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Growth Convergence Across Countries and Regions in the Long Run: An Empirical Study Using Panel Analysis (1980-2018)

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(1980-2018)

BY

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DECLARATION

I hereby declare that this dissertation is the result of my original work undertaken by me under the guidance of my supervisor; and that this dissertation has neither been submitted in part or whole for a degree elsewhere, except for the references to the works of other people which have been duly cited.

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ABSTRACT

With the emergence of new superpowers, the changing landscape of the global economy, and the heterogeneity of growth experiences being discovered in recent times, the concept of growth convergence must be revisited. This study examines whether developing countries are catching up with the advanced countries in terms of their per capita income. The study uses a panel analysis of 69 countries over a period of 39 years spanning from 1980 to 2018 to test for growth convergence (both absolute and conditional) among countries based on the Augmented Solow model. The countries were further divided into three regions namely, Europe, Asia, and Sub-Saharan Africa. The results show no evidence of absolute convergence indicating a lack of progress in closing the income gap between the developed and developing countries. However, there is strong evidence of the presence of conditional convergence across countries and within regions after controlling for investment, population growth, and human capital. This suggests that countries with similar characteristics tend to converge in per capita income in the long run. As a result, poor countries can be made to converge to prosperity if they could adopt or attain the socio-economic structures and productivity levels in rich countries. The results also show that macroeconomic variables increase the rate of convergence in growth rates of income.

Keywords: growth convergence, global economy, absolute convergence, conditional convergence, income gap, catch up.

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CHAPTER ONE

1.0 INTRODUCTION

1.1 Background to the Study

About three hundred years ago, about 1750, the industrial insurgency occurred in England and income started to upsurge. The revolution spread among European countries, the US, Canada, Australia, and New Zealand, and for two hundred years economic growth was continued and increased in these areas. The cause of this development was technology, science, communication, institutions, and governance. This rise in income affected the lives of around 15 percent of the people in the world (Spence, 2011). Outside this sphere, the other states remained less developed, hence, great divergence occurred. The average per capita income gap between industrial and less developed countries between the early 1800s and 1950, rose from a factor of 3 or 4 to a factor of 20 or more (Johnson & Papageorgiou, 2018).

Nevertheless, after World War II, this divergence slowed as a new pace of growth began in emerging states. Initially, it was not immense, and it only occurred in some isolated states, however, after some time, it spread to other countries. Additionally, the growth rate became even better, 7 percent, compared to developed countries that were around 2 percent through those 200 years. It appears that after two-hundred years of what has come to be called "the great divergence" (Pomeranz, 2001), convergence was gradually taking place. This wave of potential catching up behavior was however not universal as during the same period, there was dismal growth experienced by a group of poor fragile states as a result of the outbreak of wars and political unrest. Hence, lots of questions were asked concerning economic growth among countries.

A lot of the studies were directed to finding answers to questions such as: What accounts for the differences in growth rates across countries? What determines growth? What is the global

distribution of income across countries? among several others. Popular among these studies was the Solow Model of Economic Growth, which provided deep insights into the causes of growth and brought into the limelight the concept of convergence in growth rates across countries.

The "convergence" hypothesis simply states that the initial conditions of a country have no implications on its long-run per capita income because poor countries will tend to grow faster than the rich and eventually catch up with them, causing disparities in income levels across countries to decline over time. Thus, in the long-run, countries will converge to a common level of income per capita.

Testing of this hypothesis empirically became prominent in the mid-eighties and nineties with the emergence of modern growth theory, as it was an important part of unlocking the mechanics of economic growth. These seminal studies [Solow (1956), Abramovitz (1986), Baumol (1986), Barro and Sala-i-Martin (1992)] resulted in very broad and interesting conclusions on growth and income convergence among countries. Some of the studies argued that developed countries tend to converge in terms of per capita income, but the world as a whole does not. Others argued that countries with a low to medium-high level of development show signs of convergence, but countries with a medium-high to a very high level of development show signs of divergence. Again, some studies argued that convergence in income per capita across countries cannot occur in an absolute sense, but rather conditional on several factors. These inconsistencies in the literature necessitate the need for further studies.

Additionally, with the emergence of new superpowers, the changing landscape of the global economy, and the heterogeneity of growth experiences being discovered in recent times, the concept of growth convergence must be revisited. This study, therefore, seeks to examine whether

poor countries tend to catch up with the rich in terms of per capita income by building upon previous empirical studies using more contemporary data spanning the period from 1980 to 2018.

1.2 Research Questions

The study seeks to find answers to the following questions:

- Is there convergence in growth rates of income per capita across countries?
- Is the convergence in income levels absolute or conditional?
- What factors account for the convergence in growth rates?
- Do institutional variables like corruption and political stability play a role in the convergence process?
- Have developing countries made progress in closing the income gap between their per capita income and those of the developed countries?

1.3 Objectives of the Study

The major objective of this study is to test empirically the existence of the convergence hypothesis among countries by using recent data and selected countries in Europe, Asia, and Sub Saharan Africa. Based on the research questions, the study seeks to achieve specifically the following objectives:

- To test empirically the existence of the convergence hypothesis among countries with a focus on β-convergence hypothesis
- To identify the main factors of the convergence process
- To examine the role of corruption and democracy in the convergence process especially in Sub-Sahara Africa
- It is also hoped that the findings of this study will be used to suggest measures that might help reduce the differences in income per capita among countries

1.4 Hypothesis

The hypotheses to be tested for this study based on the general objectives are:

H_0: There is absolute convergence in GDP per capita across countries and within regions

H_1: There is no absolute convergence in GDP per capita across countries and within regions

H_0 : There exists conditional convergence in GDP per capita across countries and within regions

H_1 : There is no conditional convergence in GDP per capita across countries and within regions

1.5 Justification of the Study

There has been a vast and worthwhile empirical literature on the convergence hypothesis following the seminal work of Baumol (1986). While his seminal studies supported the idea of absolute convergence among rich countries, subsequent studies document the presence of conditional convergence and reject the null hypothesis of absolute convergence. Different methodologies and datasets have been employed by many researchers to test the convergence hypothesis but the results have been mixed. While the concept appears to be strongly rejected by some data sets, it is also accepted by others. These inconsistencies in the literature necessitate the need for further studies.

Also, most of the empirical studies on the convergence hypothesis date to the mid-eighties and nineties. There have been a lot of changes in the global economy since then, with the emergence of new superpowers and heterogeneity of growth experiences. Therefore, an empirical study using a more contemporary data could share more light on the hypothesis in recent times.

Again, not much has been done in examining the role of institutional variables in the convergence hypothesis. This study includes variables such as corruption, democracy, and political stability in the analysis.

The study also builds upon previous empirical studies by extending the dataset to 2018, and finally, the findings of the study will contribute to the existing body of knowledge on the subject matter.

1.6 Organization of the Study

The study is in five sections. Chapter one introduces the background to the study. Chapter two analyzes the theoretical basis and some empirical studies on the convergence hypothesis identified in the literature. Chapter three describes the dataset and model specifications. Chapter four discusses the result of the empirical analysis. Finally, Chapter five summarizes the findings and concludes with recommendations.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Introduction

This chapter deals with the review of relevant literature for the study. It is divided into four sections. The first section contains a theoretical perspective on the convergence hypothesis. The second section presents some concepts of convergence This is followed by a highlight of the factors of growth convergence, and finally, the last section deals with a review of the empirical studies of the concept of convergence.

2.2 Theoretical Perspectives on Convergence

2.2.1 The Solow Model of Economic Growth

The starting point of most of today's growth models is the neoclassical model of Solow (1956). Solow's model of growth is based on the assumptions of constant return to scale, diminishing marginal productivity of capital, substitutability of capital and labor, and technological progress which is exogenously determined. The model highlights savings, investment, population growth, and new technology as important determinants of economic growth.

The model established the basic framework for the discussion of issues of growth and convergence. It outlined the dynamics of growth by distinguishing between two types of growth: Catching up growth and Cutting-edge growth. It argues that a country can grow much faster when it's catching up as opposed to when its already at the cutting-edge.

The model argues that there exists a balanced growth path known as the steady-state equilibrium for every economy. And a country's growth rate depends on its initial position to this steady-state equilibrium. The further away a country is from the steady-state income, the faster will be the growth of income levels and vice versa. Thus, the growth rate of income per capita is negatively

related to the initial level of income. This proposition is based on the assumption of diminishing marginal returns of capital, which states that output increases less than proportionately with each additional unit of capital stock. Because developed countries are capital-abundant, and have reached or nearing their steady-state, any attempt to increase the stock of capital will yield returns lower than the cost. As a result, as the marginal product of capital starts diminishing in these countries, the accumulation of capital should come to a stop and be transferred to countries with low capital stocks whose marginal returns to capital is still increasing so that rich countries' growth will slow, allowing poorer countries to catch up. Thus, the Solow model suggests that the rate of return on capital is lower in countries with a higher ratio of capital per worker than those with low capital-labor ratio. As a result, capital should flow from rich countries to poor ones. This effect will continue until the rates of return balance out in the two countries leading to convergence. The Solow model, therefore, predicts that economies who have reached their steady-states will ultimately converge to the same level of income in the long run regardless of their initial conditions.

Specifically, the basic Solow model describes growth as a function of capital(K), labor(L), and level of technology(A). If we assume a Cobb-Douglas production function, production at time *t* becomes:

$$Y(t) = K(t)^{\alpha}(A(t)L(t))^{1-\alpha} \qquad 0 < \alpha < 1, \qquad (1)$$

Where *Y* is output, *K* is capital, *L* is labor, and *A* is the level of technology.

The model takes the rates of savings, population growth, and technological progress as exogenous. Hence, *L* and *A* grow at rates *n* and *g* defined at period *t* by:

$$L(t) = L(0)e^{nt} \qquad (2) \qquad A(t) = A(0)e^{gt} \qquad (3)$$

Equation 2 and 3 suggest that effective labor ***A(t)L(t)*** grows at ***n + g,*** and output(Y) is only an increasing function of capital(K) stock. The model also assumes that a constant fraction of output, ***s,*** that is not consumed is invested. If ***k*** is defined as the stock of capital per effective worker, ***k*** = K/AL, and ***y*** as the level of output per effective worker, ***y*** = Y/AL, then, the rate of change in capital per effective worker can be given as:

$$\dot{k}(t) = sy(t) - (n + g + \delta)k(t) = sk(t)^{\alpha} - (n + g + \delta)k(t), \qquad (4)$$

where $sy(t)$ is the level of investment in the economy, and $(n + g + \delta)k(t)$ is the rate of growth of population and depreciation. Equation (4) implies that as long as the level of investment in a country exceeds the rate of depreciation and population growth, a country will increase its capital stock accumulation until *k* converges to the steady-state $\boldsymbol{k}^*$ where investment is just enough to replace existing or old capital. The steady-state capital is defined by:

$$k^* = [\frac{s}{n+g+\delta}]^{1/(1-\alpha)} \qquad (5)$$

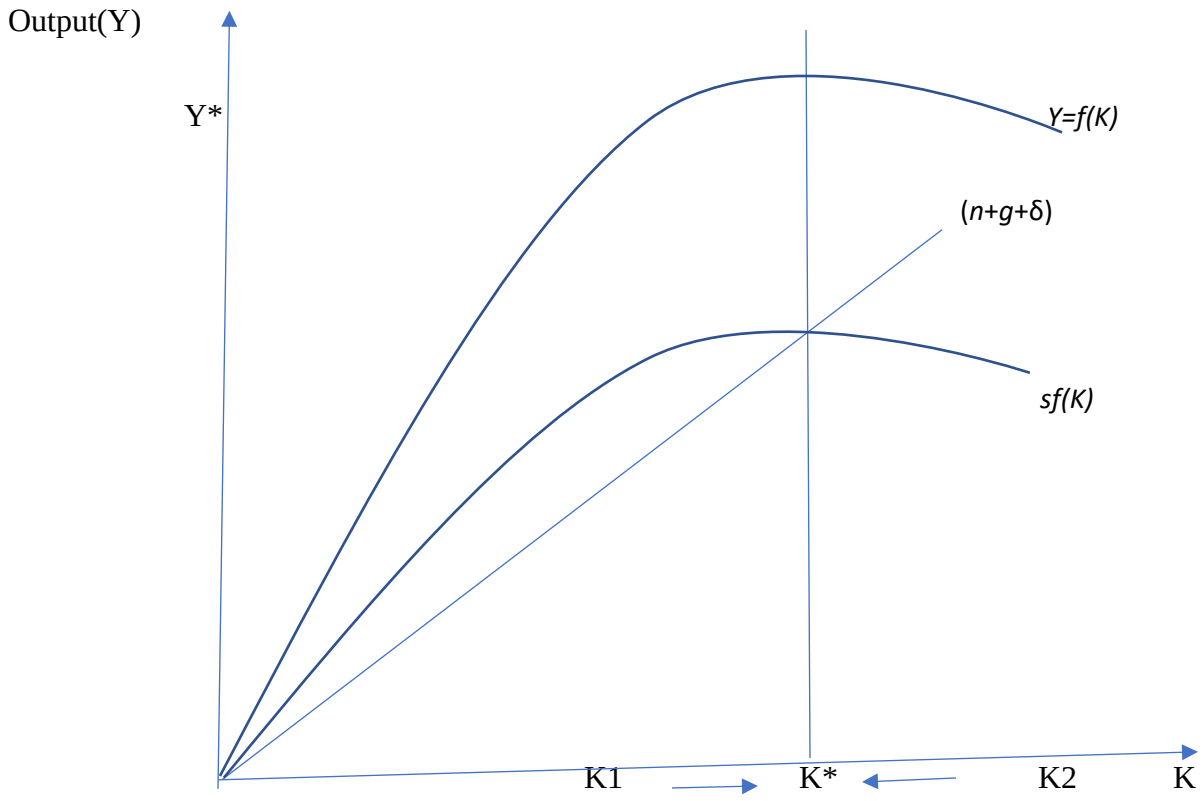
Equation (5) implies that the steady-state level of capital per effective worker is positively related to the rate of saving, and negatively related to the rate of population growth. At this steady-state, the level of investment is equal to the rate of depreciation and there is no new capital being created since capital stock accumulation has reached its maximum. Also, since effective labor ***A(t)L(t)*** is assumed to be constant and output(Y) is an increasing function of capital stock, the steady-state level of capital, $\boldsymbol{k}^*$, determines the steady-state level of output.

Substituting (5) into the original production function and taking logs of both sides, the steady-state income per capita is given by:

$$\ln\left(\frac{Y(t)}{L(t)}\right) = \ln\big(A(0)\big) + gt + \frac{\alpha}{1-\alpha}\ln(s) - \frac{\alpha}{1-\alpha}\ln\,(n + g + \delta) \qquad (6)$$

Equation (6) implies that the steady-state level of per capita income is positively related to technological progress and investment, and negatively related to the rate of growth of population and depreciation. Thus, the Solow model predicts that countries will eventually converge to this steady-state level of per capita income determined by the steady-state level of capital in the long run.

The model is represented graphically below:



Output increases with the stock of capital but does so at a diminishing rate. This implies the marginal product of capital diminishes as K increases. If investment exceeds depreciation (K1), the capital stock will increase until it reaches the steady-state level, K*, where $sf(K) = (n+g+\delta)$. If depreciation exceeds investment, K2, the capital stock will decrease until it reaches the steady-

state level K*. Either way, countries move toward the steady-state This implies that at the steady-state, all investments are used to replace old or existing capital so there is no new capital being created and hence no growth. Thus, the steady-state level of capital stock determines the steady-state level of output. Countries will eventually converge to the same level of income.

2.2.2 The New Growth Model

Recent endogenous growth models that accept constant and increasing returns to capital have questioned the role of technological progress as a key driver of long-run economic growth. Proponents of these theories (Romer,1986; Lucas,1988; Grossman and Helpman, 1991; Aghion and Howitt,1992) argue that the introduction of factors such as new knowledge, human capital development, innovation, and externalities to capital, will induce self-sustained economic growth. They argue that private returns to capital may be diminishing but social returns can be constant or increasing leading to knowledge spillovers and other externalities that can induce growth. Romer's (1986) study, for instance, shows that without diminishing returns to capital, the growth rate of GDP per capita is dependent on the initial level of per capita income. Thus, endogenous growth models suggest that convergence is unlikely to occur when increasing returns and knowledge spillovers prevail, but rather divergence. This is because the growth of the developed economies at the steady-state will not be constant but determined by how fast new ideas are formed, and how much these ideas increase productivity. Divergence refers to higher-income countries maintaining a higher rate of economic growth compared to lower-income countries. Thus, inequalities increase over time (Artelaris et al. 2011).

2.3 Convergence Concepts

The concept of convergence has been analyzed from various aspects. The two most common classifications are δ-convergence and β- convergence. Perhaps the first question that comes to mind with regards to the evolution of the distribution of income per capita is whether the dispersion of this variable tends to decrease over time (De la Fuente, 2000). The concept of convergence implicit in this question is what Barro and Sala-i-Martin (1992) described as δ-convergence. It studies the dispersal of income at a given moment in time. If the dispersion of real per capita income across economies tends to fall over time, then sigma convergence is achieved. It is an indication of whether incomes are being equitably distributed across economies over time, and the one closest to the intuitive notion of convergence.

It is not, however, the only possible one. An important question that may also be asked is whether poor countries tend to catch up with the rich, or whether the relative position of each country within the income distribution tend to stabilize over time. These questions correspond with the concepts of absolute and conditional β- convergence proposed by Barro and Sala-i-Martin. Absolute β-convergence is the tendency for a given selection of countries or regions in a sample to converge to the same income per capita. It assumes that the countries are homogenous and are characterized by the same steady-state. They differ only in their initial level of per capita income. Initially, poor economies will tend to grow faster and catch up with the rich, and as a result, will all converge to the same level of income per capita in the long run. This does not mean that inequalities will disappear completely because countries are not structurally identical, and there will be random shocks with uneven effects on the different countries. Such disturbances, however, will have only transitory effects, implying that, in the long run, we should observe a reshuffling in which the relative positions of the different countries change rapidly.

Conditional β-convergence, on the other hand, accepts that there are differences in economic conditions amongst countries. For instance, countries differ in the levels of technology, attitudes towards saving, tax rates, etc., and will, therefore, converge towards different steady-states. Thus, with conditional β-convergence, countries or regions will converge towards its steady-state which can be very different from each other. As a result, income disparities could persist even in the long run and there would also be high persistence in the relative positions of the different economies.

Although there exists a sharp contrast between absolute and conditional β-convergence in principle, it is not much clear in practice. In empirical convergence equations, it is common to find several variables other than initial income suggesting that steady states differ across countries or regions. This implies that convergence is only conditional. However, these conditioning variables change over time and often tend to converge themselves across countries or regions. Hence, income may still converge in absolute terms in the long run, and this convergence may reflect in part the gradual equalization of the underlying fundamentals. Estimation of absolute and conditional β-convergence under this circumstance will yield different results of the convergence rate. There is, however, no contradiction between these estimates once we recognize that the estimates are measuring different things. While the absolute convergence estimate measures the overall intensity of a process of income convergence which may work in part through changes over time in various structural characteristics, the conditional convergence parameter captures the speed at which the economy would be approaching a "pseudo-steady-state " whose location is determined by the current values of the conditioning variables (De la Fuente, 2000).

It is also important to note that, the three concepts of convergence although related are far from being equivalent. From a superficial point of view, one might think that absolute β-convergence implies decreasing dispersion and vice versa. However, this might not be the case since the world

is not deterministic, but stochastic (Haider at al., 2010). Some type of β-convergence is considered only a necessary but not sufficient condition for δ-convergence (Barro and Sala-i-Martin, 1992). This is because over time some reshuffling among the countries is always taking place, and this implies that there will always be some random shocks. In this way β-convergence may be observed at the same time as there is no δ-convergence; in fact, β-convergence may be consistent with δ-divergence (i.e. when the rich grow faster than the poor). Hence, it is inaccurate to conclude that β-convergence implies δ-convergence without further investigation.

2.4 Factors of Growth Convergence

The first and necessary condition for convergence in growth is the existence of diminishing returns to reproducible capital (De la Fuente, 2000). This assumption implies that output grows less than proportionately with the accumulation of capital, indicating a decrease in the marginal productivity of capital. As a result, more developed countries that are capital-abundant will experience lower returns to investment, reducing both the incentive to save and the contribution to the growth of a given volume of investment, and thereby, creates a tendency for growth to slow down over time. In contrast, poor countries have low capital to labor ratios and hence have high marginal products of capital. As capital investment spreads to these countries, high growth rates are experienced. Hence, poor countries will tend to grow faster than the rich, and consequently, convergence will occur.

A second factor to consider, according to De la Fuente (2000), in the convergence mechanism is the determinants of technological progress. Countries may differ in the intensity of their efforts to generate or adopt new technologies, which may result in differences in their long-term growth rates. These differences across countries in rates of technological investment would however not be sustainable as there would be a tendency towards the gradual equalization of technical

efficiency levels due to the assumption of diminishing marginal productivity of capital. It is however argued whether the accumulation of knowledge should be subject to the law of diminishing returns. If the cost of additional innovations falls with scientific or production experience, for instance, the return on technological investment may not be a decreasing function of the stock of accumulated knowledge, and cross-country differences in levels of technological effort could persist indefinitely. This suggests that technological progress could be an important divergence factor.

Nevertheless, technical progress can also be an important convergence factor. Many authors have signaled that the public good properties of technical knowledge have an international dimension that tends to favor less advanced countries, provided they can absorb foreign technologies and adapt them to their own needs (De la Fuente,2000). This is because it is easier to adopt technology than to invent it. Hence, less developed countries will not have to reinvent each wheel, but acting as followers, will be in a better position to grow quicker than the technological leader, who will have to assume the costs and lags associated with the development of new leading-edge technologies. The resulting process of technological catch up could contribute significantly to convergence, particularly within the group of countries that can exploit the advantages derived from technological imitation.

The literature also identifies a third convergence mechanism in addition to decreasing returns and technological diffusion. This factor is featured less prominently in theoretical models but has great practical importance. This mechanism works through structural change or the reallocation of productive factors across sectors. Poorer countries and regions tend to have relatively large agricultural sectors. Given that output per worker is typically much lower in agriculture than in manufacturing or in the service sector, the flow of resources out of agriculture and into these other

activities tends to increase average productivity. Since this process, moreover, has generally been more intense in poor economies than in rich ones in the last few decades, it may have contributed significantly to the observed reduction in productivity differentials across territories.

Dervis (2012) also suggest globalization as a key factor contributing to the convergence process. According to him, globalization through strengthened trade links and increasing foreign direct investment expediates catch-up growth as emerging countries import and adopt know-how and technology of the developed countries. This he explained as a result of the easiness of adopting technology than inventing it.

2.4 Empirical Studies

There is a huge literature concerned with the empirical testing of the convergence hypothesis across countries. This empirical evidence is however mixed. The most frequently cited study is the one performed by Baumol (1986). His study test for growth convergence among a sample of 16 developed countries over the period 1870-1979 using Maddison's data. Baumol found a significant negative correlation between initial levels of productivity and productivity growth. His findings supported the existence of absolute β-convergence. However, in another research (Baumol et al., 1994) when the sample was extended to include less developed countries, there was no evidence of convergence. The interesting conclusion reached by the two studies was that countries with similar economic, political, and social environments appear to converge with each other, while the world as a whole does not.

Baumol's finding was confirmed by Barro and Sala-i-Martin (1992) in their study of convergence across the 48 U.S states. Using data on personal income and state gross product over a long-term period, about a century, they found clear evidence of convergence among the states. They argued, however, that their result can be reconciled with the neoclassical model only if diminishing returns

to capital set in very slowly. Also, Barro and Sala-i-Martin found evidence of conditional convergence when they extended their study to a broad cross-section of countries and included human capital into their econometric model.

Besides the neoclassical framework of economic growth, new growth theories for which technology is endogenously determined have tried to investigate the convergence hypothesis by including variables such as human capital, innovation, and public infrastructure. The diffusion of technology through foreign trade and foreign direct investment has also been greatly emphasized. For instance, the empirical study by Mankiw, Romer, and Weil (1992) used the endogenous growth model to assess the convergence hypothesis. Using data spanning the period from 1960 to 1985 in 121 countries, and the human-capital-augmented Solow growth model, the study finds evidence of conditional convergence. Their result indicates that countries converge at about the same rate (2% per annum) as predicted by the Solow model when population growth and capital accumulation are held constant.

Miller and Upadhyay (2002) empirically analyze the endogenous growth model. They take a sample of rich and poor countries and estimate total factor productivity with and without the stock of human capital. Using cross-section and time-series data, absolute and conditional convergence of total factor productivity and real GDP per worker was tested. Their study finds evidence of both absolute and conditional convergence of total factor productivity for the whole sample, but only conditional convergence of real GDP per worker.

Varblane and Vahter (2005) analyzed the process of economic convergence of transition countries during the period 1995–2004 in Europe. They compare the relative income level of these countries with the EU-15 level, and among themselves. The results show the existence of absolute β-convergence across the transition economies. A reduction in the dispersion of income levels

between the accession countries was also observed indicating the existence of δ-convergence. The study also showed that the transition countries' levels of real per capita GDP have converged towards the EU-15 level at a comparatively high speed than with the previous entrants into the EU (Ireland, Greece, Spain, and Portugal).

Another study by Borys et al (2008) in Europe focused on real convergence and its determinants in the EU candidate and potential candidate countries. Their study revealed that total factor productivity growth has been the main driver of convergence, followed by capital deepening, whereas labor has contributed only considerably to economic growth. There was evidence of conditional convergence in the transition countries of central, eastern, and south-eastern Europe. More specifically, controlling for the quality of institutions, the extent of market reforms and macroeconomic policies, the study finds a significant and negative link between the initial level of GDP and subsequent growth.

Regarding Asian economies, Haider et al. (2010) empirically examined whether income convergence is occurring over time in South Asian economies. Additionally, the study also compares the convergence results of South Asian economies with its parallel East Asian region within the Asian block. The empirical analysis tests for absolute convergence (using beta and sigma convergence methodologies as well as Theil's inequality-based approach) and conditional convergence by taking into consideration relevant control variables. Their result shows no evidence to accept the null hypothesis of the existence of absolute income convergence. However, it reveals the presence of conditional income convergence for both East and South Asian economies. It indicated that the income gap between these two groups of economies had narrowed down based on some common characteristics, but it remains quite large.

Another research by Chowdhury and Malik (2007) examined the time series cross-country output convergence in eleven countries of East Asia and the Pacific. They modeled the Stochastic Unit Root process for cross-country output differences. Their results show that there is no convergence in the large samples of the countries but there is evidence of convergence in the small sample groups of countries.

Johnson & Papageorgiou (2018) also analyzed the record of cross-country growth over the past 50 years and asked if emerging countries have made advancement in closing the income gap between their per capita incomes and those in the developed economies. They concluded that, as a group, they have not based on a survey of the literature on absolute convergence with emphasis on the last decade. The literature supported their findings of a lack of improvement in closing the income gap between countries. They closed with a brief examination of the recent literature on the cross-individual distribution of income which finds that, regardless of the lack of progress on cross country convergence, global inequality has tended to fall since 2000.

The empirical study by Artelaris et al. (2011) uses quadratic weighted least squares regression analysis to study convergence patterns in the world economy. Their result indicates that countries with a low to medium-high level of development show convergence, however, countries with a medium-high to a very high level of development show divergence. Thus, convergence and divergence co-exist but at different rates and with different strengths. The forces of divergence, however, dominate after a certain threshold and further increases in the world development gap, which have serious implications for theory and policy.

In the case of Africa, Wahiba (2015) focused on the study of conditional convergence hypothesis among African countries that belonged to the West African Economic and Monetary Union (WAEMU). His paper investigated the effect of convergence, stability, and growth pact on the

convergence dynamics, by considering control variables comprising the share of investment in gross domestic product, the enrolment, and the opening ratio. The study revealed that these variables contribute to the revival of economic growth in the region.

Another study on developing economies was conducted by Dufrenot et al (2009). Relying upon recent econometric methodologies (nonstationary long-memory models, wavelet models, and time-varying factor representation models) and data spanning from 1950 to 2005, their study found no evidence of absolute convergence. Their study revealed that that the transition paths to long-run growth were persistent over time and non-stationary, thereby yielding a variety of potential growth steady states (conditional convergence). Their findings do not back the idea according to which the emerging countries share a common factor (such as technology) that eliminates growth divergence in the very long run. Instead, they conclude that growth is an idiosyncratic phenomenon that yields different forms of transitional economic performance: growth tragedy (some countries with an initial low level of per capita income diverge from the richest ones), growth resistance (with many countries experiencing a low speed of growth convergence), and rapid convergence.

In addition to the above, Quah (1993); Linden (2000); Amplatz (2003); Liberto and Symons (2003); in investigating the convergence hypothesis documents the presence of absolute convergence, while conditional convergence is estimated by Islam (1995); Murthy and Ukpolob (1999); Caselli et al. (1996); and Lee (2005). Devkota and Upadhyay (2008); Dobson and Ramlogan (2002), on the other hand, find evidence of both absolute and conditional convergence.

As it can be observed from the above-reviewed literature, the empirical evidence on convergence is mixed. While some studies provide evidence of absolute convergence, others support the conditional convergence hypothesis. There is however considerable agreement in the literature with regards to conditional convergence than absolute convergence. Other studies also reveal that

while some countries (developed economies) show signs of convergence, others (developing economies) show signs of divergence. These mixed results have raised very important questions that are paramount to human welfare and hence necessitate the need for further studies using more recent data.

This study aims to test whether poorer countries tend to catch up with the rich in terms of per capita income by using more contemporary data. Thus, the main focus will be on β-convergence. The study will build upon previous surveys by extending the data to 2018. In particular, the study will carry out a panel analysis of 69 countries over the period 1980-2018, to evaluate whether there is empirical evidence of the β-convergence hypothesis.

CHAPTER THREE

3.0 METHODOLOGY

3.1 Introduction

This section presents an overview of the sample size, data, and variables used in this research effort. It also set outs the empirical model used in examining the concept of β-convergence, thus both absolute and conditional. The first section describes the sample and the data sources for all the variables of interest. The next section contains the model specification which sets out the models to be used for the estimation. This is followed by a description of the various variables and the a priori expectations. The section ends with the econometric techniques adopted in estimating the various models and highlights from the table of summary statistics.

3.2 Sample and Data

The study makes use of a sample of 69 countries with annual data covering the period between 1980 to 2018. The selected countries are based on the availability of data and the sample is further divided into three sub-regions namely, Europe, Asia, and Sub-Sahara Africa. The reason for this division is to be able to test for conditional convergence in each of these regions since countries within these groups share similar initial conditions and structural characteristics. The data used in the analysis are obtained from the World Bank Development Indicators (WDI, 2019), Transparency International, Polity V, and Penn World Table 9 databases. The selected countries are presented in the appendix.

3.3 Model Specification

The model is based on the Solow model of growth but augmented with human capital. This is because of the emphasis placed on human capital as an important driver of growth by endogenous growth models. Including human capital modifies the original production function in equation (1) to become:

$$Y(t) = K(t)^{\alpha} H(t)^{\beta} \big(A(t)L(t)\big)^{1-\alpha-\beta} \qquad 0 < \alpha, \beta < 1 \qquad (7)$$

Where H is the stock of human capital, and $\alpha + \beta < 1$, signifying decreasing returns to capital.

Given that the model makes the same assumptions as before, the constant fraction of output, ***s***, which is invested in capital stock is split into two, with s_K representing the fraction invested in physical capital, and s_H the fraction invested in human capital. The evolution of both physical and human capital is given as:

$$\dot{k}(t) = s_K y(t) - (n + g + \delta)k(t) \qquad (8)$$

$$\dot{h}(t) = s_H y(t) - (n + g + \delta)h(t) \qquad (9)$$

Assuming that the same level of depreciation and production function applies to both physical and human capital, the economy converges to a stable steady-state given as:

$$k^* = \left[\frac{{s_K}^{1-\beta} {s_H}^{\beta}}{n+g+\delta}\right]^{1/(1-\alpha-\beta)} \qquad (10) \qquad\qquad h^* = \left[\frac{{s_K}^{\alpha} {s_H}^{1-\alpha}}{n+g+\delta}\right]^{1/(1-\alpha-\beta)} \qquad (11)$$

Substituting equations (10) and (11) into the original production function and taking logs gives a steady-state per capita income defined by:

$$\ln\left(\frac{Y(t)}{L(t)}\right) = \ln\big(A(0)\big) + gt + \frac{\alpha}{1-\alpha-\beta}\ln(s_K) + \frac{\beta}{1-\alpha-\beta}\ln(s_H) - \frac{\alpha+\beta}{1-\alpha-\beta}\ln(n + g + \delta) \qquad (12)$$

Modifying equation (12) to express the growth rate of per capita income over time, the model for the regression analysis becomes:

$$\ln(y(t)) - \ln(y(0)) = (1 - e^{-\lambda t})\frac{\alpha}{1-\alpha-\beta}\ln(s_K) + (1 - e^{-\lambda t})\frac{\beta}{1-\alpha-\beta}\ln(s_H)$$
$$-(1 - e^{-\lambda t})\frac{\alpha+\beta}{1-\alpha-\beta}\ln(n+g+\delta) - (1 - e^{-\lambda t})\ln(y(0)),$$

This implies that the growth rate of per capita income is a positive function of the level of investment in physical and human capital, and a negative function of the rate of population growth, depreciation, and initial level of income.

A vast of the literature make use of real GDP per capita growth as the dependent variable to measure growth rate and GDP per capita as the explanatory variable to proxy for initial income when estimating growth convergence. These variables are however correlated since per capita GDP growth rate is derived directly from per capita GDP. This study, therefore, modifies the dependent variable by using a more standardized measure of growth as employed by Haider et al. (2010) in their estimation of β-convergence in South Asian economies. The growth of per capita GDP across countries, which is used as the dependent variable is computed as:

$$g_{it} = \frac{1}{T}\log\left(\frac{y_{it}}{y_{io}}\right)$$

Where T represents the duration of the period (39 years), y_{it} is the per capita GDP across *i* at time *t*, y_{io} is the initial per capita GDP across *i* at time *t*=0, *i* represents the various countries and *t* is the current year. Since this analysis cover the period from 1980-2018, y_{io} is the per capita GDP in 1980, which is used as the initial year (*t*=0). The variable g_{it} is used as a proxy for

growth and is believed to be a more standardized measure that minimizes the correlation problem as compared to the annual growth rate of per capita GDP.

Several determinants have been used in the empirical literature in analyzing growth. A few of the relevant variables have been identified from the literature and employed in this analysis. Thus, following the pioneers of economic growth theory and findings of previous empirical studies (Solow, 1956; Romer,1986; Lucas,1988; Barro,1991; Grossman and Helpman,1991; Aghion and Howitt,1992; Baumol et al., 1994; Sala-i-Martin,1995), the functional form of the model is expressed as:

g_{it} = f ($GDP\ per\ capita, Savings, Technology, Population\ growth, Human\ capitial, Gov't\ expenditure, Trade\ openness, Foreign\ Direct\ Investment, Democracy, corruption$)

The model is specified by estimating the following equations:

Absolute Convergence

$g_{it} = \alpha + \beta_1 \ln y_{io} + \varepsilon_{it}$

Conditional Convergence

$g_{it} = \alpha + \beta_1 lny_{i0} + \beta_2 lnSAV_{it} + \beta_3 \ln (n + g + \delta)_{it} + \beta_4 lnHC_{it} + \varepsilon_{it}$ ..... *Primary Model*

$g_{it} = \alpha + \beta_1 lny_{i0} + \beta_2 lnSAV_{it} + \beta_3 \ln (n + g + \delta)_{it} + \beta_4 lnHC_{it} + \beta_5 lnTrade_{it} + \beta_6 lnFDI_{it} + \beta_7 lnGov'tExp_{it} + \beta_8 lnINFL_{it} + \beta_9 Democracy_{it} + \beta_{10} Corruption_{it} + \varepsilon_{it}$ .....*Secondary Model*

Where g_{it} is the average growth rate of per capita GDP, lny_{i0} is the log of the initial income per person in 1980, $lnSAV_{it}$ is the log of gross domestic savings (% of GDP), $\ln (n + g + \delta)_{it}$ represents population growth rate, rate of growth of technology, and rate of depreciation

respectively, $lnHC_{it}$ is the log of human capital stock, $lnTrade_{it}$ is the log of trade openness (% of GDP), $lnFDI_{it}$ is Foreign direct investment inflows (% of GDP), $lnGov'tExp_{it}$ represents Government expenditure (% of GDP), $lnINFL_{it}$ is the inflation rate, $Democracy_{it}$ is Democracy, and $Corruption_{it}$ is Corruption index, α is the intercept, β_j (j=1, 2,….,10) is the respective coefficients of the independent variables, and ε_{it} is a random error term. The subscript i represents the various countries, whereas t indicates the time. The study seeks to estimate both absolute and conditional β-convergence using the above models.

3.4 Variable Description and Priori Expectations

- **Economic Growth**

As it is standard in the literature, GDP is used as a proxy for the economic performance of a country. It reflects the measure of the value of all final goods and services produced in a country in a period, usually one year. GDP per capita in constant 2010 US dollars is used in this analysis rather than GDP corrected for Purchasing Power Parity (PPP) due to the ease of data acquisition. However, for the dependent variable, the average growth rate of GDP per capita is used. The average growth rate of GDP per capita over 39 years is used to capture economic growth as shown in the computation above.

- **GDP per capita**

GDP per capita is used to measure the economic well-being of the people within the country. It is calculated by dividing the gross domestic product of a country by its population. This measure is deemed appropriate because it eliminates any possible black-market bias and reflects the true value of prosperity within a country. GDP per capita is used as a proxy of the initial conditions of a country. In this sample, the GDP per capita in 1980 is used as the original position of a country and will help to determine the growth path of the economy over the sample period. The use of this

variable allows us to correct for the initial economic position, which could play a role in terms of the growth path of the country. It is hypothesized to have a negative relationship with the growth rate. A significant negative impact implies the existence of growth convergence. The data for GDP per capita is obtained from the World Bank Database.

- **Gross Domestic Savings**

Gross domestic savings consists of savings of households, firms, and the government realized throughout the year in a country. It is calculated as GDP less final consumption expenditure. Both neoclassical and endogenous growth models identify savings and investment as important variables that have a significant impact on economic growth. It is assumed that any savings are allocated to investment. As a result, gross domestic savings as a percentage of GDP is used as a proxy for investment in this study. Using this variable eliminates any international influence and thus, makes it a good measure of the investment level of a country. Higher savings generate more revenue for investment, and thus, a positive relationship is expected between domestic savings and economic growth.

- **Population Growth**

This refers to the annual growth rate of a country's population. It is calculated as the change in a country's population by deducting the previous year's population from the current population, expressed as a percentage. The average population growth is used in this analysis and a negative relationship is expected to exist between population growth and economic growth. The Solow model considers technological progress and depreciation together with population growth $(n + g + \delta)$ and as such these variables are also considered. Technological growth and depreciation are usually estimated to be 7.5% or 5% in the economic literature. However, in this analysis 5% will

be used as was done by Mankiw et al. (1992). The estimation is directly added to the population growth figure to make the analysis easier.

- **Human Capital**

Endogenous growth models emphasize the contribution of human capital to growth. They argue that human capital, new knowledge, and innovation can induce self-sustained growth, hence its inclusion in the model. The human capital index based on years of schooling and the returns to education is used in this analysis. The data was obtained from the Penn World Table. It is expected to have a positive impact on growth as the acquisition of new knowledge leads to innovation and propels growth.

- **Trade Openness**

The ratio of trade (imports + exports) to GDP is used often in the literature as a measure of the openness of an economy, although other measures exist. The larger the volume of the sum of imports to exports as a percentage of GDP the more open is the country. Studies have shown that trade openness is an important variable which significantly influences economic growth. It is a measure of the ease with which a country trades with other countries. From empirical literature, market liberalization tends to be positively associated with growth as multinational corporations usually prefer to locate in countries with the more open economy since trade restrictions generally imply higher transaction costs. A priori, a positive relationship is expected between trade openness and growth.

- **Foreign Direct Investment (FDI)**

These are foreign investments by foreign companies or individuals in the domestic country. It can be in the form of either establishing business operations or acquiring business assets in the domestic country. Foreign direct investment is believed to be the most important type of capital movement, which stimulates additional investment in both human and physical capital. However, a certain precondition of economic position needs to exist in the host country to attract these investments. For instance, the existence of a certain level of human capital to absorb new technologies, some level of political and economic security, among others. The study makes use of net inflows of FDI expressed as a percentage of GDP. Several empirical works of literature have affirmed a significant positive relationship between FDI and economic growth. Higher FDI implies a higher inflow of resources which leads to higher levels of output and growth. I, therefore, expect a positive a priori relationship. The data is obtained from WDI.

- **Government Expenditure**

The effect of government expenditure on growth is ambiguous in the literature. While some studies provide evidence of a positive effect, others present a negative effect. It is used as a control variable to check the robustness of the model. Its main purpose is to show if at all, government spending influences economic growth and affects convergence. The data is extracted from the World Bank database and measures the general government final consumption expenditure on goods and services expressed as a percentage of GDP. Karras (2001) argues that the impact of government activities on growth depends mainly on the net productivity effect and the size effect. Low government consumption can increase the productive effect of private spending which can stimulate growth. On the other hand, high levels of government consumption may affect growth

negatively by reducing the economic activity of the private sector. A priori, either a positive or negative relationship is expected to exist between government expenditure and economic growth.

- **Inflation Rate**

Inflation can be described as a persistent rise in the prices of goods and services. It reflects the annual percentage change in the cost to the average consumer of acquiring a basket of goods and services. From the literature, the relationship between inflation and growth is ambiguous. While some studies argue that inflation hurts growth through its negative direct effect on capital accumulation, others point out that inflation may have a positive effect on growth through an increase in the cost of holding money, that is related to higher investment and growth. The debate about the precise relationship between these two variables is still ongoing, however, it is generally accepted that inflation hurts medium and long-term growth. Studies by Borys et al. (2008), and Bassanini et al. (2001), establish a negative relationship between inflation and growth. In contrast, Tobin (1965) found a positive association. The inflation rate is measured by the annual growth rate of the GDP implicit deflator and it is extracted from the WDI database.

- **Corruption**

This variable is included in the model to account for the institutional effect on economic growth. Corruption is measured using the transparency, accountability, and corruption in the public sector rating index from Transparency International. It is measured on a scale 0f 0-100, where 0 means that a country is perceived to be highly corrupt, and 100 means it is perceived to be very clean. This index is however adjusted to an original index of 100 so that an increase in the index (from 0-100) can be interpreted directly as an increase in the level of corruption. It is hypothesized to be negatively associated with economic growth.

- **Democracy**

Another institutional variable captured in the model is democracy. It refers to a political system in which there is a rule of law, systems of checks and balances, and freedom of the press. It is used as a control variable to check the robustness of the model and to show the extent if at all, democracy impacts economic growth and affect convergence. Polity is used as an indicator for democracy and it is obtained from the Polity V dataset from Centre for Systemic Peace. It provides a single regime score that ranges from +10 to -10, after considering both autocratic and democratic characteristics of a state. +10 implies a state is fully democratic, and -10 means full autocracy. A dummy variable representing democracy is used with autocracy as the reference category. A positive relationship is expected to exist between democracy and growth.

3.5 Estimation Strategy

The techniques of panel data estimation are used for this empirical analysis because the data consists of several cross-sectional units surveyed over time. Since the study focuses on growth convergence among countries over time, this regression technique is deemed appropriate as it covers more observations and enables us to study the dynamics of change. The panel estimation technique is preferred because it has larger degrees of freedom and minimizes the bias that might result from aggregating individuals into broad categories. It can also better detect and measure effects that cannot be simply observed by time series or cross-section regression models. Panel analysis also allows us to study more complicated behavioral models and reduces multicollinearity leading to improved efficiency of econometric analysis (Gujarati, 2004).

There are three ways of estimating panel data models. The simplest approach is the Pooled Ordinary Least Squares (OLS). This approach assumes that all countries are the same and clumps them together disregarding their heterogeneities by just estimating the OLS regression. This

method has been criticized to be naïve since it makes very highly restricted assumptions that may misrepresent the true nature of the relationship between the dependant and the explanatory variables.

To take into account the specific heterogeneities across the countries, either the Fixed Effect (FE) or the Random Effect (RE) approach can be applied. The Fixed Effect approach accepts that there are special characteristics of each country which set them apart from other countries. These differences could be structural, geographic, economic, or may even be unobservable characteristics. However, this approach assumes that some of these heterogeneities do not vary over time and need to be eliminated to obtain consistent parameters. Thus, the FE controls for the time-invariant variables by treating unobserved country-specific heterogeneities to be correlated with the explanatory variables. It does so by mean-differencing the average of each variable from its original observation. This eliminates the country-specific heterogeneities and provides more consistent estimators. The FE approach is used when a researcher is only interested in analyzing the impact of variables that vary over time.

The Random Effect (RE) approach, on the other hand, acknowledges that there are country-specific heterogeneities but assumes that these heterogeneities are not correlated with the explanatory variables. Rather, the unobserved heterogeneity is assumed to be random and captured in the composite error term. When these underlying assumptions are satisfied, then the RE is efficient. Otherwise, the FE should be used. Whereas FE is applied to fully demeaned data, RE is applied to partially demeaned data. This enables relevant explanatory variables that are constant over time to be retained in the model.

For this study, however, the FE approach cannot be employed due to the nature of the data used in the analysis. The estimation makes use of GDP per capita in 1980 as a measure of the initial

conditions of a country. This variable is constant over the years and time-invariant. Thus, using FE omits the variable completely through mean differencing, and hence cannot be employed in this analysis.

Consequently, the Breusch and Pagan Lagrangian Multiplier (LM) test is conducted to choose between the Pooled OLS and the Random Effect. The null hypothesis says that there are no significant differences across individual units, i.e. the variances across countries are zero, suggesting that the pooled OLS is appropriate. If the null hypothesis is rejected, it follows that the random effect is appropriate for the estimation. In this study, the null hypothesis was rejected for all the estimated models at 1% with a p-value of 0.000, and this suggests that the RE model is preferred to the Pooled OLS. The results are presented in the appendix.

The first model is specified to determine whether there is absolute β-convergence across the full sample and the three regions. The second model is estimated to assess the existence of conditional convergence using the primary variables in the human capital augmented Solow model. The third model control for other variables that have been identified in the literature to influence growth (trade openness, foreign direct investment, government expenditure, inflation, corruption, and democracy), and test for conditional convergence across the full sample, and the regions. The regression results are based on a sample of 69 countries over a period of 39 years ranging from 1980 to 2018. The Random Effect and the Pooled OLS estimation techniques are adopted for all the models. However, the Breusch and Pagan Lagrangian Multiplier (LM) test favored the random effect technique, so the results that are interpreted are the estimates of the random effects. All regressions are run using the STATA statistical package.

3.6 Summary Statistics

This section presents a summary of the descriptive statistics of the variables of interest in the sample. The data covers the period from 1980 to 2018.

Table 3: Descriptive Statistics 1980-2018 (Full Sample)

	(1)	(2)	(3)	(4)	(5)
Variable	**mean**	**Standard deviation**	**minimum**	**maximum**	**observation**
GDPGR	0.005	0.018	-0.1234	0.0796	2679
GDPPC	14642.50	19504.34	207.01	92077.60	2679
DSAV	20.226	14.723	-53.1103	88.40	2624
n +g + δ	1.857	1.198	-6.7162	8.17	2691
HC	2.225	0.755	1.0142	3.97	2508
TOPEN	74.509	56.048	6.3203	442.62	2647
FDI	2.845	6.109	-37.1548	86.61	2567
GOVEXP	15.381	6.434	0.0910	73.58	2618
INFL	24.532	528.771	-31.9047	26765.90	2673
DEMOC	3.18	6.81	-9	10	2486
CORRUPT	48.13	25.11	0	96	1045

The table above provides a summary statistic of the variables for countries in the sample. Over the period, per capita GDP growth averaged 0.005% with a standard deviation of 0.018. The minimum growth rate of -0.123% was recorded in India in 1980. This negative growth could be attributed to a build-up of external debt caused by real exchange rate depreciation and nominal devaluation at the time. The maximum growth of 0.079% was recorded in China, the world's largest economy, manufacturer, and merchandise trader in 2018. GDP per capita averaged US$14,642.50 within the period with a standard deviation of US$19,504.34. The lowest value of US$207 was recorded by Rwanda in 1994, and the highest value of US$92,077.60 was recorded by Norway in 2018. Domestic savings averaged 20.23% of GDP with a standard deviation of 14.72. The lowest value recorded was -53.11% by Togo in 2014. This negative value was largely due to the decline in the overall efficiency of the banking sector during this period. The maximum value of domestic

savings was 88.40% recorded by Nigeria in 1981. Population growth, technological progress, and rate of depreciation averaged 1.85% and a standard deviation of 1.20 was observed. The minimum and maximum values within the period were -6.72% and 8.17% recorded by Rwanda in 1993 and 1998 respectively.

The fifth row displays the mean value of the human capital index to be 2.23, with a standard deviation of 0.76, and minimum and maximum values of 1.01 and 3.97 recorded by Burkina Faso in 1980 and Singapore in 2017 respectively. Trade openness as a percentage of GDP averaged 74.50% with a standard deviation of 56.05. The minimum value over the period was 6.32% recorded by Ghana in 1982, and the maximum value was 442.62% recorded by Hong Kong in 2013. The Hong Kong economy experienced rapid export growth most especially in the services sector during the period and hence explains the high value for openness. Foreign direct investment had a mean value of 2.85% and a standard deviation of 6.10 over the period. It was lowest in Mongolia in 2016 with a value of -37.15%. This negative value was due to the decline in commodity prices as a result of the global economic slowdown and policy missteps such as the Adoption of Law on the Regulation of Foreign Investment in Entities operating in Strategic Sectors in 2012. FDI was highest in the Netherlands in 2007 with a value of 86.61% resulting from their liberal policy towards foreign investment. Particularly, in 2007, the Dutch government lowered the corporate tax for international companies well below the EU average and became the first destination for FDI in Europe.

The eighth row shows that on average government expenditure as a percentage of GDP was about 15.41%, with variability of 6.41%. The minimum value over the period was 0.091% recorded by Nigeria in 1996, and the maximum value was 73.58% recorded by Togo in 2014. It can be observed from the ninth row that inflation is highly volatile over the sample period with a mean value of

24.53% and a standard deviation of 528.77%. The lowest value of -31.90% was recorded by Brunei Darussalam in 1986, and this was caused by a combination of sharply lower petroleum prices in world markets and voluntary production cuts in Brunei. The maximum value of 26,745.90% was recorded by the Democratic Republic of Congo in 1994. This outrageous value was attributed in part to the collapse of the Soviet Union and heightened demands for democratic reforms, continued currency depreciation, and the outbreak of civil conflicts in the early 1990s.

Democracy has a mean value of 3.18 and a standard deviation of 6.80 which suggests low levels of democracy on average in the selected sample. The lowest value recorded is -9.00 in the Philippines (1980), Cote d'Ivoire in (1981), Guinea (1982), and Zambia (1988). The maximum value of 10.00 was recorded in European countries like Austria, Belgium, Denmark, Finland, and Germany. Corruption also averaged 48.13 over the period with a variability of 25.11. The minimum value of 0 was recorded in Finland (2000) and Denmark (1999), and the highest value of 96 was recorded in Bangladesh in 2001.

3.7 Some Trends in Growth across Countries

Over the last half-century, the world has experienced unprecedented economic growth. The period between 1960 to 2014, witnessed an increase in average GDP per capita across the globe from US$4,155 to US$13,368, implying an average annual growth of 4 percent (Johnson & Papageorgiou, 2018). This growth has however been uneven across countries and different periods. These heterogeneities have been defined as a feature of modern growth experiences. The table below shows the differences in the average growth rate in GDP per capita across geographical regions for 39 years.

Table 1: Heterogeneities in Average Growth Rate of Per Capita GDP Across Regions (1980-2018)

Geographical Region	1980	1990	2000	2010	2018
Europe	1.90	2.27	3.79	1.05	1.89
Asia	0.38	3.88	4.08	6.38	3.50
Sub-Saharan Africa	-0.14	-0.57	0.50	3.33	1.86
Full Sample	0.58	1.39	2.35	3.58	2.30

Source: Author's Computations based on WDI dataset

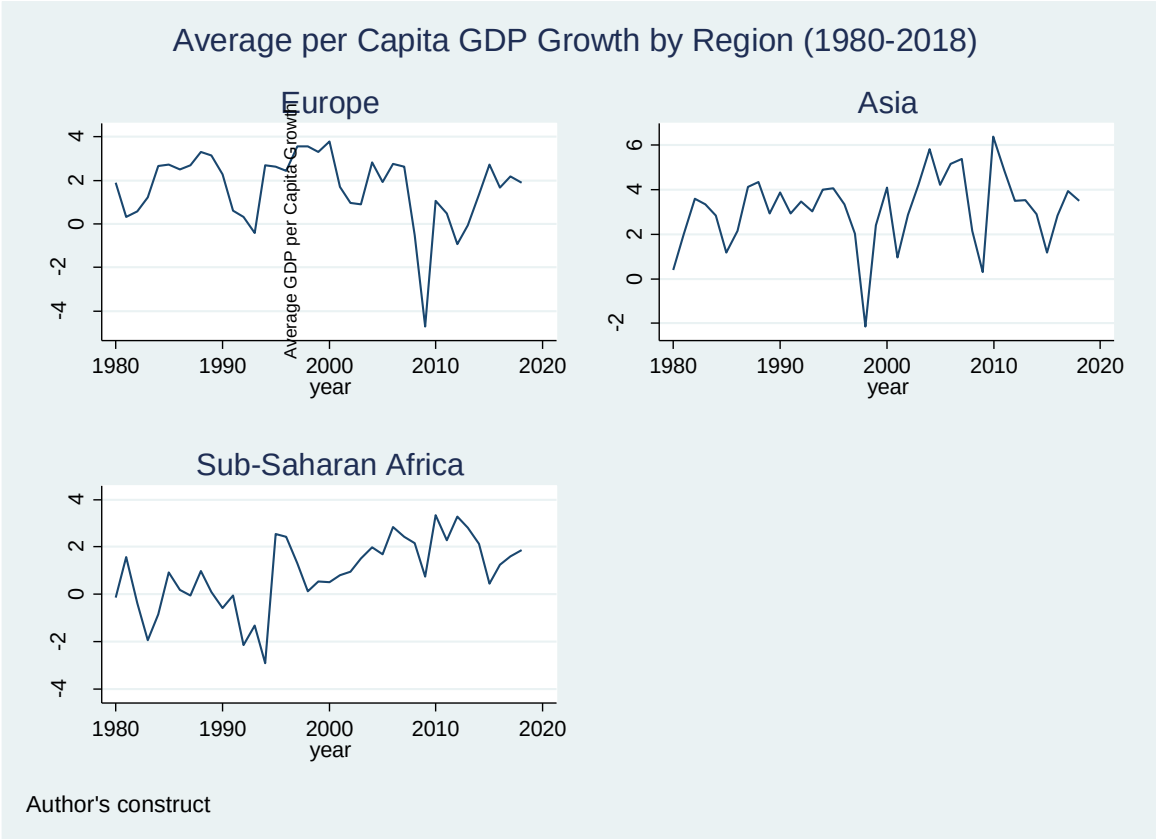
The table reports the average growth rate in Europe, Asia, and Sub-Saharan Africa in decades from the period between 1980 to 2018. Growth rates were generally low in all the three regions in 1980 due to the great depression that occurred during this time. Europe recorded an average growth of 1.90%, while Asia and Sub-Saharan Africa recorded growth rates of 0.38% and -0.14% respectively. Sub-Saharan Africa experienced the greatest decline with growth falling into the negative territory. The regions, however, began to recover in the 1990s and 2000s except for Sub-Saharan Africa where growth was still very low. For Asia, growth was relatively high after 1980 but decelerated in the latter part of 1990. This was followed by a dramatic bounce back in 2000, during which it was the fastest-growing region, recording an annual growth of 4.08 percent, something only seen previously in Europe. After very dismal performances in the previous two decades, Sub-Saharan Africa witnessed a notable bounce back in the 2000s recording an average growth rate of 3.33%. This strong performance by some African countries generated optimistic views among some economists (see Miguel, 2009; Radelet, 2010), while others argued that the experience was as a result of the sharp rise in commodity prices.

Overall, growth has been quite stable in Europe between 1980-2018 hovering around 2%. This constant growth is an indication that most of the countries in this region have reached or nearing their steady-state equilibrium. Asia has experienced a tremendous rise in its growth rates over the

years with a growth rate of about 4% in recent times which is higher than that of Europe. SSA has also, made progress in its growth rates, and is almost at par with the rate of growth in Europe in recent times. This suggests that there is some progress being made by developing economies to catch up with the advanced countries.

Figure 1 illustrates regional progress from 1980 to 2018 with Asia showing remarkable improvements in per capita GDP.

Figure 1



Author's construct

Figure 1 plots the average growth rate of GDP per capita for Europe, Asia, and Sub- Saharan Africa. Between 1980 to 1990, the average growth rate of per capita GDP was positive ranging between 0.5% to 3.5% in Europe, while that of Asia was between 0.5% to 4.0%. Sub-Saharan

Africa, on the other hand, experienced a declining growth in per capita GDP ranging from -0.3% to 1.8% which is far below that of Europe and Asia. Growth began to decline drastically in Asia in the late 1990s reaching the negative territory but picked up after 2000 with the growth rate reaching as high as 6%. Europe's growth rate hovered within the same range from 0.5% to about 4% after the 1990s through to the early 2000s, and Sub-Saharan Africa also began to recover, recording positive growth in GDP per capita from -3% to 2.2% between 1995 to the early part of 2000. The average growth in GDP per capita deteriorated drastically across the globe in 2008/2009 due to the financial crisis. The impact was most felt in Europe as average growth of GDP per capita reached the negative (about -4.2%), which was the lowest compared to Asia and Sub-Saharan Africa where growth declined to about -2% and -3% respectively. Average per capita GDP growth started rising after 2010 across the three regions, with higher growth rates in Asia, followed by Europe, and then Sub-Saharan Africa. This was followed by a slowdown in Asia and SSA between 2012-2015, but this trend was reversed after 2015 where growth started to rise again and have been quite stable across the regions.

CHAPTER FOUR

4.0 EMPIRICAL RESULTS AND DISCUSSION

4.1 Introduction

This chapter presents the results obtained from the estimation of the models specified in chapter three and a discussion and interpretation of the results.

4.2 Results and Discussions

4.2.1 Absolute Convergence (model one)

This estimation results test for absolute convergence across the full sample, as well as the three regions. It presents the relationship between the growth rate of GDP per worker and the initial level of per capita GDP. The results are presented below.

Table 2: Absolute Convergence

	FULL SAMPLE		EUROPE		ASIA		SSA	
Variables	Pooled OLS	Random Effect	Pooled OLS	Random Effect	Pooled OLS	Random Effect	Pooled OLS	Random Effect
Lngdppc	-0.0007***	-0.0007	-0.003***	-0.0028	-0.0084***	-0.00834	0.00067*	0.00063
	(0.0003)	(0.0012)	(0.0007)	(0.0022)	(0.0008)	(0.0052)	(0.0003)	(0.0017)
Constant	0.0110***	0.0110	0.0372***	0.0372	0.0759***	0.0757**	-0.0032	-0.0028
	(0.00205)	(0.0097)	(0.0073)	(0.0229)	(0.0062)	(0.0375)	(0.0023)	(0.0115)
Observations	2,679	2,679	702	702	737	737	1,240	1,240
R-squared	0.005		0.024		0.206		0.003	
Number of countries		69		18		19		32

Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

The table shows little evidence of absolute convergence as has been found earlier in the literature (Romer, 1987). The coefficient of the log of initial GDP per capita is negative in most cases, except for SSA where it is positive, but not statistically significant. To accept the null hypothesis of the

existence of absolute β-convergence, the slope coefficient must be negative and significant. Although the first criterion is valid, which is an indication that the relative variation in GDP per capita is decreasing over time, due to the insignificance of the result, it can be concluded that there is no absolute convergence in per capita GDP over the entire sample period. Thus, there is no tendency for poor countries to grow faster than the rich countries hence the absolute convergence hypothesis does not hold. Similar results were obtained by Barro (1991), and Haider et al. (2010).

4.2.2 Conditional Convergence (Primary model)

Table 3: Conditional Convergence (Primary Model)

	Full Sample		Europe		Asia		SSA	
VARIABLES	Pooled OLS	RE	Pooled OLS	RE	Pooled OLS	RE	Pooled OLS	RE
Lngdppc	-0.0108***	-0.0092***	-0.0176***	-0.026***	-0.018***	-0.014***	-0.005***	-0.0041***
	(0.000626)	(0.00166)	(0.000654)	(0.00391)	(0.00080)	(0.00367)	(0.00041)	(0.00159)
Lnsav	0.0045***	0.0013***	0.0117***	0.0105***	0.0215***	0.00472*	0.0017***	0.000699*
	(0.000459)	(0.000486)	(0.000750)	(0.00284)	(0.00154)	(0.00245)	(0.000301)	(0.000409)
n +g + δ	-0.0017***	0.000769*	0.0020***	0.0013***	0.0062***	0.00116	-0.002***	0.000606
	(0.000373)	(0.000461)	(0.000319)	(0.00045)	(0.00095)	(0.00121)	(0.000662)	(0.000445)
Hc	0.0233***	0.0243***	0.0120***	0.0228***	0.0355***	0.0294***	0.0132***	0.0164***
	(0.00137)	(0.00209)	(0.000451)	(0.00150)	(0.00188)	(0.00481)	(0.000833)	(0.00268)
Constant	0.0323***	0.0204**	0.113***	0.165***	0.0142***	0.0337	0.0128***	-0.000357
	(0.00279)	(0.0100)	(0.00505)	(0.0360)	(0.00481)	(0.0237)	(0.00432)	(0.0105)
Observations	2,324	2,324	684	684	714	714	926	926
R-squared	0.493	0.468	0.613	0.536	0.709	0.641	0.335	0.294
Number of countries		66		18		19		29

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

The results indicate the existence of conditional convergence across the full sample, and in Europe, Asia, and Sub-Saharan Africa. The coefficients associated with the log of initial GDP per capita

are negative and statistically significant at 1% level. This implies that countries in these regions converge to their steady-state level of income. Hence, the conditional convergence hypothesis holds for the selected countries in the sample.

The results also show a positive and significant relationship between savings and growth of GDP per capita for the full sample and all the sub-regions. This is in line with the a priori expectation. The significance level is 1% for the full sample and in Europe, while that of Asia and SSA is at 10%. This implies that a 1% increase in savings will result in 0.0013%, 0.0105%, 0.00472%, and 0.000699% increase in growth of GDP per capita in the full sample, Europe, Asia, and SSA respectively, ceteris paribus.

The results indicate that human capital is a significant determinant of GDP per capita growth with a statistical significance of 1% across the three regions and the full sample. The relationship is positive, and it is in line with the a priori expectation. A 1% increase in human capital accumulation will result in 0.0243%, 0.0228%, 0.0294%, and 0.0164% increase in GDP per capita growth in the full sample, Europe, Asia, and SSA respectively, all other things being equal.

Population growth and technological progress ($n + g + \delta$) are found to be positive for all the regions and in the full sample. It is statistically significant at 10% and 1% in the full sample and in Europe respectively. It is however insignificant in Asia and Sub Saharan Africa. A priori a negative effect was expected but there is a large pool of theoretical and empirical evidence that supports the existence of a positive relationship between population and economic growth. Notably, Simon's view (Simon 1987) on the population supports this assertion. This view holds that the level of technology is enhanced by population growth. It also increases total demand and facilitates the division of labor which will lead to higher economic growth (Todaro and Smith, 2012). This could be a possible explanation for the positive relationship realized from the regression results.

The R-squared which indicates the fit of the model was considerably high in the full sample, and also in Europe and Asia, but a little low in SSA.

4.2.3 Conditional Convergence (Secondary Model)

This estimation results include other macroeconomic variables as well as some institutional variables that have been identified in the literature to have an impact on economic growth and hence influence convergence.

Table 4: Conditional Convergence (Secondary Model)

VARIABLES	Full Sample		Europe		Asia		SSA	
	Pooled OLS	RE	Pooled OLS	RE	Pooled OLS	RE	Pooled OLS	RE
Lngdppc	-0.0164***	-0.0115***	-0.0130***	-0.0148***	-0.0247***	-0.0208***	-0.0102***	-0.00575***
	(0.00105)	(0.00234)	(0.000891)	(0.00339)	(0.000720)	(0.00396)	(0.000962)	(0.00221)
Lnsav	0.0046***	0.000311	0.0074***	0.0065***	0.0148***	0.0109*	0.0032***	-4.55e-05
	(0.00124)	(0.000357)	(0.000976)	(0.00183)	(0.00194)	(0.00588)	(0.00112)	(0.000229)
n +g + δ	-0.0058***	0.000243	0.0030***	0.0013***	0.00110*	-0.000379	-0.0099***	-0.000813
	(0.000549)	(0.000495)	(0.000411)	(0.000354)	(0.000651)	(0.000670)	(0.00119)	(0.00138)
Hc	0.0188***	0.0230***	0.0067***	0.0097***	0.0277***	0.0262***	0.0104***	0.0206***
	(0.00132)	(0.00297)	(0.000783)	(0.00244)	(0.00191)	(0.00605)	(0.00143)	(0.00309)
Lntop	0.0032***	-0.000584	0.0013***	0.0030***	-0.000709	0.000192	-0.0061***	-0.00179
	(0.000868)	(0.00165)	(0.000419)	(0.00115)	(0.00124)	(0.00218)	(0.00146)	(0.00179)
Lnfdi	-8.60e-05	0.000213	0.00025**	0.000125	-0.0032***	-7.43e-05	0.0019***	0.000551***
	(0.000330)	(0.000141)	(0.000106)	(0.000105)	(0.000614)	(0.000551)	(0.000471)	(0.000190)
Lngovexp	0.0041***	-0.00175	0.0032***	0.0059***	0.0084***	-0.00421	0.00266**	7.16e-05
	(0.00139)	(0.00185)	(0.000688)	(0.00222)	(0.00217)	(0.00279)	(0.00103)	(0.00133)
Infl	-2.27e-05	1.05e-05	0.000173	0.000120	0.00030**	-3.61e-05	-2.00e-05	1.24e-05
	(5.33e-05)	(1.83e-05)	(0.000108)	(9.47e-05)	(0.000118)	(5.10e-05)	(4.60e-05)	(1.75e-05)
Democ	-0.0004***	3.65e-05	0.0011***	2.55e-05	-0.0006***	0.000218	0.0003***	0.000107
	(8.54e-05)	(5.93e-05)	(0.000270)	(0.000165)	(0.000169)	(0.000139)	(9.30e-05)	(8.64e-05)

Corrupt	-0.0004***	-0.0003***	2.14e-05	1.29e-05	-0.0008***	-0.0005***	-9.45e-05	-0.000163***
	(4.76e-05)	(4.83e-05)	(1.50e-05)	(1.91e-05)	(5.59e-05)	(0.000107)	(6.91e-05)	(5.65e-05)
Constant	0.0951***	0.0654***	0.0718***	0.0797***	0.121***	0.111***	0.0965***	0.0255
	(0.00911)	(0.0159)	(0.00922)	(0.0301)	(0.0108)	(0.0289)	(0.0110)	(0.0212)
Observations	864	864	282	282	244	244	338	338
R-squared	0.685	0.569	0.748	0.637	0.937	0.877	0.579	0.390
Number of countries		61		17		16		28

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 4 shows that the inclusion of trade openness, foreign direct investment, government expenditure, inflation, democracy, and corruption increased the size of the coefficient of initial GDP per capita. This suggests that the variables increase the rate of convergence in growth rates across countries, although most of them were not significant individually.

The coefficients associated with the log of initial GDP per capita remains negative and statistically significant at 1% level in the full sample and across the three sub-regions. This confirms the presence of conditional convergence in the selected sample. Savings still maintained its positive and significant effect on the growth rate of GDP per capita in the full sample and across the regions (except for SSA). Population growth, depreciation, and rate of growth of technology ($n + g + \delta$) was positive and insignificant in Europe but insignificant and negative in Asia and SSA. The reason for this significant positive effect in Europe could be a result of the low rate of population growth coupled with the high rate of technological progress which increases labor productivity and hence growth in Europe.

Human capital was still positive and significant at 1% level in the full sample and across the three regions appearing as a robust driving force of growth. This is in line with the findings of Mankiw, Romer, and Weil (1992) who concluded that investment in human capital plays an important role

in the growth process, and countries that invest more in physical capital and education will tend to grow faster and eventually attain high levels of relative income. Trade openness was found to have a positive and statistically insignificant effect on growth in Europe, but not in Asia and SSA.

FDI was significant at a 1% level in SSA. More specifically, an increase of FDI by 1% in SSA, has a positive net effect on the growth of GDP per capita equal to 0.0006%, ceteris paribus. This confirms the stance of the neoclassical growth models that the flow of capital from the developed countries to the developing countries is a significant source of technology diffusion, and speeds up the rate of convergence. Government expenditure was only significant in Europe.

Democracy has a positive but insignificant effect on growth in the full sample and across the regions. This is not a surprising result, as it has often been found in literature, that democracy does not have a strong impact on growth. Thus, democracy in itself is not a determinant of growth, rather it is the effectiveness of institutions that are formed in a democracy. Therefore, it is possible to have a democracy, but if the level of institutions is low, economic growth is not likely to occur.

On the contrary, except for Europe, corruption has a negative and significant effect on growth in the full sample, Asia, and SSA. All things being equal, a decrease in corruption by one unit will result in an increase in growth of per capita GDP by 0.0003%, 0.0005%, and 0.0002% percentage points in the full sample, Asia, and SSA respectively. The result is in line with the a priori expectation and supports the hypothesis that a country that improves its standing on corruption will experience an increase in its GDP growth rate.

CHAPTER FIVE

5.0 SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

5.1 Introduction

This chapter presents a summary of the results obtained and discussed in the previous chapter. It also presents the conclusions and policy recommendations based on the results.

5.2 Summary

The study sought to test for the existence of absolute and conditional convergence in GDP per capita across countries focusing on three regions: Europe, Asia, and Sub-Saharan Africa. This was done with the help of a thorough literature review which helped identify some of the relevant factors of the convergence process. More specifically, the analysis examined the main factors of the convergence process by investigating the effect of a set of macroeconomic variables widely used in the growth literature, along with corruption and democracy to account for the possible institutional effect on growth. The analysis covered a sample of 69 countries with annual data spanning the period from 1980 to 2018. The human capital augmented Solow model was used as a basis for the estimation.

For the absolute convergence hypothesis, the study specified a model with the average growth rate of per capita GDP as the dependent variable and GDP per capita in 1980 as the explanatory variable. Concerning the conditional convergence hypothesis, the study specified two models. The first model was based on the Augmented Solow Model and captured growth rate of per capita GDP as the dependent variable and savings, population growth, depreciation rate, rate of technological progress, and human capital as the explanatory variables. The second model included macroeconomic variables such as trade openness, foreign direct investment, government expenditure, and inflation, which are widely used in growth literature. It also included corruption

and democracy to account for the possible institutional effect on growth. The models were estimated using the Random Effects estimation technique.

The findings provided no evidence of absolute convergence in the full sample as well as in the regions which are in line with the empirical literature. However, the results show strong evidence of the presence of conditional convergence across the regions and in the full sample. This implies that countries with similar characteristics tend to converge in per capita GDP in the long run.

Additional variables (trade openness, foreign direct investment, inflation, government expenditure, democracy, and corruption) were included in the model but did not show much significant impact on economic growth except for foreign direct investment and corruption. They were however useful as they increased the rate of convergence and checked the robustness of the results. The general results show that the Solow model is a good estimation of the convergence hypothesis. After controlling for variables that, according to the model, determine the steady-state, strong evidence of conditional convergence is found.

5.3 Conclusion

Based on the augmented Solow model, the study concludes that there is no absolute convergence in growth rate across the selected countries in the sample. Although, the disparities in per capita GDP have been declining over time, the changes have not been significant. Thus, poor countries are still struggling to catch up with developed countries.

The study, however, found strong evidence of conditional convergence in the entire sample and Europe, Asia, and Sub-Saharan Africa. Thus, the result shows that countries with similar technological progress, population growth, and capital accumulation tend to converge to the same level of income per capita in the long run. This suggests that countries grow towards different steady states based on specific country heterogeneities. Thus, each region converges to its steady-

state income. This, however, implies that a high degree of inequality could persist, even in the long run, since these steady-states can be very different from each other. In other words, rich economies will generally remain rich while the poor continue to lag. However, poor countries can be made to converge to prosperity if they could adopt or attain the productivity levels and socioeconomic structures found in rich countries.

Furthermore, the study confirms that savings(investment), and human capital influences growth positively across the regions and hence are significant factors of the convergence process. The Solow model predicts that higher levels of savings lead to higher investments which result in higher income at the steady-state. Investment in physical and human capital increases labor efficiency and productivity which propels economic growth and aids in the convergence of GDP per capita among countries.

Population growth is another important variable that impacts growth. The Solow model predicts that a higher rate of population growth will lead to a lower income per capita in the steady-state. This was seen in Asia and Sub-Saharan Africa, where the impact on growth was negative due to the high rates of population growth which supersedes the rate of technology in these regions.

The study also looked at several additional variables that have been known to impact economic growth in the literature. The results reveal that although the variables themselves may not have a significant impact on growth, they tend to increase the rate of convergence. FDI, for instance, had a significant positive impact on growth in SSA which confirms the stance of neoclassical growth models that the flow of capital from the developed countries to developing countries is a significant source of technology diffusion which will promote growth and speed up the convergence process.

Corruption which is another important variable of interest was found to be significant and impact growth negatively in Asia, and SSA. This coincides with the findings of Chapsa et al. (2015), who concluded that a country that improves its standing on corruption will experience an increase in its GDP growth rate.

5.4 Recommendations

Based on the findings of the study, the following recommendations are made

- Governments of developing countries should create a favorable domestic environment that promotes domestic savings and attracts foreign investors or multinational corporations to boost their level of investment.
- Developing economies should invest heavily in physical and human capital development as this will promote innovations, and technological advancement which induces growth and fuels the convergence process
- Governments of developing economies should ensure that public funds are made available for research and development, and measures are put in place to reward those who invest time and resources in creating new products to encourage more technological innovations.
- Developing economies should also endeavor to build strong institutions that make government officials accountable and minimize malpractices such as corruption which hampers growth. This will ensure that resources are channeled to ventures that promote growth
- It is also very important that developed economies assist poor countries to attain high levels of productivity through foreign direct investments to enable them to get access to more advanced technology and know-how to speed up their process of growth, and potential catch up.

5.5 Limitations of the Study

It is important to note that the rate of convergence in this study was low compared to the 2% that have been found in the literature. Therefore, some alterations could be made to the data to be able to draw more precise conclusions.

Also, other dimensions of convergence in GDP per capita (i.e. sigma convergence) were not considered in this study. Future research should investigate whether inequalities in per capita income have reduced over time within regions with the existence of conditional convergence.

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Appendix

The Breusch and Pagan Lagrangian Multiplier (LM) test for Random Effect

Absolute Convergence			
	Test Statistic	P-value	Null Hypothesis
Full Sample	35318.23	0.000	Var (u)=0
Europe Subsample	386.74	0.000	Var (u)=0
Asia Subsample	10033.60	0.000	Var (u)=0
SSA Subsample	10110.17	0.000	Var (u)=0
Conditional Convergence (Primary Model)			
Full Sample	30998.35	0.000	Var (u)=0
Europe Subsample	1747.38	0.000	Var (u)=0
Asia Subsample	8277.95	0.000	Var (u)=0
SSA Subsample	6881.72	0.000	Var (u)=0
Conditional Convergence (Secondary Model)			
Full Sample	5017.85	0.000	Var (u)=0
Europe Subsample	612.33	0.000	Var (u)=0
Asia Subsample	752.55	0.000	Var (u)=0
SSA Subsample	910.18	0.000	Var (u)=0

Table 2: Countries in the Sample

Europe	Asia	Sub-Sahara Africa
Austria	Bangladesh	Benin Botswana
Belgium	Brunei	Burkina Faso Burundi
Denmark	China	Cameroon Congo
Finland	Hong Kong	Democratic Republic
France	Indonesia	Congo Republic
Germany	India	Comoros Cote d'Ivoire
Greece	Iran	Egypt Gambia
Iceland	Israel	Ghana Guinea
Ireland	Japan	Guinea Bissau Kenya

Italy	Malaysia	Madagascar Mali
Netherlands	Macao	Malawi Mauritania
Norway	Mongolia	Mauritius Namibia
Portugal	Nepal	Niger Nigeria
Spain	Korea Republic	Rwanda Sierra Leone
Sweden	Pakistan	Senegal South Africa
Switzerland	Philippines	Sudan Togo
United Kingdom	Singapore	Uganda
United States	Sri Lanka	Zambia
	Thailand	Zimbabwe