THE IMPACT OF CLIMATE CHANGE ON THE ECONOMIC GROWTH IN AUSTRALIA, INDIA AND SOUTH AFRICA

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SEPTEMBER 2020

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A research project submitted in partial fulfillment of the requirement for the degree of

BACHELOR OF ECONOMICS(HONS)FINANCIAL ECONOMICS

UNIVERSITI TUNKU ABDUL RAHMAN

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DECLARATION

We hereby declare that:

(1) This undergraduate research project is the end result of our own work and that due acknowledgement has been given in the references to ALL sources of information be they printed, electronic, or personal.

(2) No portion of this research project has been submitted in support of any application for any other degree or qualification of this or any other university, or other institutes of learning.

(3) Equal contribution has been made by each group member in completing the research project.

(4) The word count of this research report is : 15,387

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Date : 30th September 2020

ACKNOWLEDGEMENT

We would like to grab the opportunity to extend our utmost gratitude and appreciation towards those who have made the completion of this project possible. We are sincerely thankful to the parties who have rendered their fruitful ideas, insights, guidance, advice and feedback during the course of our project.

First and foremost, we applaud our research supervisor, Ms. Chitrah Devi from the Department of Economics, who has assumed a great deal of responsibility by being our beacon of guidance throughout this project. We praise her for imparting her pearls of wisdom and wise thoughts and feedbacks to us. Her esteemed support has enabled us to thrive in turbulent times of our research. If it was not for her, our research would not have seen the light of day.

Without a doubt, we are also immensely thankful to our families and friends for their sheer love and support. A token of appreciation also goes to the parties who have directly or indirectly conveyed their unrelenting support in one way or another during the development of our research. The infinite support and love from all these parties will forever remain treasured in the core of our hearts and memory.

DEDICATION

We would like to dedicate this final year project to Ms Chitrah Devi a/p Krishnan, our research supervisor and to our dear families and friends for being our pillars of strength. Without their unwavering support and endless motivation, it would have been nearly impossible for us to successfully reach the completion of this study.

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CO2	CARBON DIOXIDE
DV	DEPENDANT VARIABLE
EKC	THE ENVIRONMENTAL KUZNETS CURVE
FDI	FOREIGN DIRECT INVESTMENT
FEM	FIXED EFFECT MODEL
GDP	GROSS DOMESTIC PRODUCT
GIS	GEOGRAPHICAL INFORMATION SYSTEM
IMD	INDIAN METEOROLOGICAL DEPARTMENT
IV	INDEPENDENT VARIABLE
LAND	ARABLE LAND
LPG	LIQUEFIED PETROLEUM GAS
OLS	ORDINARY LEAST SQUARES
PREP	PRECIPITATION
REM	RANDOM EFFECT MODEL
SO	SOUTHERN OSCILLATIONS

SPEI	STANDARDIZED PRECIPITATION
SPI	SCHEDULE PERFORMANCE INDEX
TEMP	TEMPERATURE
USD	UNITED STATES DOLLAR
WBG	WORLD BANK GROUP

PREFACE

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Climate change may or may not be the main subject for the economics of the world. However, to evaluate the impact of climate change on economic growth, it has to go through an ultimate challenge of complexity as of the possible mechanisms though which climate change may influence economic growth, negatively or positively is very great and tough to investigate comprehensively. Climate change is based on the shifts in a set of variables including temperature and precipitation.

This is a global issue but the impacts are mostly varied from country to country and also region to region. Some countries may be experiencing more adverse effect compared to others. The capability to adapt to climate change can have influence on how climate change affect people, communities, countries and the world population.

Variables like temperature, precipitation, arable land and foreign direct investments are used to access the impact caused by economic growth. Generally, a country who depends largely on environmental factors may be affected more in terms of Gross Domestic Product (GDP) compared to a developed country. This is because a developed country does not have a higher reliance on these factors to improve their GDP.

The main purpose of this research is to evaluate the impact of climate change on economic growth in Australia, India and South Africa. Based on this study, it can provide some insights on the depth of climate change causing changes in an economy in countries from different continents. It could also provide a better guidance for future researches in studying this particular topic.

ABSTRACT

This article reviews the impacts of climate change on Australia, India and South Africa. Current prediction shows that climate change will mostly have limited impact on the economy in the 21st century. The paper uses variables including temperature, precipitation, arable land and foreign direct investment. We have used data from the year 2004 to 2014. These countries show the variation of developed and developing countries and how climate change embodies a vital role in affecting each country's economic growth.

Descriptive analysis of Pooled OLS, Fixed Effect Model, Random Effect Model, Hausman test and Wald test were used to determine the climate change impacts. Based on the tests, we have found significant affect shown on economic growth by arable land and precipitation. However, temperature and foreign direct investment do not show significant effects.

Despite the limitations found in this research study, there is a clearer vision on the depth of impact the climate change may cause to the growth of an economy. Recommendations are guven in relation to the limitations which would guide future researchers. This outcome of this research would contribute to better understanding for those who are keen to know more about the topic studied.

CHAPTER 1: RESEARCH OVERVIEW

1.0 Introduction

Climate change is a vital subject of this time as earth is changing climates faster than any point in the history of current evolution. The impacts of climate changes in a certain country or globally are unprecedented in scale. It is affected by heat trapping-gases that are warming the planet and the seas. This causes sea levels to rise which may increase the risk of catastrophic flooding, storm pattern fluctuations, changed currents from oceans, snow and ice melt, weather changes that affect food production, extreme heat occasions and many more. The impacts shown is believed to be continued as long as global warming takes place which may lead to affecting development, human life, agriculture, freshwater supplies and many more.

The U.S Environmental Protection Agency has corresponded that the change in climate has been occurring heavily and is believed to be caused by human activities like burning of fossil fuels (The United States Environmental Protection Agency, U.S. EPA, 2017). Climate change is not the same as weather change, where it is commonly misinterpreted. Weather determines atmospheric conditions over a short period in a day to day basis whereas climate, on the other hand, holds an average pattern of weather for a longer period which is usually 30 years (U.S. EPA, 2017).

Moreover, other countries like Japan and Germany have also become victim to climate change impacts on the economy. In 2018, Japan was ravaged by massive climate change with the heavy rains that hit the country accompanied by heatwaves, the Osaka earthquake and Jebi typhoon. Japan faced many deaths, economic losses up to 35.8 million dollars and a drop in per capita Gross Domestic Product (GDP) of 0.64%. 2018 was the hottest year for Germany and the climate change cost the country to suffer from a 3,500 million dollars' worth of damage to the agricultural sector. Germany also loss

5,038 million dollars and a 0.12% drop in per capita GDP ("Which countries are most threatened by and vulnerable to climate change?", 2020).

The recent bushfires in Australia that cost them more than 100 billion dollars are proof that some countries have it harder than others during climate changes (McDonald, 2020).

This research is chosen to study the change in climate significantly which affects the economic growth in Australia, India and South Africa. These countries show the variation of developed and developing countries and how climate change embodies a vital role in affecting each country's economic growth.

1.1 Background study

1.1.1 Australia

Australia has several different climate zones due to the 7,617,930 square kilometres landmass size that it occupies (Hanna, Kjellstrom, Bennett, & Dear, 2011). The Northern side of Australia has a more hot and humid influenced climate in the summer, and rather warm and dry in the winter. At the same time, the Southern portions are chiller with slight summers, occasionally rainy winters. The seasons change oppositely; when it is summer in the North, it is winter south of the equator and vice versa.

The hottest months Australia are January and December, the coolest months are July and August. Australia's southern areas are generally warmer with temperatures between 25 °C and 30 °C. Their cold days are only between 5 °C to 10 °C. Australia also has extreme weathers at the Tasmanian Mountains

where it's covered by snow year-round and desert in central Australia at 50 °C and more ("Australia climate: average weather, temperature, precipitation, best time", 2020).

Tropical cyclones occur not very often at the northern coastal areas which causes heavy wind and rains storms usually in April and November. Temperature rise in Australia is observed across all seasons with both day and night time temperatures evidently getting warmer. ("Australia climate: average weather, temperature, precipitation, best time", 2020).

Research shows that every month the change in day and night temperatures show very high temperatures. This upward shift in the circulations of temperature has happened across all seasons, with the largest change in spring ("State of the Climate 2018: Bureau of Meteorology", 2020). In the past year, Australia has been hit with an unfortunate fire season. About 18 million hectares of the fire has burnt through the bush; which is an area larger than of the normal European country and over five times the size of blazes in the Amazon (Stephenson, Handmer, & Betts, 2013).

1.1.2 India

India is a country that resides a greater part of South Asia. It is a constitutional republic country that consists of 29 states that have its own degree of control over its own dealings. India has the second greatest number of populations in the world, after China. It roughly has one-sixth of the world's total population which is 1,374,937,024. The increase in prosperity and cultural dynamism in India despite a lot of challenges regarding domestic challenges and economic inequality can be seen in the developed infrastructure and many diversified industrials like scientific, engineering which is one of the world's largest,

agriculture sector and cultural trade of music, cinema and art. Even though a large part of India remains rural, India has three most cosmopolitan and populated metropolises in the world like Mumbai, Calcutta and Delhi. Chennai, Bangalore and Hyderabad are one of the world's quick-growing high technology centres (*World Regional Geography: People, Places and Globalization*, 2020).

India's climate varies in a broad range of different kind of weather in the whole of India's geographic scale which makes it difficult to generalize. The variation of climates in different regions are extraordinary. According to the Koppen System which is a climate classification, there are six major climate subtypes in India which comprise of alpine tundra and glaciers in the north, arid deserts in the west and tropical weather in the southwest and island territories. A lot of regions have variations of microclimates which makes India one of the most diverse countries in the sense of climate in the world. India follows the international standard with climatological seasons of four which includes winter on January and February, summer during March, April and May, and a monsoon which means rainy season from June to September and a post-monsoon period from October to December. The geographic and geologic condition of India is climatically important. In the Northside of India, it is mostly warm or gently cold or chills during winter but the identical thermal dam keeps most regions hot during summer (*World Regional Geography: People, Places and Globalization*, 2020).

There is a great dependence on monsoon winds for the climate of India. Monsoon typically happens due to the different kind of heat on land and water. The land will heat up faster than water. The difference in pressure is caused by a change in heating which leads to currents. Therefore, these pressure condition changes affect monsoons. Usually, the pressure condition in the humid eastern South Pacific Ocean will be higher and in the tropical eastern Indian Ocean, the pressure will be lower. But during the past few years, a reversal of pressure conditions has been taking place. Therefore, the eastern Pacific has lesser

pressure. This periodic change in pressure situations is known as Southern Oscillations (SO). The reasons why the climate of India differ are plenty. The Latitude determines changes as the tropic of Cancer lies at the centre of India which is directing at east-west. Therefore, the sub-tropical region covers the North of India while the tropical region lies in the southern part of India. As the tropical region lies closer to the equator, it experiences steady great temperatures all year with slight differences. On the other hand, the other side experiences extreme climate as it is further from the equator (Geertz, 2020).

The climate of India is also partly affected by distance from the sea. As long coastline exists, a steady climate is seen throughout big coastal regions. Regions that are located in the centre of India is less impacted by the sea. Therefore, those areas have extreme climates. For example, the community of Mumbai and Konkan coast are not exposed to extreme temperatures and seasonal weather changes whereas Delhi and Amritsar experience seasonal disparities on the weather.

1.1.3 South Africa

Climate change has been documented as one of the biggest challenge faced by the world in the 21st Century. South Africa is well identified for its immense exquisiteness, amusing biodiversity, and plentiful wildlife. However, climate change represents a tangible risk to these natural resources, as well as to the people who live in this beautiful country. This country is especially defenseless to the impacts of climate change because of its geographic exposure, low incomes, more prominent dependence on climate-sensitive sectors and less ability to adapt to the changing climate. The South African economy relies essentially on the dynamics of climate change (Kreft, 2016). The weakness of the general economy and key parts of the economic performance such as

forestry, coastal resources, agriculture, energy, tourism, and water resources to climate change has been known to be substantial.

The topographical location of most South African countries on the lesser scopes has already put the region at a drawback where about 80 per cent of damages from climate change are intense. Any further warming would influence a country's productivity (Mendelsohn, 2009). For the past five decades (1960-2009), many countries in Africa (e.g. Sudan, Chad, Uganda, Botswana and Tunisia) has a considerable increase in temperature – running from 1◦ to more than 3◦C as stated by (Abidoye & Odusola, 2015).

From a socio-economic aspect, South Africa is particularly defenseless to the effects of climate change for various reasons. Primarily, a huge proportion of the residents live in distressing conditions, where casual settlements are set up in areas that are vulnerable to extraordinary weather events, and insufficiency of satisfactory housing structures to offer satisfactory protection against rain, wind and cold. Furthermore, there is a high rate of disease, which spots impoverished individuals at further risk as described by Edokpayi et al. 2018. Many parts of South Africa come across low and variable precipitation, with access to safe clean water representing an issue in certain communities. As most of the surface water resources are already utilized to their maximum capacity, water shortages could represent an issue later on, and climate change could exacerbate this further.

1.2 Problem Statement

According to Andrew Oswald, Professor of Economics and Behaviour Science, Warwick University and Nicholas Stern, IG Patel Professor of Economics and Government, London School of Economics (LSE), economists are letting down the world on climate change. Carbon dioxide, for example, has been increasing rapidly in

concentration and is more than 400 parts per million . The sea levels have risen more than 10-20 metres compared to millions of years ago (Oswald & Stern, 2019). As climate change, or not to change, becomes a central issue for the world economy, this research is moving towards the impact of climate changes towards economic growth.

The Indian Meteorological Department (IMD, 2019) stated that the average temperature has risen about 0.6℃ in the year 2009-2018, which reached an average reading of 25.84 ℃. In the year 2016, the average temperature across India is 26.2℃, which hit the hottest year. A more alarming scene was painted by the World Bank, that if the climate change continues to go rampant, India's average temperature could go up to 29.1 ℃ by the end of centuries (IMD, 2019).

Human health and productivity is an essential concern of the climate change issue. According to the Environment Ministry in India, about 2,400 Indians are dead due to extreme weather occasions (The Times of India, 2019). This may lead to a decrease in the labour hours of the country. Increasing warmth and precipitation act as a spur to a proliferation of the insect pests, which these insects can spread the infections like dengue, Zika virus, West Nile virus and Lyme disease. This is because the warming temperature could cause the cold-blooded insects to become more active, and thus these insects can reproduce rapidly. Besides, for the Australia case, the agriculture sector is most at risk to climate change, (Cho, 2020). The agricultural sector can be the main income for some of the states in the Midwest. The vents of extreme rainfalls have rose 37 per cent since the 1950s. Presently, the amount of rainfall and snowmelt has led to the historical flood. Many fields have washed away, and the crops are drowned. Not only the flood being the killer of crops, the insect pests, fungi and bacteria too (Denchak, 2019). A research was done by Prof Curtis Deutsch (2018), an ecologist from University of Washington, and his research team shows that about 10-16 percent of producing crops is lost due to insect, fungi, bacteria and some pests. This is because the warmth temperature boosts the digestion rate of the insects, leading them to demolish the crops with a higher rate. This will lead to an increase in the price of goods (Deutsch, 2018).

Besides, the increase in heat and drought will also cause the crop yield to dive. For South Africa, the temperature has been getting higher since the year 1960. In the year

of 2004, the scientists viewed the records of weather stations across the country and unveiled the average increase of 0.13°C per decade. From 1960 until now, the trends showed the warm days in South Africa are more than cooler days. The scientists could not explain the phenomenon in which the average temperature is rising with closing to double. The rainfall patterns are predicted to shift to lower that certain level (Joubert, 2019).

The studies had expected that the average temperature will rise by 1-3°C in the future. By the end of this century, the average temperature of South Africa will be approximately 3.4°C warmer, which has been proven and confirmed from earlier studies by Lee, H. (2007).

In 2019, according to the Africa Center for Economic Transformation (ACET), Cape Town had the highest amount of rainfall ever in the year 2013, and another wet winter in the year 2014. The main reservoirs (artificial lake) are almost full and the African states that the supply of water will be sufficient up to 2020. Then the drought began. The level of reservoirs started to decrease to 71 per cent in the year 2015, 60 per cent in the year 2016 and 38 per cent in the year 2017 (ACET, 2019). In 2018, the visitors are requested to protect the waters and there is a plan to tow the iceberg for the supply of freshwater. Following the drought, the severe shortage of water caused the 72 hours of water rationing per week, which caused the waste to 'store' and accumulate in the pipe. They can only be able to flush their waste at 7:30 p.m. local time. The locals called it "Big Flush".

According to the previous research conducted to assess the influences of climate change on economic growth, foreign direct investment played major roles in many researches. For example in Borenstein's research on economic growth he claims that there is a major play of foreign direct investment in estimating the acceleration of economic growth. Similarly, in Maria Carkovic and Ross's research on economic growth, foreign direct investment seems to have affected the acceleration of a country's profit significantly. After the economic crisis in 1997s and 1998s, Asia countries experienced declines in outward FDI which significantly impacted the economics. OutwardFDI is the business strategy in which domestic firms expand their operation in foreign countries, or expand the foreign facilities. This heavily impacted Asia countries

in which outflow from Asia declined by 2.5 percent about 401 billion. The decline is mainly due to decline in investment from China, and reduction in investment from Singapore in the next year (unctad.org ,12 June, 2019). In the year ended 2019, Covid-19 had struck China, and was soon going rampant globally. This dramatically impacts the flow of FDI, and directly impacts globalization. This is due to the fact that global production logistics are being disrupted which is resulting in shock in demand and supply (World Economic Forum, 2020). Therefore, economists are concerned about the FDI as lessons from China already showed how the Covid-19 affect globalization.

1.3 Research Objectives

1.3.1 General Objectives

The general objective is to examine the impact of climate change on the economic growth in Australia, India and South Africa.

1.3.2 Specific Objectives

This research has four specific objectives which are:

1. To determine the relationship between changes in temperature and economic growth (GDP).

2. To determine the relationship between precipitation and economic growth (GDP).

3. To determine the relationship between arable land and economic growth (GDP).

4. To determine the relationship between foreign direct investment (FDI) and economic growth (GDP).

1.4 Research Questions

The research questions in this research are:

1. Is there any relationship between changes in temperature and economic growth?
2. Is there any relationship between precipitation and economic growth?
3. Is there any relationship between arable land and economic growth?
4. Is there any relationship between foreign direct investment and climate change on economic growth?

1.5 Proposed Hypotheses of Study

The hypotheses constructed for this study are as follows:

Table 1.1: *Proposed Hypotheses of the Study*

H1:	A decrease in temperature is positively related with economic growth.

H2:	An increase in carbon emission is negatively related with economic growth.
H3:	An increase in arable land is positively related with economic growth.
H4:	A decrease in precipitation is negatively related with economic growth
H5:	A decrease in foreign direct investment is negatively related with economic growth

1.6 Significant of Study

1.6.1 Academic or Theoretical purpose

This research will benefit and serve as a guideline of information to future researches who anticipate researching the impacts of climate change on other countries, for example, Malaysia, Brazil, and etc. The future researches can adapt to the model proposed in this research and may develop it to be better theoretically based on their research. In addition to that, this study will also help future researches enhance their knowledge on the impacts of climate change on a country. In this study, the proposed model is only narrowed down to four variables which are arable land, temperate, precipitation and carbon emission. Therefore, future researches will be able to use the presented variables to explain their effects or add to this study with different variables. Moreover, by using this study as a baseline, future researches will be able to differentiate the more significant factors on climate change that affect economic growth.

1.6.2 Practical or Managerial purpose

In-depth of the analysis of this study, the information of the variables may be used as important tools for market users such as policymakers, investors, business owners, financial analysts to justify the economic conditions. This study is important because a prolonged change in climate can lead to critical economic condition and it is highly assumable of an increase in corruption and restlessness in the general populace yet can lead to long term systemic issues which are tough to dissolve. This research also assists economists in a country to identify more factors that affect the economic growth of a country and can work towards solutions to overcome future deficits.

1.7 Chapter Layout

This study has five chapters. They are Chapter 1, Chapter 2, Chapter 3, Chapter 4 and Chapter 5. Chapter 1 contributes a general review of studies by providing the research background of the study, problem statement, research questions and research objectives, as well as the significance of the study. Chapter 2 contains literature reviews accordingly, contains an analysis of models and theoretical framework that have been used in this research obtained from related journals and articles. This chapter also explains the descriptions of the key terms and explains the research strategy for secondary data. Next, the methodologies of the study are the main focus of Chapter 3. This chapter explains the research process, explains the research design, and application of data collection method, as well as ethical consideration, are also included in this chapter. This chapter also explained the definition of the dependant variables and independent variables, model as well as the type of hypothesis testing used. Chapter

4 presents and analyses the data from the research objectives and hypotheses. Chapter 5 is mainly to discuss the major findings, implications and limitations of the study and the conclusion.

CHAPTER 2: LITERATURE REVIEW

2.0 Introduction

Chapter two gives an overview of how climate change has affected the economic growth in several countries through the analysis of past studies. Besides, it addresses on theories that can explain factor that impacts the economic growth of a country. Furthermore, it will also look into possible theories that suspect the correlation of economic growth and climate change. The study is to investigate the effect of climate change on the economic growth in Australia, India and South Africa.

This chapter is systematized into four sections. This section gives a brief introduction of the literature review as a whole while section 2.2 is the theoretical literature which discusses on theories that are related to economic growth and government debt and how the two variables are correlated. Empirical literature critically analyses similar past studies which serve as a guideline to predict possible outcomes in section 2.3. Finally, section 2.4 summarises the chapter, provides possible contribution and the expected results of this study.

2.1 Review of Empirical Literature

2.1.1 Temperature

According to Diffenbaugh and Burke (2019) has found that global warming has been possibly intensifying global economic inequality showing a rise of 25 per cent in population-weighted between-country inequality over many years. This

rise in results was affecting yearly economic growth that has been vigorously accumulating and a significant decrease in output of the economy in warmer, poorer countries and rise in cooler, richer countries. Their studies show global warming causing the extensive increase and decrease in temperatures which is likely caused by fossil fuels has magnified the economic inequality.

Based on the study of Pretis, Schwarz, Tang, Haustein and Allen (2018), they have found that there is a non-linear relationship of temperature and GDP growth for an estimation made based on a year monthly temperature variability also monthly maximum and minimum temperatures and outliers. Changes in temperature have a slight impact on economic for counties that have an optimal annual average temperature and on the other hand a larger impact for countries that show very high and vice versa annual average temperatures consistent.

According to Choi, Heshmati, & Cho (2010), climate change can relate to the variations in economic conditions and help predict upcoming execution in economic advancement and development. Researcher shows that pollution can influence total production and quality of life by reduced productivity of man-made capital and labour. There is a negative impact of climate change on the economic growth of developing countries stated by Abidoye & Odusola, 2015. Abidoye & Odusola (2015) studies on the effects of climate change on economic growth and improvement have just centered around specific parts of Africa and developing nations.

Dell, Jones, & Olken (2012) discover three basic results from their research. First, greater temperatures considerably decrease financial developing in non-developing countries. For instance, a 1˚ Celsius increase in temperature in a specific year decrease financial development by 1.3 per cent focuses overall. Second, higher temperatures appear to diminish development rates, not simply the degree of production. Third, higher temperatures have wide-scale impacts, reducing farming output, mechanical output, and political quality.

The effect of climate is not influential to changes in economic growth and samples observed by Thurlow, et al, 2009, using global information for 1950-2004. In any case, the moving average-centered quantity of temperature for Africa is related with harmful effect – however only at 10 per cent level. Also, Ali (2012), utilizing a co-coordination investigation on Ethiopia finds a negative effect on development. He unequivocally observed that adjustment in precipitation extent and fluctuation has a drawn out drag-impact on development.

The monetary effect of environmental change on U.S. agrarian territory by assessing the effect of arbitrary year-to-year arrangement in temperature and precipitation on agricultural revenue estimated by Deschênes and Greenstone, 2012. They found climate change to higher annual profits by 4 per cent. Zilberman et al. (2004), introduced an applied system of the effect of environmental change on agriculture. They acknowledged that environmental change acquires a preparation impact and a move of agro-natural conditions from the equator toward the posts. The move was presumably going to diminish yield in light of decreasing grounds, however the treatment impact will extend yield. The total impact depends upon relies upon whichever of the two overwhelms.

Burke, Hsiang & Miguel (2015) examined the connection between chronicled temperature fluctuations and economic growth. They stated that not quite the same as past research, aggregate macroeconomic productivity is nonlinear, with efficiency at an annual average temperature of 13°C and drop strappingly at greater temperatures. For a cooler nation, warming will prompt an economic blast. Thus, given the presence of nonlinearities, climate change has a positive impact up to a limit and shifts to a negative impact on economic productivity.

Adiku et al. (2015) found that the impact of climate change on crops comparative with pattern climates were generally negative for cereal yields (e.g., millet and maize). In additionally referred by Moriondo, Giannakopoulos,

& Bindi (2011) that discovered a negative effect of temperature on crop yield. The researcher stated temperature as consuming the utmost antagonistic impact on crop yield among very climate parameters. In reality, this is so because specific phases of crop growth are especially delicate to temperature variation. Increased temperature more prominent than the specific limit, for the majority of crops, can bring about noteworthy yield loss during the reproductive stage, through its impact on grain-filling, grain numbers and even sterility.

This research will categorize the least developed countries in low- revenue and developing & developed countries in high- revenue countries. The interesting fact is that relationship between both categories are different.

2.1.2 Arable Land

Historically, few issues have caught the attention of economists to look into the contribution of agricultural sector towards the economic growth, wherein the impacts were seeking and results were generated via econometrics or simulation analysis. A lot of economists had done several types of research on both empirical and theoretical, focused on the contribution of agriculture sectors from least developed countries to high-income countries. However, this study will be mainly focused on the relationship between arable land and economic growth for low-income country and developing country. Due to different urbanization and technology development in a developed country, the relationship between the arable land and economic growth for the developed country tend to be uncertain, lead to insignificant in results for the research, therefore this research does not focus on the high-income country.

2.1.2.1 Developing Countries

The poor occupy a higher proportion than the middle income and rich through the world population, study the economics of being poor, this study could see what the economics matters about. Majority of low-income family obtain the earnings from agriculture sector, by this, this study assumed study the economics of agriculture can reflect the economics of a nation (Schultz, 1979).

To prove the number of people that live in poverty, this study has reviewed on the World Bank's Data (2019) and realized that there is two-third of the global population live in extreme poverty, where the extreme poverty is defined by the 'poverty trend' as living on less than $1.90 per day. Extreme poverty was projected to be continued until the year 2030.

The hypothesis shows that the arable land and economic growth has a positive relationship as the low-income countries rely on the agriculture sector as one of the main GDP contributions. The economic growth of a nation will continuously shrink as the availability of arable lands for harvesting are decreasing, vice versa.

According to the World Bank (2007), there are three out of four, which is 75 per cent of people in the developing countries live in a rural area, rely on the agricultural for their livelihood.

Previous researches had studied the area in India and China which both of the countries has the similarity in term of a developing country, huge population, rapid economics and scarce of natural resources. Both countries are facing stress on ensuring food security.

For India, it is experiencing two monsoons, summer and winter, which affect the agriculture system, development and economy of India. India was ranked second worldwide in agriculture in the worldwide (Multidisciplinary Digital

Publishing Institute, 2015). The arable lands in India correspond to 57 percent of the total land of India, and the agriculture sectors are accounted for 19 percent throughout South Asia in 2007. This can conclude that arable land and economic growth has a positive relationship in India.

While for China, it is experiencing a more complex and monsoonal climate that harmed the agriculture like flood, drought, cold waves and unequal distribution of water resources. China was ranked to be highest worldwide as it is the world largest food producer as it supplies 22 percent of the worldwide population. However, there is only 13 per cent of China's landmass are available for arable. There is a 29 per cent increase in the urbanization rate of China from the year 1979 to 2010, which the per capita arable land decrease from 0.14 hectare to 0.09 hectare in 2009. However, following the decrease in arable land, the per capita GDP for a growth rate is double comparing to the world average in the period. The relationship between arable land and economic growth is uncertain in China. Although there are several kinds of research of China's per capita arable land and economic growth, respectively, the economists do not provide a reliable estimation on the land that meet the requirements of food consumption and demand for human nutrition.

Therefore, for the arable land, the relationship of arable land and economic growth in a developing country is uncertain, because industrialization and urbanization for the countries are different.

2.1.3 Precipitation

In many types of research done to determine the climate change effects of economic growth, precipitation is a popularly used climate variable. Precipitation which is the formation of any moisture in the environment like drizzle, rain, snow and even hail in extreme amounts can affect a country's

economy. Precipitation is an interesting variable as increased levels of precipitation such as floods and storms and decreased levels of precipitation such as droughts both have a negative relationship towards economic growth in a country, unlike usual linear independent variables.

In research on social and economic impacts of climate by Carleton (2016), it is found that surpluses or deficits on precipitation may harm economies predominantly in countries that are highly dependent on agriculture. The effects are mostly quantitively significant. The research shows the decrease in global economic growth in Africa by 11 per cent and may continue to decline by 0.28 per cent due to decreased precipitation and droughts. Even if the precipitation level in the U.S. did not affect the rice and soy, it lowered the yields of maize and wheat by 3.8 per cent and 5.5 per cent. This research proves a positive link between precipitation and economic growth.

Following research done by Haddad (2015) on economic impacts of natural disasters in Megacities, the economy in Brazil was negatively affected by increased precipitation levels in the country. The rainfall surpassed 80 mm/day in São Paulo, Brazil which caused floods and extreme output shocks based on the Geographical Information System (GIS) simulations to the country's GDP. The floods resulted in a decrease of city growth and welfare, therefore, resulting in lower competition locally in both local and international markets. This negatively affected the overall regional economies in Brazil. This shows a non-linear relationship between precipitation and economic growth.

From the research done by Berlemann (2018) on short-term and long-term effects of precipitation and economic growth, it is said that when covering datasets from rich or developed countries by using different linear rainfall indicators, Schedule Performance Index (SPI) and Standardized Precipitation Evapotranspiration Index (SPEI). There is very little evidence to conclude of any significant or systematic effect precipitation has on the economy. In addition to that, when distinguishing between precipitation deficits and

surpluses in those countries, the model was negative and cumulative coefficient results showed not significantly different from zero. Thus, proving very weak empirical evidence in favour of precipitation affecting economic growth. However, in comparison to that, in developing countries or poorer countries, the results differ. There is an increase in the significance of the precipitation level affecting economic growth using linear indicator variants. It shows that a deficit in precipitation levels like droughts causes decrease to the economic growth at the same time the surpluses cause systematic effects on economic growth. This research also highlights Sub-Saharan African countries that show positive growth due to surpluses in precipitation in the form of rainfall. This research also follows through with more findings of a negative long-term effect in economic growth due to decreased precipitation levels in poor countries. Precipitation deficits are threats to low-level development countries and agriculture predominant countries as it causes crop failures. This research shows the non-linear relationship of precipitation and economic growth.

In research done by an economist from the World Bank, Brown (2010), stated that precipitation variability has a strong influence and vital effect on economic growth. The results in this research show that national economies are hindered by precipitation levels, periods of precipitation surpluses or deficits. With the lack of globally available data on daily precipitation levels, a precise description of the effects of precipitation on each country is difficult to sustain. Nevertheless, the increase levels on precipitation are said to have more significant effects on the GDP of a country compared to the deficits of precipitation. Regression coefficients showed a negative impact of an increase in precipitation like excess rainfall which involved flooding and destruction of infrastructure. Damages caused by precipitation surpluses on infrastructure decreased output in terms of GDP and industrial value-added. Overall the study conducted by World Bank concluded evidence of statistically significant impact on economic growth by precipitation variability. This research shows a non-linear relationship between precipitation and economic growth.

2.1.4 Foreign Direct Investment

Foreign direct investment (FDI) has assumed the main job in a significant several of the economies of the region. There is an across the board conviction among policymakers that foreign direct investment (FDI) improves the efficiency of home countries and encourages advancement. There are a few researchers done on FDI and economic development. A portion of the investigations testing the relationship between FDI and economic development while some are determining the causality between two variables. Their discoveries are fluctuating from various strategy use on their research, for example, some analysts found that FDI positively affects economic growth. For instance, is Balasubramanyam et al (1996) stated that by using cross-sectional data and OLS regression FDI positively affects economic growth in having home countries.

According to Peterson & Laudicina (2020), stated that climate change playing a significant role in foreign direct investment decisions and are customed to develop as a need. Remarkably, 85 per cent of financial investors state that the natural effect of potential foreign investment targets is essential to them. Significantly, 77 per cent of financial specialists' state that climate-related risks are probably going to influence their investment choices throughout the following three years. However, this study will be mainly attentive on the relationship between foreign direct investment and economic growth.

Bengoa and Sanchez-Robles (2003) examine the connection between FDI, financial opportunity and economic growth in Latin America. The researcher concluded that FDI has a encouraging effect on economic growth. However, Borensztein et al (1998) the greatness relies upon home country conditions. Carkovic and Levine (2002) by using panel dataset to investigate the relationship between FDI inflows and economic development. The researcher

there is no significant relationship between inward FDI to home country economic growth.

There is further examination done by Chowdhury and Mavrotas (2003) which look at the causal connection among FDI and economic progression by utilizing a creative econometric procedure to contemplate the investigate of interconnection between the two variables. The researcher used time-series data from 1969 to 2000 for three developing nations, which are Chile, Malaysia and Thailand, every one of the significant beneficiaries of FDI with various history of strategy systems and development designs. The researcher stated that there is solid proof of bi-directional causality between the two factors. The power of the above discoveries is affirmed by the utilization of a bootstrap test utilized to examine the legitimacy of the outcome.

Hansen and Rand (2006) stated that there is a solid causal relationship among FDI and GDP for 31 developing countries during 1970-2000. Johnson (2006) mention that FDI had a fundamentally optimistic affect on economic development for the countries with high income. In researching 140 nations, FDI positively affects genuine per-capita GDP (Ghatak and Halicioglu, 2007). Besides that, Roy and Berg (2006) mention that there is a positive and critical effect of the portion of FDI in GDP on economic development for the US. According to Udo and Obiora (2006) stated that there is no solid evidence of the relationship between FDI- economic development while examining the West African Monetary Zone.

According to Vinh (2015) stated that effect of FDI on the environment for in Vietnam by utilizing a GMM investigation on a period arrangement information of carbon dioxide emission, FDI, GDP and GDP squared, and discovered outcomes that affirm the EKC hypothesis. The result from the study demonstrated a two-path linkage among FDI and the environment; where an expansion in FDI 44 builds the degree of pollution for all division, and the expanded degree of discharge additionally helps the measure of FDI inflows

into Vietnam, supporting the pollution assumption. A long way from affirming the EKC theory, the study concludes additionally uncovered sectorial nature of the relationship. The degree of pollution in the vitality division was high despite the inflow of tone FDIs into the segment. On sub-area premise, the Production and Distribution of Electricity, Gas and Water uncovered genuine pollution of nature but the constrained estimation of FDI while the Manufacturing Industries and Construction which pulled in huge measure of FDI has less extreme ecological effects.

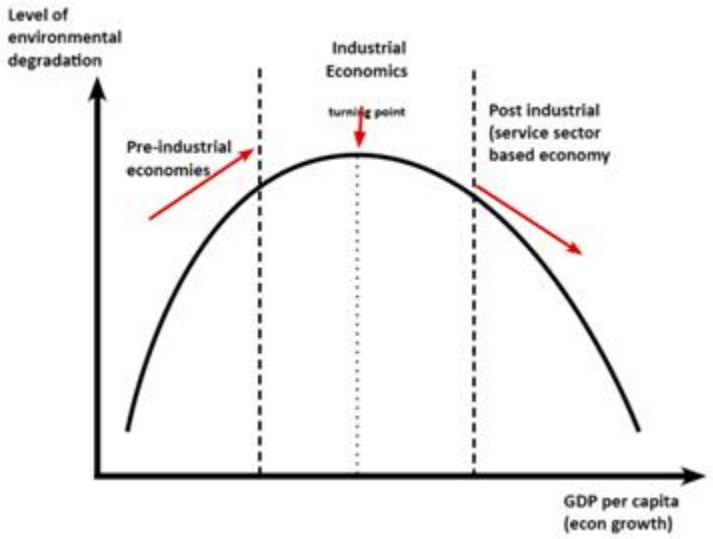
2.2 Review of Theoretical Framework

2.2.1 The Environmental Kuznets Curve (EKC)

The EKC was defined as the growth of economic initially caused damage to the environment, then after reached a certain level of growth, the society started to improve the relationship between environmental degradation and economic growth, and the degradation reduced (Pettinger, 2019). It was firstly introduced in the World Development Report in 1992 (Stern, 2004), investigated the relationship between sulphur dioxide and per capita GDP, and results in inverted U-Shape wherein it is positively related in certain point (Cederborg and Snöbohm, 2016). The EKC is later introduced in general environmental degradation worldwide (2004). The hypothesis applied in an inverted U-shape curve which investigate the relationship between per capita GDP and environmental issues (carbon emission). The EKC proposed that level of environmental degradation first increase, then fall as the increase in the GDP per capita. It is named for Kuznets who founded that income inequality first increase than decrease as the GDP per capita rising.

This can be explained by the scale effect, which if the country's development level, the structure of technology remains unchanged, the growth in the GDP will result in pollution and other environmental issues. The traditional view of economic growth and environmental quality is negatively related, which economic growth will lead to a decrease in environmental quality. EKC proposed that for the higher income/ richer countries, at the higher level of development, structure and more advanced technology will direct the structure change in the country towards more information-intensive, higher environmental awareness, enforcement of rules and regulations and higher environment expenditure, which lead to diminishing in marginal degradation as the economy grows.

Figure 2.1: *Environmental Kuznets Curve (EKC)*



Note adapted from *Pettinger, 2019*

The pre-industrial economies effects, an initial increase in the environmental damage, called the scale effect. This indicates that the surge in economic output will result in a rise in carbon emission. Increase in output require inputs, which require more natural resources to be used, lead to an increase

in labour hour and carbon emissions. The environmental degradation is thought to increase with the scale of economic growth.

The turning point, industrial economies indicates that the existence of other mechanisms eliminating the scale effect. All the mechanisms work together and decrease the level of environmental degradation as the economy grow. The mechanisms include technological effect, composition effect, international trade effect, better environment demand and stronger regulation.

The post-industrial economies indicate the degradation of environment decrease as the economy grows. This is due to more advance technology and higher efficiency and effectiveness in production. Competitive market pressure firms to charge the products at a lower price, which the firms need to make the production cheaper by invest in developing new technology and effective technology.

For the low-income country, it is in the pre-industrial economies. For the middle-income country, it is in the industrial economies, while for the high-income country, it is in the post-industrial economies. This is because a richer country can invest more in R&D, which they can develop more advance technology, which results in diminishing in environmental degradation following the increase in economic growth.

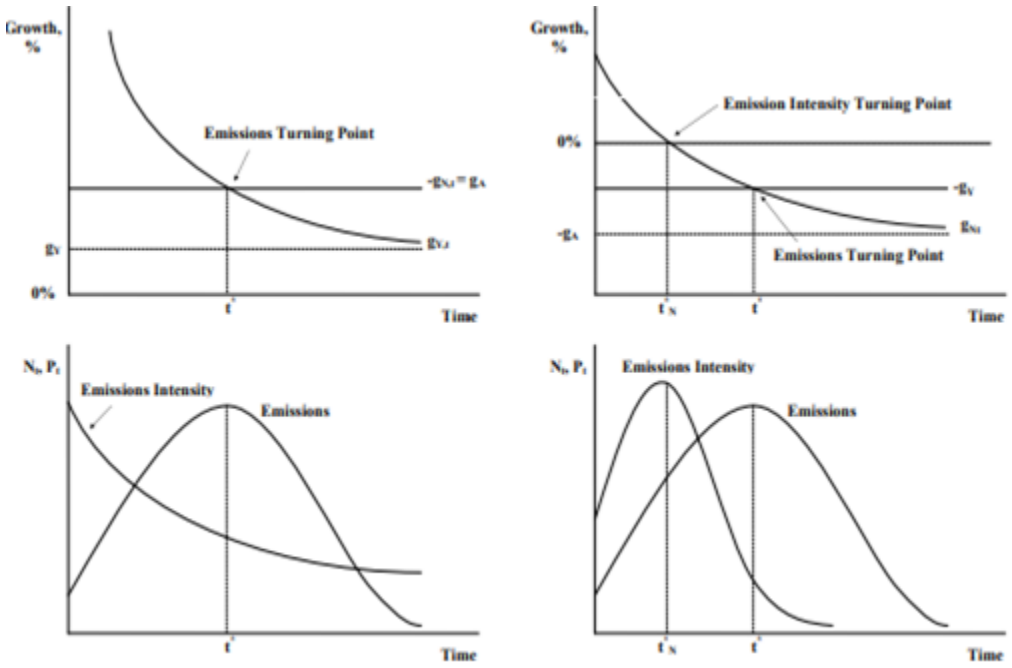
2.2.2 The Green Solow Model

The key empirical finding the relationship between economic and the environment - Environmental Kuznets Curve and the model of modern macroeconomics- Green Solow model are closely related (Brock & Taylor, 2010). As the EKC sometimes confuse readers, and the empirical results are fragile, this model explains the puzzles related to EKC.

Green Solow Model offers a simple explanation of the EKC, which are first how to economists square the reduction in emission with pollution abatement costs, second the facts of a humped-shape profile of environment degradation when graphed over time or GDP, and lastly the regression trend can vary with different population and procedure.

In the year 2013, Radoslaw Stefanski from Laval University and OxCarre presented the possible alternative which is comparing with the EKC according to Brock and Taylor. The comparison is as follow.

Figure 2.2: *Green Solow Model by Brock and Taylor in 2010 and possible alternative by Radoslaw Stefanski in 2013*



(a) Brock and Taylor (b) Possible alternative

Note adapted from *Stefanski, 2013*

The Brock and Taylor presented a simple traditional Solow which output, Y is produced by capital, K and labour, L and the productivity, B. The function is as follow.

$$Y = F(K, B * L)$$

The model is regressed as follow

$Y_t = (1 - \theta)F(K_t, B_tL_t)$

$K_t = sY_t - \delta K_t$

$P_t = a(\theta)\Omega_t F(K_t, B_tL_t)$

$L_t = nL_t \quad B_t = gB_t \; \Omega_t = -gA\Omega_t w,$

Where Y= output, K= capital, L= labor, B= productivity, s= saving rate, g= exogenous growth rate, n= labor force growth rate, δ= depreciation rate and Ω= pollution rate.

The main assumption of traditional Solow is that pollution is caused by every unit of production. The second assumption is the fraction of income can be reduced. Both assumptions have influenced the dynamic of the Solow model. The pollution caused by production does not affect economic growth.

Stefanski re-writing the model as follow.

$y_t = (1 - \theta)f(k_t)$.

$k_t = s(1 - \theta)f(k_t) - (\delta + n + g)k_t$

$p_t = \Omega_t a(\theta)f(k_t),$

Where Y= output, K= capital, L= labor, B= productivity, s= saving rate, g= exogenous growth rate, n= labor force growth rate, δ= depreciation rate and Ω= pollution rate.

Stefanski concluded that the real world is more likely in the column 2 in Figure 2.2, than the one Brock and Taylor explained in their journals. The GDP growth rate remains all the time, and the emission intensity drop sharply. This refutes the hump-shaped emission intensity.

2.2.3 Classical Growth Theory

We found that one prominent basic models of economic growth is the Classical Growth Theory. The theory shows that the increase in temperature and precipitation, which leads to a decrease in economic growth, both have an un-linear relationship in affecting economic growth. Therefore, the classical growth theory can be expressed in equation (1):

$$Y = f(C,X) \qquad (1)$$

Where *Y* denotes economic growth in gross domestic product per capita, climate variables (*C*) and other variables (*X*) to the outcomes, *Y*. *C* may include temperature, precipitation, and extreme weather. The outcomes of interest would include national income, agricultural output, industrial output, labour productivity, political stability, energy use, health, and migration, among others. *X* would include any characteristics correlating with *C*, which affect the outcomes of interest possibly by conditioning the climate response.

2.3 Proposed Theoretical Framework

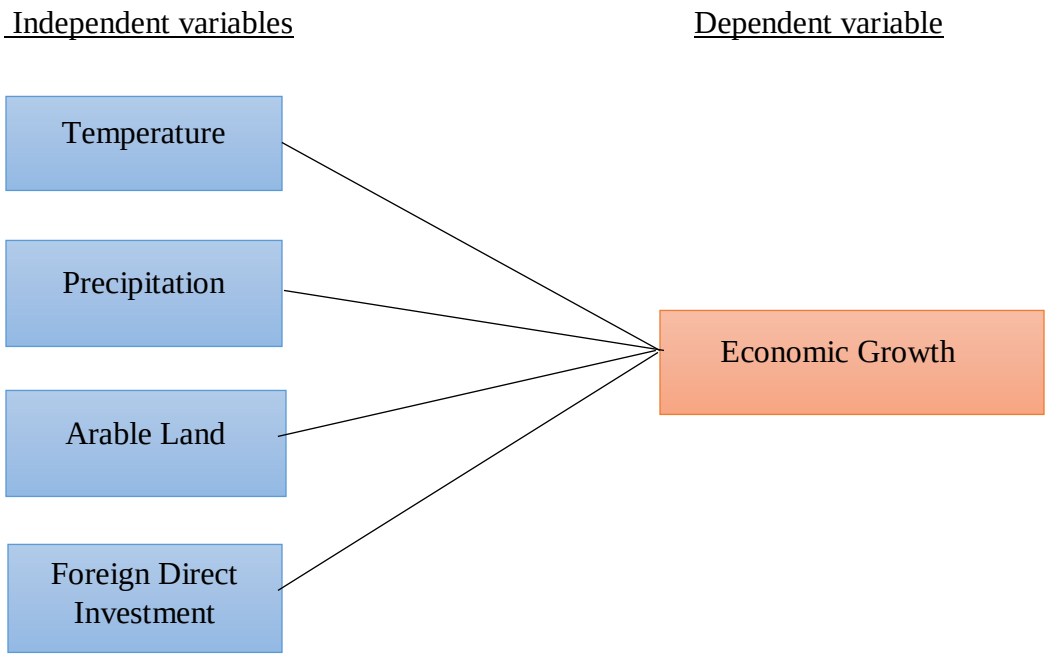


Figure 2.3: *Proposed Theoretical Framework*

Figure 2.3 shows the proposed theoretical framework is the crucial basis of this research. EKC, Green Slow Model and Classical Growth Theory are applied in this research framework. Figure 2.3 of the theoretical framework to interpret the relationship between the dependent variable which is the economic growth and the independent variables which are temperature, precipitation, arable land and foreign direct investment.

2.4 Hypothesis Framework

Model's hypothesis and all the explanatory variables will be formed to study the theoretical validity which has been formulated after the conceptual framework was formed based on the previous review. And the hypotheses were shown as below: -

Ho:$\beta 1 = 0$ (There is no significant relationship between economic growth and temperature)

H_1:$\beta 1 \neq 0$ (There is a significant relationship between economic growth and temperature)

Ho:$\beta 2 = 0$ (There is no significant relationship between economic growth and arable land)

H_1:$\beta 2 \neq 0$ (There is a significant relationship between economic growth and arable land)

Ho:$\beta 3 = 0$ (There is no significant relationship between economic growth and precipitation)

H_1:$\beta 3 \neq 0$ (There is a significant relationship between economic growth and precipitation)

Ho:$\beta 4 = 0$ (There is no significant relationship between economic growth and foreign direct investment)

H_1:$\beta 4 \neq 0$ (There is a significant relationship between economic growth and foreign direct investment)

2.5 Conclusion

In conclusion, the proposed topic of climate change has been supported by all findings on past research. We have used past studies to come out with a source un executing the hypothesis development. The chapter followed by will explained in more detail about the methodologies of research used to observe the model.

CHAPTER 3: METHODOLOGY

3.0 Introduction

In this chapter, we will discuss the primary methodology of the research used in this study. Besides that, we also will explain the data collection, model specification and analysis of data in this chapter. To ensure our research is statistical accuracy, we apply several diagnostic tests for data checking. To conduct this research, we are determining the relationship between economic growth and temperature, arable land, precipitation and foreign direct investment. Thus the 4 independent variables have been carefully selected to run the test and conduct the research.

3.1 Research design

This research aims to study the relationship between the economic growth and independent variables such as temperature, arable land, precipitation and foreign direct investment in Australia, India and South Africa. Besides, this research is examining the relationship the dependant variable which is economic growth (GDP) and the all selected independent variables which are temperature (TEMP), arable land (LAND), precipitation (PREP) and foreign direct investment (FDI). The reason we choose economic growth (GDP) as a dependant variable is due to its importance of the variable's role which has a significant impact on the country's economic performance. Lastly, all the data that is used in this research is annually based data.

All the hypothesis testing and diagnostic in this research checking will be completely run E-views 10 software is to perform statistical and econometrical analysis. Besides,

it is useful for this research as this software is developed for researchers that using cross-section, time-series data or longitudinal data and most importantly can manage the data efficiency as it combined by the flexible. Lastly, the software is capable to produce tables and graphs to provides the user with a better idea and also the purpose of presentation.

Most of the econometric test that is used for this research can be completed by using E-views 10 software. One of the models used in this research, which is the Pooled OLS model is extremely suitable to run E-Views software because of the strong features that comprise of Pooled OLS method. Besides, all the detection tests that used to detect the econometric problems such as Fixed Effects, Random Effects, Hausman Test and Wald Test can be run by E-views 10 software.

3.2 Data Collection Method

This paper is used and focused on the secondary data and all the variables in this research are collected from the World Bank Group (WBG). Also, the collection of data period is covered from 2004 to 2014 in collaboration of 10 sample size with three different countries such as Australia, India and South Africa. All the data collected is based on an annual basis.

3.2.1 Secondary Data

The nature of the data collected in this study is secondary data. The dependant variable (DV) in this study is which is economic growth (GDP) and the independent variables (IV_s) like temperature, precipitation, arable land and

foreign direct investment. The data is obtained through the World Bank Group (WBG) and the details of the variables are listed below in Table 3.2.1.

Table 3.1: *Details of Variables*

Variables	Detail	Unit Measurement
Economic Growth	The economic growth is measured by the annual Gross Domestic Product (GDP) (in purchasing power parity) which is the monetary value of all the finished goods and services produced in a country.	Current international $ millions
Temperature	The temperature measured by degrees Celsius (°C)	Increase/decrease of 1 point in °C
Arable Land	Percentage of land area	% of land area
Precipitation	Precipitation is measured by using a rain gauge. The unit of precipitation is linear to depth, usually in millimetres (volume/area), or kg m–2 (mass/area) for liquid precipitation.	mm per square meter
Foreign direct investment	FDI measures the total level of direct investment in foreign at a given period, normally end of quarter or year	Total direct investment (USD)

Note adapted from *World Bank Data,* 2020

3.3 Model Specification

$$Y_{it} = \beta_0 + \beta_1 Temp_{it} + \beta_2 Prep_{it} + \beta_3 Land_{it} + \beta_4 FDI_{it} + \mathcal{E}_{it} \quad (1)$$

where GDP is GDP (current Landing Craft Utility) (LCU) and the inputs Temp, Prep, Land and CO2 which represents temperature, precipitation, arable land and CO2 emissions. The i and t denote country and time whereas ε is an error term for country i and period t. Lastly, β is the coefficients to be estimated.

$$LGDPit = \beta_0 + \beta_1 LPrep_{it} + \beta_2 LTemp_{it} + \beta_3 LLand_{it} + \beta_4 LFDI_{it} + \varepsilon_{it} \quad (2)$$

$LGDP_{it}$ = Natural Logarithms of GDP (current LCU) for period t and country i

$LPrep_{it}$ = Natural Logarithms of Precipitation for period t and country i

$LTemp_{it}$ = Natural Logarithms of Temperature for period t and country i

$LLand_{it}$ = Natural Logarithms of Arable Land for period t and country i

$LFDI_{it}$ = Natural Logarithms of CO2 emissions for period t and country I

β_1 shows the impact of temperature that would affect the economic growth.

β_2 shows the impact of precipitation that would affect economic growth.

β_3 shows the impact of arable land that would affect economic growth.

β_4 shows the impact of carbon emission that would affect economic growth

Table 3.2 : *Expected Sign for Variables*

Variables	Expected Sign	Study
Temperature	(-)	• Climate change and economic growth in Africa: an econometric analysis. Journal of African Economies, by Abidoye, B. O., & Odusola, A. F. • Climate change impacts on west african agriculture: an integrated regional assessment by Adiku, S. G., MacCarthy, D. S., Hathie, I., Diancoumba, M., Freduah, B. S., Amikuzuno, J., ... and Lizaso, J. I. • Climate change and economic growth: An empirical analysis of Pakistan. Pakistan Journal of Applied Economics by Akram, N., & Gulzar, A. • Climate Change and Economic Growth in a Rain-fed Economy: How Much Does Rainfall Variability Cost Ethiopia? By Ali. S • An empirical study of relationships between CO2emissions, economic growth and openness by Choi, E., Heshmati, A., and Cho, Y. • Temperature Shocks and Economic Growth: Evidence from the Last Half Century by Dell, M., B. F. Jones, and B. A. Olken • The impact of climate variability and change on economic growth and poverty in Zambia by Thurlow, J., Zhu, T., & Diao, X. • The economic impacts of climate change: evidence from agricultural output and random fluctuations in weather by Deschênes and Greenstone.

		• The economics of climate change in agriculture. Mitigation and Adaptation Strategies for Global Change by Zilberman, D., Liu, X., Roland-Holst, D., & Sunding, D • Climate change impact assessment: the role of climate extremes in crop yield simulation. by Moriondo, M., Giannakopoulos, C., & Bindi, M.
Arable Land	(+)	• Agrarian Social Pacts and Poverty reduction by Sheingate • The economics of being poor by Schultz.W • Changes in arable land demand for food in india and china by Nath.R, Luan.Y and Yang.W.
Precipitation	(+)	• Social and economic impacts of climate by Carleton, T. A., and Hsiang, S.
Foreign direct investment	No significance relationship	• Does foreign direct investment accelerate economic growth by Carkovic, M., & Levine, R. • Determinants of foreign direct investment in the West African Monetary Zone: A system equations approach by Udo, E. A., & Obiora, I. K

	Bidirectional	• The two-way linkage between foreign direct investment and environment in Vietnam - from sectoral perspectives by Vinh, C.T.H
	(+)	• Foreign direct investment and growth in EP and IS countries by Balasubramanyam • Foreign direct investment, economic freedom and growth: new evidence from Latin America Bengoa and Sanchez-Robles • How does foreign direct investment affect economic growth by Borensztein et al • On the causal links between FDI and growth in developing countries by Hansen, H., & Rand, J • Foreign direct investment and economic growth: Some evidence from across the world by Ghatak, A., & Halicioglu, F • Foreign direct investment and economic growth: a time-series approach by Roy, A. G., & Van den Berg, H. F

3.4 Data Collection Method

Panel data consists of a group of cross-sectional data (temperature, precipitation, arable land, foreign direct investment) that are collected over a specific time frame (10 years). There are few estimators which are used to regress the data set and generate results- Pooled OLS, Fixed Effect Model (FEM), Random Effect Model (REM), Hausman Test and Wald Test.

3.4.1 Pooled OLS

Pooled OLS assumes that all the coefficients are the same regardless intercept or slope, they are same all across the country. To see whether the independent variable significantly affects the dependent variable, we compare the P-value of the variable with a significant level at $\alpha = 0.05$. If the P-value is lower than the significant level, this indicates that the IVs is significantly affected the DV.

3.4.2 Fixed Effect Model (FEM)

FEM model assumes that all the independent variables for the three countries are different, however, the slope is the same, and it is time-invariant, which will not change over time. To see whether the independent variable significantly affects the dependent variable, we compare the P-value of the variable with a significant level at $\alpha = 0.05$. If the P-value is lower than the significant level, this indicates that the IVs is significantly affected the DV.

3.4.3 Random Effect Model (REM)

REM model assumes that the intercept for each country is different but the slope is the same, and it is time-invariant, which will not change over time. To see whether the independent variable significantly affects the dependent variable, we compare the P-value of the variable with a significant level at $\alpha = 0.05$. If the P-value is lower than the significant level, this indicates that the IVs is significantly affected the DV.

3.4.4 Hausman Test

The Hausman Test observes the endogenous variable (independent variable) in a regression model. The endogenous variable is a variable in a statistic model that is determined or changed by its relationship between other variables in the model. This is because it correlates with other factors in the model being studied. Having this variable will cause the OLS estimator to fail as OLS assumes there is no correlation between the variables and error term. Before choosing the regression model, the Hausman Test can be used to detect if there is an endogenous variable in the model. If the endogenous variable was detected, the instrumental variable estimator can be used as an alternative. The instrumental variable estimator is the third variable correlated with the explanatory variable and uncorrelated with the error term.

3.4.5 Wald Test

Wald test is used to test the significance of explanatory variables in the model. If the variable is significant in the model, this means the independent variable, X can affect the dependent variable, Y in a meaningful way within the model. To test, this test null hypothesis, H_0 the economic growth is affected by temperature. If the Wald test results in 0, it indicates that temperature has no effect on economic growth, and it can be removed from the variable without harming the model. If the Wald test is not zero, this study should include the variable in the model.

CHAPTER 4: DATA ANALYSIS

4.0 Introduction

In this Chapter, we will deliver the results of our empirical data and by interpreting the results gained from our research data which we have mentioned in the earlier methodology in Chapter 3. The outcomes of our empirical analysis have been gained through diagnostic checking from Eviews. The results will be tabulated to get a better overview of the depth of the findings.

4.1 Descriptive Analysis

Table 4.1: *Summary of Eviews Results*

Variable	Pooled OLS Model	Fixed Effect Model	Random Effect Model
LPREC	0.8052**	0.8865	0.8052**
	(0.3637)	(0.6964)	(0.3695)
LTEMP	-1.7218	0.7416	-1.7218
	(1.1427)	(3.9377)	(1.1609)

LLAND	0.2559 (0.26)	-5.9095 (7.6946)	0.25559 (0.2641)
LFDI	-0.1134 (0.0903)	0.0123 (0.1464)	-0.1134 (0.0918)
C	3.2997 (3.3169)	13.66237 (21.7126)	3.2997 (3.3700)
R^2	0.6716	0.7877	0.6716
Adjusted R^2	0.6211	0.5451	0.6211
F-Statistic	13.2946	3.2472	13.2945
D-W test stat	1.7461	2.0131	1.7461

Standard error in parentheses

Note: ***, ** and * denotes significant at 1%, 5% and 10% significance levels

Note adapted from E-views results in Appendix

4.1.2 Pooled OLS

$$GDP_{it} = 3.2997 + 0.8052LPrep_{it} - 1.7218LTemp_{it} + 0.2559LLand_{it} - 0.1134LFDI_{it} + \varepsilon_{it}$$

Based on the results of Pooled OLS, it shows that the GDP per capita on average is USD USD 3.2997 when there is no other factor affecting the GDP. When there is an increase mm per square meter of linear depth in precipitation, the average increase in GDP is 0.8052 USD showing a positive relationship between GDP per capitation and precipitation. For every raise in 1 degree Celsius, on average, the GDP decreased by 1.7218USD. The temperature is reacting negatively towards GDP. For arable land, it shows an increase in GDP of 0.2559 USD for every expansion in 1 percent of arable land proving a positive link. The foreign direct investment however increases by 1USD on average when GDP is decreased by 0.1134 USD. The R^2 of 0.6716 indicates that 76.16 per cent of the variation can be explained by the four IVs (prep, temp, land, FDI) in this study. The other 23.84 per cent denoted the factors to which were not studied. The durbin Watson test of 1.7461 indicates that there is positive autocorrelation detected in the sample

4.1.3 Fixed EfFect Model

$$LGDP_{it} = 13.6624 + 0.8865LPrep_{it} + 0.7416LTemp_{it} - 5.9095LLand_{it} + 0.0123LFDI_{it} + \varepsilon_{it}$$

From the Fixed Effect Model, we have computed that on average, the GDP is USD 13.6624 when there is no other factor affecting the GDP. For precipitation, every increase in mm per square meter of linear depth, on average, the GDP increased by 0.8865 USD. The GDP decreases by 0.7416 USD for every rise in 2 degree celsius of temperature showing a negative relationship. For every

expansion in 1% of arable land, on average, the GDP decreased by 5.9095 USD. The foreign direct investment however shows that GDP increases by 0.0123 USD for every 1USD. The R^2 of 0.7877 indicates that 78.77 per cent of the variation can be explained by the four IVs (prep, temp, land, FDI) in this study. The other 21.23 per cent denoted the factors to which were not studied. Durbin Watson test = 1.7461 indicates that there is positive autocorrelation detected in the sample.

4.1.4 Random Effect Model

$$LGDP_{it} = 3.2997 + 0.8052LPrep_{it} - 1.7218LTemp_{it} + 0.2559LLand_{it} - 0.1134LFDI_{it} + \varepsilon_{it}$$

Based on the Random Effect Model, we have discovered that on average, the GDP is USD 3.2997 when there is no other factor affecting the GDP. When there is an increase in mm per square meter of linear depth, on average, the GDP increases by 0.8052 USD. For temperature, there is a rise of 1 degree Celsius, on average, the GDP decreased by 1.7218USD showing a negative relationship between both variables. There is an increase in GDP by 0.2256 USD for every expansion in 1 percent of arable land. The average foreign direct investment of 1USD shows a decrease in GDP by 0.1134 USD on average. We have computed R^2 0.7616 which indicates that 76.16 per cent of the variation can be explained by the four IVs (prep, temp, land, FDI) in this study. The other 23.84 per cent denoted the factors to which were not studied. The Durbin Watson test equivalent to 1.7461 indicates that there is positive autocorrelation detected in the sample. [LG9]

4.1.5 Hausman Test

Hausman test is conducted to distinguish whether FEM or REM will be more suitable for this research.

Table 4.2: *Hausman Test Results*

Test summary	Chi-sq. Statistic	Chi-sq. d. f.	Prob.
Cross-section random	0.664499	4	0.9556

Hypothesis:

H_0: REM is endorsed in this study

H_1: FEM is endorsed in this study

Decision Rules:

1. Reject null hypothesis (H_0) if the p-value is lower than the significance level of 5 per cent. This will indicate that FEM will be the most suitable model for this research.

2. Do not reject the null hypothesis (H_0) if the p-value is greater than the 5 percent significance level. This shows that REM will be the most suitable model for this research.

Conclusion:

The P-value that the Hausman Test produced is 0.9556 which is more than $\alpha = 0.05$. H_0 will not be rejected. REM is the most suitable model for this research.

4.2 Wald Test

Decision rule :

1. Reject null hypothesis, (H_0) when the significance level (0.05) is higher than the P-value.

2. Do not reject the null hypothesis, (H_0) if the significance level (0.05) is lower than the P-value.

Table 4.3*: Summary of Wald Test Results*

Variable	t-statistic	F-statistic	Chi-square	P-Value
LFDI	-1.2551	1.5753	1.5753	0.2206
LLAND	0.9844	0.9691	0.9691	0.3340
LPREC	2.2138	4.9010	4.9010	0.0358**
LTEMP	-1.5068	2.2704	2.2704	0.1439
C	0.9948	0.9897	0.9897	0.3290

Note adapted from *E-views results*

Note: ***, ** and * denotes significant at 1%, 5% and 10% significance levels,

It indicates the significance of individual variables in relationship to income GDP growth per capita in Australia, India and South Africa.

For independent variable FDI, P-value is 0.2206 which is higher than the significant level of 5 per cent. Therefore, the null hypothesis is not rejected. At the same time, the wald test shows that arable land also shows P-values that are higher than the 0.05 significance level. The null hypothesis is not rejected. Similarly, for temperature, the null hypothesis is not rejected. This proves that FDI, arable land and temperature are all significant short-run variables. However, the P-value of precipitation is 0.0358 which is lower than significant level 0.05. The null hypothesis is rejected and this proves that there is the long-run significance of the individual variable in this model.

4.3 Conclusion

In conclusion, chapter 4 has delivered the outcome of relationships between the dependent variable and the independent variable. The empirical results have been formed. In the later chapter, the summarized version of this whole research paper will be delivered and discussed.

CHAPTER 5: DISCUSSION, CONCLUSION AND IMPLICATIONS

5.0 Introduction

This research subject has principally focused on examining the relationship between the economic growth and four independent variables which are temperature, precipitation, arable land and foreign direct investment from the year 2004 to 2012 for Australia, India and South Africa. The objective of this study is to observe if climate change has any impact on the changes in economic growth. The chapter starts with a deeper understanding by discussing the relationship of each independent variable with the dependent variable by verifying the statistical information and findings from all the tests done from Chapter 4. By using the findings, we will deliver the implication of the study for upcoming changes or improvements needed to be made in the future for some areas. Moreover, the delivery of limitation for study and recommendation to improve future research will be stated. Finally, the last part would be the total conclusion for the whole study.

5.1 Discussion of Major Findings

5.1.1 Relationship Between Temperature and Economic Growth

The empirical results gotten from the data analysis shows that there is an insignificant relationship between temperature and economic growth. This is because the P-value is larger than 0.05. This means that there is no long-run effect of temperature on economic growth.

However, there is opposition in the results of past studies. (Colacito et al, 2018) found that the rise in temperature during summer harms economic growth. Also, they found the opposite effect when the temperature decreases. This shows a significant result of temperature on the economic growth of the USA. Huntington (2015) studied that is known for a while that there is a negative cross-sectional relationship between the two. Moreover, the link between temperature fluctuations and economic growth has been historic. They have found significant effects but not in rich countries (Mellisa, 2011). Their study shows that in poor countries, the economic growth drops by 1.3 percentage point when there is an increase of temperature by 1-degree Celcius which concluded that climate change might impact GDP rate more likely than the level of output. Thus, it shows that our results defer from past studies.

5.1.2 Relationship between Precipitation and Economic Growth

With a p-value of 0.0358 which is less than 0.05 indicates that there is a positive relationship between precipitation and economic growth. This means that there is a long run significant effect of precipitation on economic growth.

Our results are in agreeable terms with past studies like Richardson (2007) who researched regarding the rainfall as precipitation measure on economic growth in Zimbabwe and finds a positive relationship between precipitation and economic growth. Brown et al. (2011) who has researched impact rainfall shows on economic growth for the sample of 42 Sub-Saharan countries and is seen a significantly small reaction of rainfall on the GDP per capita. A study was done by Akram (2012) on a few Asian countries has resulted in the precipitation having a significant effect on economic growth which is mainly due to the agricultural field. However, the study done by Dell, Jones and Olken (2012) proves that there is a difference in the impact of precipitation in accordance with different country's level of development. When there is a positive outcome of rainfall on economic growth in low earning countries, it is vice versa for rich countries. Overall, it is proven that precipitation has a positive impact on economic growth.

5.1.3 Relationship between Arable Land and Economic Growth

Results from the tests show that there is an insignificant relationship between arable land and economic growth. This is said because the P-value of 0.3340 is larger than the significant level of 0.05. This means that there is no long-run effect of arable land of economic growth.

However, these results differ from Schultz's research in 1979 on China's arable land and economy effects. Schultz's research showed a positive impact of arable land on economic growth as in underdeveloped countries the arable land is needed as one of a significant factor for the economy as they are agriculture dominant economies. This study also based and compared their results to other countries using the World Bank's data and their results showed that arable land and economic growth has a positive relationship as the underdeveloped countries rely on their agricultural sectors as one of the GDP's main contributors. Therefore, our results have differed from past studies that have been done on underdeveloped countries.

5.1.4 Relationship between Foreign Direct Investment and Economic Growth

Results from the tests show that foreign direct investment is an insignificant factor in affecting the economic growth in Australia, India and South Africa with a large P-value of 0.2206 (higher than 0.05

significant level). This can be interpreted as arable land having no long-run effect on the economic growth of said countries.

Nevertheless, these results differ from Peterson and Laudicina's research early this year on foreign direct investment which is said to have an important role in the economy's growth. 77 per cent of financial investors state that climate-related risks make a huge difference in foreign direct investment decisions; thus, affecting the economy. Similarly, Bengoa and Sanchez's research in 2003 also states that the foreign direct investment of a country is vital for GDP growth. They concluded that FDI has a positive effect on economic growth in Latin America. In Chowdhury's research in 2005 on Thailand, Malaysia and Chile, FDI showed significant beneficiaries to the country's economic growth. In contrast, Borensztein et al (1998) researched using panel set data which is 72 developed and developing countries and his research showed no significant relationship between FDI and economic growth of countries. In conclusion, it can be said that our results are similar to Borensztein's as it shows that FDI is an insignificant factor in contributing to economic growth.

5.2 Implications of Study

5.2.1 Policy Implications

The factors that effects climate change which is arable land and precipitation have shown significant effects on the economic growth of a country while temperature and foreign direct investment don't have significant effects according to annual data from in this research study. This result would then can act as guidelines and references to future

researchers, policymakers and governments on their duties role to carry out their task. The findings have vital practical and policy implications.

According to Wade and Jennings (2016), decarbonizing the world's energy supply through fast energy progress will lessen the dangers of environmental change. The utilization of biofuels, hydrogen and tidy energy can accelerate decarbonisation close by decreasing demand through energy proficiency measures. Governments may offer endowments to green energy suppliers to advance the development and decrease the expense of energy from these segments. The Bank of England has as of late dedicated to investigating the dangers to the money related framework if atmosphere guideline were to restrict worldwide temperature increments. It follows on from remarks made by Mark Carney during the 2014 World Bank class that referred to the likelihood that most of demonstrated coal, oil and gas stores could be considered "unburnable" if guideline limited temperature increments to 2°C. Among financial experts, it is perceived that to successfully stem the creation of carbon dioxide, an all-inclusive perceived market-based methodology is required. One of the most broadly proposed measures is carbon valuing. Setting a cost on every ton of carbon dioxide transmitted, or disseminating tradable grants that permit an expressed degree of carbon dioxide emissions, is accepted to be a viable measure to battle global warming.

Awareness to residents lined up with government administrative force can be a potential solution for environmental degradation issue. They must be made aware of the outcomes of using bad quality oil-based commodities and boost to use energy-saving gadgets and services, for example, sun-powered household things, LPG for cooking and energy moderating electric bulbs. Where these things are expensive to buy, the legislature can give them at financed rates. Measures to control deforestation by the residents of the nation’s should be fortified since

these exercises discharge CO2 emission into the atmosphere. Emission standards must be set for ventures and emission monitoring policies ought to be set up to ensure compliance. The advancement of the monetary business sectors in these nations can likewise help with upgrading interest in innovative work in current energy proficient advances consequently guaranteeing lower emanations.

Classifying fitting policies for mitigation and for adjusting to outstanding atmosphere harms additionally requires a long-term overview. Despite short-range policy costs, climate change approaches have noteworthy advantages. To begin with, approaches that accomplish outflow decreases in the close to term convey a flood of future advantages by diminishing environmental change impacts, while variation lessens the unfavourable results of atmosphere impacts that are now in progress. Furthermore, there are significant co-profits by strategy activity that can be harvested right away. The government assistance expenses of unexpected losses and the expanded dangers for huge scope solitary occasions are of specific significance. Co-benefits outside the atmosphere area incorporate improved wellbeing from decreased air pollution (Bollen and Brink, 2014).

5.2.2 Theoretical Implication

By looking at the point of view, we first suggest Environmental Kuznets curve (EKC), investigating the relationship between the level of environmental degradation and the GDP per capita. However, this model has a lot of criticism and drawbacks, which lately smother by Green Solow Model and classical growth model. EKC sometimes will

confuse the reader, and the empirical results are fragile, Green Solow Model comes in later to explain the puzzles regarding the EKC on the environmental degradation and GDP. By understanding the Green Solow Model, it will help the future researchers to understand more about the classical Solow model, and solve the puzzles of EKC which confused the readers.

Besides, regarding the precipitation and temperature, this study suggested the classical growth theory, which the theory suggests that the precipitation and temperature has a negative relationship towards the GDP. This strongly explained the main focus in this study regarding the factor affecting the GDP in India, Australia and South Africa. With this, the future researches can refer to this theory, which they can understand more on this framework, investigating the relationship between the environmental issues and GDP for the nation.

For the test run and diagnostic, this study suggested Pooled OLS, Fixed effect model and random effect model. To test whether which test is most appropriate, the Hausman test is suggested to run and lastly, the Wald test is run to test the independent variable is significant, which add value to the model. Through the Hausman test, random effect model is more suitable for this study. Human behaviour is hard to predict, which any study that predicts human behaviour will tend to have the R^2 value of less than 50 per cent. From this study, through the random effect model, the R^2 value is 67.16 per cent which is higher than 50 per cent. Therefore, we can conclude that all the independent variables are significant in this study which implies that all the independent variables can be used to describe 67.16 per cent of the variation in the GDP. Therefore, the validity and applicability of the model of this study toward the GDP are demonstrated. This might help future researches to understand more of those independent variables identified in this study

and help the future researches to formulate an effective model for the GDP in Australia, India and South Afrika.

Besides, the theoretical implication of the study is to find out the relationship between the IV (temperature, precipitation, arable land, foreign direct investment) and DV(GDP). The results demonstrated that all the dependent variables are relating to the GDP, and all the conceptual models are adequate. Future researches can refer to the framework to understand more and facilitate their researches.

Moreover, this study not only concerned about environmental issues, but also the FDI, which concerned about the investment inflows and outflows. Unlike past study which only focuses mainly on the funds' inflow and outflows or mainly focuses on environmental issues. This study looked into both essential sources of the nation's GDP, which can conclude that this study provides a significant reference for future researches regarding the relationship between the independent variables and dependent variable. With this, this study is significant and strong to use as a reference for future researches.

5.3 Limitations of Study

In this study, we focused on the impacts of climate change on economic growth in Australia, India and South Africa such as temperature, arable land, precipitation and foreign direct investment. Along with our research outcome, we faced several limitations that influence our research result. Firstly, the results obtained in this research are not essentially sufficient and precise enough to alone construct and reflect the effects of independent variables on dependant variable due to several limitations that may affect the accuracy and effectiveness of the findings on this

research. Lastly, the researcher and readers must aware of the limitations as the important aspects or minimize or maybe prevent the losses in the financial sector and economic stability. Further discussion of the limitation of the study is revealed in the below paragraphs.

The research is quite narrow as it is concentrated on the Australia, India and South Africa's economic growth performances and all the data conducted to run out the hypothesis testing are based on Australia, India and South Africa' economic and politic historical data. As this research completely based on Australia, India and South Africa based, any outcome from this research is only relevant and appropriate in applying on Australia, India and South Africa' economic growth. Any other investigator who wants to use the results of this research in other countries rather than Australia, India and South Africa, must have consideration of other major factors that is relevant to the country even though the countries used the same classification inform economic, political standing, and geographic standpoint. This is because of different style in their distinction in the investment environment and economic implication on a policy.

Besides that, the period of data we obtained from 2004 to 2014 annually data. Throughout this research, we find the information can be less and lack that most likely come out from insufficient of research work and study can related to the selected topic which is capital stock in Australia, India and South Africa. We couldn't find sufficient data for capital stock which is considered one of the important microeconomic variable for this research. So, we substitute the capital stock variable with foreign direct investment. Thus, we faced a limitation that will affect the accuracy of our outcome. Nevertheless, these limitations are a reminder for future research purpose and it does not falsely or distort the findings throughout this research.

5.4 Recommendations for Future Research

Throughout the research, this study investigates the relationship of temperature, precipitation, arable land and FDI towards the GDP. From the limitation of this research, this study suggested a few recommendations which might be useful to the future researches for better facilities of the study.

Although the R^2 of this study is 67.16 per cent which considered as high, however, some of the independent variables are not significant to explain the GDP. Instead of investigating the factors affecting the GDP, future researches can research on factors limiting the GDP, which the proposed independent variable could be health condition and education level, the economic infrastructure, flight of capital, policy stability and institutional framework. This is because most of the researches tend to investigate the factors that have a direct impact on the Economics, while the factors limiting the GDP can be a new field of research which tend to get better result of the test and diagnostic.

Besides, this study is mainly focused on Australia, India and South Africa, which China, Norway and the United States are proposed to be the countries for better data collection. To collect more accurate and precise data, China is very important to be selected as China is the highest population developing country. Next would be Norway, which is the world's most developed nation that has the human development index of 0.954. This is essential as the technology advancement in Norway is significant to affect the import, export and investment from foreigners. Lastly, the United States is proposed to be a sample country due to top international influence ranking. Most of the researches, from the past decade or recent researches, are interested in the United States because the U.S has the highest power to influence global economics.

Lastly, the panel data that this study looked into is from 2004 to 2014 yearly data. For the environmental issues like global warming that impact temperature, precipitation, 10 years period is not sufficient to conclude the relationship

between GDP and it. This study suggesting future researches to gather data from the 19th century as the climate change issues began in the early 19th century which is the 1930s. The evidence increasingly becomes convincing since the 1960s, which some scientists had pointed out the human activities that generate atmospheric pollution will impact the environment. Therefore, this study suggests the future researches to investigate the data from the 1950s to 2000s.

5.5 Conclusion

In summary, this study objectifies in investigating the impact of climate change on economic growth in Australia, India and South Africa from the year 2004 to 2014. The are many factors which would affect economic growth deeply, but the impact of climate change has always been not clearly stated or seen. Therefore, this study is to deliver the perspective of our results based on our information gained. According to the examined results, we have found that two variables have a positively related to the economic growth which is temperature and arable land. The other two variables which are precipitation and foreign direct investment has a negative relationship with economic growth. Based on the Walt test result that we carried out, it was proven that only precipitation has a long-run effect on economic growth while temperature, arable land and foreign direct investment has a short term effect. Besides that, we have also included Pooled OLS test, Fixed Effect model test, Random Effect Model test and Hausman test to check the normality of this model. Limitations and recommendations have also been provided in this research to be able to guide future researchers who aim to study this subject of area. Moreover, this research paper may also be advantageous to business people or policymakers in regards to deciding on climate change on economic growth. Lastly, we have concluded that the effect of climate change on economic growth is only significant on a smaller scale.

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APPENDICE A

Dependent Variable: LGDP
Method: Panel Least Squares
Date: 08/23/20 Time: 18:20
Sample: 2004 2014
Periods included: 11
Cross-sections included: 3
Total panel (unbalanced) observations: 31

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LTEMP	-1.721799	1.142689	-1.506795	0.1439
LPREC	0.805183	0.363715	2.213775	0.0358
LARLAND	0.255919	0.259969	0.984425	0.3340
LFDI	-0.113379	0.090335	-1.255091	0.2206
C	3.299748	3.316928	0.994820	0.3290

Root MSE	0.273357	R-squared	0.671627
Mean dependent var	1.411882	Adjusted R-squared	0.621108
S.D. dependent var	0.484916	S.E. of regression	0.298486
Akaike info criterion	0.566502	Sum squared resid	2.316440
Schwarz criterion	0.797790	Log likelihood	-3.780779
Hannan-Quinn criter.	0.641896	F-statistic	13.29458
Durbin-Watson stat	1.746100	Prob(F-statistic)	0.000005

Fixed Effect Model

Dependent Variable: LGDP
Method: Panel Least Squares
Date: 08/23/20 Time: 18:24
Sample: 2004 2014
Periods included: 11
Cross-sections included: 3
Total panel (unbalanced) observations: 31

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LTEMP	0.741581	3.937686	0.188329	0.8533
LPREC	0.886517	0.696441	1.272926	0.2238
LARLAND	-5.909524	7.694628	-0.768006	0.4552
LFDI	0.012327	0.146424	0.084190	0.9341
C	13.66237	21.71257	0.629238	0.5393

Effects Specification

Cross-section fixed (dummy variables)
Period fixed (dummy variables)

Root MSE	0.219780	R-squared	0.787732
Mean dependent var	1.411882	Adjusted R-squared	0.545141
S.D. dependent var	0.484916	S.E. of regression	0.327043
Akaike info criterion	0.904395	Sum squared resid	1.497400
Schwarz criterion	1.690775	Log likelihood	2.981883
Hannan-Quinn criter.	1.160735	F-statistic	3.247152
Durbin-Watson stat	2.013106	Prob(F-statistic)	0.016110

Random Effect Model (Wallace and Hussain)

Dependent Variable: LGDP
Method: Panel EGLS (Cross-section random effects)
Date: 08/23/20 Time: 18:31
Sample: 2004 2014
Periods included: 11
Cross-sections included: 3
Total panel (unbalanced) observations: 31
Wallace and Hussain estimator of component variances

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	3.299748	3.369899	0.979183	0.3365
LTEMP	-1.721799	1.160938	-1.483110	0.1501
LPREC	0.805183	0.369523	2.178977	0.0386
LARLAND	0.255919	0.264120	0.968951	0.3415
LFDI	-0.113379	0.091778	-1.235362	0.2277

Effects Specification	S.D.	Rho
Cross-section random	0.000000	0.0000
Idiosyncratic random	0.303253	1.0000

Weighted Statistics			
Root MSE	0.273357	R-squared	0.671627
Mean dependent var	1.411882	Adjusted R-squared	0.621108
S.D. dependent var	0.484916	S.E. of regression	0.298486
Sum squared resid	2.316440	F-statistic	13.29458
Durbin-Watson stat	1.746100	Prob(F-statistic)	0.000005

Unweighted Statistics			
R-squared	0.671627	Mean dependent var	1.411882
Sum squared resid	2.316440	Durbin-Watson stat	1.746100

Hausman test

Correlated Random Effects - Hausman Test
Equation: Untitled
Test cross-section random effects

Test Summary	Chi-Sq. Statistic	Chi-Sq. d.f.	Prob.
Cross-section random	0.664499	4	0.9556

** WARNING: estimated cross-section random effects variance is zero.

Cross-section random effects test comparisons:

Variable	Fixed	Random	Var(Diff.)	Prob.
LTEMP	-0.679917	-1.721799	5.923350	0.6686
LPREC	0.637025	0.805183	0.078233	0.5477
LARLAND	3.066829	0.255919	18.656752	0.5152
LFDI	-0.098669	-0.113379	0.001441	0.6983

Cross-section random effects test equation:
Dependent Variable: LGDP
Method: Panel Least Squares
Date: 08/23/20 Time: 18:40
Sample: 2004 2014
Periods included: 11
Cross-sections included: 3
Total panel (unbalanced) observations: 31

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-8.144618	14.44811	-0.563715	0.5782
LTEMP	-0.679917	2.696503	-0.252148	0.8031
LPREC	0.637025	0.463444	1.374546	0.1820
LARLAND	3.066829	4.327414	0.708698	0.4853
LFDI	-0.098669	0.099316	-0.993480	0.3304

Effects Specification

Cross-section fixed (dummy variables)

Root MSE	0.269647	R-squared	0.680480
Mean dependent var	1.411882	Adjusted R-squared	0.600600
S.D. dependent var	0.484916	S.E. of regression	0.306458
Akaike info criterion	0.668205	Sum squared resid	2.253991
Schwarz criterion	0.992009	Log likelihood	-3.357177
Hannan-Quinn criter.	0.773757	F-statistic	8.518775
Durbin-Watson stat	1.894110	Prob(F-statistic)	0.000051

Wald test

Dependent Variable: LGDP
Method: Panel Least Squares
Date: 08/23/20 Time: 21:11
Sample: 2004 2014
Periods included: 11
Cross-sections included: 3
Total panel (unbalanced) observations: 31

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LFDI	-0.113379	0.090335	-1.255091	0.2206
LARLAND	0.255919	0.259969	0.984425	0.3340
LPREC	0.805183	0.363715	2.213775	0.0358
LTEMP	-1.721799	1.142689	-1.506795	0.1439
C	3.299748	3.316928	0.994820	0.3290

Root MSE	0.273357	R-squared	0.671627
Mean dependent var	1.411882	Adjusted R-squared	0.621108
S.D. dependent var	0.484916	S.E. of regression	0.298486
Akaike info criterion	0.566502	Sum squared resid	2.316440
Schwarz criterion	0.797790	Log likelihood	-3.780779
Hannan-Quinn criter.	0.641896	F-statistic	13.29458
Durbin-Watson stat	1.746100	Prob(F-statistic)	0.000005

C1= LFDI

C2=LARLAND

C3=lPREC

C4=LTEMP

C5=C

Wald Test:
Equation: Untitled

Test Statistic	Value	df	Probability
t-statistic	-1.255091	26	0.2206
F-statistic	1.575253	(1, 26)	0.2206
Chi-square	1.575253	1	0.2094

Null Hypothesis: C(1)=0
Null Hypothesis Summary:

Normalized Restriction (= 0)	Value	Std. Err.

C(1)	-0.113379	0.090335

Restrictions are linear in coefficients.

Wald Test:
Equation: Untitled

Test Statistic	Value	df	Probability
t-statistic	0.984425	26	0.3340
F-statistic	0.969092	(1, 26)	0.3340
Chi-square	0.969092	1	0.3249

Null Hypothesis: C(2)=0
Null Hypothesis Summary:

Normalized Restriction (= 0)	Value	Std. Err.
C(2)	0.255919	0.259969

Wald Test:
Equation: Untitled

Test Statistic	Value	df	Probability
t-statistic	2.213775	26	0.0358
F-statistic	4.900798	(1, 26)	0.0358
Chi-square	4.900798	1	0.0268

Null Hypothesis: C(3)=0
Null Hypothesis Summary:

Normalized Restriction (= 0)	Value	Std. Err.
C(3)	0.805183	0.363715

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Wald Test:
Equation: Untitled

Test Statistic	Value	df	Probability
t-statistic	-1.506795	26	0.1439
F-statistic	2.270432	(1, 26)	0.1439
Chi-square	2.270432	1	0.1319

Null Hypothesis: C(4)=0
Null Hypothesis Summary:

Normalized Restriction (= 0)	Value	Std. Err.
C(4)	-1.721799	1.142689

Wald Test:
Equation: Untitled

Test Statistic	Value	df	Probability
t-statistic	0.994820	26	0.3290
F-statistic	0.989668	(1, 26)	0.3290
Chi-square	0.989668	1	0.3198

Null Hypothesis: C(5)=0
Null Hypothesis Summary:

Normalized Restriction (= 0)	Value	Std. Err.
C(5)	3.299748	3.316928

Restrictions are linear in coefficients.