POPULATION DYNAMICS AND ECONOMIC DEVELOPMENT IN MALAWI

MASTER OF ARTS (ECONOMICS) THESIS

STEVEN LIMBANAZO KUCHANDE

UNIVERSITY OF MALAWI

CHANCELLOR COLLEGE

SEPTEMBER, 2018

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By

STEVEN LIMBANAZO KUCHANDE

Bsoc.Sc. (Economics and Demography) – University of Malawi

Submitted to the Department of Economics, Faculty of Social Science in partial fulfilment of the requirements for a Master of Arts degree in Economics

University of Malawi

Chancellor College

September, 2018

DECLARATION

I, the undersigned, hereby declare that this thesis is my original work and that it has never been submitted for similar purposes to this or any other university or institution of higher learning. Acknowledgements have been duly made where other people's work has been used. I am solely responsible for all errors contained herein.

STEVEN LIMBANAZO KUCHANDE

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Full Legal Name

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Signature

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Date

CERTIFICATE OF APPROVAL

We declare that this thesis is from the student's own work and effort and that where he has used other sources of information, due acknowledgement has been made. This thesis is submitted with our approval.

Signature: ___________________________ Date: ____________________________

Chiwaula, L.S., PhD (Associate Professor of Economics)

Main Supervisor

Signature: ___________________________ Date: ____________________________

Mazalale, J., PhD (Lecturer)

Second Supervisor

DEDICATION

I dedicate this work to my beloved family.

ACKNOWLEDGEMENTS

My supreme thanks be to God for guiding me through all my endeavours in undertaking this study from conception through completion. May your name be exalted.

I greatly appreciate the guidance rendered to me on the course of this study under the supervision of Dr. Levison Chiwaula. It took your extremely kind heart to accommodate me in supervision despite your being on sabbatical leave. May God bless you sir! Much thanks also go to Dr. Jacob Mazalale for your guidance from course work through research. The assistance I got from both of you helped me not only to complete this study but also to deepen my skills and knowhow as a researcher.

I am also grateful for the assistance from the Africa Economic Research Consortium in collaboration with the Department of Economics for offering me a full scholarship to study for a Master's degree in Economics. I do not take it for granted, thank you.
Special recognition also goes to my family including my dad, my mom, my uncles, my aunts and notably to Atupele, Francis, Chifundo, Grace, Zione, Shakira and Patrick. Your constant motivation and belief in my capability is simply priceless. I appreciate and love you all dearly.

To all my classmates and friends, this road has not been an easy one but together, we've sailed through tightly holding hands from day one. May God bless you all as I wish you all the best in life beyond this phase.

ABSTRACT

The study dwells on analysing population dynamics in relation to economic development in Malawi. As Malawi's population grows at 3% per year, this rapid growth of the population has been identified as a challenge by various players in the area of development calling for innovative ways of managing population phenomena for sustainable development. The study's specific objectives are threefold which are to determine the effects of changes in Malawi's population size, population growth, age structure and spatial distribution on one hand on economic growth, food production and socioeconomic development in Malawi on the other hand. The study employed Autoregressive Distributed Lag models on time-series data spanning from 1960 to 2016 obtained from the World Bank's World Development indicators and the Food and Agriculture Organisation of the United Nations. The study first finds that population dynamics and economic development have a significant long run relationship in Malawi. Specifically, the rate of population growth and the share of urban population have a negative effect on economic development while the young and working aged population have a positive effect. In sum, the study identifies how population dynamics relate to economic development and thus how they can be managed to achieve development targets both in the short term as well as in the long term. The implications on policy are that interventions need to be made on the reduction of the rate of population growth, investments in the current youth and working aged population's human capital as well as skills development and physical capital formation in rural areas.

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LIST OF ABBREVIATIONS

AIC	Akaike Information Criterion
AO	Additive Outlier
ARDL	Autoregressive Distributed Lag
BD	Break Date
CBR	Crude Birth Rate
CDR	Crude Death Rate
CMR	Clemente-Montañés-Reyes
CUSUM	Cumulative Sum
ECM	Error Correction Model
FAO	Food and Agriculture Organisation
FAOSTAT	Food and Agriculture Organisation Statistics
FPI	Food Production Index
GDI	Gender Development Index
GDP	Gross Domestic Product
GII	Gender Inequality Index
GNI	Gross National Income
GoM	Government of Malawi
HDI	Human Development Index
i.i.d	Independently and Identically Distributed
IHDI	Inequality-adjusted Human Development Index
IO	Innovation Outlier
JB	Jarque-Bera
LM	Lagrange Multiplier

MDHS	Malawi Demographic and Health Survey
MGDS	Malawi Growth and Development Strategy
MIC	Middle-Income Country
MICS	Multiple Indicator Cluster Survey
MPI	Multidimensional Poverty Index
NSO	National Statistical Office
PHC	Population and Housing Census
RESET	Regression Specification Error Test
SSA	Sub-Saharan Africa
TFR	Total Fertility Rate
UN	United Nations
UNDP	United Nations Development Programme
UNFPA	United Nations Population Fund
WBG	World Bank Group
WDI	World Development Indicators

CHAPTER ONE

INTRODUCTION

1.1 Background

Rapid population growth persists to manifest itself in Malawi and its effects are increasingly of major concern to development efforts. At 3 percent per annum, Malawi's population growth rate is very high compared to the Sub-Saharan African (SSA) region and the world which stand at 2.8 percent per annum and 1.2 percent per annum respectively (UN Population Division, 2015a). The notion that high population growth will deplete resources for the current and future generations has been of core concern in socio-economic development planning. As such, it has become incumbent on planners in Malawi and several other countries with a similar demographic profile to integrate population phenomena in development planning (United Nations, 2017).

The experience of high-income countries has shown that a low pace of population growth may slow development while low-income countries face problems with high population growth (Peterson, 2017). The effects have also been found to vary according to what factors underlie the growth. Population growth emanating from high fertility is likely to bring about social and economic problems compared to that brought about by falling mortality.

Some scholars also argue that the success of many western countries dwelt on strong population growth which aided their economies through supplies of workers and consumers (Gamble, 2014). However, as is the case in most developing countries, this benefit ceased when the population outpaced the productive capacities of the economies.

Over the years, the development of Malawi's economy has been erratic compared to other countries with similar geographic and demographic profiles (Record et al., 2017). Through the period 1990 to 2015, Malawi has been identified as an outlier on the development front. The growth of the economy by real per capita GDP growth averaged 1.5 percent compared to a regional average of non-resource rich Sub-Saharan Africa of 2.67 percent of which most were in a similar state of development 20 years ago (Record et al., 2017). This was coupled with insignificant drops in poverty between 2004 and 2011 despite a remarkable experience of economic growth (Record et al., 2017). Innovative efforts are needed to solve the puzzle of Malawi's lack of development.

While socioeconomic development has generally improved, Malawi also lags behind in the Sub-Saharan African region and the world at large. As measured by the Human Development Index (HDI), Malawi has improved in terms of human longevity, knowledge and standard of living between 1990 and 2015 from an HDI value of 0.325 to and HDI value of 0.476 (United Nations Development Programme, 2016). This HDI level however ranks Malawi below the average of 0.497 in the low human development group of countries and below the average Sub-Saharan HDI of 0.523. Significant development gains are needed to uplift Malawi's socioeconomic wellbeing.

With more than half of the population living in poverty, Malawi faces chronic challenges in food security and nutrition. Over 3 million people are food insecure and half of the children suffer from acute malnutrition which has been exacerbated by a rapid incidence of rural poverty (Food and Agriculture Organisation of the United Nations [FAO], 2015). The government has sought to spur food production through Agricultural Input Subsidy Programmes to alleviate the situation but impacts have only been significant in improving maize production and net crop income (FAO, 2015). However, the impacts have been limited in improving food consumption and household income (FAO, 2015).

Population dynamics on the other hand have also demonstrated stochasticity over time. Malawi has experienced high population growth rates since 1901 through birth rates being significantly higher than death rates (House & Zimalirana, 1992). There have also been various indications of changes in age structure producing a young population with almost half (47%) of the population being aged below 18 with a median age of 15 (Government of Malawi [GoM], 2016). These trends have made the child dependency burden pervasive. Recent evidence from surveys conducted by the National Statistical Office (NSO) shows that urbanization and population density in the major cities of Malawi are on the rise (GoM, 2016). While this could benefit the productivity of some sectors of the economy with a positive socioeconomic transformation, the phenomenon also spells major challenges in the form of slum formation and urban poverty if the population is not properly managed and assimilated (GoM, 2016).

The high and unprecedented growth of population in Malawi has been earmarked as a major drawback to gains in economic growth and development (GoM, 2012b). While this may be the case, the present knowledge regarding influences of population on economic development is not straightforward. The primary focus of several development plans lies almost entirely on the growth of the population (National Economic Council, 2000; IMF, 2002; GoM, 2012a; GoM, 2006; GoM; 2017; IMF, 2017). While some scholars and studies argue that rapid population growth impacts development negatively through diminishing returns (Malthus, 1798; Bucci, 2003; Wenig & Zimmermann, 2012), some argue that rapid population growth affects development positively through economies of scale and innovations in production (Kuznets, 1967; Simon, 1981; Jackson, 1995) and others argue that population growth has no effect at all (Bloom & Freeman, 1986). Notwithstanding, there is more to population dynamics than just growth itself. A deeper understanding of the change in the components embedded in that growth of population may be vital in as far as steering policy direction may be concerned to improve the efficacy of such development interventions.

Economic development is a complex concept which includes incremental gains in various aspects of the economy such as output growth, productivity growth, equitable distribution of resources and improvement of livelihoods and various aspects of social wellbeing (Todaro & Smith, 2012). In this respect, economic development is envisioned through gains in economic growth, food production and socioeconomic development while Population dynamics entail changes in population size, population growth, age structure and spatial distribution (Todaro & Smith, 2012).

1.2 Problem Statement

The relationship between economic development and population dynamics is not clear-cut and relies largely on empirical evidence (Furuoka, 2009). Various studies on how population affects development in developing countries have found mixed results (Easterlin, 1967; Cincotta & Engelman, 1997; World Bank, 2000; Sinding, 2009). That is, it is unclear whether population dynamics in growth, age structure, and rural-urban disparities contribute positively, negatively or have no impact on economic development.

The currently available empirical literature on the effects of population phenomena on economic development in Malawi is scanty. Closely related studies by Mlia and Kalipeni (1987) as well as by House and Zimalirana (1992) focused on implications of rapid population growth on natural resources and social amenities. The ultimate finding was that the increasing pressure from population depleted resources and exacerbated poverty. The United Nations Population Fund (UNFPA) reviewed demographic and economic opportunities pertaining to Malawi's population and projected that the youth hold great potential for prospective monumental gains in economic growth (GoM, 2016). However, these studies as well as other policies and documents (National Economic Council, 2000; GoM, 2012b; GoM, 2012c; IMF, 2017; GoM, 2017b) have not established the links between population dynamics and economic development. This study therefore sets out to decipher these links and fill this gap in knowledge.

1.3 Significance of the study

Malawi's population policy envisions a manageable population growth, structure and distribution in tandem with the country's resource endowments for sustainable development (GoM, 2012c). To apprise this principle of population management, the study's findings will relay relevant information on how changes in population variables affect development as well as what aspects of these changes are of high relevance. These will guide development programmes on what measures to take in order to harness economic gains from population change.

1.4 Objectives

The overall objective of this study is to analyse the influences of population dynamics on economic development in Malawi.

The specific objectives of this study are:

i. To determine the effects of population growth, age structure and spatial distribution on the one hand, on economic growth on the other hand in Malawi.
ii. To analyse the effects of population growth, age structure and spatial distribution on the one hand, on food production on the other hand in Malawi.
iii. To investigate the effects of population growth, age structure and spatial distribution on the one hand, on socioeconomic development on the other hand in Malawi.

1.5 Hypotheses

The following null hypotheses will be tested in the analysis of the influences of population dynamics on economic development:

i. Population growth, age structure and spatial distribution have no effect on economic growth in Malawi.
ii. Population growth, age structure and spatial distribution have no effect on food production in Malawi.

iii. Population growth, age structure and spatial distribution have no effect on socioeconomic development in Malawi.

1.6 Organization of the study

The rest of the study is organized as follows: Chapter two gives a brief overview of the situational context of economic development in relation to population phenomena in Malawi. Chapter three provides the theoretical and empirical literature reviews on population dynamics and economic development. Chapter four accounts for the methodology the study will use. Chapter five presents the study's results and discussion. Chapter six provides the ultimate conclusions and policy implications.

CHAPTER TWO

OVERVIEW OF POPULATION DYNAMICS AND ECONOMIC DEVELOPMENT IN MALAWI

2.1 Introduction

This chapter provides insight into the economy of Malawi highlighting the historical and current situation of economic development and population phenomena as well as projected trends in various indices capturing both. It also provides the policy framework regarding the incorporation of population issues in development planning in Malawi.

2.2 Trends in population dynamics in Malawi

The population of Malawi has experienced high fertility rates over time. More notably, heavy childbearing in the rural areas of the country from which most of the population reside has caused high Total Fertility Rates (TFR)[1] (GoM, 2016). While the TFRs have been observed to be declining over time, the reduction in fertility levels has been minimal and many children continue to be born every year. These trends are illustrated in Figure 2.1.

[1] The Total Fertility Rate is a measure of current fertility measured as the average number of children expected to be borne by a woman at the end of her reproductive period (usually ages 15-49) if the prevailing levels of fertility were to persist over that period (National Statistical Office, 2010).

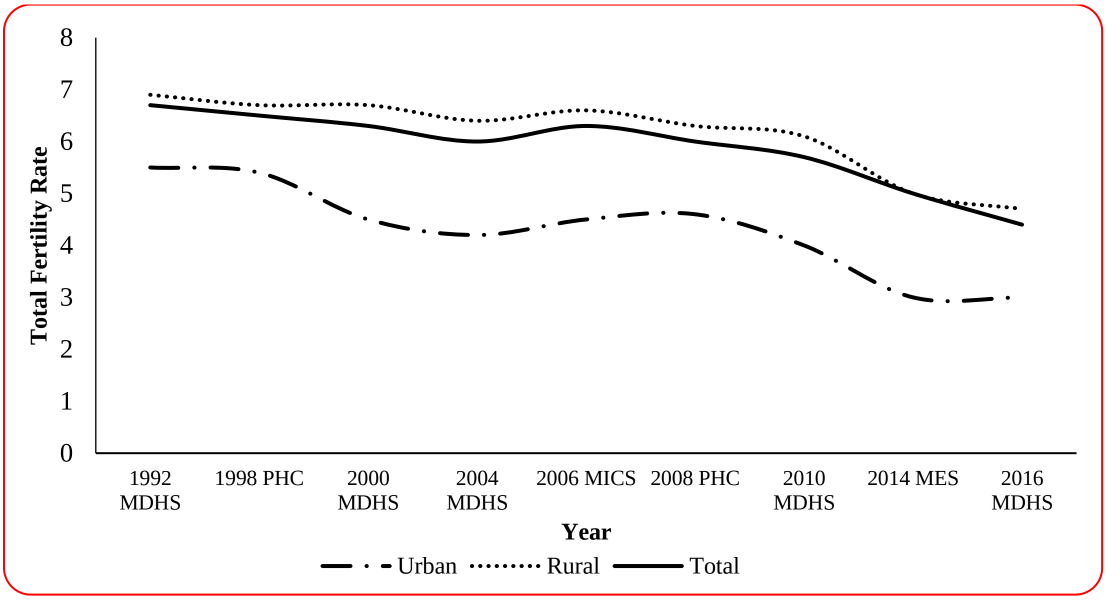

Figure 2.1: Fertility trends in Malawi

Source: NSO (2009; 2015; 2016)

In 1992, on average, a child-bearing woman was expected to give birth to 6.7 children in her lifetime. This figure dwindled to 6 children in 2004 and recently to 4.4 children in 2016 (NSO, 2016). The portrayed higher trends in rural fertility intuitively drive up the aggregate level of fertility for the country.

While birth rates remain persistently high, death rates are much lower and have been falling more than birth rates. This implies that more people join the population through births while less leave the population through deaths which leads to high population growth in the country. Figure 2.2 shows Crude Birth Rates and Crude Death Rates[2] as demographic measures of births and deaths respectively.

[2] The Crude Birth Rate is a fertility measure given as the number of births in a calendar year expressed per 1000 of that year's mid-year population and similarly, the Crude Death Rate is a mortality measure given as the number of deaths in a calendar year expressed per 1000 of that year's mid-year population.

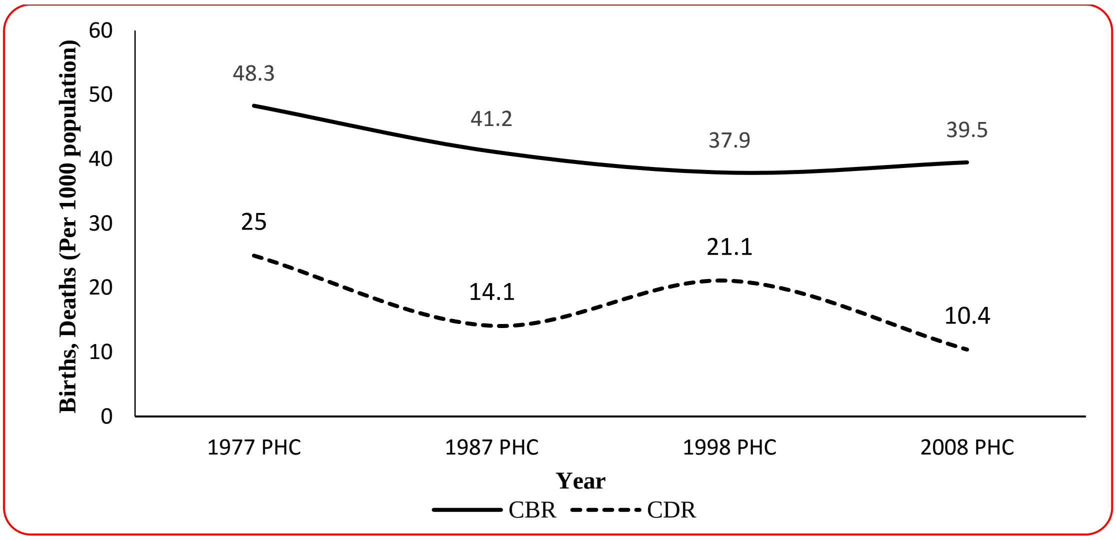

Figure 2.2: Trends in Birth and Death rates in Malawi

Source: NSO (2009)

In 1977, Malawi had an average of about 48 births per 1000 people in the country and 25 deaths indicating a natural increase[3] of about 23 more people for every 1000 people. Over the years, adult and child mortality have declined with improvements in health services and child survival. As such, there have been significant drops in death rates to 10.4 deaths per 1000 people in 2008 while births have declined relatively less (NSO & ICF Macro, 2011; NSO, 2011). The resultant effect of these trends has evidently been the rapid growth of the population of Malawi.

This growth has seen Malawi's population multiply almost twentyfold in the past 100 years and almost doubled in the past 20 years. The population continues to grow rapidly at an annual rate of 3% (United Nations Population Division, 2015a). Figure 2.3 provides a snapshot of the growth of the population of Malawi since 1901.

[3] Natural increase is the difference between the Crude Birth rate and the Crude Death Rate.

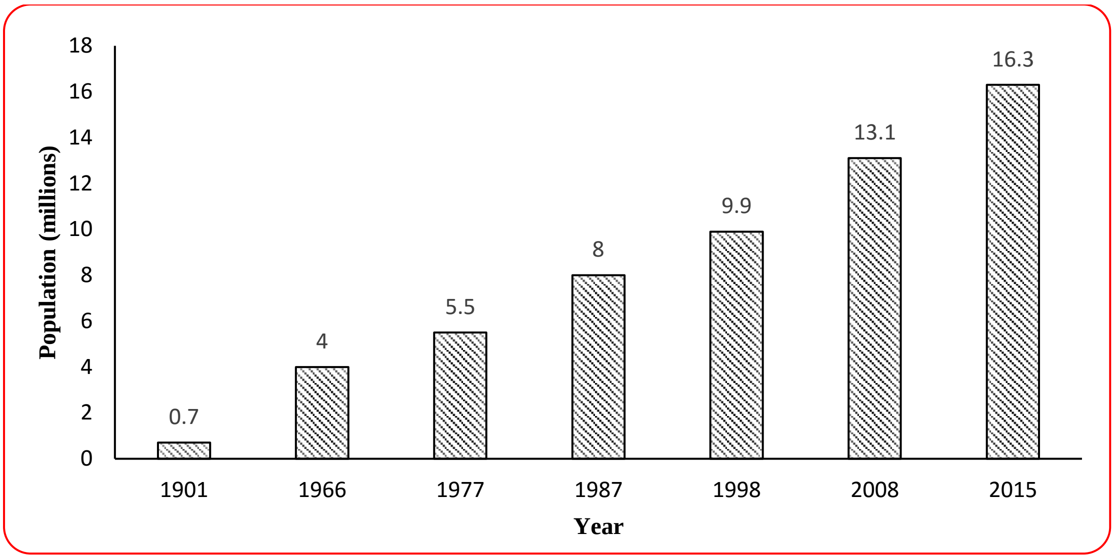

Figure 2.3: Population size in Malawi from 1901 to 2015

Source: House and Zimalirana (1992), NSO (2009;2010)

In the past 100 years, the population of Malawi has grown at unprecedented levels from a relatively small population to a large and dense population. With less than a million people at the beginning of the last century, Malawi had a small and sparsely distributed population. However, over time, millions of people have been added to the population which now stands close to 17 million people (GoM, 2016).

The high fertility levels coupled with falling mortality have indicated Malawi to be experiencing the early stages of the demographic transition[4] (GoM, 2016). This implies that the population is expected to continue rising for many more years to come. It is projected that if prevailing trends in fertility persist, the TFR will decline to 3.94 by 2054 (GoM, 2016).

[4] The Demographic Transition is a model of fertility and mortality trends in which a population initially faces high fertility and mortality rates which offset resulting in slow population growth. As the transition proceeds, mortality falls due to improvements in health resulting to rapid population growth. The transition is completed when fertility falls in the end and parity is restored with mortality and the growth of the population stabilizes (GoM, 2016).

This is a very long time which requires a sharp decline in the fertility rate to have a manageable population. If this sharp decline is achieved, the fertility is projected to drop to near replacement level[5] of a TFR of 2.12 by 2050. In this scenario, the population could grow at a slower pace from which better population planning outcomes could be realised. Figure 2.4 provides projections based on three scenarios regarding fertility trends.

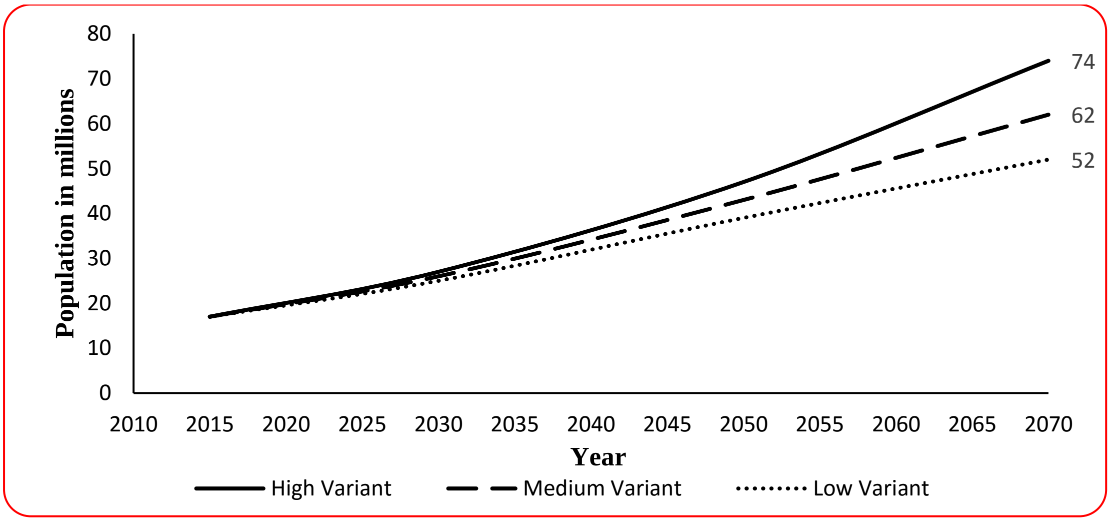

Figure 2.4: Population projections for Malawi (2015-2070)

Source: GoM (2016)

With UN high variant assumptions[6], the population of Malawi is expected to reach 47 million in 2050 and 74 million in 2070 while low variant assumptions project population to 39 million in 2050 and 52 million in 2070 (United Nations Population Division, 2015). With medium variant assumptions, we should expect population to reach 43 million in 2050 and 62 million in 2070.

[5] Replacement fertility refers to a level of fertility at which the child-bearing population is eventually just replaced by their children measured at a TFR of about 2 children (Craig, 1994).
[6] High, medium and low variants correspond to assumptions of high, medium and low fertility respectively made by the UN.

In either scenario, productivity must increase and more resources and investments in physical and human capital need to be made to support the growing population if development is to be sustainable.

As the population continues to grow with fertility rates protractedly being high, the population of Malawi remains predominantly young (GoM, 2016). This population subgroup continues to mount pressure on the working population. In 2015, the child dependency ratio[7] was estimated at 89.7 (WBG, 2017). This implies that on average, for every 100-working people, there were 90 children to provide for. This is worsened by high levels of unemployment. Figure 2.5 illustrates the age structure of Malawi's population.

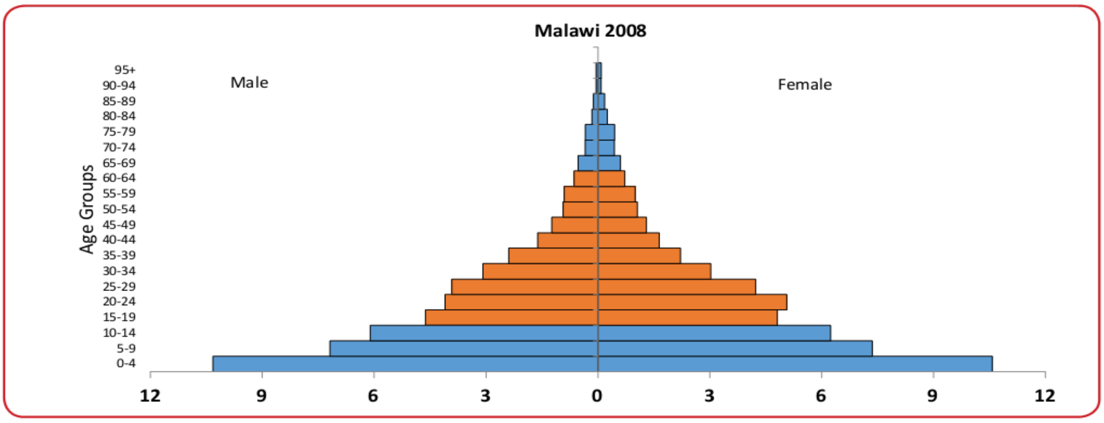

Figure 2.5: Population Pyramid for Malawi in 2008

Source: NSO (2009)

The population pyramid of Malawi has not made significant changes since 1960 and it is further projected that under the status quo, it will remain relatively the same in the next 25 years (NSO, 2010; WPP, 2012).

[7] The child dependency ratio measures the child dependency burden and is calculated as the number of children [population aged 0-14] per 100 economically productive people [population aged 15-64] (GoM, 2016).

Unless population variables change considerably, the persistence of a broad base of the pyramid signifies a detriment to developmental progress.

With increasing population, the proportion of people living in urban areas has also been rising. A number of factors have been driving people out of rural areas to settle in urban areas including: environmental degradation and diminishing rural land holdings and lack of off-farm economic opportunities (GoM, 2016). With proper urban planning, urban growth as well as rural-urban migration can benefit the economy through increased availability of labour in the manufacturing and service sectors, increased demand for commodities, consumer spending as well as savings (GoM, 2016). To ensure food security with urbanization, it is of essence that urban dwellers have adequate money to purchase food for much of food production is done in rural areas (Mcqueen, 2000). Conversely, investments in modern agricultural technology with intensive farming are necessary to sustain both the rural and the growing urban areas. Poor planning can however lead to proliferation of slum conditions and urban poverty.

2.3 Trends in economic development in Malawi

With over half of the population living in poverty, Malawi is one of the poorest nations in the world (GoM, 2016). The prevailing development plans have intended to upturn the situation and achieve middle-income country status in the long term (National Economic Council, 2000). However, progress towards achieving the designated development targets has been slow. Instead, the economy has experienced recurrent episodes of macroeconomic instability worsened by erratic supplies of food and the rapid growth of the population. Figure 2.6 shows recent trends in economic growth, population growth and food production growth.

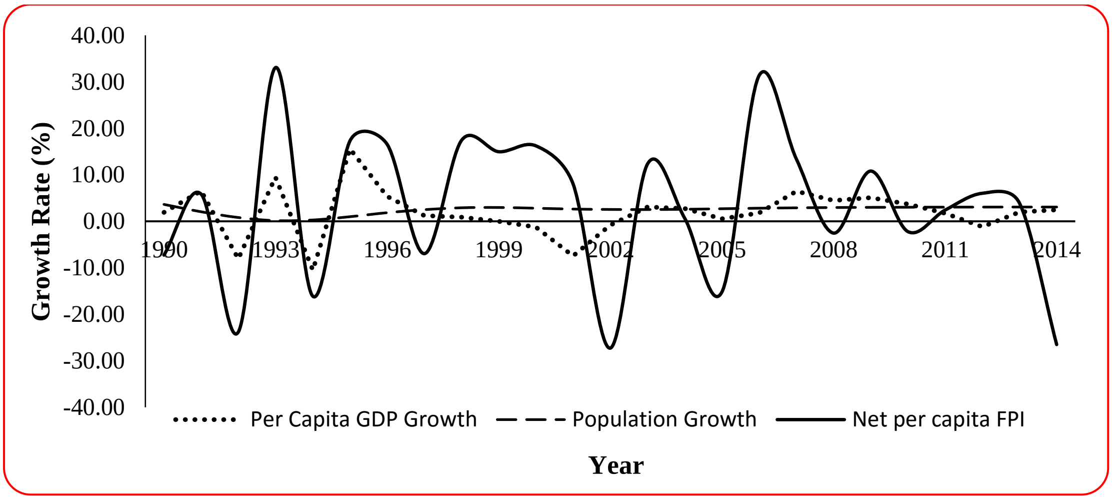

Figure 2.6: Growth in per capita GDP, population and food production for Malawi

Source: World Bank (2017), FAO (2018)

Between 1990 and 2015, economic growth and food production was highly variable while population growth maintained a steady positive value around 3%. Weather, policy and external shocks affected the patterns over the period (Record et al., 2017). A general decline in economic growth and population was experienced between 1990 and 1993 as food production growth plunged to negative levels. This might be partly attributed to cutbacks in donor aid as well as drought and famine that hit over 70% of the population during the period. Volatile growth was experienced between 1995 and 2002. The 1994 National Population policy as well as the 2002 Malawi Poverty Reduction Strategy which advocated for reduced growth in population but had significant shortcomings. They stressed on the reduction of the pressure of the population on productive resources such as land and social amenities like education and healthcare provision. However, their impact was limited and population growth continued to be high (IMF, 2002; GoM, 2012c).

A period of high economic growth was then experienced between 2003 and 2010. Food production had been very steady until the 2001-2003 period when droughts and floods affected about 30% of the population and caused a negative food supply shock. Population growth however remained stable. Successful implementation in Agricultural Input Subsidy Programmes led to increased food production as well as economic growth as the economy is predominantly agrarian (Record et al., 2017). Policy impulses from the Malawi Economic Growth Strategy as well as the Malawi Growth and Development Strategy recognised that health and education are necessary for sustainable economic growth and development as the major sectors of the economy require educated and skilled workers to proliferate (GoM, 2006). The notion towards a reduced rate of population growth was reiterated in the MGDS for sustainable economic growth and development. While the economic growth and food production were relatively high, so was the rate of population growth.

From 2011 through 2015, economic growth experienced a major downturn and so did food production. With the second MGDS II in operation, success in the MGDS was an inspiration towards continued progress in development processes. However, major macroeconomic shocks arose and distorted the process. In 2012, the economy suffered effects of a major currency devaluation while donor aid froze around the same period as several donors withdrew aid citing unsustainable policies (Record et al, 2017). Further, from 2013 through 2015, droughts and floods which affected over 40% of the population hampered economic growth and food supply. The 2013 National Population Policy augmented the previous policy to include the planning for a manageable age structure and spatial distribution (IMF, 1994; GoM, 2012c).

This call has been echoed by other development partners (UNFPA, 2013; African Union Commission, 2015; UN, 2017). However, the realisation of such targets would be experienced in the long term.

In the context of socioeconomic development, Malawi has made strides in improving the welfare of its people over the years. According to the UNDP (2016b), socioeconomic development can be measured through human development indices, gender indices and the Multidimensional Poverty Index (MPI)[8]. The Human-development indices comprise of the Human Development Index[9] (HDI) and the Inequality-adjusted human development index (IHDI). The Gender-focused indices include the Gender Development Index (GDI) and the Gender Inequality Index (GII)[10]. These indices capture socioeconomic development in terms of the longevity of life, levels of knowledge, health and education with special focus on human development, gender provisions and poverty respectively. Malawi has over the years registered improvements in socioeconomic development through improvements in life expectancy, schooling and living standards Figure 2.7 plots estimated HDI values from 1990 to 2015.

[8] The MPI captures deprivations at household level in education, health and standard of living (United Nations Development Programme, 2016b)

[9] The HDI is a summary index for measuring long-term progress in three dimensions of human development which include: average years of schooling, life expectancy at birth and per capita GDP (GoM, 2016). The IHDI is a derivative of the HDI corrected for inequality.

10 The GDI captures gender disparities in achievement of the three dimensions of the HDI while the GII measures gender-based disadvantages in reproductive health, empowerment and in the labour market (United Nations Development Programme, 2016b).

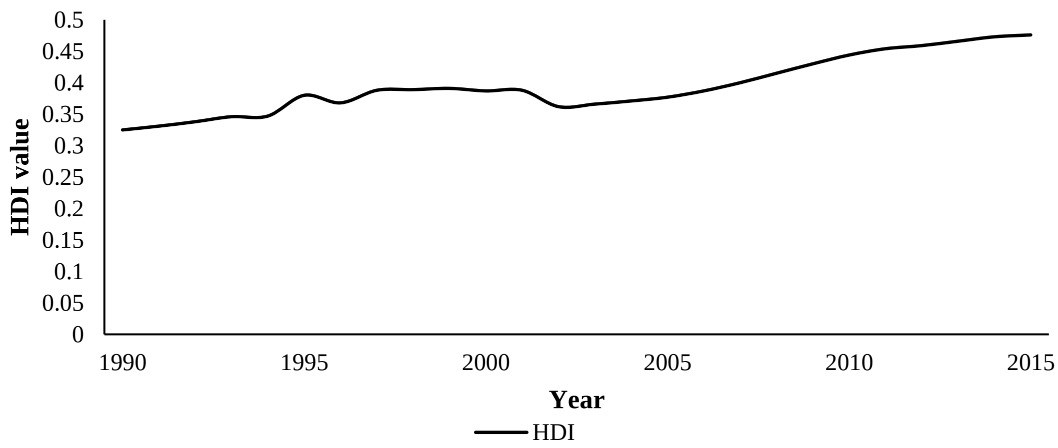

Figure 2.7: HDI trends in Malawi

Source: UNDP (2016b)

As one of the poorest nations in the world, Malawi ranks very low in terms of HDI. According to UNDP (2016), Malawi ranked on position 170 of 187 countries in the world in terms of HDI. However, since independence, it is clear that on average, individuals are living longer. In 1964, life expectancy at birth indicated that the average new-born Malawian was expected to live up to age 39 but as of 2014, the figure has increased tremendously to a current estimate of about 63 years. As development proceeds, especially in the health sector, it is expected that residents can live even longer. Between 1990 and 2015, the average years of schooling increased by 1.9 years, the expected years of schooling increased by 5.4 years while the Gross National Income per capita decreased by 27.2 percent UNDP (2016b). If population centred programmes take effect in the intended manner, the country could expect to register significant positive gains in socioeconomic development.

MGDS III also recognizes Malawi's population as highly youthful which connotes a high dependency burden and heralds low investment in physical and human capital formation (GoM, 2017a).

It emphasizes this population bulge of the youth as an asset towards future economic growth and socioeconomic development if well managed and as a liability if mismanaged. The strategy recognizes health and education as the main intervening variables in interaction with development. As such, it calls for developments in health through effective health sector planning and developments in education to empower people including women, youth and disabled people.

2.4 Conclusion

Population growth is very high in Malawi due to high birth rates and low death rates which culminate in a young population. The growth pattern of the economy has been largely affected by climatic shocks with the country's reliance on rain-fed agriculture. Consequently, these climatic shocks combined with policy-induced negative shocks have persistently led to macroeconomic instability (Record et al., 2017). These shocks in turn have caused low investments in physical capital through which economic growth has largely been unstable. High inequality and unemployment have also stalked in the rear and rendered regressive effects on development.

CHAPTER THREE

LITERATURE REVIEW

3.1 Introduction

This chapter reviews various literature pertaining to population dynamics as well as economic development. To begin with, the chapter outlines various theories by classics in the realms connecting the two broad themes in the theoretical literature review section. Thereafter, the chapter goes ahead to make an account of various empirical studies by scholars in the fields of population dynamics as well as economic development.

3.2 Theoretical literature review

This section advances two main schools of thought relating population to economic development. The first is the pessimistic school which regards population to have adverse impacts on development. This is championed by the Malthusian model. The other school of thought criticizes Malthus by providing alternatives which suggest that population can generate positive consequences on development. Models in this school include the Cornucopian model, the Boserup model, the Demographic Dividend and Simon’s theory.

3.2.1 Malthusian model

The Malthusian model of population was propounded by Thomas Robert Malthus in his essay on population growth and food supply (Malthus, 1798).

The theory postulates that population increases geometrically while food supply increases arithmetically implying that population growth eventually outpaces the supply of food for the population. Malthus (1798) made propositions that population needed two major kinds of checks to avoid overpopulation. Preventive Checks entailed individuals' voluntary use of methods to limit population growth while Positive Checks entailed methods of controlling population growth which are resultant of the lack of utilization of the Preventive checks to repress increases which already begun. In his prediction, without preventive action, scarce resources would be increasingly shared among a growing number of people then inevitably, factors such as famine and diseases would eventually level the population with the productive capacity of the population (Malthus, 1798). This limitation to growth has been commonly referred to as "The Malthusian population trap" depicted in Figure 3.1.

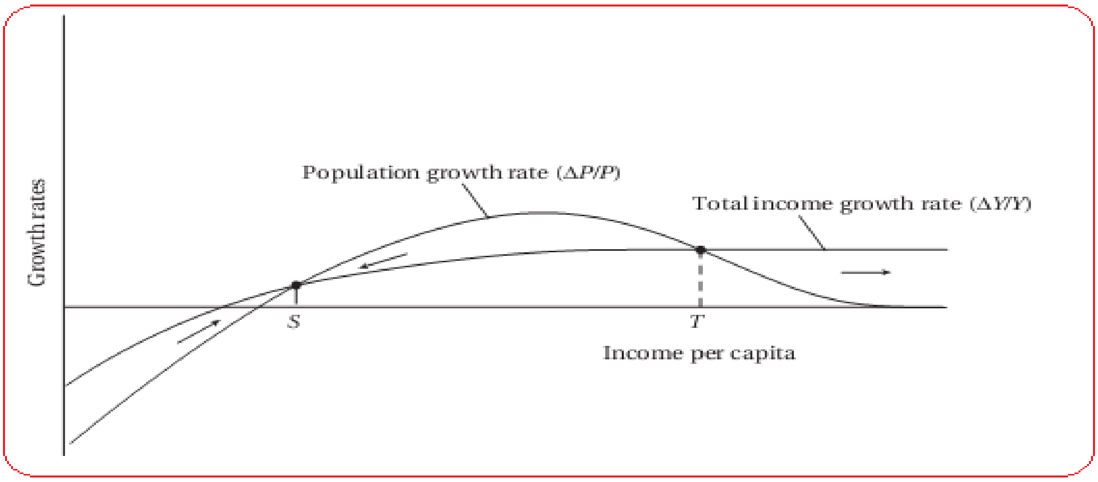

Figure 3.1: The Malthusian population trap

Source: Todaro and Smith (2012)

The vertical distance between income and population growth is the growth rate of per capita income. That is, whenever income growth supersedes population growth, per capita income increases causing a rightward movement along the x-axis.

At a low level of growth of income, the population faces poor livelihoods such as infectious diseases as well as poor health service (Todaro & Smith, 2012). Starvation becomes inevitable. This describes the conditions as depicted to the left of the subsistence point S. Income levels beyond that point signify periods of improved health and nutrition which cause the population to grow. As population growth exceeds income growth, per capita income falls and thus moves leftwards towards point S. Point S is thus technically a stable equilibrium. Point T is an attainable threshold ideally for rich economies after which population growth is less than income growth and per capita income grows perpetually at a steady rate.

This study will test the relationship between the rate of growth of Malawi's population in relation to its productivity. The results of the test will inform whether the observed trends in the growth of the population of Malawi imply a prospective limit due to resource constraints. It also should be noted that the theory only considers the dependency aspect of young population. It disregards the potential productivity of this population subgroup in the long run. It also disregards external means of sourcing food such as through donor aid.

3.2.2 Cornucopian, Simon and Boserup theories

Unlike the sentiments made by Malthus, Cornucopians advance a contemporary view on population growth. In their view, increases in population have positive effects to the development of the economy (Jackson, 1995). Increase in population leads to an increase in a pool of human capital capable of producing ideas to curtail challenges associated with population growth for the sustenance of the population and improvement of living standards.

These ideas in turn generate various modern technologies which enable specialization of labour and more effective and efficient production systems (Jackson, 1995). The negative consequences of population growth can thus be averted through the utilization of the various technologies. With Technical Progress, a country is able to generate a level of income that is greater than the growth rate of population at all levels of per capita income through changes in economic and social institutions. The economy is thus able to produce self-sustaining growth.

Julian Simon's theory also issues a criticism to Malthusian perspectives of "limits to growth" (Aligica, 2009). He put forward an alternative in the pro-growth paradigm. Contrary to diminishing returns as implied by Malthus' model, Simon's theory suggests that detrimental effects of population growth are only transitory but economic gains are achieved in the long run (Simon, 1977). Similar to the Cornucopian perspective, a moderately growing population can take advantage of Technological Progress resulting in economies of scale in which much productivity can be realized and food production can surpass population growth itself (Simon, 1992).

Esther Boserup also refuted the persistence of diminishing returns to labour as suggested by Malthus. The suggestion made was that a larger population could foster efficient division of labour and advanced agricultural practices which could produce tremendous agricultural productivity (Boserup, 1965). Similar to Cornucopian perspectives as well as Simon's theory, technological advancements are key to this implied productivity.

The population can use this advanced technology over traditional agricultural practices to derive intensive agricultural output to sustain the population and in turn generate economic development. Thus, all countries have the potential for averting the Malthusian population trap through technical progress that has the enabling potential to stimulate production above population growth at all discernible levels of per capita income. As Malawi aims to be a technologically-driven middle-income country in the long term, it provides hope that the productive capacity of the economy can be revamped to support the growing population. As Malawi experiences deagrarianisation, there are significant shifts of labour towards manufacturing (Record et al., 2016). With government expenditures on modern farm mechanisation and irrigation agriculture, it is expected that productivity could increase and sustain the growing population.

3.2.3 Demographic dividend

The concept of the demographic dividend was coined by demographic economists to imply a prospective economic benefit of a youthful population increasing in the share of working age adults to child dependents due to a decline in birth and death rates (Fang, 2010). This is intuitive in the sense that for a substantial period, the economy benefits from a huge chunk of the labour r force with a minimal drag in resources with fewer dependents. There is thus a need for policy intervention to facilitate rapid declines in fertility as well as create favourable conditions to combat mortality so that it declines as well.

According to Lee and Mason (2006), with fewer dependents, the working aged population also has a larger propensity to save and accumulate assets which can also in turn boost portfolio investment on the capital market.

The efficacy of the demographic dividend can be augmented with increased investment in education and job creation to make the most of the working class (Fang, 2009). In this light, harnessing the demographic dividend can boost economic growth and development. In the dawn of the new millennium, the concept of the demographic dividend proceeds to assume a major role in development planning in various countries with youthful populations like Malawi. With over 60 percent of Africa's population aged 24 and below, the prospects of forthcoming economic development emanating from the youth are very high (African Union, 2017).

This was widely recognized by the 2007 African Population Commission, 2012 State of Africa Population Report, 2013 Africa regional conference on population and development, 2014 Executive council report as well as the 2017 Africa Cup of Nations which all called for investments in the youth in order for African nations to harness the demographic dividend (African Union, 2017).

In light of this, the African Union devised a roadmap centred on harnessing the Demographic Dividend through investments in the youth to guide African countries towards achieving goals set by the Agenda 2063 as well as the 2030 Agenda for sustainable development. In the case of Malawi, the age structure of the population has stagnated for decades with a bottom-heavy distribution (GoM, 2016). Inadequate contraceptive prevalence, momentum of the population as well as low levels of education achievement in the rural areas are among some of the driving factors. Dwelling on successes of several countries in East Asia, the persistent bulge of young people in the country continues to posit itself as a window of opportunity for future development waiting to be exploited. The current state of affairs has population growing rapidly thus hampering the required investments needed to achieve the Demographic Dividend. Unemployment remains high with insufficient job creation (GoM, 2016). Furthermore, Malawi has the lowest per capita expenditures in health much of which is donor funded (GoM, 2017b). The government of Malawi however notes that achievement of the Demographic Dividend will require combined efforts of investments in economic reforms as well as prioritization of family planning programmes and education (GoM, 2016).

While the economic gain of a Demographic Dividend would be enjoyed for about 5 decades before the working population grows old, there exist further prospects of a longer-lasting second demographic dividend as social and economic changes motivate people to accumulate wealth (African Union Commission, 2013). Following the first Demographic Dividend, greater investments in capital formation may be made while accelerating wealth accumulation and further driving up a nation's per capita income.

This study will delve into the age distribution of Malawi's population as a crucial element of Malawi's population dynamics to decipher its short and long run linkages to economic development.

3.2.4 Solow growth model

This is a Neoclassical theory of economic growth propounded by works of both Robert Solow and Trevor Swan in 1956 (Acemoglu, 2008). The model employs Capital and Labour as factors of production. Both factors experience diminishing returns in production but constant returns to scale.

Economic growth in the long term is generated by an exogenously determined technological change while the labour force growth and depreciation only account for the level of economic output in the long term. Their collective effects are thus only transitory. Figure 3.2 illustrates the mechanics of the Solow growth model.

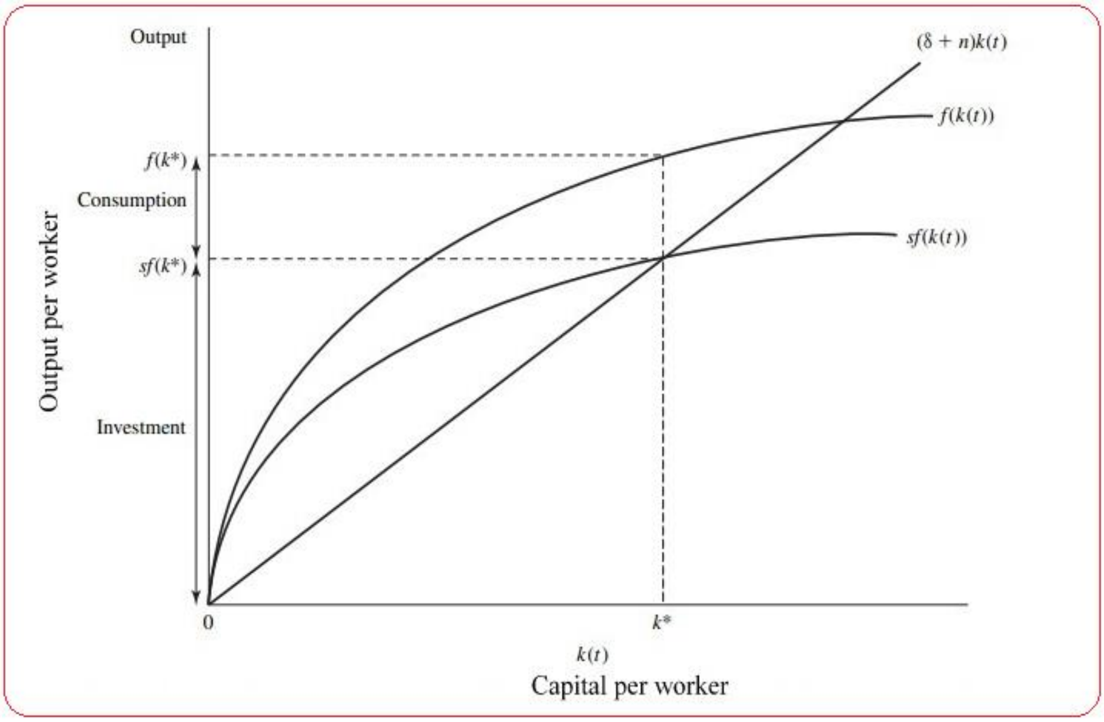

Figure 3.2: Solow growth model
Source: Acemoglu (2008)

The economy's total per capita output at time t is represented by $f(k(t)$ where $s(f(k(t))$ is the fraction that is saved for investment while the rest is used for consumption. The labour force grows at a rate of n per year which is in this case the rate of growth of population while the capital stock depreciates exponentially at a rate equal to δ.The total stock of capital increases when savings which are equal to Actual Investment $[s(f(k(t))]$ are greater than the investment requirement to service for depreciation and new workers joining the labour force $[(\delta + n)k(t)]$. Conversely, when this actual investment falls short of the investment requirement to replenish capital, the stock of capital falls.

The dynamics are given as:

$$\Delta k = sf(k(t)) - (\delta + n)k(t) \tag{3.1}$$

When actual investment equals the investment requirement, the economy reaches a long-run condition known as the steady state signified by the level of capital per worker k^*. This is a stable equilibrium towards which levels of capital beyond and below eventually converge. In this model, only the change in the growth rate of technical progress affects the growth of capital per worker in steady state. The effect of population growth is that it raises the investment requirement and thus steers the economy to converge to a lower level of steady state capital per worker.

The Solow model has high relevance to the study's analysis. Whereas the rate of growth of population captures labour force growth, the analysis modifies the model prescription to include dynamics of age structure and spatial distribution.

3.3 Empirical literature review

Various studies have looked at the influence of various population dynamics on economic development in developing as well as in developed countries and discovered differing results. The following is an account of the various findings.

A group of researchers have found evidence that population dynamics have a negative influence on economic growth and development in developing countries (Kelley, 1998; Bucci, 2003; Wenig & Zimmerman, 2012). A study on third world countries by Kelley (1988) found that rapidly growing populations dragged economic growth. The relationship was investigated by means of relating population growth against per capita income growth. A country with a population growing at an annual rate greater than 2 percent annually would have its per capita income growing at a pace less than 2 percent. Therefore, if population growth is to be instrumental to economic growth and development, it has to grow at manageably low levels. However, the relationship is insignificant in many other countries (Kelley, 1988).

Wenig and Zimmermann (2012) engaged a neoclassical framework by applying an economy-wide production function in their study of the influence of population growth on steady state per capita income and convergence. They found that a 10 percent increment in the population growth rate would cause a 5 percent decline in per capita income. The study further showed that investment in human capital augments the detrimental impact of population growth on the growth of per capita income. The reasoning is that more resources would have to be put aside to cater for the human capital needs of the growing population. As such, on average for any rate of growth of population, commensurate investment in human capital would make per capita income to decline twice as much.

Bucci (2003) found that the effect of population growth on economic growth can however be attenuated to a neutral effect when individuals choose to save endogenously. Considering a case of interaction between physical capital and human capital in new human capital formation, various permutations emerge. When physical and human capital substitute each other, population growth negatively affects per capita income while if the two are complementary, the effect is not clear cut (Bucci, 2003). For a given level of per capita physical capital, as population grows, the gross physical capital rises. In the case where physical and human capital are substitutes, the implication is that for a larger stock of physical capital, less human capital resources are demanded and vice versa. Therefore, if population increases, less human capital is demanded and with deficit utilization of human capital, per capita income is destined to decrease. When physical and human capital are complementary, an increase in physical capital stock generates demand for production of human capital. In this case, the impact of population growth on per capita income can be positive, negative or neutral. The corresponding direction of influence can only be established empirically.

On a positive note, some scholars have found evidence of a direct variation between population dynamics and economic growth and development (Bloom and Williamson, 1997; Bloom and Freeman, 1986). In this regard, population dynamics are instrumental factors for economic growth in developing countries. Bloom and Williamson (1997) showed that the ideal pathway to which demographic factors affect economic growth is beyond the growth of the population itself in absolute terms but its age structure. By including demographic variables in an economic model of economic growth, results showed that the demographic transition in East Asia contributed to its economic miracle. The working age population grew faster than the dependent population and as such, the per capita productive capacity was boosted.

Along compelling political, social and economic institutions, East Asian countries were able to achieve per capita GDP growth rates of 1.4 to 1.9 percentage points while South East Asia recorded per capita GDP growth rates of 0.9 to 1.8. In sum, they found that the effect of population growth on economic growth is transitional manifesting when the dependent and working population grow differently.

A study by Stamnova and Gveroski (2016) on the role of spatial distribution on economic development in Macedonia showed that rural areas have high importance in the development of agrarian economies. Compared to urban areas, findings indicate that rural areas significantly contribute to the reduction of unemployment and poverty. This is achieved by employing most of the working population in production, trade and other areas of economic gain. With many natural opportunities for primary agricultural production, countries where agriculture is predominant require special emphasis on the development of rural areas to foster faster economic development (Stamnova & Gveroski, 2016).

Bloom and Freeman (1986) made an analysis focusing on the impact of population growth on labour supply and employment in developing countries. They argue that fertility, mortality and migration affect labour supply differently with mortality and migration having immediate effects and fertility having delayed effects. These factors culminate in a varying age distribution. This is manifested by various age-specific growth rates of a population by which the age structure of the population changes through time. They noted that population growth that is due to high birth and death rates is inconsequential to economic growth and development whereas population growth which is due to low birth and death rates is associated with a higher growth of national income.

In essence, the latter population dynamics allow the working age group to grow faster relative to the dependent population which drives more saving and investment. In essence, their conclusion was that timing and components of population growth were revealed as important in the development process.

Others have found mixed results (Easterlin, 1967; Cincotta and Engelman, 1997; World Bank, 2000; Sinding, 2009). In essence, this leans to the direction that there is no clear prescription on how population trends and dynamics affect development outcomes. Such conclusions for particular economies can only be established through empirical evidence.

3.4 Conclusion

As reviewed by theory and empirical evidence, population is a crucial factor in the development process as well as development planning. The influences of population dynamics on economic development are not outrightly given and vary in different countries with different levels of income, population, human capital as well as technical progress. Unlike the various studies on population and development in Malawi, the current study will seek empirical evidence on the collective influences of population growth, age structure as well as spatial distribution on economic development.

CHAPTER FOUR

METHODOLOGY

4.1 Introduction

This chapter lays out the methodology used by the study to achieve its objectives. First, it discusses the measures of economic development and those of population dynamics. Then, the modelling and econometric specification is provided followed by a description of the variables used in the study as well as their expected direction of effect. The source of the data is also stated along with the design the study will take. The chapter concludes by laying out various tests crucial in establishing evidence as intended by the study

4.2 Measures of Population Dynamics and Economic Development

While economic development is a broad concept, the study selects reasonable measures. These include per capita GDP, the Inequality-adjusted Human Development Index and the Net Per capita Food Production Index. Per capita GDP is herein applied to capture economic growth while the Inequality adjusted Human Development Index captures socioeconomic development and the Net Per capita Food Production Index captures the economy's capacity of producing food. Intuitively, a developing economy should achieve higher levels of economic growth, food production and socioeconomic development.

Population dynamics which emanate from Fertility, Mortality and Migration are measured by population size, growth, share of young people in the total population, share of working-age people in the total population, share of rural residents, and share of urban residents. Population size and growth will capture the possibility of economies of scale of population, the respective shares of population in terms of age will capture the population's age structure while the respective shares according to area of residence will capture the spatial distribution.

4.3 Theoretical Framework

The study adopted the Solow-swan model. The model is derived as follows:

$$Y_t = {K_t}^{\alpha}(A_t L_t)^{1-\alpha} \qquad 0 < \alpha < 1 \qquad (4.1)$$

Y_t is the GDP or Output; K_t is the capital used in production and $A_t L_t$ is effective labour as the labour used is augmented by an exogenously determined level of technical progress *A*. The parameter α is the elasticity of output with respect to capital for which the inputs capital and labour jointly produce constant returns to scale.

Initial levels of Y_t, K_t, A_t and L_t are taken as given. Their respective changes over time are given by the derivatives with respect to time given as:

$\dot{Y}_t = \frac{dY_t}{dt}$, $\dot{K}_t = \frac{dK_t}{dt}$, $\dot{A}_t = \frac{dA_t}{dt}$, $\dot{L}_t = \frac{dL_t}{dt}$

Growth rates in the labour force given as population growth rate as well as technical progress are given as $\frac{\dot{L}_t}{L_t} = n$ and $\frac{\dot{A}_t}{A_t} = g$ respectively.

Capital accumulation is given as $\dot{K}_t = sY_t - \delta K_t$ where s is the fraction of output that is saved and δ is the rate of depreciation of capital. This implies that its corresponding growth rate is given as $\frac{\dot{K}_t}{K_t} = s\frac{Y_t}{K_t} - \delta$.

Putting Equation 4.1 in growth terms, we obtain:

$$\frac{\dot{Y}_t}{Y_t} = \frac{\dot{A}_t}{A_t} + \alpha\frac{\dot{K}_t}{K_t} + (1-\alpha)\frac{\dot{L}_t}{L_t} \implies \frac{\dot{Y}_t}{Y_t} = g + \alpha\frac{\dot{K}_t}{K_t} + (1-\alpha)n$$

In steady state, $\frac{\dot{Y}_t}{Y_t} = \frac{\dot{K}_t}{K_t}$

$$\implies \frac{\dot{Y}_t}{Y_t} = g + \alpha\frac{\dot{Y}_t}{Y_t} + (1-\alpha)n \implies \frac{\dot{Y}_t}{Y_t} = \frac{g}{1-\alpha} + n$$

The steady state growth rate in output per worker is given by the growth rate in $\frac{Y_t}{L_t}$ which may be given as $\frac{\dot{Y}_t}{Y_t} - \frac{\dot{L}_t}{L_t} = \frac{g}{1-\alpha}$. This indicates that the steady state rate of growth of output per worker only depends on the rate of growth of technical progress. The effects of population growth rates, saving rates and depreciation rates on output are thus transitory.

The long run level of output per worker is more generally given as:

$$\left(\frac{Y_t}{L_t}\right)^* = {A_t}^{\frac{1}{1-\alpha}}\left(\frac{s}{\frac{g}{1-\alpha}+n+\delta}\right)^{\frac{\alpha}{1-\alpha}} \qquad (4.2)$$

Relating the model to the study, output growth is a function of population growth. The study adopts this relation with modification to include other pertinent population dynamics of age structure and spatial distribution.

4.4 Modelling framework and econometric specification

The study used Autoregressive Distributed Lag (ARDL) models to investigate the influences of various population dynamics on economic development. This is as directed by stationarity tests indicating the presence of non-stationary variables which rule out the option of applying Ordinary Least Squares which would result in spurious regressions. Furthermore, the stationarity tests indicate the presence of I(0) and I(1) variables which make the ARDL model appropriate.

The following are the econometric specifications of ARDL models with per capita GDP, Inequality-adjusted HDI and Net Per capita FPI as dependent variables.

The econometric specification of the ARDL model in reduced form is given as follows:

$$\Delta y_t = \alpha_0 + \gamma_1 y_{t-1} + \gamma_2 x_{t-1} + \sum_{i=1}^{p-1} \phi_i ' \Delta w_{t-i} + \varphi ' \Delta x_t + u_t \qquad (4.3)$$

Where y_t is a dependent variable; x_t and w_t are vectors of dynamic regressors given as:

$$x_t = (popsize_t, popgr_t, popy_t, popw_t, urban_t)'$$

$$w_t = (y_t, popsize_t, popgr_t, popy_t, popw_t, urban_t)' = (y_t, x_t')'$$

while u_t is the error term and p is the lag length.

The models were tested for cointegration upon which long run equations in the following form were estimated when cointegration was confirmed:

$$y_t = \alpha_0 + \sum_{i=1}^{p} \alpha_i w_{t-i} + u_t \qquad (4.4)$$

The following error correction model was estimated to investigate the short-run dynamics:

$$\Delta y_t = \alpha_0 + \sum_{i=1}^{p} \alpha_i \Delta w_{t-i} + \gamma ECT_{t-1} + u_t \qquad (4.5)$$

4.5 Definition of variables and their expected signs

The study uses three dependent variables analysed in three different equations. Each of these dependent variables are separately regressed on the same set of five independent variables.

4.5.1 Dependent Variables

I. *percap*: This is the per capita GDP variable.

II. *hdi:* This is the Inequality adjusted Human Development Index.

III. *fpi:* This is the net per capita Food Production Index.

4.5.2 Independent Variables

I. *popsize:* This variable captures the total size of the population. It is expected that it will have a negative impact on economic development (per capita GDP, IHDI and Net Per capita FPI). This is due to its effect on crowding out investments in physical and human capital. However, population size could influence demand for commodities and their consumption which could influence producers to produce more output. Additionally, a higher number of people could indicate that there are more people in the productive workforce. In that case, the effect may be positive.

II. *popgr:* This is the growth rate of the population. Similarly, it is expected to have a negative influence on economic development.

The idea is that increases in population growth lead to require more investment to maintain a given level of capital per worker which in itself inhibited. Growing populations also lead to marginalization of holdings of arable land which hampers food production. They also increase pressure on available social services.

III. *popy:* This is the share of the population that is young (aged 0-14). This part of the population is considered as child dependents. The apriori expectation is that child dependents do not actively contribute to the labour force and as such, the expected direction of influence on all dependent variables is negative. The long run influence may however be positive as members of this group would eventually reach the working ages.

IV. *popw:* This variable captures the share of the population in the working ages (aged 15-64). The expectation is that members of this age group actively participate in the labour force and are very productive. Therefore, the expected direction of influence for this variable is positive for all dependent variables.

V. *urban:* This is the share of people living in the urban area. Similarly, in an urban setting requiring labour resources for production in various sectors, the share of people living in urban areas would have a discernible positive influence on all outcome variables. On the other hand, with lack of proper urban planning, the same could lead to urban poverty and proliferation of slums which is indicative of a negative direction of influence. Converse to findings on this variable, inference will be made on the share of people living in the rural area (*rural*).

4.6 Data source and study design

The study used data sourced from the Food and Agriculture Organisation Statistics (FAOSTAT) and the World Bank Group's World Development Indicators (WDI). Data on Net per capita food production indices was obtained from the FAOSTAT database while the rest of the data was obtained from the WDI. The study used a time series design spanning from 1960 to 2015.

4.7 Diagnostic tests

4.7.1 Stationarity tests

A time series is stationary if it has a constant mean and variance over time (Enders, 2015). As the study used time series data, it was imperative to test for stationarity as analysis and interpretation of non-stationary data could lead to spurious regressions (Granger & Newbold, 1974). These spurious regressions have high values of R^2 with t-statistics which appear to be significant but lack economic meaning. Least squares estimates such kinds of regressions are inconsistent and conventional tests of significance do not hold (Enders, 2015).

The study used Clemente-Montañés-Reyes (CMR), Perron-Vogelsang and Dickey Fuller with GLS Detrending (DF-GLS) tests to investigate stationarity in the various series. The first two tests consider the presence of structural breaks in the series endogenously (Türsoy, 2017). Both tests invoke the Additive Outlier (AO) and the Innovation Outlier (IO) models. The former assumes the changes in the structure of the data occur suddenly or rapidly which allows for a break in the slope while the latter assumes the changes are gradual which allows for breaks in both the intercept and the slope.

The CMR test was applied first to test the existence of two structural breaks on all variables. The stationarity of variables which showed no significant existence of two structural breaks was then tested using the Perron-Vogelsang which considers the existence of one structural break. When one structural break was also insignificant, the Augmented Dickey Fuller with GLS detrending was applied on such variables.

4.7.2 Cointegration

The Bounds test approach suggested by Pesaran et al. (2001) was applied to investigate the presence of a long run relationship between economic development and population variables. When cointegration was found to be significant, Bayer-Hanck combined cointegration tests of Engle and Granger, Johansen, Banerjee-Dolado-Mestre and

Boswjik were performed to investigate the robustness of the concluded cointegration (Bayer & Hanck, 2013).

4.7.3 Causality tests

The study applied Granger non-causality tests to determine the existence of causal influences of population dynamics to economic development. The approach tests whether the lags of an explanatory variable enter the equation of an explained variable by which the former variable is deemed to improve the forecasting of the latter (Johnston & Dinardo, 1997).

4.7.4 Parameter stability

The parameters estimated in the study's analysis were deemed reliable when they exhibited stability over time. For this purpose, recursive modelling using CUSUM tests was applied to investigate parameter stability.

4.7.5 Autocorrelation

Autocorrelation occurs when there is significant correlation between the disturbances of given series ordered in time (Gujarati, 2004). In the presence of Autocorrelation, the estimators remain unbiased, consistent as well as normally distributed asymptotically but lack efficiency. Usual hypothesis tests are consequently invalidated which makes findings unreliable. The study applied Breusch-Godfrey tests for autocorrelation of all orders for this purpose.

4.7.6 Normality

With normality, probability and sampling distributions of estimators can be easily computed. It also allows for the construction of Confidence Intervals and hypothesis tests for statistical inference (Gujarati, 2004). Jarque-Bera tests were applied in testing for normality. The test entails testing whether the residuals from regression conform to characteristics of a normal distribution. That is whether the distribution is symmetric and mesokurtic. These are indicated with Skewness not statistically differing from 0 and Kurtosis not statistically differing from 3 (Gujarati, 2004).

4.7.7 Model Specification and Selection

To test whether the respective models are properly specified, Ramsey's Regression Specification Error Tests (RESET) were used to ensure that the three models used for analysis were correctly specified. The test provides a general test for misspecification and does not require the specification of an alternative model (Gujarati, 2004). For appropriate model selection, the study used Akaike Information Criteria (AIC) to test for optimal number of lags to be included in the three respective regression models. Models with the lowest AIC values were selected for estimation.

4.7.8 Heteroskedasticity

Heteroskedasticity exists when the error variances following estimation are non-constant (Gujarati, 2004). In such a case, estimators for the parameters are unbiased and consistent but do not have minimum variance. Therefore, heteroskedasticity was tested for efficient results. The study used the Breusch-Pagan-Godfrey test for heteroskedasticity

CHAPTER FIVE

RESULTS AND DISCUSSION

5.1 Introduction

This chapter presents the results of the analyses undertaken in the study guided by the objectives following the methodology discussed in the previous chapter. To get a brief summary about the characteristics of the data, descriptive statistics are presented in the following section which include mean, standard deviation as well as maximum and minimum values. Thereafter, to analyse the relationships between the various population dynamics and economic development, multivariate regression techniques are applied further to which various diagnostic tests are invoked.

5.2 Descriptive statistics

This section provides descriptive statistics to give a snapshot of the nature of the various variables used in the study. Table 4.1 provides summary statistics of all variables which include their respective number of observations, means, standard deviations as well as maximum and minimum values.

Table 4.1: Descriptive Statistics

Variable	Observations	Mean	Standard Deviation	Min	Max
Per capita GDP	56	366	63.58	241	495
Net per capita FPI	53	94	22.22	51	153
Inequality adj. HDI	41	0.358	0.05	0.252	0.448
Population Size	56	8.71m	3985875	3.62m	17.22m
Population Growth (%)	56	2.82	1.09	0.15	6.25
Young population (%)	56	46	0.89	44	48
Working population (%)	56	51	0.89	50	53
Proportion of urban (%)	56	11	3.98	4	16

Through the period, the real GDP per capita ranged from \$241 to \$495 with an average value of \$366. The IHDI ranged from 0.252 units to 0.448 units with a mean value of 0.358 while the Net per capita FPI ranged from 51 units to 153 units with a mean value of 94 units.

The share of the youthful population varied between 44% and 48% while the share of the working age population varied between 50% and 53% both with a minimal degree of variation of roughly 0.89 standard deviation units.

The growth rate of the population span between 0.15% per annum and 6.25% per annum and averaged at a rate of 2.82% per annum while the size of the whole population ranged from 3.62 million people to 17.22 million people.

The share of the urban population varied between 4% and 16% and averaged 11%. Conversely, it implies that the share of the rural population varied between 84% to 96% while both varied with a degree of 3.98 standard deviation units.

5.3 Unit root tests

In this section, unit root tests are carried out on the variables to determine their order of integration. This study first uses the approach for testing for stationarity as devised by Clemente, Montañés and Reyes which allows for two endogenous structural breaks in the mean of the series (Clemente et al., 1998). Where results lead to rejection of the hypothesis of the presence of two break dates, the Perron-Vogelsang test which allows for one endogenous structural break is applied. If one structural break is also insignificant, the DF-GLS test is applied.

After applying CMR tests, per capita real GDP and the share of urban population were found to have two significant break dates (BD1 and BD2) whereas the rest of the series were found not to have 2 structural breaks. Their stationarity results are given in Table 4.2.

Table 4.2: Clemente-Montañés-Reyes tests for stationarity

Level	AO-model t-Statistics	BD1	BD2	IO-model t-statistics	BD1	BD2	Result
percap	-3.782	1968	2008	-3.815	1963	2005	Unit root
urban	-2.934	1978	1994	-3.678	1965	1986	Unit root
First Difference							
percap	-3.605	1976	1992	-7.611**	1978	1993	Stationary
urban	-4.674	1968	2000	-6.323**	1965	1997	Stationary

Notes: * p < 0.10, ** p < 0.05, *** p < 0.01; -5.490 (5% crit. value)
BD1 and BD2 denote the two endogenously determined Break Dates

The test uses minimum values of the pseudo t-statistics to test the null hypothesis of the presence of a unit root in the series.

The results in Table 4.2 indicate that at 5% significance level, the t-statistics for per capita real GDP and the share of urban population are insignificant. This implies that per capita real GDP and the share of urban population are nonstationary or are unit root processes at level. After first differencing, the t-statistics become significant and we conclude that the two series are stationary after first differencing. They are thus I(1) processes or integrated of order 1 as given by the IO model.

Going forth, after applying the Perron-Vogelsang test, the Inequality-adjusted HDI, the population growth rate and the population size were found to have one significant break date and their stationarity results are presented in Table 4.3.

Table 4.3: Perron-Vogelsang tests for stationarity

Level	**AO-model**	**BD**	**IO-model**	**BD**	**Result**
	t-Statistics		**t-statistics**		
hdi	-7.885*	1998	-5.278**	2001	Stationary
popgr	-9.201***	1976	-5.253**	1995	Stationary
popsize	-1.957	2014	-1.826	2003	Unit root
First Difference					
popsize	-9.366***	2014	-4.9*	1992	Stationary

Notes: * p < 0.10, ** p < 0.05, *** p < 0.01; -4.86 (5% crit. value); BD is the break date

This approach also uses t-statistics to test null hypotheses of unit roots in the series. Results in Table 4.3 show that at 5% significance level t-statistics for the Inequality-adjusted Human Development Index and the rate of growth of population are significant. This tells us that are stationary at level or they are thus I(0) processes. The size of the population is a nonstationary series at level which becomes stationary after first differencing which makes it an I(1) process as tested through the same procedure.

The stationarity properties of the rest of the variables were investigated using the Augmented Dickey Fuller Tests with GLS detrending and the results are given in Table 4.4.

Table 4.4: Augmented Dickey Fuller with GLS detrending tests for stationarity

Level	**Optimal lags**	**Tau statistic**	**5% CV**	**10% CV**	**Result**
fpi	3	-0.681	-3.116	-2.819	Unit root
popy	1	-0.896	-3.195	-2.892	Unit root
popw	1	-1.025	-3.195	-2.892	Unit root
First Difference					
Fpi	3	-3.516**	-3.120	-2.822	Stationary
Popy	1	-3.163*	-3.202	-2.898	Stationary
Popw	1	-3.375**	-3.202	-2.898	Stationary

Notes: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

The approach uses Tau statistics to test the null hypotheses of a unit root in the series. Table 4.4's results indicate that the Net per capita food production index, the share of youthful population and the share of the working age population are unit root processes at level as the Tau statistics are insignificant. They become stationary after first differencing. They are thus I(1) processes.

Ultimately, unit root tests in this section have revealed some variables to be stationary at level and others to be stationary only after first differencing. This implies that applying Ordinary Least Squares as a regression technique would lead to meaningless results of a phenomenon called spurious regressions (Granger & Newbold, 1974).
With the combination of I(0) and I(1) processes and no I(2) nor series integrated of higher orders, there's a chance of testing for cointegration using Autoregressive Distributed Lag (ARDL) models.

5.4 ARDL Modelling

After determining the order of integration of the variables, the ARDL bounds test for cointegration was applied to analyse the long run relationship of the variables. The Bayer-Hanck combined cointegration test was also applied to investigate the robustness of the Bounds test results. Table 4.5 shows results of cointegration tests of the 3 models under analysis as well as various pertinent statistics to the respective estimation procedures from both techniques.

Table 4.5: Bounds and Bayer Hanck tests for cointegration

Bounds test				
Model	**Depvar: percap**	**Depvar: fpi**		**Depvar: hdi**
Optimal Lag length	(1,3,1,4,2,4)	(4,2,4,4,4,0)		(4,4,4,4,4,2)
F-Statistic	7.6461***	7.9788**		10.1718***
Critical Values	**1%**	**2.5%**	**5%**	**10%**
Lower Bound I(0)	3.41	2.96	2.62	2.26
Upper Bound I(1)	4.68	4.18	3.79	3.35
R-Squared	0.75	0.75		0.96
Adjusted R-Squared	0.58	0.53		0.83
F-Statistic	4.5714***	3.4173***		7.714***

Bayer-Hanck test			
Model	**Fischer Statistics**		**Verdict**
	EG-JOH	EG-JOH-BAN-BOS	
$F_{percap} = f(\phi)$	56.175***	121.0689***	Cointegration
$F_{fpi} = f(\phi)$	55.7845***	69.8582***	Cointegration
$F_{hdi} = f(\phi)$	56.3116***	*166.8356****	Cointegration
Significance level	**Critical Values**	***Critical Values***	
10%	8.242	*15.804*	
5%	10.419	*19.888*	
1%	15.701	*29.85*	

Notes: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$;
ϕ is a vector of the right-hand side variables *popsize*, *popgr*, *popy*, *popw* and *urban* used in the Bayer-Hanck test.

The Bounds test uses an F-statistic to test the null hypothesis of no long run relationship between the variables specified in the ARDL model. The respective Critical Values are from Pesaran et al. (2001) and AIC was used to determine the respective optimal lag lengths. The Bounds test results lead us to reject the null hypotheses of no long run relationship in the variables in each of the 3 models estimated. The results were all significant at 1% significance level.

The Bayer-Hanck test performs joint tests of Engle and Granger (1987), Johansen (1988), Banerjee et al. (1988) and Boswijk (1994) by computing a joint Fischer statistic for the various proposed methods for testing for cointegration. The test statistic also tests the null hypothesis of no long run relationship among the variables. The computed Fischer statistics for all the 3 models evaluated lie above the critical values of both the Engle-Granger and Johansen (EG-JOH) as well as the Engle-Granger, Johansen, Banerjee-Dolado-Mestre and Boswjik (EG-JOH-BAN-BOS) methods leading to the rejection of the null hypotheses of no cointegration. This result augments the findings made by the ARDL bounds test to confirm the presence of a long run relationship in the models used in the analysis.

5.4.1 Diagnostic tests

This section involves testing the estimated ARDL models for Heteroskedasticity, Serial Correlation, Model Specification, Normality and Parameter Stability to appraise their fitness. Table 4.6 presents p-values on tests of Serial correlation, Heteroskedasticity and Normality while Figure 4.1, Figure 4.2 and Figure 4.3 provide results of recursive modelling of parameter stability based on CUSUM tests.

Table 4.6: Diagnostic tests on ARDL models

Model	Depvar: percap	Depvar: fpi	Depvar: hdi
Serial Correlation	0.6741	0.065	0.079
Model Specification	0.7579	0.1492	0.9137
Heteroskedasticity	0.6182	0.058	0.625
Normality	0.3022	0.108	0.421

Notes: Table presents p-values for the various diagnostic tests as indicated.

Under the Null hypotheses of no Serial Correlation, no Heteroskedasticity and no Normality, Table 4.6's results show that at 5% significance level, we are unable to reject all null hypotheses and conclude that our models have no Serial Correlation, no Heteroskedasticity and are multivariate normal.

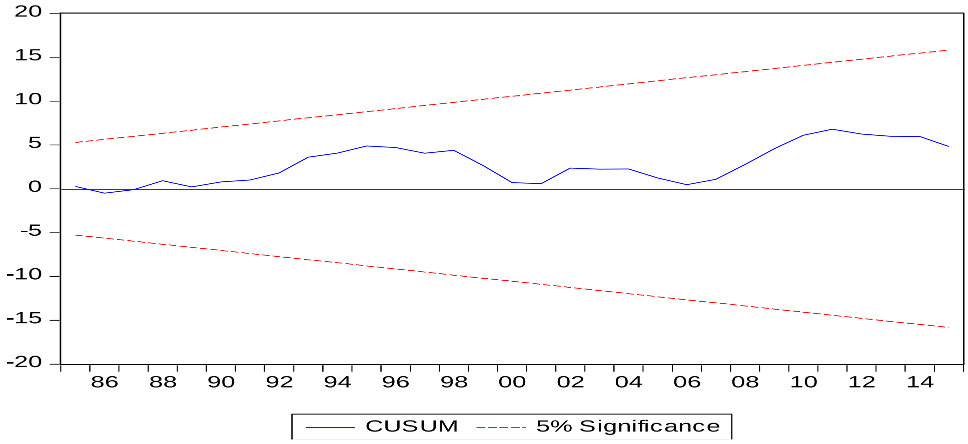

Figure 4.1: CUSUM for ARDL model with *percap* as *Depvar*

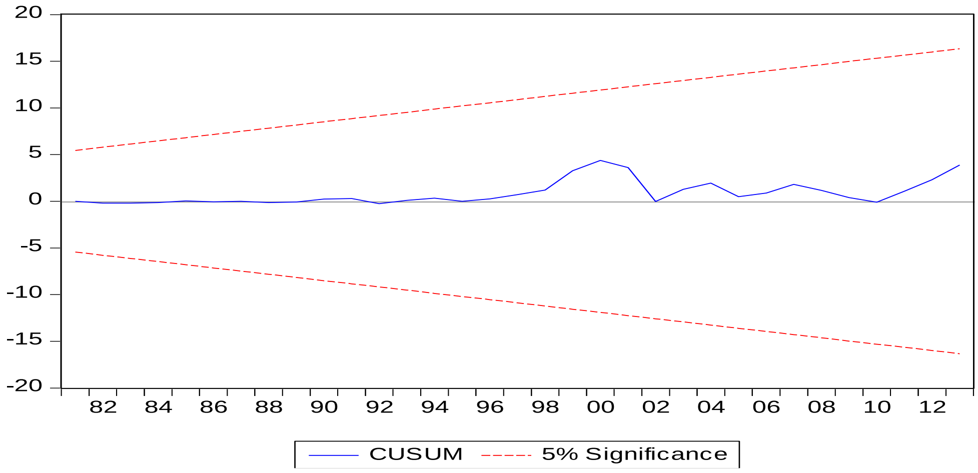

Figure 4.2: CUSUM for ARDL model with *FPI* as *Depvar*

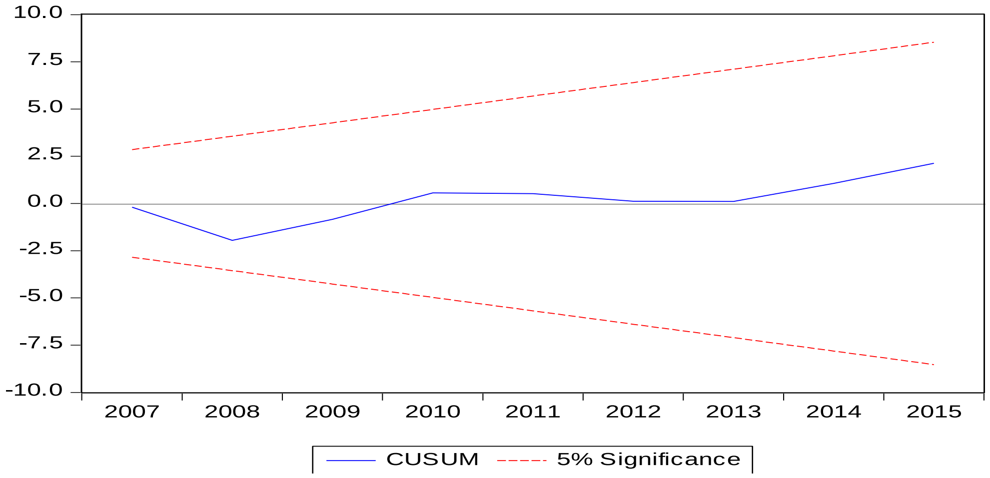

Figure 4.3: CUSUM for ARDL model with *HDI* as *Depvar*

Where Depvar is the dependent variable

As the computed CUSUMs lie within the 5% critical bounds, this indicates that the parameters for the estimated models are significantly stable over time. This shows that the three estimated models are reliable for making various analyses.

5.4.2 Granger causality

Granger causality tests were applied under Error Correction Model (ECM). Three types of Granger causality were investigated to determine the causality. These include the short-run (weak causality), the long-run as well as the joint short and long run causalities (strong causality). For the short run causality, the Wald test was applied to determine the significance of the lagged independent variables using the joint F test, the long run causality was determined by the sign of the coefficient of the Error correction term and its significance while the joint long and short run causalities were investigated by applying the Wald tests jointly on the lagged independent variables as well as the Error correction term (Türsoy, 2017). Table 4.7 gives the results.

Table 4.7: Granger causality tests

	Depvar: Percap		Depvar: fpi		Depvar: hdi	
	SR	**Joint**	**SR**	**Joint**	**SR**	**Joint**
popsize	9.22***	10.05***	6.88***	12.98***	4.47**	4.51**
popgr	7.21**	18.05***	4.21**	7.91***	5.85**	5.21**
Popy	5.3***	9***	6.01***	8.92**	0.28	0.799
Popw	3.14	11.94***	6.15***	9.15***	0.38	0.72
urban	4.83***	8.93***	.	.	-	-

Notes: * p < 0.10, ** p < 0.05, *** p < 0.01; . denote inestimable results

The results provided in Table 4.7 indicate that the size of population, its rate of growth, the proportion of urban residents and the share of the youth in the population granger cause the level of real GDP per capita in both the short and long runs as well as jointly. The working population only exhibits causality in the long run but does not granger cause real GDP per capita in the short run. This tells us the influence is a long run phenomenon.

Results on the causality towards food production indicate that the proportion of young people and that of working people granger cause the productivity of food jointly in the short and long runs. Joint causality was also found to emanate from the size of population and its rate of growth. No causality was found regarding spatial distribution. Furthermore, statistical evidence proved that the size of population and its rate of growth granger cause socioeconomic development in both the short and long runs as well as jointly while causality influences from the proportion of urban residents, the youth and the working age population are only manifested in the long run.

5.4.3 Cointegrating form and Short-run dynamics

Since the variables were found to move together in the long run, the analysis went ahead to investigate Cointegrating long run form as well as the short relationships. Table 4.8 presents estimated long run coefficients normalised on the respective dependent variables for the three estimated as well as the short run results presented with the adjustment term for long run disequilibria. The long run results are used to explain the long run effect of a change in the independent variables on the dependent variables. Both short run and long run results are meaningfully used to establish causality while the error correction term explains the speed of adjustment to long run disequilibria.

Table 4.8: ARDL Long run and short run results

	Long run results					
	Depvar: *percap*		**Depvar: *fpi***		**Depvar: *hdi***	
Variable	**Coefficient**	**t-statistic**	**Coefficient**	**t-statistic**	**Coefficient**	**t-statistic**
Popsize	0.000033	1.28	0.000025	2.62**	-4.66e-08	-4.22***
Popgr	-113.37	-2.48**	-49.19	-2.52**	-0.19	-4.93***
Popy	352.94	4.69***	51.09	1.41	-0.21	-5.43***
Popw	350.81	3.62***	31.01	0.71	-0.27	-5.94***
Urban	-23.83	-1.68*	-23.21	-3.86***	-0.03	-3.19**
	Short run results					
D.popsize	-0.0013	-0.95	-0.002	-2.09**	.	.
LD.popsize	0.0031	2.03*	0.0028	3.68***	.	.
L2D.popsize	-0.0011	-1.92*	.	.	.	.
L3D.popsize	.	.	.	.	.	.
D.popgr	168.19	2.69**	173.48	3.88***	-0.09	-0.79
LD.popgr	.	.	64.18	1.48	0.03	0.14
L2D.popgr	.	.	90.94	2.05**	0.18	1.16
L3D.popgr	.	.	-66.05	-1.61	0.05	1.71
D.popy	-236.89	-1.34	-405.81	-2.96***	-0.45	-3.92***
LD.popy	-229.5	-1.57	-219.36	-1.33	-0.02	-0.12
L2D.popy	29.98	1.9*	362.41	2.14**	-0.12	-0.67
L3D.popy	-25.46	-1.44	256.09	2.3**	-0.17	-1.38
D.popw	-266.16	-1.57	-377.61	-2.78**	-0.39	-3.42***
LD.popw	-223.62	-1.5	-194.35	-1.27**	-0.04	-0.24
L2D.popw	.	.	323.76	2.05*	-0.11	-0.66
L3D.popw	.	.	231.41	2.14**	-0.15	-1.2
D.urban	.	.	.	.	0.07	1.65
LD.urban	.	.	.	.	-0.08	-2.68**
ECT_{t-1}	-0.78	-5.97***	-0.76	-3.36***	-0.56	-6.61***

Notes: * p < 0.10, ** p < 0.05, *** p < 0.01; . denote inestimable results

With respect to real GDP per capita, the findings indicate that the rate of growth of population has a significant and highly negative impact on real GDP per capita. An increase in the growth rate of the population by 1% would lead to a fall in real per capita GDP by $113 in the long run all other things remaining the same. The share of the population currently young as well as those in the labour force has a high and significant positive impact on the long run level of per capita real GDP with that of the youth being higher.

A percentage increase in the share of the young dependent would grow the economy's per capita real GDP by $352 in the long run while a percentage increase in the share of working aged people would grow the economy by $350 in the long run ceteris paribus. The share of urban population has a negative and significant impact on the long run level of per capita real GDP implying that the rural population has a positive impact on real GDP per capita in the long run. More specifically, an increase in the share of rural residents by 1% would grow the economy by $23 in per capita real GDP in the long run while the urban population would have the opposite effect. Population size has no effect on the long run level of real per capita GDP as its influence is statistically insignificant. The disequilibria in the long run relationship is quickly corrected at a speed of 77.94 percent per year as indicated by the coefficient of the Error Correction Term.

With respect to food production, the size of the population in its totality has a significantly positive influence on the long run productivity of food. In essence, an additional 1 million people would grow the long run capacity of food production by 25 units on the net per capita food production index. The rate of growth of population also has a negative influence on long run food production. The negative influence of the rate of population growth despite the positive influence of population size depicts diminishing returns of Malawi's population to food production.

A percentage increase in the rate of growth of the population would influence a decline in long run food production by a 49 unit drop in the net per capita food production index. Age structure has no effect on food production as the influences of the present youth and working population are found to be insignificant. The share of population residing in the urban areas is found to significantly relate negatively to food production in the long run. Thus, the proportion of the rural population is likely to positively influence food production positively in the long run. An increase in the share of rural residents by 1% would grow the productivity of food by 23 units in the net per capita FPI in the long run while the urban population would have the opposite effect. The long run disequilibria in population dynamics and productivity of food is also quickly corrected at the speed of 75.58 percent per year.

Lastly, considering socioeconomic development, all the studied population dynamics have significant negative associations to socioeconomic development but the influence. An additional 1 million people lead to a decline in the long run IHDI value by 0.05 units. A 1% increase in the rate of population growth would lead to a decline in the IHDI value by 0.19 in the long run. Similar increases in the share of youthful population, share of working aged population and share of urban population would lead to declines on the long run IHDI values of 0.21, 0.27 and 0.03 respectively. The long run disequilibria in the variables is corrected at a speed of 56 percent in the following year as indicated on the error correction term.

5.5 Discussion

In line with the findings of Furuoka (2009) in Malaysia, findings have shown that there is a long run relationship between population dynamics and economic growth and development in Malawi. This is unlike findings of other studies such as that by Dawson and Tiffin (1998) in India that showed that no long-run equilibrium relationship holds for population growth and economic development. For Malawi, this means that interventions in population variables to achieve long run development are meaningful. Furthermore, in accordance with findings by Kelley (1988) in third world counties, the study's findings have shown that population growth is a detrimental factor to economic development which conforms to the pessimistic school of thought on population growth. This is unlike findings made by Thuku (2013) in Kenya which suggest that population growth has a positive influence on economic growth. With many people in the child dependent ages and rampant unemployment, it is indeed reasonable that the growth rate of the population be minimal for prospective gains in economic growth. This shows that the if the growth rate of the population of Malawi were rapidly reduced, Malawi could be on track of high development gains in the long run.

The results are also indicative of the youth bearing high long-term economic growth. This concurs with various findings on the potential of a demographic dividend to be harnessed from the youth (Lee and Mason, 2006; Fang, 2009; Fang, 2010; Wenig & Zimmerman, 2012). As the Malawi's population is currently young, future economic gains are expected while the dependency burden is expected to decline in the long run. However, fertility must decline very quickly to achieve this result.

Spatial distribution also emerged as a significant factor in explaining long term development. Concurring with a study by Stamnova and Gveroski (2016) in Macedonia, rural areas and the population of rural areas are instrumental to tapping the gains of economic development with appropriate policies and investments. For Malawi, this implies that rural areas which are predominantly agrarian need to be supported to lay the benchmark for adequate gains in long run economic growth and development.

CHAPTER SIX

CONCLUSIONS AND IMPLICATIONS

6.1 Conclusions

The overall objective of the study was to analyse population dynamics in relation to economic development in Malawi. In that regard, the study made a major finding that population and economic development in Malawi have a long run relationship. This indicates that the population can be managed to achieve long-term development targets. Furthermore, the study had three supporting objectives. The first was to determine the effect of population dynamics on Malawi's economic growth while the second objective was to discern the effect of population dynamics on Malawi's food productivity and the third was to investigate the effect of population dynamics on socioeconomic development in Malawi.

The study has found evidence that the rate of growth of the population is detrimental to economic growth, food production and socioeconomic development in the long run. This shows that the high rate of growth experienced in Malawi, where land holdings are small and other productive resources are in limited, is a momentous drawback to long term development.

More evidence points out that both the youthful population and working age population can significantly contribute to long term economic growth and food production. Malawi can thus benefit from the existing productive population as well as nurture the present young people to contribute significantly to development processes.

Furthermore, the share of the urban population has negative associations with short and long term economic growth, food production as well as socioeconomic development. This implies the converse that the share population in rural areas which currently dominates at about 84% contributes positively to real per capita GDP. This conforms to Malawi's state of agricultural dominance of the economy where most production takes place in the rural areas. This indicates that potential of sustainability of food production for the population as well as high earning agricultural produce such as cash crops lying with the population dwelling in rural areas.

6.2 Policy and analytical Implications

To begin with, the findings concluded from the study have the following implications for policy-making:

Firstly, sustainable and innovative ways need to be devised to curb rapid population growth if the economy is to grow its level of per capita GDP, food productivity and human capital development in the few decades to come. In Malawi's case where fertility is very high and mortality is dwindling, there's need to facilitate a rapid fertility decline for the effects are both short and long run phenomena.

Secondly, the findings entail that both current youthful and working populations have important implications for economic growth and food productivity. This in turn implies that for a greater multiplicative effect from these population subgroups, huge investments in skills development must be made. In particular, as the influence of the youthful population is higher, even more investments are required to be made to the population from a young age as they grow to realise much returns from them in the future. Investments in the current generation of working people as well as some of the youthful populations are also necessary to reap current gains in national output and food productive capacity.

Furthermore, the findings indicate that the current state of national output and food production is more inclined to the rural areas than the urban areas. This entails that huge investments are also needed in capital formation for rural development. This includes both investments in skills development of the various producers in the rural areas as well as in investments in physical capital to assist in intensifying agricultural production in the rural areas. This may include fixed capital such as farm machinery and systems to deal with reliance on rain-fed agriculture such as irrigation and integrated agricultural systems.

Analytically, the study finds that studies relating population to the development of the economy should be aligned to the following:

Firstly, as it has been concluded that the young dependent population bears high economic gains in the long run, the magnitude of these gains may be amplified if this group of the population bears the necessary skills to develop the economy. This implies that studies in population and development in Malawi should consider education and other closely related means of skills development as critical factors for consideration.

Secondly, also noting the prospective benefits of young dependent population as well as the detrimental effects of population growth to economic development, health issues need to be given much attention. This is to say that a healthy growing population with adequate delivery of sexual and reproductive health services could be constructive to long term economic growth. This thus implies that studies in population and development must also consider investment in health and health service delivery as an essential complement to population aspects in modelling economic development.

In addition, as the study finds spatial distribution as a significant factor affecting economic development, the relative capital formation of rural and urban areas which can boost productivity in either area bears also analytical significance. Thus, population and development research could be augmented by investigative processes of capital investments across space.

6.3 Directions for future research

The study did not study the underpinnings of population dynamics on economic development by focusing on how particular sectors of the economy are affected. It is quite intuitive from discussions made in the study that various sectors have different structural setups and composition of human population. While the various sectors require different kinds of people to develop, the dynamics in population are likely to affect their development differently in the process of gross economic development. In this regard, future research must delve in that analysis.

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APPENDIX

AUTOREGRESSIVE DISTRIBUTED LAG MODEL

An ARDL model has lags of both the dependent variable and independent variables included as additional explanatory variables. A standard ARDL(p,q) model is specified as:

$$y_t = \mu + \sum_{i=1}^{p} \gamma_i y_{t-i} + \sum_{j=0}^{q} \beta_j x_{t-j} + \varepsilon_t, \qquad \varepsilon \sim \text{i.i.d} \quad \forall t$$

$\Rightarrow C(L)y_t = \mu + B(L)x_t + \varepsilon_t$ where L is the lag operator and:

$C(L) = 1 - \gamma_1 L - \gamma_2 L^2 - ... - \gamma_p L^p$ and $B(L) = \beta_0 + \beta_1 L + \beta_2 L^2 + ... + \beta_q L^q$

The long run multiplier or the long run effect of a change in x is given by:

$$\sum_{i=0}^{\infty} \alpha_i = \frac{B(1)}{C(1)} = A(1) = \frac{\sum_i^q \beta_i}{1 - \sum_i^p \gamma_i} \qquad \text{where } A(L) = \frac{B(L)}{C(L)}$$

The long run relationship among the variables is given by:

$$\bar{y} = \frac{\mu}{C(1)} + \frac{B_1(1)}{C(1)} \overline{X}_1 + \frac{B_2(1)}{C(1)} \overline{X}_2 + ... + \frac{B_k(1)}{C(1)} \overline{X}_k$$

where $\bar{y}$ and $\overline{X}_i$ are constant values of y and x

The Error Correction Model is obtained by reparameterising the ARDL model. Consider the following ARDL (1,1) model:

$y_t = \mu + \gamma y_{t-1} + \beta_0 x_t + \beta_1 x_{t-1} + \varepsilon_t$, the ECM can be given as:

$$\Delta y_t = \beta_0 \Delta x_t + \tilde{\gamma}[y_{t-1} - (\tilde{\mu} + \theta x_{t-1})] + \varepsilon_t$$

Where: $\theta = \left(\frac{\beta_0 + \beta_1}{1 - \gamma} \right) = \frac{B(1)}{C(1)}$, $\quad \tilde{\mu} = \frac{\mu}{1 - \gamma}$, $\quad \tilde{\gamma} = \gamma - 1$,

$y_{t-1} - (\tilde{\mu} + \theta x_{t-1})$ is the error correction term

The following are the respective models estimated in the study. The first set is presented in reduced form as follows:

$$\Delta percap_t = \alpha_0 + \gamma_1 percap_{t-1} + \gamma_2 x_{t-1} + \sum_{i=1}^{p-1} \phi_i ' \Delta w_{t-1} + \varphi ' \Delta x_t + u_t \quad \text{(A.1)}$$

$$\Delta hdi_t = \beta_0 + \psi_1 hdi_{t-1} + \psi_2 x_{t-1} + \sum_{i=1}^{p-1} \lambda_i ' \Delta y_{t-1} + \kappa ' \Delta x_t + \mu_t \quad \text{(A.2)}$$

$$\Delta fpi_t = \beta_0 + \upsilon_1 hdi_{t-1} + \upsilon_2 x_{t-1} + \sum_{i=1}^{p-1} \theta_i ' \Delta z_{t-1} + \chi ' \Delta x_t + \varepsilon_t \quad \text{(A.3)}$$

Where x_t, w_t, y_t and z_t are vectors of dynamic regressors given as:

$x_t = (popsize_t, popgr_t, popy_t, popw_t, urban_t)'$

$w_t = (percap_t, popsize_t, popgr_t, popy_t, popw_t, urban_t)' = (percap_t, x_t')'$

$y_t = (hdi_t, popsize_t, popgr_t, popy_t, popw_t, urban_t)' = (hdi_t, x_t')'$

$z_t = (fpi_t, popsize_t, popgr_t, popy_t, popw_t, urban_t)' = (fpi_t, x_t')'$

while u_t, μ_t and ε_t are error terms and p is the lag length.

The following were the estimated long run equations:

$$percap_t = \alpha_0 + \sum_{i=1}^{p} \alpha_i w_{t-i} + u_t \quad \text{(A.4)}$$

$$hdi_t = \beta_0 + \sum_{i=1}^{p} \beta_i y_{t-i} + \mu_t \quad \text{(A.5)}$$

$$fpi_t = \delta_0 + \sum_{i=1}^{p} \delta_i z_{t-i} + \varepsilon_t \quad \text{(A.6)}$$

The following equations will be estimated in the error correction form.

$$\Delta percap_t = \alpha_0 + \sum_{i=1}^{p} \alpha_i \Delta w_{t-i} + \gamma ECT_{t-1} + u_t \qquad (A.7)$$

$$\Delta hdi_t = \beta_0 + \sum_{i=1}^{p} \beta_i \Delta y_{t-i} + \varphi ECT_{t-1} + \mu_t \qquad (A.8)$$

$$\Delta fpi_t = \delta_0 + \sum_{i=1}^{p} \delta_i \Delta z_{t-i} + \upsilon ECT_{t-1} + \varepsilon_t \qquad (A.9)$$

HYPOTHESIS TESTING

The study involves tests of several hypotheses to establish evidence on various parameters and statistical processes. These mainly involve testing stated null hypotheses (denoted H_0) against alternative hypotheses[11] (denoted H_1) at various significance levels[12]. When enough statistical evidence is presented against a null hypothesis, we reject it and validate the alternative hypothesis. In this case, we say our finding is statistically significant. When we fail to reject a null hypothesis, we say our finding is statistically insignificant.

[11] A null hypothesis is a statement made on a population parameter assumed to be true until it has been declared to be false while an alternative hypothesis is a statement on a population parameter that will be true if the null hypothesis is false and vice versa (Mann, 2010)

[12] The significance level of a test (denoted by α) represents the probability of rejecting a true null hypothesis (commonly referred as a Type I error). The standard values of α are 10%, 5% and 1% (Mann, 2010).

HYPOTHESIS TESTING APPROACHES

Test of significance (test statistic) approach

In this approach, a predetermined level of significance is used to calculate critical values which mark out the rejection region(s)[13] of the test depending on whether the test is one-tailed or two-tailed[14]. Then according to the probability distribution assumed for the test, a test statistic is computed on which a decision is made after its comparison against the critical value(s). Figure A.1 shows the rejection and nonrejection regions for a left-tailed test, a two-tailed test and a right-tailed test respectively.

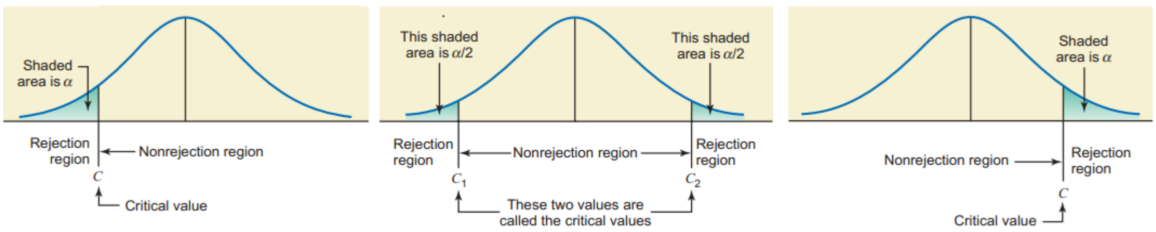

Figure A.1: One-tailed and two-tailed hypothesis tests

Source: Mann (2010)

The decision rules for this approach is to **reject** the null hypothesis if the computed test statistic falls in the rejection region and to fail to reject the null hypothesis if the computed test statistic falls in the nonrejection region.

p-value approach

The probability value (simply *p-value*) approach involves calculating the smallest significance level at which the null hypothesis is rejected (the *p-value*).

The decision rules for this approach are to **reject** a null hypothesis if *p-value* < α (or α > *p-value*) and to **fail to reject** a null hypothesis if *p-value* ≥ α (or α ≤ *p-value*).

[13] The rejection region is the region outside a $100(1-\alpha)\%$ confidence interval while the region within the $100(1-\alpha)\%$ confidence interval forms the region of acceptance (also called nonrejection region) (Gujarati, 2004). The endpoints of the confidence interval form the critical values of the test.

[14] One tailed tests have a rejection region on one-side of their probability distribution while two tailed tests have rejection regions on both sides of their probability distribution.

TESTS UNDERTAKEN IN THE STUDY

Clemente-Montañés-Reyes (CMR) Test

This test performs unit root tests on series taking into consideration the possibility of the series containing two structural breaks (Clemente, Montañés, & Reyes, 1998). The test performs the Additive Outlier (AO) as well as the Innovation Outlier (IO) models. While the AO model assumes the changes in the structure of the data occur suddenly or rapidly the IO model assumes the changes are gradual.

The test involves the following hypotheses:

H_0 : $y_t = y_{t-1} + \delta_1 DTB_{1t} + \delta_2 DTB_{2t} + u_t$ (the series y_t is nonstationary)

H_1 : $y_t = \mu + d_1 DU_{1t} + d_2 DTB_{2t} + e_t$ (the series y_t is stationary)

DTB_{it} is a pulse variable that takes the value of 1 if $t = TB_i + 1$ (i = 1,2) and 0 otherwise.

$DU_{it} = 1$ if $t > TB_i + 1$ (i = 1,2) and 0 otherwise, TB is the date of the break

In applying the IO model, we can conduct the unit root test by estimating the following model:

$$y_t = \mu + \rho y_{t-1} + \delta_2 DTB_{1t} + \delta_2 DTB_{2t} + d_1 DU_{1t} + d_2 DU_{2t} + \sum_{i=1}^{k} c_i \Delta y_{t-i} + e_t$$

While in applying the AO model, we first remove the deterministic part by estimating the following model:

$$y_t = \mu + d_1 DU_{1t} + d_2 DU_{2t} + \tilde{y}_t$$

Then estimate the model:

$$\tilde{y}_t = \sum_{i=0}^{k} \omega_{1i} DTB_{1t-i} + \sum_{i=0}^{k} \omega_{2i} DTB_{2t-i} + \rho \tilde{y}_{t-1} + \sum_{i=1}^{k} c_i \Delta \tilde{y}_{t-i} + e_t$$

In both estimated models, the minimum value of the pseudo t-ratio is computed to test whether the autoregressive parameter ρ is equal to 1 for all the time break combinations. If the t statistic is found to be significant, we conclude that the series y_t is stationary.

Perron-Vogelsang test

The approach tests for the presence of an autoregressive unit root through AO and IO models like the CMR test. In the AO model, the following hypotheses are investigated:

H0 : $y_t = \delta D(TB)_t + y_{t-1} + w_t$ (t=2,…,T) [The series y_t is nonstationary]

H1 : $y_t = c + \delta DU_t + v_t$ [The series y_t is stationary]

Where TB is the date of the break

The test undertakes the following procedure:

1. Remove the deterministic part of the series through estimating the following regression by OLS:

   $y_t = \mu + \delta DU_t + \tilde{y}_t$ (t=1,…,T)

2. Perform the test using the t-statistic for testing that $\alpha = 1$ in the regression specified as:

   $\tilde{y}_t = \omega D(TB)_t + \alpha \tilde{y}_{t-1} + \sum_{i=1}^{k} c_i \Delta \tilde{y}_{t-i} + e_t$ (t=k+2,…,T)

3. If the t statistic is found to be significant, we conclude that the series y_t is stationary.

The IO model tests the following hypotheses:

H0 : $y_t = y_{t-1} + \psi(L)(e_t + \theta D(TB)_t)$ (t=2,…,T) [The series y_t is nonstationary]

H1 : $y_t = a + \phi(L)(e_t + \delta DU)_t)$ [The series y_t is stationary]

The test undertakes the following procedure:

1. The models given in the null and alternative hypotheses are nested and approximated by the following finite order autoregressive model:

   $y_t = \mu + \delta DU_t + \theta D(TB)_t + \alpha y_{t-1} + \sum_{i=1}^{k} c_i \Delta y_{t-i} + e_t$ (t=k+2,…,T)

2. Then we estimate the model using OLS and obtain t-statistics for testing that $\alpha = 1$. If the t statistic is found to be significant, we conclude that the series y_t is stationary (Perron & Vogelsang, 1992).

DF-GLS test

This method provides an efficient approach for testing the stationarity of time series (Elliot et al., 1996). The test is conducted through the following hypotheses:

H_0 : Series has unit root

H_1 : Series has no unit root

The following steps are involved in conducting the test:

1. First consider the model in the form $y_t = a_0 + a_2 t + B(L)\varepsilon_t$
2. Preselect a constant α close to unity and subtract α y_{t-1} from y_t to obtain:

   $\tilde{y}_t = (1-\alpha)a_0 + a_2[(1-\alpha)t + \alpha] + e_t$ for t=2,…,T where $\tilde{y}_t = y_t - \alpha y_{t-1}$
3. Obtain the estimates of a_0 and a_2 through OLS
4. Use the obtained estimates to detrend the y_t series as: $y_t^{\,d} = y_t - \hat{a}_0 - \hat{a}_2 t$
5. Using the detrended data, estimate the equation: $\Delta y^d{}_t = \gamma y^d{}_{t-1} + \varepsilon_t$

   In the case of serial correlation, the augmented form is given as:

   $$\Delta y^d{}_t = \gamma y^d{}_{t-1} + \sum_{i=1}^{p} c_i \Delta y_{t-i}{}^d + \varepsilon_t$$
6. The null hypothesis can be rejected if information from critical values indicates that $\gamma \neq 0$. Note that the critical values for the test depend on whether the trend term is included (Enders, 2015).

Akaike Information Criterion (AIC)

The appropriate ARDL models in terms of lag length were selected using the AIC criterion which incorporates the idea of imposing a penalty on adding regressors to improve the fit of a model (Gujarati, 2004).

The AIC is defined as:

$$\text{AIC} = e^{2k/n}\frac{\sum \hat{u}_i^{\,2}}{n} = e^{2k/n}\frac{\text{RSS}}{n}$$

where k is the number of regressors including the intercept and n is the number of observations and RSS is the Residual Sum of Squares.

For mathematical simplicity, a transformation of natural logarithms can be applied as:

$$\ln \text{AIC} = \left(\frac{2k}{n}\right) + \ln\left(\frac{\text{RSS}}{n}\right)$$

The model with the lowest AIC value is then selected as the optimal model for estimation.

Bounds test

This approach tests for the existence of level relationships between the dependent variable and the set of dynamic regressors through the following hypotheses:

H_0 : No long run relationship exists between the dependent variable and set of regressors

H_1 : A long run relationship exists between the dependent variable and set of regressors

The approach is conducted by the following procedure:

1. The following unconditional ECM is estimated:

$$\Delta y_t = c_0 + \pi_{yy} y_{t-1} + \pi_{yxx} x_{t-1} + \sum_{i=1}^{p-1} \psi_i{}' \Delta z_{t-i} + \omega' \Delta x_t + u_t$$

   where π is the long-run multiplier matrix[15].

[15] This case considers unrestricted intercepts with no trends (case III). The trend term was found to be insignificant.

2. The significance of the lagged levels of the variables is investigated through the F statistic computed as:

$$F \equiv \frac{\hat{\pi}^{*}{}'_{y.x}\, \widetilde{Z}^{*}{}'_{-1}\, \overline{P}_{\Delta\widetilde{Z}_{-}}\, \widetilde{Z}^{*}{}_{-1} \hat{\pi}^{*}{}_{y.x} / \hat{\omega}_{uu}}{k+2}$$

Where $\hat{\pi}^{*}{}_{y.x}$ is the least squares estimator for $\pi^{*}{}_{y.x}$ given as:

$$\hat{\pi}^{*}{}_{y.x} \equiv (\widetilde{Z}^{*}{}'_{-1}\, \overline{P}_{\Delta\widetilde{Z}_{-}}\, \widetilde{Z}^{*}{}_{-1})^{-1} \widetilde{Z}^{*}{}'_{-1}\, \overline{P}_{\Delta\widetilde{Z}_{-}}\, \Delta\widetilde{y} \quad \text{and} \quad \pi^{*}{}_{y.x} = \begin{pmatrix} -\gamma' \\ I_{k+1} \end{pmatrix} \begin{pmatrix} \pi_{yy} \\ \pi'_{yx.x} \end{pmatrix}$$

3. The computed test statistic is tested against two sets of asymptotic critical values which on one hand assume that are regressors are I(0) or mutually cointegrated and that all regressors are I(1) on the other hand.
4. The two sets of critical values form the I(0) bound and the I(1) bound at various levels of significance for which the decision rules are to reject H_0 If the F statistic falls beyond the I(1) bound, fail to reject H_0 if it falls below the I(0) bound and to render the test inconclusive if it falls in between the bounds (Pesaran et al., 2001).

Overall significance

The overall significance of the regression models used was examined by employing the F Test through the following hypotheses:

H_0 : All slope coefficients are simultaneously equal to zero

H_1 : Not all slope coefficients are simultaneously equal to zero

The test is conducted in the following steps:

1. Compute the F statistic as:

$$F = \frac{\text{ESS}/(\text{k} - 1)}{\text{TSS}/(\text{n} - \text{K})}$$

The test statistic follows an F distribution with $k - 1$ numerator degrees of freedom and $n - K$ denominator degrees of freedom. ESS is the Explained Sum of Squares while TSS is the Total Sum of Squares.

2. Reject H_0 if $F > F_\alpha(k-1, n-K)$ where $F_\alpha(k-1, n-K)$ is the critical F value at the chosen level of significance α (Gujarati, 2004).

Bayer-Hanck combined cointegration test

This approach to testing for cointegration provides a meta test providing an unambiguous result in place where individual test results may provide conflicting results (Bayer & Hanck, 2013). The test is made on the following hypotheses:

H_0 : There is no cointegrating relationship among the variables

H_1 : There is at least one cointegrating relationship among the variables

The test is carried out in the following steps:

1. Compute the Engle and Granger (1987) t-statistic by first obtaining residuals $\hat{\mu}_t$ from the regression of y_t on x_t then run the regression $\Delta\hat{\mu}_t = \gamma\hat{\mu}_{t-1} + \sum_{p=1}^{p-1} v_p \Delta\hat{\mu}_{t-p} + \varepsilon_t$ then obtain the t-statistic t_γ^{ADF} on γ.
2. Compute the Johansen (1988) test statistic by first estimating the following VECM:

   $\Delta z_t = \pi z_{t-1} + \sum_{p=1}^{p-1} \Gamma_p \Delta z_{t-p} + d_t + \varepsilon_t$ then obtain the $\lambda_{\max}(h) = -T\ln(1-\hat{\pi}_1)$ test statistic
3. Estimate the following model by OLS:

$$\Delta y_t = d_t + \pi_{0x}'\Delta x_t + \varphi_0 y_{t-1} + \varphi_1' x_{t-1} + \sum_{p=1}^{p}(\pi_{px}\Delta x_{t-p} + \pi_{py}\Delta y_{t-p}) + \varepsilon_t$$

The Banerjee et al. (1998) test statistic t_{γ}^{ECR} is the t-ratio for H0: $\varphi_0 = 0$ while the Boswijk (1994) $\hat{F}$ Wald statistic H0: $(\varphi_0, \varphi_1')' = 0$.

4. Letting t_i be the test statistic for test i $\xi_i : t_i(-\xi_i = t_i)$. The joint test for ξ_i can be constructed with a suitable aggregator given by Fischer's χ^2 statistic (Fischer, 1932) given as: $\tilde{\chi}_{\mathrm{I}} = -2\sum_{i \in \mathrm{I}} \ln(p_i)$.
5. The Fischer statistic was applied to combine Engle and Granger and Johansen statistics as well as Engle and Granger, Johansen, Banerjee et al. and Boswijk statistics separately.
6. Where the combined test statistic is found to be significant, the series are found to be cointegrated.

Granger non-causality test

The test involves verifying whether the lags of one variable enter into the equation of another variable. If so, the former variable improves the forecasting performance of the latter or that the former variable granger causes the latter. Considering two series x_t and y_t, the test involves the following hypotheses:

H0 : x_t does not granger cause y_t

H1 : x_t granger causes y_t

The following are the steps for conducting the test:

1. Regress Δy_t on lagged Δy terms as:

$$\Delta y_t = A + \sum_{j=1}^{p} c_j \Delta Y_{t-j} + u_{1t}$$

2. Obtain the RSS from this restricted model (RSS_R)

3. Regress Δy_t on lagged Δy terms plus lagged Δx terms as:

$$\Delta y_t = A_1 + \sum_{j=1}^{p} c_j \Delta Y_{t-j} + \sum_{j=1}^{p} D_j \Delta X_{t-j} + u_{1t}$$

4. Obtain the RSS from this unrestricted model (RSS_{UR}).
5. Calculate the F statistic for the normal Wald test on coefficient restrictions given by: $F = \frac{(RSS_R - RSS_{UR})/p}{RSS_U/(N-k)}$

   where N is the number of observations and $k = 2p + 1$ is the number of estimated coefficients in the unrestricted model.
6. If the computed F value exceed the critical F value, reject the null hypothesis and conclude that x_t granger causes y_t (Binh, 2013).
7. The joint short and long run granger causality is obtained by including the Error Correction Term in the Wald test for multiple restrictions.

Breusch-Godfrey Test

This method was used to test for autocorrelation of all orders through the following hypotheses:

H_0 : Error terms are not autocorrelated

H_1 : Error terms are autocorrelated

The test is carried out in the following steps:

1. Run a model and obtain its residuals
2. Regress $\hat{\mu}^2$ on $x_{t1}, x_{t2}, ..., x_{tk}; \hat{u}_{t-1}, \hat{u}_{t-2}, ..., \hat{u}_{t-q}$ for all $t = (q+1), \dots, n$ and obtain the R^2.
3. Letting the obtained R^2 be ${R_{\hat{\mu}}}^2$, form the Lagrange Multiplier statistic as:

$$LM = (n - q)\, {R_{\hat{\mu}}}^2$$

The LM statistic is asymptotically distributed by a chi-square distribution with q degrees of freedom.

4. Test the significance of the LM statistic against ${\chi_k}^2$critical values.
5. If the LM statistic is significant, we conclude that the error variances exhibit heteroskedasticity (Wooldridge, 2015)

Breusch-Pagan-Godfrey Test

This method was used to test for heteroskedasticity through the following hypotheses:

H_0 : The error variances are homoskedastic

H_1 : The error variances are heteroskedastic

The following sequence is followed to conduct the test:

1. Run a model and obtain its residuals
2. Obtain the R^2 from the following model:

   $\hat{\mu}^2 = \delta_0 + \delta_1 x_1 + \delta_2 x_2 + ... + \delta_k x_k + error$

3. Letting the obtained R^2 be ${R_{\hat{\mu}^2}}^2$, form the Lagrange Multiplier statistic as:

$$LM = n \cdot {R_{\hat{\mu}^2}}^2$$

4. Test the significance of the LM statistic against ${\chi_k}^2$critical values.
5. If the LM statistic is significant, we conclude that there's autocorrelation (Wooldridge, 2015).

Jarque-Bera (JB) normality test

This test involves determining whether residuals are normally distributed.

From measures of skewness and kurtosis, a normal distribution is symmetric and mesokurtic which corresponds to a skewness value of 0 and a kurtosis value of 3

(Gujarati, 2004). The test thus checks whether the observed values of skewness and kurtosis diverge from the norms of 0 and 3 respectively.

The test involves the following hypotheses:

H_0 : Residuals are normally distributed

H_1 : The distribution of residuals is nonnormal

The test is conducted in the following sequence:

1. Run a model and obtain its residuals
2. Compute the Jarque-Bera statistic as:

   $\text{JB} = n\left[\frac{S^2}{6} + \frac{(K-3)^2}{24}\right]$, where S is Skewness and K is Kurtosis

   The JB statistic follows a chi-square distribution with 2 degrees of freedom.
3. If the computed JB statistic is significant, we conclude that the residuals are not multivariate normal.

Regression Specification Error Test (RESET)

This is a residual-based general test for specification errors proposed by Ramsey (Gujarati, 2004). The test involves the following hypotheses:

H_0 : The estimated regression model is correctly specified

H_1 : The estimated regression model is mis-specified

The test is conducted in the following sequence:

1. Run a model and obtain its estimated Y_i (that is $\hat{Y}_i$).
2. Rerun the model introducing $\hat{Y}_i$ in some form as an additional regressor.
3. Letting the R^2 from the second model be $R^2{}_{new}$ and the one of the first model be $R^2{}_{old}$, we compute an F-statistic as follows:

$$F = \frac{(R^2{}_{new} - R^2{}_{old})/number\ of\ new\ regressors}{(1 - R^2{}_{new})/(n - number\ of\ parameters\ in\ the\ new\ model)}$$

4. If the computed F value is significant, we conclude that the initial model is mis-specified.

CUSUM test

In this test, parameter stability is investigated by estimating the model recursively. The following hypotheses are tested:

H_0 : Parameters are stable over time

H_1 : Parameters are not stable over time

The procedure for conducting the test is as follows:

1. Estimate the model using the first few observations and plot the coefficients.
2. Repeat the estimations while adding more observations until they are exhausted.
3. Create a one-step-ahead forecast error at every step using all observations.
4. If the model fits the data well, the forecasts should be unbiased so that the sum of the forecast errors should not be too far from zero.
5. The cumulative sum is given as:

$$CUSUM_N = \sum_{i=n}^{N} e_i(1)/\sigma_e \quad N=n,\ldots,T-1$$

   Where n is the date the forecast error was constructed, T is the date of the last observation in the data set and σ_e is the estimated standard deviation of the forecast errors.

6. Using the 5% significance level, the plot value of each value of $CUSUM_N$ should lie within a band of approximately $\pm 0.948[(T-n)^{0.5} + 2(N-n)(T-n)^{-0.5}]$ otherwise, the parameters are unstable (Enders, 2015)