessed 11.1.22).

Emam, A., 2022. Present and future: Does agriculture affect economic growth and the environment in the Kingdom of Saudi Arabia? Agric. Econ. – Czech 68, 380–392. https://doi.org/10.17221/58/2022-AGRICECON

Evolution of Internet of Things (IoT) and its significant impact in the field of Precision Agriculture, 2019. . Computers and Electronics in Agriculture 157, 218–231. https://doi.org/10.1016/j.compag.2018.12.039

nders, W., 2014. Applied Econometric Time Series, Fourth Edition. ed. WILEY Publisher, USA.

Engle, R.F., Granger, C.W.J., 1987. Co-Integration and Error Correction: Representation, Estimation, and Testing. Econometrica 55, 251–276. https://doi.org/10.2307/1913236

Enu, P., 2014. Analysis of the Agricultural Sector of Ghana and Its Economic Impact on Economic Growth. Academic Research International 5, 11.

Fajgelbaum, P.D., Redding, S.J., 2014. External Integration, Structural Transformation and Economic Development: Evidence from Argentina 1870-1914 (SSRN Scholarly Paper No. ID 2501498). Social Science Research Network, Rochester, NY.

FAO, 2018. The State of Food Security and Nutrition in the World 2018. Building climate resilience for food security and nutrition |Policy Support and Governance| Food and Agriculture Organization of the United Nations [WWW Document]. URL https://www.fao.org/policy-support/tools-and-publications/resources-details/en/c/1152267/ (accessed 3.28.22).

Food and Agriculture Organization Zambia, 2016. | Integrated Production and Pest Management Programme in Africa | Food and Agriculture Organization of the United Nations https://www.fao.org/agriculture/ippm/projects/zambia/en/ (accessed 11.3.22).

Fert\Ho, I., Szerb, A.B., 2018. The duration of the Hungarian maize exports. Bulgarian Journal of Agricultural Sciences 24, 352–359.

Gardner, B.L., 2005. Causes of rural economic development. Agricultural Economics 32, 21–41. https://doi.org/10.1111/j.0169-5150.2004.00012.x

Green, W.H., 2017. Econometric Analysis, Eighth Edith. ed. Pearson Education, USA.

Harris, D., Orr, A., 2014. Is rainfed agriculture really a pathway from poverty? Agricultural Systems 123, 84–96. https://doi.org/10.1016/j.agsy.2013.09.005

Hausmann, R., 2011. Structural Transformation and Economic Growth in Latin America [WWW Document]. The Oxford Handbook of Latin American Economics. https://doi.org/10.1093/oxfordhb/9780199571048.013.0021

Hafeez, M., Yuan, C., Shah, W.U.H., Mahmood, M.T., Li, X., Iqbal, K., 2020a. Evaluating the relationship among agriculture, energy demand, finance and environmental degradation in one belt and one road economies. Carbon Management 11, 139–154. https://doi.org/10.1080/17583004.2020.1721974

Hafeez, M., Yuan, C., Shah, W.U.H., Mahmood, M.T., Li, X., Iqbal, K., 2020b. Evaluating the relationship among agriculture, energy demand, finance and environmental degradation in one belt and one road economies. Carbon Management 11, 139–154. https://doi.org/10.1080/17583004.2020.1721974

Harchaoui, S., Chatzimpiros, P., 2018. Can Agriculture Balance Its Energy Consumption and Continue to Produce Food? A Framework for Assessing Energy Neutrality Applied to French Agriculture. Sustainability 10, 4624. https://doi.org/10.3390/su10124624

Hatirli, S.A., Ozkan, B., Fert, C., 2005. An econometric analysis of energy input–output in Turkish agriculture. Renewable and Sustainable Energy Reviews 9, 608–623. https://doi.org/10.1016/j.rser.2004.07.001

Headey, D., Fan, S., 2008. Anatomy of a crisis: the causes and consequences of surging food prices. Agricultural economics 39, 375–391.

Herrendorf, B., Rogerson, R., Valentinyi, Á., 2014. Chapter 6 - Growth and Structural Transformation, in: Aghion, P., Durlauf, S.N. (Eds.), Handbook of Economic Growth, Handbook of Economic Growth. Elsevier, pp. 855–941. https://doi.org/10.1016/B978-0-444-53540-5.00006-9

Hess, W., Persson, M., 2012. The duration of trade revisited. Empirical Economics 43, 1083–1107.

Hussain, A., Taqi, M., 2014. Impact of agricultural credit on agricultural productivity in Pakistan: An empirical analysis. International Journal of Advanced Research in Management and Social Sciences 3, 125–139.

IAPRI, 2016. Opportunities and challenges in enhancing agricultural development in Zambia Indaba Agriculture Policy Research Institute (IAPRI) Zambia, https://www.iapri.org.zm/opportunities-and-challenges-in-enhancing-agricultural-development-in-zambia/ (accessed 11.1.22).

IDRIS, A., ISMAIL, N.W., SIDIQUE, S.F.A., KALIAPPAN, S.R., 2020b. The Export Survival of Malaysia's Processed Food. International Journal of Economics & Management 14.

Ikram, M., Zhang, Q., Sroufe, R., Shah, S.Z.A., 2020. Towards a sustainable environment: The nexus between ISO 14001, renewable energy consumption, access to electricity, agriculture and CO2 emissions in SAARC countries. Sustainable Production and Consumption 22, 218–230. https://doi.org/10.1016/j.spc.2020.03.011

Isermann, K., 1994. Agriculture's share in the emission of trace gases affecting the climate and some cause-oriented proposals for sufficiently reducing this share. Environmental Pollution 83, 95–111. https://doi.org/10.1016/0269-7491(94)90027-2

Jansen, D., Rukovo, A. ,1992,Agriculture and the policy environment | Semantic Scholar https://www.semanticscholar.org/paper/Agriculture-and-the-policy-environment-Jansen-Rukovo/43ddbd00b839524c3b9f7df4b2cd9b7ae794a216

Jayne, T., Govereh, J., Chilonda, P., Mason, N.M., Chapoto, A., Haantuba, H.H., 2007. Trends in Agricultural and Rural Development Indicators in Zambia. https://www.semanticscholar.org/paper/Trends-in-Agricultural-and-Rural-Development-in-Jayne-Govereh

Jayne, T., Mather, D., Mghenyi, E., 2010. Principal Challenges Confronting Smallholder Agriculture in Sub-Saharan Africa. World Development 38, 1384–1398. https://doi.org/10.1016/j.worlddev.2010.06.002

Jenkins, S.P., 2005. Survival analysis. Unpublished manuscript, Institute for Social and Economic Research, University of Essex, Colchester, UK 42, 54–56.

Johansen, S., Juselius, K., 1990. Maximum likelihood estimation and inference on cointegration—with appucations to the demand for money. Oxford Bulletin of Economics and statistics 52, 169–210.

Johnston, B.F., Mellor, J.W., 1961. The Role of Agriculture in Economic Development. The American Economic Review 51, 566–593.

Kajoba, G.M., 2008. Vulnerability and Resilience of rural Society in Zambia: From the Viewpoint of Land Tenure and Food Security, working paper on social-ecological resilience series No.2008-003. Research Institute For Humanity and nature, Kyoto.4

Kasoma, A., 2019. ANALYSIS OF RURAL FINANCE POLICY AND STRATEGY IMPLEMENTATION. https://doi.org/10.13140/RG.2.2.19887.05288

Karkacier, O., Gokalp Goktolga, Z., Cicek, A., 2006. A regression analysis of the effect of energy use in agriculture. Energy Policy 34, 3796–3800. https://doi.org/10.1016/j.enpol.2005.09.001

Kastratović, R., 2019. Impact of foreign direct investment on greenhouse gas emissions in agriculture of developing countries. Aust J Agric Resour Econ 1467-8489.12309. https://doi.org/10.1111/1467-8489.12309

Kaur, P., Singh, P., Sohi, B.S., 2020. Adaptive MAC Protocol for Solar Energy Harvesting Based Wireless Sensor Networks in Agriculture. Wireless Pers Commun 111, 2263–2285. https://doi.org/10.1007/s11277-019-06985-9

Khan, M.T.I., Ali, Q., Ashfaq, M., 2018. The nexus between greenhouse gas emission, electricity production, renewable energy and agriculture in Pakistan. Renewable Energy 118, 437–451. https://doi.org/10.1016/j.renene.2017.11.043

Kean, S., Wood, A., 1992. The dynamics of policy formulation in the Second Republic. Agricultural policy reform in Zambia: undefined.

Kongolo, M., Simelane, B.P., Dlamini, D.K., 2011. Empirical Assessment of Agricultural Development in Manzini Region, Swaziland. African Research Review 5, 397–410.

Koo, W.W., Karemera, D., 1991. Determinants of world wheat trade flows and policy analysis. Canadian Journal of Agricultural Economics/Revue canadienne d'agroeconomie 39, 439–455.

Kuznets, S., 1961. Economic growth and the contribution of agriculture: notes on measurement.

Lavopa, A.M., Szirmai, A., Verspagen, Bart, RS: FSE, 2015. Structural transformation and economic development : can development traps be avoided? Maastricht University. https://doi.org/10.26481/dis.20150312al

Lee, T.-M., Chi, P.-Y., Chang, K.-I., 2020. Duration and determinants of fishery trade patterns: Evidence from OECD countries. Marine Policy 118, 103977.

Lee, H.-C., Lee, J.-W., Hwang, J.-H., Yoe, H., 2010. A Study on Energy Efficient MAC Protocol of Wireless Sensor Network for Ubiquitous Agriculture. Security-Enriched Urban Computing and Smart Grid 78, 591. https://doi.org/10.1007/978-3-642-16444-6_74

Lewcock, C., 1995. Farmer use of urban waste in Kano. Habitat international 19, 225–234.

Liu, X., Zhang, S., Bae, J., 2017. The nexus of renewable energy-agriculture-environment in BRICS. Applied Energy 204, 489–496. https://doi.org/10.1016/j.apenergy.2017.07.077

Liew, V.K.-S., 2006. Which Lag Length Selection Criteria Should We Employ? (SSRN Scholarly Paper No. ID 885505). Social Science Research Network, Rochester, NY.

Ligon, E., Sadoulet, E., 2008. Estimating the Effects of Aggregate Agricultural Growth on the Distribution of Expenditures. World Bank, Washington, DC.

Lorenz, K., Lal, R., 2016. Environmental Impact of Organic Agriculture, in: Advances in Agronomy. Elsevier, pp. 99–152. https://doi.org/10.1016/bs.agron.2016.05.003

Lu, Y., Mu, H., Li, H., 2011. An Analysis of Present Situation and Future Trend about the Energy Consumption of Chinese Agriculture Sector. Procedia Environmental Sciences 11, 1400–1406. https://doi.org/10.1016/j.proenv.2011.12.210

Los, E., Gardebroek, C., 2015. Unravelling the links between agriculture and economic growth: a panel time series approach for post-WW II Africa, in: 10th New Frontiers in African Economic History Workshop Is Africa Growing out of Poverty. pp. 30–31.

Lowder, S.K., Bertini, R., Croppenstedt, A., 2017. Poverty, social protection and agriculture: Levels and trends in data. Global food security 15, 94–107.

Luo, Y., Bano, S., 2020. Modelling New Zealand dairy products: Evidence on export survival and duration. Australian Journal of Agricultural and Resource Economics 64, 605–631.

Luthra, S., Mangla, S.K., Garg, D., Kumar, A., 2018. Internet of Things (IoT) in Agriculture Supply Chain Management: A Developing Country Perspective, in: Dwivedi, Y.K., Rana, N.P., Slade, E.L., Shareef, M.A., Clement, M., Simintiras, A.C., Lal, B. (Eds.), Emerging Markets from a Multidisciplinary Perspective: Challenges, Opportunities and Research Agenda. Springer International Publishing, Cham, pp. 209–220. https://doi.org/10.1007/978-3-319-75013-2_16

Mabhaudhi, T., Mpandeli, S., Madhlopa, A., Modi, A.T., Backeberg, G., Nhamo, L., 2016b. Southern Africa's Water–Energy Nexus: Towards Regional Integration and Development. Water 8, 235. https://doi.org/10.3390/w8060235

Maitah, M., Saleem, N., Malec, K., Boubaker, M., Gouda, S., 2015a. Economic value added and stock market development in Egypt. Asian Social Science 11, 126.

Maitah, M., Saleem, N., Malec, K., Boubaker, M., Gouda, S., 2015b. Economic value added and stock market development in Egypt. Asian Social Science 11, 126.

Majune, S. K., Moyi, E., & Kamau, G. J., 2020. Explaining Export Duration in Kenya. *South African Journal of Economics*, 88(2), 204-224.

Mahmood, H., Alkhateeb, T.T.Y., Al-Qahtani, M.M.Z., Allam, Z., Ahmad, N., Furqan, M., 2019. Agriculture development and CO2 emissions nexus in Saudi Arabia. PLoS ONE 14, e0225865. https://doi.org/10.1371/journal.pone.0225865

Mankiw, G.N., 2016. Macroeconomics, Ninth Edition. ed. Worth Publishers, USA.

Mapfumo, A., Mushunje, A., Chidoko, C., 2012. The impact of government agricultural expenditure on economic growth in Zimbabwe.

Matsuyama, K., 1992. Agricultural productivity, comparative advantage, and economic growth. Journal of Economic Theory 58, 317–334. https://doi.org/10.1016/0022-0531(92)90057-O

May, J., Rogerson, C.M., 1995. Poverty and sustainable cities in South Africa: The role of urban cultivation. Habitat international 19, 165–181.

Menegaki, A.N., 2019. The ARDL Method in the Energy-Growth Nexus Field; Best Implementation Strategies. Economies 7, 105. https://doi.org/10.3390/economies7040105

Mero, G., Keco, R., Osmani, M., Kambo, A., 2021. Role of Agriculture to GDP and National per Capita Income Growth-What do Global Data Reveal for Albania?

Ministry of Agriculture, 2022. Zambia National Agricultural Policy 2012-2030. [WWW Document]. URL https://www.agriculture.gov.zm/ (accessed 3.7.22).

Ministry of Finance and National Planning, 2022. Budget address by Honourable Dr. Situmbeko Musokotwane, MP delivered to National Assembly Zambia. https://www.parliament.gov.zm/node/10630

Mitchell, D., 2008. A note on rising food prices. World bank policy research working paper.

Moussa, A., 2018. Does Agricultural Sector Contribute to the Economic Growth in Case of Republic of Benin? Journal of Social Economics Research 5, 85–93. Moghaddasi, R., Pour, A.A., 2016. Energy consumption and total factor productivity growth in Iranian agriculture. Energy Reports 2, 218–220. https://doi.org/10.1016/j.egyr.2016.08.004

Mucavele, F.G., 2013. True contribution of agriculture to economic growth and poverty reduction: Malawi, Mozambique and Zambia synthesis report.

Mukuka R.M, 2013. Maize dependency and agricultural subsidies in Zambia, Africa Research Institute https://www.africaresearchinstitute.org/newsite/blog/agricultural-subsidies-in-zambia/

Naylor, J., Deaton, B.J., Ker, A., 2020. Assessing the effect of food retail subsidies on the price of food in remote Indigenous communities in Canada. Food Policy 93, 101889.

Nandal, V., Dahiya, S., 2021. IoT Based Energy-Efficient Data Aggregation Wireless Sensor Network in Agriculture: A Review [WWW Document]. URL https://www.semanticscholar.org/paper/IoT-Based-Energy-Efficient-Data-Aggregation-Sensor-Nandal-Dahiya/af15c86d3b9c7a5fab0f44fb38946d283ae3896e (accessed 12.18.22).

Navarro, E., Costa, N., Pereira, A., 2020. A Systematic Review of IoT Solutions for Smart Farming. Sensors (Basel, Switzerland).

Nelson, R., 2020. Viewpoint: International agriculture's needed shift from energy intensification to agroecological intensification. Food Policy 91, 101815. https://doi.org/10.1016/j.foodpol.2019.101815

Ngarava, Zhou, Ayuk, Tatsvarei, 2019. Achieving Food Security in a Climate Change Environment: Considerations for Environmental Kuznets Curve Use in the South African Agricultural Sector. Climate 7, 108. https://doi.org/10.3390/cli7090108

Niyigaba, J., Ya Sun, J., Peng, D., Uwimbabazi, C., 2020. Agriculture and Green Economy for Environmental Kuznets Curve Adoption in Developing Countries: Insights from Rwanda. Sustainability 12, 10381. https://doi.org/10.3390/su122410381

Nelson, C.R., Plosser, C.R., 1982. Trends and random walks in macroeconmic time series: Some evidence and implications. Journal of Monetary Economics 10, 139–162. https://doi.org/10.1016/0304-3932(82)90012-5

Ninan, K.N., Bedamatta, S., 2012. Climate change, agriculture, poverty, and livelihoods: a status report. Institute for Social and Economic Change Bangalore.

Nitsch, V., 2009. Die another day: duration in German import trade. Rev World Econ 145, 133–154. https://doi.org/10.1007/s10290-009-0008-3

Nkolola, N., Libanda, J., Nyasa, L., 2016. Economic Significance of Agriculture for Poverty Reduction: The Case of Zambia. Archives of Current Research International 5. https://doi.org/10.9734/ACRI/2016/26464

Nolte, K., 2014. Large-scale agricultural investments under poor land governance in Zambia. Land Use Policy 38, 698–706. https://doi.org/10.1016/j.landusepol.2014.01.014

Odetola, T., Etumnu, C., 2013. Contribution of agriculture to economic growth in Nigeria, in: Proceeding: The 18th Annual Conference of the African Econometric Society (AES), Accra, Ghana 22nd And. pp. 1–28.

OEC Brazil, 2020. The Observation of Economic Complexity (OEC). Available online: https://oec.world/en/profile/country/bra/ (accessed on 4 May 2020).

Olanipekun, I.O., Olasehinde-Williams, G.O., Alao, R.O., 2019. Agriculture and environmental degradation in Africa: The role of income. Science of The Total Environment 692, 60–67. https://doi.org/10.1016/j.scitotenv.2019.07.129

Olakunle, O.O., 2021. The Impact of Agricultural Output on Human Life Expectancy in Nigeria. Asian Journal of Economics, Finance and Management 169–183.

Onifade, S.T., Acet, H., Sava, Ge.K., 2022. Modeling the Impacts of Msmes' Contributions to Gdp and Their Constraints on Unemployment: The Case of African's Most Populous Country. Stud. Bus. Econ. 17, 154–170. https://doi.org/10.2478/sbe-2022-0011

Orji, A., Ogbuabor, J.E., Anthony-Orji, O.I., Nkechi Alisigwe, J., 2020. Agricultural financing and agricultural output growth in developing economies: any causal linkage in Nigeria? International Journal of Finance, Insurance and Risk Management 10.

Oyetade, O., Al, E., 2021. Impact of Agricultural Output on Economic Growth in Nigeria: Application of Numerical Prediction and Econometric Analysis. Turkish Journal of Computer and Mathematics Education (TURCOMAT) 12, 1793–1801.

Panwar, N.L., Kaushik, S.C., Kothari, S., 2011. Solar greenhouse an option for renewable and sustainable farming. Renewable and Sustainable Energy Reviews 15, 3934–3945. https://doi.org/10.1016/j.rser.2011.07.030

Parcerisas, L., Dupras, J., 2018. From mixed farming to intensive agriculture: energy profiles of agriculture in Quebec, Canada, 1871–2011. Reg Environ Change 18, 1047–1057. https://doi.org/10.1007/s10113-018-1305-y

Paris, B., Vandorou, F., Balafoutis, A.T., Vaiopoulos, K., Kyriakarakos, G., Manolakos, D., Papadakis, G., 2022. Energy use in open-field agriculture in the EU: A critical review recommending energy efficiency measures and renewable energy sources adoption. Renewable and Sustainable Energy Reviews 158, 112098. https://doi.org/10.1016/j.rser.2022.112098

Pathak, A., AmazUddin, M., Abedin, M.J., Andersson, K., Mustafa, R., Hossain, M.S., 2019. IoT based Smart System to Support Agricultural Parameters: A Case Study. Procedia Computer Science.

Popescu, G., 2015. ANALYSIS OF TECHNICAL PROGRESS, ENERGY CONSUMPTION AND VALUE ADDED IN EUROPEAN UNION�S AGRICULTURE. Presented at the 2nd International Multidisciplinary Scientific Conference on Social Sciences and Arts SGEM2015. https://doi.org/10.5593/SGEMSOCIAL2015/B23/S7.007

Pratibha, G., Srinivas, I., V. Rao, K., M.K. Raju, B., Shanker, A.K., Jha, A., Uday Kumar, M., Srinivasa Rao, K., Sammi Reddy, K., 2019. Identification of environment friendly tillage implement as a strategy for energy efficiency and mitigation of climate change in semiarid rainfed agro ecosystems. Journal of Cleaner Production 214, 524–535. https://doi.org/10.1016/j.jclepro.2018.12.251

Praveen, K.V., Jha, G.K., Aditya, K.S., 2021. Discerning Sustainable Interaction Between Agriculture and Energy in India. Current Science 120, 1833. https://doi.org/10.18520/cs/v120/i12/1833-1839

Pesaran, M.H., Shin, Y., Smith, R.J., 2001. Bounds testing approaches to the analysis of level relationships. Journal of Applied Econometrics 16, 289–326. https://doi.org/10.1002/jae.616

Peskett, L., Slater, R., Stevens, C., Dufey, A., 2007. Biofuels, agriculture, and poverty reduction. Natural resource perspectives 107, 1–6.

Peterson, E.B., Grant, J.H., Rudi, J., 2015. Survival of the Fittest: Export Duration and Failure in US Fresh Fruit and Vegetable Markets.

PHILLIPS, P.C.B., PERRON, P., 1988. Testing for a unit root in time series regression. Biometrika 75, 335–346. https://doi.org/10.1093/biomet/75.2.335

Phiri, J., Malec, K., Kapuka, A., Maitah, M., Appiah-Kubi, S.N.K., Gebeltová, Z., Bowa, M., Maitah, K., 2021a. Impact of Agriculture and Energy on CO2 Emissions in Zambia. Energies 14, 8339. https://doi.org/10.3390/en14248339

Phiri, J., Malec, K., Majune, S.K., Appiah-Kubi, S.N.K., Gebeltová, Z., Kotásková, S.K., Maitah, M., Maitah, K., Naluwooza, P., 2021b. Durability of Zambia's Agricultural Exports. Agriculture 11, 73. https://doi.org/10.3390/agriculture11010073

Phiri, J., Malec, K., Majune, S.K., Appiah-Kubi, S.N.K., Gebeltová, Z., Maitah, M., Maitah, K., Abdullahi, K.T., 2020. Agriculture as a Determinant of Zambian Economic Sustainability. Sustainability 12, 4559. https://doi.org/10.3390/su12114559

Pingle, M.; Mahmoudi, M., 2016 *Economic Growth and Government Size*; Financial Reports; Nevada State Controller's Office: Carson City, NV, USA. Available online: http://controller.nv.gov/FinancialReports (accessed on 6 May 2020).

Prus, P., 2019. The role of higher education in promoting sustainable agriculture. J East Eur Manag Stud 99–119.

Ragazou, K., Garefalakis, A., Zafeiriou, E., Passas, I., 2022. Agriculture 5.0: A New Strategic Management Mode for a Cut Cost and an Energy Efficient Agriculture Sector. Energies 15, 3113. https://doi.org/10.3390/en15093113

Rahman, M.M., Khan, I., Field, D.L., Techato, K., Alameh, K., 2022. Powering agriculture: Present status, future potential, and challenges of renewable energy applications. Renewable Energy 188, 731–749. https://doi.org/10.1016/j.renene.2022.02.065

Rahman, S.U., Faisal, F., Sami, F., Ali, A., Chander, R., Amin, M.Y., 2022. Investigating the Nexus Between Inflation, Financial Development, and Carbon Emission: Empirical Evidence from FARDL and Frequency Domain Approach. J Knowl Econ. https://doi.org/10.1007/s13132-022-01076-w

Rauf, A., Zhang, J., Li, J., Amin, W., 2018a. Structural changes, energy consumption and carbon emissions in China: Empirical evidence from ARDL bound testing model. Structural Change and Economic Dynamics 47, 194–206. https://doi.org/10.1016/j.strueco.2018.08.010

Rauf, A., Zhang, J., Li, J., Amin, W., 2018b. Structural changes, energy consumption and carbon emissions in China: Empirical evidence from ARDL bound testing model. Structural Change and Economic Dynamics 47, 194–206. https://doi.org/10.1016/j.strueco.2018.08.010

Rauf, A., Zhang, J., Li, J., Amin, W., 2018c. Structural changes, energy consumption and carbon emissions in China: Empirical evidence from ARDL bound testing model. Structural Change and Economic Dynamics 47, 194–206. https://doi.org/10.1016/j.strueco.2018.08.010

Raza, M.Y., Wu, R., Lin, B., 2023. A decoupling process of Pakistan's agriculture sector: Insights from energy and economic perspectives. Energy 263, 125658. https://doi.org/10.1016/j.energy.2022.125658

Rijal, K., Bansal, N.K., Grover, P.D., 1991. Energy and subsistence Nepalese agriculture. Bioresource Technology 37, 61–69. https://doi.org/10.1016/0960-8524(91)90112-W

Rokicki, T., Ratajczak, M., Bórawski, P., Bełdycka-Bórawska, A., Gradziuk, B., Gradziuk, P., Siedlecka, A., 2021. Energy Self-Subsistence of Agriculture in EU Countries. Energies 14, 3014. https://doi.org/10.3390/en14113014

Rehman, A., Chandio, A.A., Hussain, I., Jingdong, L., 2019. Fertilizer consumption, water availability and credit distribution: Major factors affecting agricultural productivity in Pakistan. Journal of the Saudi Society of Agricultural Sciences 18, 269–274.

Roman, Micha\l, Roman, Monika, Prus, P., 2020. Innovations in agritourism: Evidence from a region in Poland. Sustainability 12, 4858.

Rostow, W.W. *The Stages of Economic Growth. A Non-Communist Manifesto*; Cambridge University Press: Cambridge, UK, 1960.

Rostow, Walt Whitman, Rostow, W. W., 1990. The Stages of Economic Growth: A Non-Communist Manifesto. Cambridge University Press.

Saleem, M., 2022. Possibility of utilizing agriculture biomass as a renewable and sustainable future energy source. Heliyon 8, e08905. https://doi.org/10.1016/j.heliyon.2022.e08905

Sebri, M., Abid, M., 2012. Energy use for economic growth: A trivariate analysis from Tunisian agriculture sector. Energy Policy 48, 711–716. https://doi.org/10.1016/j.enpol.2012.06.006

Security analysis of a park-level agricultural energy Internet considering agrometeorology and energy meteorology, 2020. . CSEE JPES. https://doi.org/10.17775/CSEEJPES.2019.03230

Shaari, M.S., Mariadas, P.A., Hussain, N.E., Murthy, U., 2021. The Effect of Energy Consumption in the Agricultural Sector on CO2 Emissions in Malaysia.

Shah, M.I., AbdulKareem, H.K.K., Ishola, B.D., Abbas, S., 2022. The roles of energy, natural resources, agriculture and regional integration on CO2 emissions in selected countries of ASEAN: does political constraint matter? Environ Sci Pollut Res. https://doi.org/10.1007/s11356-022-23871-3

Shamshiri, R., Kalantari, F., Ting, K., Thorp, K., Hameed, I., Weltzien, C., Ahmad, D., Shad, Z., 2018. Advances in greenhouse automation and controlled environment agriculture: A transition to plant factories and urban agriculture. International Journal of Agricultural and Biological Engineering.

Sichuan University, Liu, J., Chai, Y., Sichuan University, Xiang, Y., Sichuan University, Zhang, X., National Grid, Gou, S., Sichuan University, Liu, Y., Sichuan University, 2018. Clean energy consumption of power systems towards smart agriculture: roadmap, bottlenecks and technologies. CSEE JPES 4, 273–282. https://doi.org/10.17775/CSEEJPES.2017.01290

Sirotenko, O.D., Abashina, H.V., Pavlova, V.N., n.d. SENSITIVITY OF THE RUSSIAN AGRICULTURE TO CHANGES IN CLIMATE, CO2 AND TROPOSPHERIC OZONE CONCENTRATIONS AND SOIL FERTILITY.

Sivamani, S., Bae, N., Cho, Y., 2013. A Smart Service Model Based on Ubiquitous Sensor Networks Using Vertical Farm Ontology. International Journal of Distributed Sensor Networks.

Sahoo, P., Pradhan, K.C., Nayak, T., 2021. Inclusiveness of Poverty Reduction: A Study of Andhra Pradesh and Telangana. The Indian Economic Journal 00194662211063575.

Saasa, O., 1996. Policy Reforms and Structural Adjustment in Zambia: The Case of Agriculture and Trade. https://www.semanticscholar.org/paper/Policy-Reforms-and-Structural-Adjustment-in-Zambia.

Sam, C.Y., McNown, R., Goh, S.K., 2019. An augmented autoregressive distributed lag bounds test for cointegration. Econ. Model. 80, 130–141. https://doi.org/10.1016/j.econmod.2018.11.001

Sane, M., Hajek, M., Phiri, J., Babangida, J.S., Nwaogu, C., 2022. Application of Decoupling Approach to Evaluate Electricity Consumption, Agriculture, GDP, Crude Oil Production, and CO2 Emission Nexus in Support of Economic Instrument in Nigeria. Sustainability 14, 3226. https://doi.org/10.3390/su14063226

Sanjuán-López, A.I., Dawson, P.J., 2010. Agricultural Exports and Economic Growth in Developing Countries: A Panel Cointegration Approach. Journal of Agricultural Economics 61, 565–583. https://doi.org/10.1111/j.1477-9552.2010.00257.x

Schiff, M., Valdés, A., 1992. The Plundering of Agriculture in Developing Countries (Washington, DC: The World Bank).

Schultz, T.W., 1966. Transforming Traditional Agriculture: Reply. Journal of Farm Economics 48, 1015–1018. https://doi.org/10.2307/1236629

Sertoğlu, K., Ugural, S., Bekun, F.V., 2017. The Contribution of Agricultural Sector on Economic Growth of Nigeria 7, 6.

Setboonsarng, S., 2006. Organic Agriculture, Poverty Reduction, and the Millennium Development Goals: Discussion Paper. ADB Institute Discussion Paper No. 54.

Seven, U., Tumen, S., 2020. Agricultural credits and agricultural productivity: cross-country evidence. Singapore Econ. Rev. 65, 161–183. https://doi.org/10.1142/S02175908204400147

Sihlobo, W., 2060. SA and Zambia able to replace global producers' maize exports to neighbours. Agriculture Economics Today. Retrieved https://wandilesihlobo.com/2020/06/11/sa-and-zambia-able-to-replace-global-producers-maize-exports-to-neighbours/ Accessed (24/06/2022).

Simatele, M.C., 2006. Food production in Zambia: The impact of selected structural adjustment policies. African Economic Research Consortium.

Simon, D., Williams, G., 2009. Structural Adjustment Program - an overview | ScienceDirect Topics https://www.sciencedirect.com/topics/earth-and-planetary-sciences/structural-adjustment-program .

Simutanyi, N., 1996. The politics of structural adjustment in Zambia. Third World Quarterly 17, 825–839. https://doi.org/10.1080/01436599615407

Sitko, N., Bwalya, R., Kamwanga, J., Wamulume, M., 2012. Assessing the Feasibility of Implementing the Farmer Input Support Programme (FISP) Through an Electronic Voucher System in Zambia.

Sitko, N., Jayne, T., 2014. Structural transformation or elite land capture? The growth of "emergent" farmers in Zambia. Food Policy 48. https://doi.org/10.1016/j.foodpol.2014.05.006

Socrates, M.K., Moyi, E., Gathiaka, K., 2020. Explaining export duration in Kenya. South African Journal of Economics 88, 204–224.

Srinivasan, P., Kumar, P.K.S., Ganesh, L., 2012. Tourism and Economic Growth in Sri Lanka An ARDL Bounds Testing Approach. Environ. Urban. ASIA 3, 397–405. https://doi.org/10.1177/0975425312473234

Steger, T., 2000. Economic growth with subsistence consumption, in: Transitional Dynamics and Economic Growth in Developing Countries. Springer, pp. 21–60.

Stiglitz, J.E., Walsh, C.E., 2006. Economics, Fourth Edition. ed. USA.

T. A., K., Maitah, M., N. A., K., Hajek, P., B. S., T., A. K, B., 2015a. Economic Analysis of the Impact of Changing Production Conditions on Wheat Productivity Level. Rev. Eur. Stud. 7, 125.

T. A., K., Maitah, M., N. A., K., Hajek, P., B. S., T., A. K, B., 2015b. Economic Analysis of the Impact of Changing Production Conditions on Wheat Productivity Level. Rev. Eur. Stud. 7, 125.

Tahamipour, M., Mahmoudi, M., 2018. The Role of Agricultural Sector Productivity in Economic Growth: The Case of Iran's Economic Development Plan.

Thomson, A., Price, G.W., Arnold, P., Dixon, M., Graham, T., 2022. Review of the potential for recycling CO2 from organic waste composting into plant production under controlled environment agriculture. Journal of Cleaner Production 333, 130051. https://doi.org/10.1016/j.jclepro.2021.130051

Türkekul, B., Unakıtan, G., 2011. A co-integration analysis of the price and income elasticities of energy demand in Turkish agriculture. Energy Policy 39, 2416–2423. https://doi.org/10.1016/j.enpol.2011.01.064

Turyareeba, P.J., 2001. Renewable energy: its contribution to improved standards of living and modernisation of agriculture in Uganda. Renewable Energy 24, 453–457. https://doi.org/10.1016/S0960-1481(01)00028-3

Tembo, G., Chapoto, A., Jayne, T., Weber, M., 2010. Fostering Food Market Development in Zambia,https://www.researchgate.net/publication/238603787_Fostering_Food_Market_Development_in_Zambia.

Teshome, A., 2006. Agriculture, growth, and poverty reduction in Ethiopia: policy processes around the new PRSP (PASDEP), in: A Paper for the Future Agricultures Consortium Workshop, Institute of Development Studies, University of Sussex, UK. Citeseer, pp. 20–22.

Tiffin, R., Irz, X., 2006. Is agriculture the engine of growth? Agricultural economics 35, 79–89.

The Global Competitiveness Report 2019. 2019. World Economic Forum Available online: http://www3.weforum.org/docs/WEF_TheGlobalCompetitivenessReport2019.pdf (accessed on 6 May 2020).

Todaro, M.P., Smith, S.C., 2015. Economic Development, 12th Edition, Twelventh Edition. ed. Pearson Education, USA.

Trinh, T.Q., Rañola, R.F., Camacho, L.D., Simelton, E., 2018. Determinants of farmers' adaptation to climate change in agricultural production in the central region of Vietnam. Land Use Policy 70, 224–231. https://doi.org/10.1016/j.landusepol.2017.10.023

Uddin, M.M.M., 2020. What are the dynamic links between agriculture and manufacturing growth and environmental degradation? Evidence from different panel income countries. Environmental and Sustainability Indicators 7, 100041. https://doi.org/10.1016/j.indic.2020.100041

Uhlin, H.-E., 1999. Energy productivity of technological agriculture-lessons from the transition of Swedish agriculture. Agriculture, Ecosystems & Environment 73, 63–81. https://doi.org/10.1016/S0167-8809(99)00002-X

Ullah, R., Abbas, A., Ullah, M., Khan, R., Khan, I.U., Aslam, N., Aljameel, S.S., 2021. EEWMP: An IoT-Based Energy-Efficient Water Management Platform for Smart Irrigation. Sci. Program.

Urbano, B., Barquero, M., González-Andrés, F., 2022. The environmental impact of fresh tomatoes consumed in cities: A comparative LCA of long-distance transportation and local production. Scientia Horticulturae 301, 111126. https://doi.org/10.1016/j.scienta.2022.111126

United Nations, 2022. Sustainable Development Goals. United Nations Development Programme [WWW Document]. UNDP. URL https://www.undp.org/sustainable-development-goals (accessed 3.28.22).

Vandone, D., Peri, M., Baldi, L., Tanda, A., 2018. The impact of energy and agriculture prices on the stock performance of the water industry. Water Resources and Economics 23, 14–27. https://doi.org/10.1016/j.wre.2018.02.002

Wang, P., Tran, N., Wilson, N.L.W., Chan, C.Y., Dao, D., 2019. An Analysis of Seafood Trade Duration: The Case of ASEAN. Marine Resource Economics 34, 59–76. https://doi.org/10.1086/700599

Waheed, R., Chang, D., Sarwar, S., Chen, W., 2018. Forest, agriculture, renewable energy, and CO2 emission. Journal of Cleaner Production 172, 4231–4238. https://doi.org/10.1016/j.jclepro.2017.10.287

Wang, A., Lv, J., Wang, J., Shi, K., 2022. CO2 enrichment in greenhouse production: Towards a sustainable approach. Front. Plant Sci. 13, 1029901. https://doi.org/10.3389/fpls.2022.1029901

Wang, L., Mehmood, U., Agyekum, E.B., Uhun amure, S.E., Shale, K., 2022. Associating Renewable Energy, Globalization, Agriculture, and Ecological Footprints: Implications for Sustainable Environment in South Asian Countries. IJERPH 19, 10162. https://doi.org/10.3390/ijerph191610162

Wang, L., Vo, X.V., Shahbaz, M., Ak, A., 2020. Globalization and carbon emissions: Is there any role of agriculture value-added, financial development, and natural resource rent in the aftermath of COP21? Journal of Environmental Management 268, 110712. https://doi.org/10.1016/j.jenvman.2020.110712

Warsaw University of Life Sciences, Wysokinski, M., Trebska, P., Gromada, A., 2018. Use of energy in Polish agriculture. Presented at the 19th International Scientific Conference "Economic Science for Rural Development 2018," pp. 531–536. https://doi.org/10.22616/ESRD.2018.062

White, E.M., Latta, G., Alig, R.J., Skog, K.E., Adams, D.M., 2013. Biomass production from the U.S. forest and agriculture sectors in support of a renewable electricity standard. Energy Policy 58, 64–74. https://doi.org/10.1016/j.enpol.2013.02.029

Woods, J., Williams, A., Hughes, J.K., Black, M., Murphy, R., 2010. Energy and the food system. Phil. Trans. R. Soc. B 365, 2991–3006. https://doi.org/10.1098/rstb.2010.0172

Wysokiński, M., Domagała, J., Gromada, A., Golonko, M., Trębska, P., 2020. Economic and energy efficiency of agriculture. Agric. Econ. – Czech 66, 355–364. https://doi.org/10.17221/170/2020-AGRICECON

Türkcan, K., & Saygılı, H., 2018. Economic Integration Agreements and the Survival of Exports. *Journal of Economic Integration*, 33(1),1046-1095

UNDP, 2022. Human Development Reports. United Nations Development Program. Retrieved https://hdr.undp.org/data-center/human-development-index#/indicies/HDI(accessed 18/06/2022).

WHO, 2022. World Health Statistics. World Health Organization. Retrieved https://www.who.int/data/gho/publications/world-health-statistics (accessed 18/06/2022).

Wichmann, T., 1995. Food consumption and growth in a two sector economy. TU, Wirtschaftswiss. Dokumentation, Fachbereich 14.

Woodridge, J.M., 2018. Introductory Econometrics A Modern Approach, Seventh Edition. ed. Cengage Learning, Inc., USA.

World Bank, 2019. Annual Report 2019. Ending Poverty, Investing in Opportunity https://openknowledge.worldbank.org/handle/10986/32333 (accessed 11.1.22).

World Bank, 2022. World Development Indicators https://databank.worldbank.org/source/world-development-indicators (accessed 2.21.22).

World Bank., 2021. Zambia's Farmer Input Support Program and Recommendations for Re-designing the Program (Report). World Bank, Washington, DC.

Yang, B., Anderson, J., Fang, Y., 2021. Trade duration of Chinese shrimp exports. Aquaculture Economics & Management 25, 260–274.

Young, A.O., 2018. Impact of Labour Force Dynamics on Economic Growth in Nigeria: An Empirical Analysis Using ARDL Bound Testing Approach. Journal of Resources Development and Management 42, 31–46.

Yan, Q., Yin, J., Baležentis, T., Makutėnienė, D., Štreimikienė, D., 2017. Energy-related GHG emission in agriculture of the European countries: An application of the Generalized Divisia Index. Journal of Cleaner Production 164, 686–694. https://doi.org/10.1016/j.jclepro.2017.07.010

Yasmeen, R., Padda, I.U.H., Yao, X., Shah, W.U.H., Hafeez, M., 2022. Agriculture, forestry, and environmental sustainability: the role of institutions. Environ Dev Sustain 24, 8722–8746. https://doi.org/10.1007/s10668-021-01806-1

Yu, Y., Jiang, T., Li, S., Li, X., Gao, D., 2020. Energy-related CO2 emissions and structural emissions' reduction in China's agriculture: An input–output perspective. Journal of Cleaner Production 276, 124169. https://doi.org/10.1016/j.jclepro.2020.124169

Zambia Development Agency (2015). Zambia's Investment Guide 2015, "Investment and Employment Pledges – January – September 2014 and 2015".

Zambia Statistics Agency, 2022. Agriculture [WWW Document]. URL https://www.zamstats.gov.zm/ (accessed 3.7.22).

https://doi.org/10.17221/170/2020-AGRICECON

Zang, L., Zhang, C., 2019. Biomass energy from agriculture in China: Potential and evolutionary trend. IOP Conf. Ser.: Earth Environ. Sci. 291, 012034. https://doi.org/10.1088/1755-1315/291/1/012034

Zelingher, R., Ghermandi, A., De Cian, E., Mistry, M., Kan, I., 2019. Economic Impacts of Climate Change on Vegetative Agriculture Markets in Israel. Environ Resource Econ 74, 679–696. https://doi.org/10.1007/s10640-019-00340-z

Zhang, J., Cherian, J., Parvez, A.M., Samad, S., Sial, M.S., Ali, M.A., Khan, M.A., 2022. Consequences of Sustainable Agricultural Productivity, Renewable Energy, and Environmental Decay: Recent Evidence from ASEAN Countries. Sustainability 14, 3556. https://doi.org/10.3390/su14063556

Zhu, Y., Li, P., Feng, X., Sun, D., Fang, T., Zhu, X.X., Zhang, Y., Li, C., Jia, X., 2021. Reversible CO2 absorption and release by fatty acid salt aqueous solutions: From industrial capture to agricultural applications. Journal of CO2 Utilization 54, 101746. https://doi.org/10.1016/j.jcou.2021.101746

Zhang, D., Tveterås, R., 2019. A fish out of water? Survival of seafood products from developing countries in the EU market. Marine Policy 103, 50–58.

Zinnbauer, M., Mockshell, J., Zeller, M., 2018. Effects if Fertilizer Subsidies in Zambia: A Literature Review, https://www.semanticscholar.org/paper/Effects-if-Fertilizer-Subsidies-in-Zambia%3A-A-Review-Zinnbauer-Mockshell

Zivot, E., Andrews, D.W.K., 2002. Further Evidence on the Great Crash, the Oil-Price Shock, and the Unit-Root Hypothesis. Journal of Business & Economic Statistics 20, 25–44. https://doi.org/10.1198/073500102753410372

APPENDIXES

APPENDIX A: LIST OF ZAMBIA'S IMPORTER COUNTRIES FOR THE DURABILITY ANALYSIS

Algeria	Ghana	Norway
Angola	Greece	Pakistan
Argentina	Guatemala	Philippines
Armenia	Honduras	Poland
Australia	Hong Kong	Portugal
Austria	Hungary	Romania
Azerbaijan	India	Russian Federation
Bahrain	Indonesia	Rwanda
Bangladesh	Iran	Saudi Arabia
Belarus	Ireland	Senegal
Belgium	Israel	Serbia and Montenegro
Bosnia and Herzegovina	Italy	Seychelles
Botswana	Japan	Singapore
Brazil	Jordan	Slovak Republic
Bulgaria	Kenya	Slovenia
Burkina Faso	Korea	South Africa
Burundi	Kuwait	Spain
Cambodia	Kyrgyzstan	Sri Lanka
Cameroon	Lao PDR	Sudan
Canada	Latvia	Swaziland
Chile	Lesotho	Sweden
China	Lithuania	Switzerland
Colombia	Luxembourg	Tanzania
Cote d'Ivoire	Madagascar	Thailand
Croatia	Malawi	Tunisia
Cyprus	Malaysia	Turkey
Czech Republic	Mauritius	Uganda
Denmark	Mexico	Ukraine
Dominican Republic	Moldova	United Arab Emirates
Egypt	Morocco	United Kingdom
Estonia	Mozambique	United States
Ethiopia	Namibia	Uruguay
Finland	Netherlands	Vietnam
France	New Caledonia	Yemen
Georgia	New Zealand	Zimbabwe
Germany	Nigeria	

APPENDIX B: ORIGINAL UNIT ROOT ESTIMATION OUTPUTS

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

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-0.249273	0.9890
Test critical values:	1% level	-4.252879	
	5% level	-3.548490	
	10% level	-3.207094	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(GDP)
Method: Least Squares
Date: 09/25/22 Time: 11:36
Sample (adjusted): 1987 2020
Included observations: 34 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
GDP(-1)	-0.073622	0.295347	-0.249273	0.8050
D(GDP(-1))	-0.839348	0.310947	-2.699332	0.0116
D(GDP(-2))	-0.582328	0.284682	-2.045536	0.0503
D(GDP(-3))	-0.246718	0.204830	-1.204505	0.2385
C	2.039881	1.445236	1.411452	0.1691
@TREND("1983")	-0.084495	0.086798	-0.973469	0.3387

R-squared	0.462551	Mean dependent var	-0.103204
Adjusted R-squared	0.366578	S.D. dependent var	4.444175
S.E. of regression	3.537021	Akaike info criterion	5.523232
Sum squared resid	350.2945	Schwarz criterion	5.792590
Log likelihood	-87.89494	Hannan-Quinn criter.	5.615091
F-statistic	4.819597	Durbin-Watson stat	1.949361
Prob(F-statistic)	0.002648		

Null Hypothesis: D(GDP) has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 2 (Automatic - based on SIC, maxlag=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-5.482528	0.0004
Test critical values:	1% level	-4.252879	
	5% level	-3.548490	
	10% level	-3.207094	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(GDP,2)
Method: Least Squares
Date: 09/25/22 Time: 11:37
Sample (adjusted): 1987 2020
Included observations: 34 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(GDP(-1))	-2.792081	0.509269	-5.482528	0.0000
D(GDP(-1),2)	0.891102	0.375156	2.375285	0.0244
D(GDP(-2),2)	0.266831	0.185200	1.440771	0.1604
C	2.050717	1.421031	1.443119	0.1597
@TREND("1983")	-0.099285	0.062321	-1.593109	0.1220

R-squared	0.822857	Mean dependent var	-0.098087
Adjusted R-squared	0.798424	S.D. dependent var	7.749606
S.E. of regression	3.479357	Akaike info criterion	5.466625
Sum squared resid	351.0718	Schwarz criterion	5.691090
Log likelihood	-87.93263	Hannan-Quinn criter.	5.543174
F-statistic	33.67750	Durbin-Watson stat	1.968489
Prob(F-statistic)	0.000000		

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

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-4.284910	0.0086
Test critical values:	1% level	-4.226815	
	5% level	-3.536601	
	10% level	-3.200320	

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

Residual variance (no correction)	12.05831
HAC corrected variance (Bartlett kernel)	15.78709

Phillips-Perron Test Equation
Dependent Variable: D(GDP)
Method: Least Squares
Date: 09/25/22 Time: 11:38
Sample (adjusted): 1984 2020
Included observations: 37 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
GDP(-1)	-0.705132	0.180101	-3.915200	0.0004
C	1.286211	1.217904	1.056086	0.2984
@TREND("1983")	0.069723	0.064043	1.088683	0.2840

R-squared	0.323367	Mean dependent var	-0.022118
Adjusted R-squared	0.283565	S.D. dependent var	4.279728
S.E. of regression	3.622468	Akaike info criterion	5.489793
Sum squared resid	446.1573	Schwarz criterion	5.620408
Log likelihood	-98.56117	Hannan-Quinn criter.	5.535841
F-statistic	8.124407	Durbin-Watson stat	2.055901
Prob(F-statistic)	0.001306		

Null Hypothesis: GDP has a unit root
Trend Specification: Trend and intercept
Break Specification: Intercept only
Break Type: Innovational outlier

Break Date: 1992
Break Selection: Minimize Dickey-Fuller t-statistic
Lag Length: 0 (Automatic - based on F-statistic selection, lagpval=0.1, maxlag=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-4.140148	0.2923
Test critical values:	1% level	-5.347598	
	5% level	-4.859812	
	10% level	-4.607324	

*Vogelsang (1993) asymptotic one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: GDP
Method: Least Squares
Date: 09/25/22 Time: 10:46
Sample (adjusted): 1984 2020
Included observations: 37 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
GDP(-1)	0.254284	0.180118	1.411759	0.1677
C	0.982955	1.323434	0.742731	0.4631
TREND	-0.009709	0.086603	-0.112109	0.9114
INCPTBREAK	2.688774	2.143576	1.254340	0.2188
BREAKDUM	-5.306083	3.875032	-1.369300	0.1804

R-squared	0.242017	Mean dependent var	3.712026
Adjusted R-squared	0.147269	S.D. dependent var	3.884959
S.E. of regression	3.587505	Akaike info criterion	5.517880
Sum squared resid	411.8462	Schwarz criterion	5.735571
Log likelihood	-97.08077	Hannan-Quinn criter.	5.594626
F-statistic	2.554320	Durbin-Watson stat	1.953555
Prob(F-statistic)	0.057848		

Null Hypothesis: D(GDP) has a unit root
Trend Specification: Trend and intercept
Break Specification: Intercept only
Break Type: Innovational outlier

Break Date: 1994
Break Selection: Minimize Dickey-Fuller t-statistic
Lag Length: 0 (Automatic - based on F-statistic selection, lagpval=0.1, maxlag=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-10.98435	< 0.01
Test critical values:	1% level	-5.347598	
	5% level	-4.859812	
	10% level	-4.607324	

*Vogelsang (1993) asymptotic one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(GDP)
Method: Least Squares
Date: 09/25/22 Time: 10:49
Sample (adjusted): 1985 2020
Included observations: 36 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(GDP(-1))	-0.390646	0.126602	-3.085611	0.0043
C	1.712048	1.076172	1.590869	0.1218
TREND	-0.181827	0.077307	-2.352002	0.0252
INCPTBREAK	2.705047	1.843886	1.467036	0.1524
BREAKDUM	-14.69004	3.409642	-4.308380	0.0002

R-squared	0.571413	Mean dependent var	-0.068006
Adjusted R-squared	0.516112	S.D. dependent var	4.331195
S.E. of regression	3.012870	Akaike info criterion	5.171909
Sum squared resid	281.3989	Schwarz criterion	5.391842
Log likelihood	-88.09437	Hannan-Quinn criter.	5.248672
F-statistic	10.33268	Durbin-Watson stat	2.062051
Prob(F-statistic)	0.000020		

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

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-3.398632	0.0670
Test critical values:	1% level	-4.226815	
	5% level	-3.536601	
	10% level	-3.200320	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(AGRICULTURE)
Method: Least Squares
Date: 09/25/22 Time: 11:41
Sample (adjusted): 1984 2020
Included observations: 37 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
AGRICULTURE(-1)	-0.493580	0.145229	-3.398632	0.0017
C	9.916717	3.031447	3.271282	0.0025
@TREND("1983")	-0.201294	0.071938	-2.798139	0.0084

R-squared	0.261398	Mean dependent var	-0.303302
Adjusted R-squared	0.217951	S.D. dependent var	3.912484
S.E. of regression	3.459948	Akaike info criterion	5.397989
Sum squared resid	407.0221	Schwarz criterion	5.528604
Log likelihood	-96.86279	Hannan-Quinn criter.	5.444037
F-statistic	6.016465	Durbin-Watson stat	2.114935
Prob(F-statistic)	0.005794		

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

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-9.337344	0.0000
Test critical values:	1% level	-4.339330	
	5% level	-3.587527	
	10% level	-3.229230	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(AGRICULTURE,2)
Method: Least Squares
Date: 09/25/22 Time: 11:42
Sample (adjusted): 1994 2020
Included observations: 27 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(AGRICULTURE(-1))	-8.199867	0.878180	-9.337344	0.0000
D(AGRICULTURE(-1),2)	6.166641	0.825702	7.468357	0.0000
D(AGRICULTURE(-2),2)	5.169990	0.748695	6.905336	0.0000
D(AGRICULTURE(-3),2)	4.182173	0.655342	6.381663	0.0000
D(AGRICULTURE(-4),2)	3.213425	0.556104	5.778463	0.0000
D(AGRICULTURE(-5),2)	2.297321	0.458435	5.011221	0.0002
D(AGRICULTURE(-6),2)	1.579709	0.361962	4.364300	0.0006
D(AGRICULTURE(-7),2)	1.002179	0.261959	3.825716	0.0017
D(AGRICULTURE(-8),2)	0.529755	0.165567	3.199632	0.0060
D(AGRICULTURE(-9),2)	0.193765	0.083373	2.324077	0.0346
C	2.171527	1.257207	1.727263	0.1046
@TREND("1983")	-0.253288	0.059656	-4.245814	0.0007

R-squared	0.974932	Mean dependent var	-0.336847
Adjusted R-squared	0.956549	S.D. dependent var	7.024390
S.E. of regression	1.464234	Akaike info criterion	3.901644
Sum squared resid	32.15973	Schwarz criterion	4.477572
Log likelihood	-40.67220	Hannan-Quinn criter.	4.072898
F-statistic	53.03358	Durbin-Watson stat	0.784819
Prob(F-statistic)	0.000000		

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

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-3.398632	0.0670
Test critical values:	1% level	-4.226815	
	5% level	-3.536601	
	10% level	-3.200320	

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

Residual variance (no correction)	11.00060
HAC corrected variance (Bartlett kernel)	11.00060

Phillips-Perron Test Equation
Dependent Variable: D(AGRICULTURE)
Method: Least Squares
Date: 09/25/22 Time: 11:43
Sample (adjusted): 1984 2020
Included observations: 37 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
AGRICULTURE(-1)	-0.493580	0.145229	-3.398632	0.0017
C	9.916717	3.031447	3.271282	0.0025
@TREND("1983")	-0.201294	0.071938	-2.798139	0.0084

R-squared	0.261398	Mean dependent var	-0.303302
Adjusted R-squared	0.217951	S.D. dependent var	3.912484
S.E. of regression	3.459948	Akaike info criterion	5.397989
Sum squared resid	407.0221	Schwarz criterion	5.528604
Log likelihood	-96.86279	Hannan-Quinn criter.	5.444037
F-statistic	6.016465	Durbin-Watson stat	2.114935
Prob(F-statistic)	0.005794		

Null Hypothesis: D(AGRICULTURE) has a unit root
Exogenous: Constant, Linear Trend
Bandwidth: 35 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-24.09789	0.0000
Test critical values:	1% level	-4.234972	
	5% level	-3.540328	
	10% level	-3.202445	

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

Residual variance (no correction)	13.62274
HAC corrected variance (Bartlett kernel)	0.648804

Phillips-Perron Test Equation
Dependent Variable: D(AGRICULTURE,2)
Method: Least Squares
Date: 09/25/22 Time: 11:44
Sample (adjusted): 1985 2020
Included observations: 36 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(AGRICULTURE(-1))	-1.317622	0.165285	-7.971815	0.0000
C	0.562784	1.369087	0.411066	0.6837
@TREND("1983")	-0.050469	0.062240	-0.810875	0.4232

R-squared	0.658232	Mean dependent var	-0.006365
Adjusted R-squared	0.637518	S.D. dependent var	6.403000
S.E. of regression	3.855019	Akaike info criterion	5.616284
Sum squared resid	490.4188	Schwarz criterion	5.748244
Log likelihood	-98.09312	Hannan-Quinn criter.	5.662342
F-statistic	31.77830	Durbin-Watson stat	2.213882
Prob(F-statistic)	0.000000		

Null Hypothesis: AGRICULTURE has a unit root
Trend Specification: Trend and intercept
Break Specification: Intercept only
Break Type: Innovational outlier

Break Date: 2002
Break Selection: Minimize Dickey-Fuller t-statistic
Lag Length: 9 (Automatic - based on F-statistic selection, lagpval=0.1, maxlag=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-14.61738	< 0.01
Test critical values:	1% level	-5.347598	
	5% level	-4.859812	
	10% level	-4.607324	

*Vogelsang (1993) asymptotic one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: AGRICULTURE
Method: Least Squares
Date: 09/25/22 Time: 10:58
Sample (adjusted): 1993 2020
Included observations: 28 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
AGRICULTURE(-1)	-3.356932	0.298065	-11.26241	0.0000
D(AGRICULTURE(-1))	2.602762	0.246230	10.57046	0.0000
D(AGRICULTURE(-2))	1.907078	0.212893	8.957939	0.0000
D(AGRICULTURE(-3))	1.315788	0.153996	8.544292	0.0000
D(AGRICULTURE(-4))	0.520924	0.106237	4.903424	0.0002
D(AGRICULTURE(-5))	-0.236472	0.088818	-2.662445	0.0186
D(AGRICULTURE(-6))	-0.643887	0.105113	-6.125640	0.0000
D(AGRICULTURE(-7))	-0.633203	0.097834	-6.472199	0.0000
D(AGRICULTURE(-8))	-0.600718	0.167699	-3.582129	0.0030
D(AGRICULTURE(-9))	0.172291	0.057122	3.016191	0.0092
C	93.81861	6.061307	15.47828	0.0000
TREND	-3.556537	0.210491	-16.89635	0.0000
INCPTBREAK	21.09644	1.540297	13.69635	0.0000
BREAKDUM	-22.09658	2.982758	-7.408103	0.0000

R-squared	0.987901	Mean dependent var	11.66739
Adjusted R-squared	0.976666	S.D. dependent var	5.850441
S.E. of regression	0.893682	Akaike info criterion	2.919919
Sum squared resid	11.18134	Schwarz criterion	3.586021
Log likelihood	-26.87887	Hannan-Quinn criter.	3.123553
F-statistic	87.93162	Durbin-Watson stat	2.248084
Prob(F-statistic)	0.000000		

Null Hypothesis: MANUFACTURING has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 1 (Automatic - based on SIC, maxlag=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.763712	0.2191
Test critical values:	1% level	-4.234972	
	5% level	-3.540328	
	10% level	-3.202445	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(MANUFACTURING)
Method: Least Squares
Date: 09/25/22 Time: 11:46
Sample (adjusted): 1985 2020
Included observations: 36 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
MANUFACTURING(-1)	-0.241473	0.087373	-2.763712	0.0094
D(MANUFACTURING(-1))	0.505863	0.152153	3.324700	0.0022
C	6.223500	2.572331	2.419401	0.0214
@TREND("1983")	-0.154851	0.073660	-2.102235	0.0435

R-squared	0.315964	Mean dependent var	-0.354985
Adjusted R-squared	0.251836	S.D. dependent var	3.256763
S.E. of regression	2.816986	Akaike info criterion	5.013651
Sum squared resid	253.9331	Schwarz criterion	5.189598
Log likelihood	-86.24572	Hannan-Quinn criter.	5.075061
F-statistic	4.927060	Durbin-Watson stat	1.854888
Prob(F-statistic)	0.006324		

Null Hypothesis: D(MANUFACTURING) has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 1 (Automatic - based on SIC, maxlag=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-4.186142	0.0115
Test critical values:	1% level	-4.243644	
	5% level	-3.544284	
	10% level	-3.204699	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(MANUFACTURING,2)
Method: Least Squares
Date: 09/25/22 Time: 11:47
Sample (adjusted): 1986 2020
Included observations: 35 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(MANUFACTURING(-1))	-0.788423	0.188341	-4.186142	0.0002
D(MANUFACTURING(-1),2)	0.283954	0.170447	1.665931	0.1058
C	-0.656195	1.133449	-0.578937	0.5668
@TREND("1983")	0.015607	0.050561	0.308679	0.7596

R-squared	0.370922	Mean dependent var	-0.041052
Adjusted R-squared	0.310044	S.D. dependent var	3.635181
S.E. of regression	3.019513	Akaike info criterion	5.155279
Sum squared resid	282.6412	Schwarz criterion	5.333033
Log likelihood	-86.21738	Hannan-Quinn criter.	5.216639
F-statistic	6.092826	Durbin-Watson stat	1.920674
Prob(F-statistic)	0.002205		

Null Hypothesis: MANUFACTURING has a unit root
Exogenous: Constant, Linear Trend
Bandwidth: 1 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-2.048098	0.5566
Test critical values:	1% level	-4.226815	
	5% level	-3.536601	
	10% level	-3.200320	

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

Residual variance (no correction)	9.233734
HAC corrected variance (Bartlett kernel)	13.15998

Phillips-Perron Test Equation
Dependent Variable: D(MANUFACTURING)
Method: Least Squares
Date: 09/25/22 Time: 11:48
Sample (adjusted): 1984 2020
Included observations: 37 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
MANUFACTURING(-1)	-0.162199	0.093026	-1.743579	0.0903
C	3.974181	2.670020	1.488447	0.1459
@TREND("1983")	-0.105738	0.077094	-1.371545	0.1792

R-squared	0.082105	Mean dependent var	-0.327854
Adjusted R-squared	0.028111	S.D. dependent var	3.215450
S.E. of regression	3.169933	Akaike info criterion	5.222903
Sum squared resid	341.6482	Schwarz criterion	5.353518
Log likelihood	-93.62370	Hannan-Quinn criter.	5.268951
F-statistic	1.520633	Durbin-Watson stat	1.138276
Prob(F-statistic)	0.233068		

Null Hypothesis: D(MANUFACTURING) has a unit root
Exogenous: Constant, Linear Trend
Bandwidth: 5 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-3.598890	0.0440
Test critical values:	1% level	-4.234972	
	5% level	-3.540328	
	10% level	-3.202445	

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

Residual variance (no correction)	8.737349
HAC corrected variance (Bartlett kernel)	6.708831

Phillips-Perron Test Equation
Dependent Variable: D(MANUFACTURING,2)
Method: Least Squares
Date: 09/25/22 Time: 11:48
Sample (adjusted): 1985 2020
Included observations: 36 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(MANUFACTURING(-1))	-0.608889	0.160426	-3.795446	0.0006
C	-0.327616	1.094912	-0.299217	0.7667
@TREND("1983")	0.005871	0.049548	0.118492	0.9064

R-squared	0.304552	Mean dependent var	0.007711
Adjusted R-squared	0.262403	S.D. dependent var	3.594799
S.E. of regression	3.087338	Akaike info criterion	5.172151
Sum squared resid	314.5446	Schwarz criterion	5.304110
Log likelihood	-90.09871	Hannan-Quinn criter.	5.218208
F-statistic	7.225705	Durbin-Watson stat	1.769932
Prob(F-statistic)	0.002497		

Null Hypothesis: MANUFACTURING has a unit root
Trend Specification: Trend and intercept
Break Specification: Intercept only
Break Type: Innovational outlier

Break Date: 1999
Break Selection: Minimize Dickey-Fuller t-statistic
Lag Length: 7 (Automatic - based on F-statistic selection, lagpval=0.1, maxlag=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-11.24308	< 0.01
Test critical values:	1% level	-5.347598	
	5% level	-4.859812	
	10% level	-4.607324	

*Vogelsang (1993) asymptotic one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: MANUFACTURING
Method: Least Squares
Date: 09/25/22 Time: 11:06
Sample (adjusted): 1991 2020
Included observations: 30 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
MANUFACTURING(-1)	-2.620901	0.322056	-8.138033	0.0000
D(MANUFACTURING(-1))	2.914856	0.235281	12.38882	0.0000
D(MANUFACTURING(-2))	2.443824	0.272054	8.982855	0.0000
D(MANUFACTURING(-3))	2.451287	0.240092	10.20978	0.0000
D(MANUFACTURING(-4))	2.119943	0.235200	9.013347	0.0000
D(MANUFACTURING(-5))	2.529760	0.342862	7.378356	0.0000
D(MANUFACTURING(-6))	0.158745	0.084654	1.875218	0.0771
D(MANUFACTURING(-7))	0.389288	0.084970	4.581499	0.0002
C	95.23200	8.712452	10.93056	0.0000
TREND	-0.760415	0.081743	-9.302507	0.0000
INCPTBREAK	-47.54699	4.528720	-10.49899	0.0000
BREAKDUM	35.07040	5.154004	6.804495	0.0000

R-squared	0.983985	Mean dependent var	10.85263
Adjusted R-squared	0.974198	S.D. dependent var	6.907093
S.E. of regression	1.109491	Akaike info criterion	3.334853
Sum squared resid	22.15745	Schwarz criterion	3.895332
Log likelihood	-38.02280	Hannan-Quinn criter.	3.514155
F-statistic	100.5396	Durbin-Watson stat	2.027117
Prob(F-statistic)	0.000000		

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

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.272140	0.4379
Test critical values:	1% level	-4.226815	
	5% level	-3.536601	
	10% level	-3.200320	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(SERVICES)
Method: Least Squares
Date: 09/25/22 Time: 11:54
Sample (adjusted): 1984 2020
Included observations: 37 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
SERVICES(-1)	-0.274842	0.120962	-2.272140	0.0295
C	8.569755	3.605610	2.376784	0.0232
@TREND("1983")	0.209874	0.114239	1.837149	0.0749

R-squared	0.133167	Mean dependent var	0.621384
Adjusted R-squared	0.082176	S.D. dependent var	3.909249
S.E. of regression	3.745182	Akaike info criterion	5.556422
Sum squared resid	476.8973	Schwarz criterion	5.687037
Log likelihood	-99.79381	Hannan-Quinn criter.	5.602470
F-statistic	2.611611	Durbin-Watson stat	1.795032
Prob(F-statistic)	0.088086		

Null Hypothesis: D(SERVICES) has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 1 (Automatic - based on SIC, maxlag=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-5.597885	0.0003
Test critical values:	1% level	-4.243644	
	5% level	-3.544284	
	10% level	-3.204699	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(SERVICES,2)
Method: Least Squares
Date: 09/25/22 Time: 11:55
Sample (adjusted): 1986 2020
Included observations: 35 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(SERVICES(-1))	-1.366628	0.244133	-5.597885	0.0000
D(SERVICES(-1),2)	0.318632	0.167948	1.897207	0.0672
C	0.847593	1.479646	0.572835	0.5709
@TREND("1983")	-0.003228	0.065733	-0.049103	0.9612

R-squared	0.566965	Mean dependent var	-0.015364
Adjusted R-squared	0.525058	S.D. dependent var	5.695928
S.E. of regression	3.925408	Akaike info criterion	5.680028
Sum squared resid	477.6737	Schwarz criterion	5.857782
Log likelihood	-95.40049	Hannan-Quinn criter.	5.741389
F-statistic	13.52922	Durbin-Watson stat	1.846612
Prob(F-statistic)	0.000008		

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

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-2.328404	0.4091
Test critical values:	1% level	-4.226815	
	5% level	-3.536601	
	10% level	-3.200320	

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

Residual variance (no correction)	12.88912
HAC corrected variance (Bartlett kernel)	13.61655

Phillips-Perron Test Equation
Dependent Variable: D(SERVICES)
Method: Least Squares
Date: 09/25/22 Time: 11:56
Sample (adjusted): 1984 2020
Included observations: 37 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
SERVICES(-1)	-0.274842	0.120962	-2.272140	0.0295
C	8.569755	3.605610	2.376784	0.0232
@TREND("1983")	0.209874	0.114239	1.837149	0.0749

R-squared	0.133167	Mean dependent var	0.621384
Adjusted R-squared	0.082176	S.D. dependent var	3.909249
S.E. of regression	3.745182	Akaike info criterion	5.556422
Sum squared resid	476.8973	Schwarz criterion	5.687037
Log likelihood	-99.79381	Hannan-Quinn criter.	5.602470
F-statistic	2.611611	Durbin-Watson stat	1.795032
Prob(F-statistic)	0.088086		

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

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-6.051935	0.0001
Test critical values:	1% level	-4.234972	
	5% level	-3.540328	
	10% level	-3.202445	

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

Residual variance (no correction)	14.82785
HAC corrected variance (Bartlett kernel)	14.82785

Phillips-Perron Test Equation
Dependent Variable: D(SERVICES,2)
Method: Least Squares
Date: 09/25/22 Time: 11:56
Sample (adjusted): 1985 2020
Included observations: 36 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(SERVICES(-1))	-1.040467	0.171923	-6.051935	0.0000
C	0.487653	1.432586	0.340401	0.7357
@TREND("1983")	0.002722	0.064540	0.042168	0.9666

R-squared	0.526229	Mean dependent var	-0.152302
Adjusted R-squared	0.497515	S.D. dependent var	5.673773
S.E. of regression	4.021920	Akaike info criterion	5.701051
Sum squared resid	533.8027	Schwarz criterion	5.833011
Log likelihood	-99.61892	Hannan-Quinn criter.	5.747109
F-statistic	18.32693	Durbin-Watson stat	2.009252
Prob(F-statistic)	0.000004		

Null Hypothesis: SERVICES has a unit root
Trend Specification: Trend and intercept
Break Specification: Intercept only
Break Type: Innovational outlier

Break Date: 1998
Break Selection: Minimize Dickey-Fuller t-statistic
Lag Length: 4 (Automatic - based on F-statistic selection, lagpval=0.1, maxlag=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-7.985761	< 0.01
Test critical values:	1% level	-5.347598	
	5% level	-4.859812	
	10% level	-4.607324	

*Vogelsang (1993) asymptotic one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: SERVICES
Method: Least Squares
Date: 09/25/22 Time: 11:57
Sample (adjusted): 1988 2020
Included observations: 33 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
SERVICES(-1)	-0.429002	0.178944	-2.397414	0.0246
D(SERVICES(-1))	0.717559	0.141849	5.058622	0.0000
D(SERVICES(-2))	0.759908	0.172968	4.393333	0.0002
D(SERVICES(-3))	0.700877	0.118125	5.933352	0.0000
D(SERVICES(-4))	1.003091	0.214595	4.674336	0.0001
C	40.91739	5.172441	7.910653	0.0000
TREND	0.733503	0.110998	6.608241	0.0000
INCPTBREAK	13.56882	2.439547	5.562023	0.0000
BREAKDUM	-19.07194	4.558631	-4.183700	0.0003

R-squared	0.965218	Mean dependent var	45.10641
Adjusted R-squared	0.953624	S.D. dependent var	10.20585
S.E. of regression	2.197836	Akaike info criterion	4.639825
Sum squared resid	115.9316	Schwarz criterion	5.047963
Log likelihood	-67.55711	Hannan-Quinn criter.	4.777151
F-statistic	83.25177	Durbin-Watson stat	2.411179
Prob(F-statistic)	0.000000		

Null Hypothesis: MINERALS has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 1 (Automatic - based on SIC, maxlag=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-3.093159	0.1232
Test critical values:	1% level	-4.234972	
	5% level	-3.540328	
	10% level	-3.202445	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(MINERALS)
Method: Least Squares
Date: 09/25/22 Time: 12:01
Sample (adjusted): 1985 2020
Included observations: 36 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
MINERALS(-1)	-0.368237	0.119049	-3.093159	0.0041
D(MINERALS(-1))	0.395085	0.163959	2.409663	0.0219
C	1.385872	1.348023	1.028077	0.3116
@TREND("1983")	0.037816	0.058522	0.646181	0.5228

R-squared	0.264478	Mean dependent var	0.191557
Adjusted R-squared	0.195522	S.D. dependent var	4.011429
S.E. of regression	3.597958	Akaike info criterion	5.503049
Sum squared resid	414.2496	Schwarz criterion	5.678996
Log likelihood	-95.05488	Hannan-Quinn criter.	5.564459
F-statistic	3.835496	Durbin-Watson stat	1.911024
Prob(F-statistic)	0.018760		

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

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-4.595748	0.0040
Test critical values:	1% level	-4.234972	
	5% level	-3.540328	
	10% level	-3.202445	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(MINERALS,2)
Method: Least Squares
Date: 09/25/22 Time: 12:01
Sample (adjusted): 1985 2020
Included observations: 36 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(MINERALS(-1))	-0.788400	0.171550	-4.595748	0.0001
C	0.036016	1.431453	0.025160	0.9801
@TREND("1983")	0.008060	0.064788	0.124404	0.9018

R-squared	0.390347	Mean dependent var	0.199241
Adjusted R-squared	0.353398	S.D. dependent var	5.021786
S.E. of regression	4.038097	Akaike info criterion	5.709079
Sum squared resid	538.1055	Schwarz criterion	5.841039
Log likelihood	-99.76343	Hannan-Quinn criter.	5.755137
F-statistic	10.56456	Durbin-Watson stat	1.834660
Prob(F-statistic)	0.000284		

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

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-2.380858	0.3829
Test critical values:	1% level	-4.226815	
	5% level	-3.536601	
	10% level	-3.200320	

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

Residual variance (no correction)	13.36344
HAC corrected variance (Bartlett kernel)	14.74641

Phillips-Perron Test Equation
Dependent Variable: D(MINERALS)
Method: Least Squares
Date: 09/25/22 Time: 12:02
Sample (adjusted): 1984 2020
Included observations: 37 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
MINERALS(-1)	-0.268406	0.117439	-2.285486	0.0286
C	0.742875	1.357127	0.547388	0.5877
@TREND("1983")	0.040801	0.059354	0.687411	0.4965

R-squared	0.135986	Mean dependent var	0.109071
Adjusted R-squared	0.085161	S.D. dependent var	3.987018
S.E. of regression	3.813471	Akaike info criterion	5.592562
Sum squared resid	494.4471	Schwarz criterion	5.723176
Log likelihood	-100.4624	Hannan-Quinn criter.	5.638609
F-statistic	2.675604	Durbin-Watson stat	1.393427
Prob(F-statistic)	0.083340		

Null Hypothesis: D(MINERALS) has a unit root
Exogenous: Constant, Linear Trend
Bandwidth: 15 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-5.232076	0.0007
Test critical values:	1% level	-4.234972	
	5% level	-3.540328	
	10% level	-3.202445	

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

Residual variance (no correction)	14.94738
HAC corrected variance (Bartlett kernel)	2.474237

Phillips-Perron Test Equation
Dependent Variable: D(MINERALS,2)
Method: Least Squares
Date: 09/25/22 Time: 12:03
Sample (adjusted): 1985 2020
Included observations: 36 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(MINERALS(-1))	-0.788400	0.171550	-4.595748	0.0001
C	0.036016	1.431453	0.025160	0.9801
@TREND("1983")	0.008060	0.064788	0.124404	0.9018

R-squared	0.390347	Mean dependent var	0.199241
Adjusted R-squared	0.353398	S.D. dependent var	5.021786
S.E. of regression	4.038097	Akaike info criterion	5.709079
Sum squared resid	538.1055	Schwarz criterion	5.841039
Log likelihood	-99.76343	Hannan-Quinn criter.	5.755137
F-statistic	10.56456	Durbin-Watson stat	1.834660
Prob(F-statistic)	0.000284		

Null Hypothesis: MINERALS has a unit root
Trend Specification: Trend and intercept
Break Specification: Intercept only
Break Type: Innovational outlier

Break Date: 2005
Break Selection: Minimize Dickey-Fuller t-statistic
Lag Length: 7 (Automatic - based on F-statistic selection, lagpval=0.1, maxlag=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-7.673898	< 0.01
Test critical values:	1% level	-5.347598	
	5% level	-4.859812	
	10% level	-4.607324	

*Vogelsang (1993) asymptotic one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: MINERALS
Method: Least Squares
Date: 09/25/22 Time: 12:05
Sample (adjusted): 1991 2020
Included observations: 30 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
MINERALS(-1)	-0.422413	0.185357	-2.278913	0.0351
D(MINERALS(-1))	0.697827	0.143744	4.854641	0.0001
D(MINERALS(-2))	0.346888	0.136216	2.546596	0.0202
D(MINERALS(-3))	0.391677	0.136199	2.875767	0.0101
D(MINERALS(-4))	0.432506	0.127454	3.393435	0.0032
D(MINERALS(-5))	0.257683	0.111742	2.306065	0.0332
D(MINERALS(-6))	0.168553	0.108161	1.558351	0.1366
D(MINERALS(-7))	0.272604	0.103597	2.631387	0.0169
C	4.527293	1.278702	3.540538	0.0023
TREND	-0.265655	0.118420	-2.243329	0.0377
INCPTBREAK	12.73293	2.645383	4.813264	0.0001
BREAKDUM	-7.686334	2.657022	-2.892838	0.0097

R-squared	0.897295	Mean dependent var	4.592546
Adjusted R-squared	0.834530	S.D. dependent var	4.888406
S.E. of regression	1.988505	Akaike info criterion	4.501818
Sum squared resid	71.17475	Schwarz criterion	5.062297
Log likelihood	-55.52727	Hannan-Quinn criter.	4.681120
F-statistic	14.29623	Durbin-Watson stat	1.502887
Prob(F-statistic)	0.000001		

APPENDIX C: ORIGINAL ARDL ESTIMATION OUTPUT

Dependent Variable: GDP
Method: ARDL
Date: 09/10/22 Time: 15:41
Sample (adjusted): 1987 2020
Included observations: 34 after adjustments
Maximum dependent lags: 4 (Automatic selection)
Model selection method: Akaike info criterion (AIC)
Dynamic regressors (4 lags, automatic): AGRICULTURE MANUFACTURING SERVICES MINERALS
Fixed regressors: C
Number of models evaluated: 2500
Selected Model: ARDL(4, 3, 0, 4, 3)

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
GDP(-1)	-0.161984	0.243801	-0.664409	0.5165
GDP(-2)	-0.055720	0.246776	-0.225794	0.8244
GDP(-3)	-0.084673	0.249690	-0.339111	0.7392
GDP(-4)	0.328351	0.173637	1.891023	0.0781
AGRICULTURE	0.698104	0.241688	2.888445	0.0113
AGRICULTURE(-1)	-0.505627	0.410277	-1.232403	0.2368
AGRICULTURE(-2)	-0.149691	0.364382	-0.410808	0.6870
AGRICULTURE(-3)	0.834335	0.269629	3.094376	0.0074
MANUFACTURING	0.090660	0.121640	0.745320	0.4676
SERVICES	0.587919	0.265311	2.215963	0.0426
SERVICES(-1)	-0.246622	0.360586	-0.683948	0.5044
SERVICES(-2)	-0.166933	0.273768	-0.609761	0.5511
SERVICES(-3)	0.592525	0.240791	2.460739	0.0265
SERVICES(-4)	-0.253238	0.128447	-1.971534	0.0674
MINERALS	0.366255	0.126341	2.898954	0.0110
MINERALS(-1)	0.139507	0.160433	0.869566	0.3982
MINERALS(-2)	-0.357071	0.158994	-2.245813	0.0402
MINERALS(-3)	0.302210	0.134177	2.252315	0.0397
C	-34.26987	12.44037	-2.754730	0.0147

R-squared	0.915552	Mean dependent var	3.980665
Adjusted R-squared	0.814215	S.D. dependent var	3.935743
S.E. of regression	1.696415	Akaike info criterion	4.194249
Sum squared resid	43.16737	Schwarz criterion	5.047215
Log likelihood	-52.30223	Hannan-Quinn criter.	4.485134
F-statistic	9.034700	Durbin-Watson stat	1.999041
Prob(F-statistic)	0.000044		

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