MALAYSIA'S SUSTAINABLE GIFT: A COMPREHENSIVE ANALYSIS OF PALM OIL INDUSTRY

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DECLARATION

We hereby declare that:

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(2) No portion of this FYP 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 FYP.

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LIST OF ABBREVIATIONS

ADF	Augmented Dickey-Fuller
AIC	Akaike Information Criterion
ARDL	Autoregressive Distributed-lag
CO_2	Carbon Dioxide
CPO	Crude Palm Oil
ECM	Error Correction Model
EU	European Union
FTA	Free Trade Agreement
GDP	Gross Domestic Product
GHGs	Greenhouse gases
GTMP	Green Technology Master Plan
JB	Jarque-Bera
KLCI	Kuala Lumpur Composite Index
MPOB	Malaysian Palm Oil Board
NBP	National Biofuel Policy
NGTP	National Green Technology Policy
OLS	Ordinary Least Square
PP	Philips-Perron
SBO	Soybean Oil
SDGs	Sustainable Development Goals
VAR	Vector Autoregression Model
VECM	Vector Error Correlation Model
VIF	Variance Inflation Factor

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PREFACE

Malaysia, a Southeast Asian nation is engaged in agriculture as its main economic activity due to its strong dynamic geography. Agriculture is the backboned of Malaysia by contributing RM96 billion to the Gross Domestic Product (GDP) and around 800K of employment in 2017. Besides, it is also the second largest crude palm oil (CPO) producer and exporter in the world market. As overall, the CPO Price has become the sustainable factor in palm oil industry due to the intense competition in Asian country, economy of Malaysia with high dependency of palm oil, and high usage of palm oil in variety of final products. Therefore, CPO price has become our main analysis in this study.

CPO price has started to become more fluctuated in 2008 compared to the past decade. This has brought negative impacts towards the Malaysia in terms of its economy growth, unstable job employment, export revenue, and also potential of stock pile and short of stock. Therefore, this has raised the awareness for the authors to conduct this study due to the huge impacts of CPO industry towards the Malaysia economy. The authors have come out with the ideas to first determine the factors affecting the CPO price and also from that, they want to provide some policies to control the CPO price and also create a long-lasting demand. As a result, it can achieve the sustainability of palm oil industry and subsequently achieve the sustainable development goals of Malaysia.

In order to achieve the sustainability of palm oil industry, the authors have decided to identify the relationship between the CPO price and the factors from three perspectives, including economic, financial and environment. The determinants that affect CPO price are crude oil price, soybean oil price, production of CPO, export of CPO, exchange rate, biodiesel production, stock price and climate change. Climate change will also act as the interaction term to all the independent variables to make this study more comprehensive. Lastly, the authors hope this research will provide a clear picture and comprehensive study to the readers about the palm oil industry in Malaysia.

ABSTRACT

Starting from 1960, CPO had become the main contributors to Malaysia's Gross Domestic Product (GDP), job opportunities and export revenue until today. However, the price of CPO was fluctuated over the past decade that has brought significant negative effect to Malaysia's economic performance. In order to achieve Sustainable Development Goals of Malaysia, sustainability of CPO industry should take into consideration. This paper investigates the key elements that affect the CPO price through three main perspectives, which are economy, financial and environment. The independent variables include CPO production, biodiesel production, crude oil price, export of CPO, exchange rate, stock price and climate change. This research examines the determinants of CPO price and identifies the combination effects of all the independent variables towards CPO price. Besides, climate change has additionally taken as interaction term in this study to examine its indirect effect towards CPO price to achieve sustainability of palm oil industry.

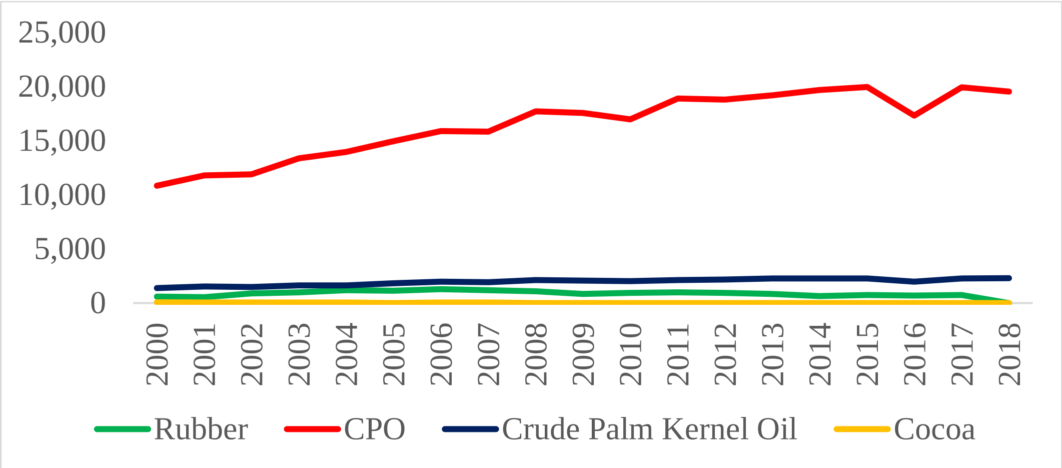
The method utilized in this research is ARDL to examine the relationship between variables by adopting time series analysis from January 2007 to May 2018. As the result showed, crude oil price is insignificant towards CPO price under all the models due to the error term of crude oil price is not normally distributed which may lead to bias and unreliable result. Also, stock price is insignificant in all the models except for the full model with climate change as interaction. This is driven by stock price is slightly instable in the CUSUM test and tend to create a misleading conclusion and inaccurate forecast. In overall, policies will be provided at the end of the research to achieve the sustainability of palm oil industry by coping with the current issues and creating a long-lasting demand. Besides, recommendation also provided in this study for the benefits of future researchers.

CHAPTER 1: RESEARCH OVERVIEW

1.0 Introduction

A rapid growth of agriculture intensification has occurred in Southeast Asia that driven by large population growth, strong economies and a higher consumer demand (Lam, Pham & Nguyen-Viet, 2017). Malaysia, a Southeast Asian nation is engaged in agriculture as its main economic activity due to its strong dynamic geography. Moreover, Agriculture is also the backboned of the country by providing exports revenue, local consumption and employment opportunities (Sharala Axryd & Chari, 2019). It has made a contribution of 8.2% or 96 million to the Gross Domestic Product (GDP) and around 835,974 of employment in 2017 (Shaheera Aznam Shah & Rahimi Yunus. 2019). Moreover, the gross output of agriculture was stood at RM91.2 billion in 2017 and has increased 11.1% per year since 2015 (Department of Statistic Malaysia, 2019). In Malaysia, there are 2 types of agriculture called as Plantation and Food Production (Khairani Afifi Noordin, 2018). In general, plantation involves palm oil, rubber, cocoa while Food Crops includes rice, vegetables, fruits and others (Nasir Shamsudin, 2018). Figure below is the statistic depicting the production of Major Agricultural Products in Malaysia from 2000 to 2018.

Figure 1.1: *Production of Major Agricultural ('000 tonnes)*



Sources: Bank Negara Malaysia 2018

1.1 Research Background

1.1.1 Palm Oil Industry

From the graph above, it is clear to see that crude palm oil (CPO) production has the highest production and growth across the years. From the contribution of agriculture to GDP (RM96 billion), CPO has occupied 46.6%, acting as a main contributor in this sector (Department of Statistic Malaysia, 2018). Palm Oil industry was began 100 years ago in Malaysia and is now developed to the second largest CPO production and exporters in the world market (Balu Nambiappan et al., 2018). By reviewing its historical movement from 1960 to 2016, there is a rapid growth in Malaysia planted area and also CPO production where it increase to 5.74 million hectares and 17.32 million tonnes from 55,000 hectares and 100,000 tonnes respectively (Balu Nambiappan et al., 2018). Likewise, export of CPO from solely depending on Europe in the earlier years has now expanded into more than 200 markets worldwide. There was roughly $8.7 billion export of CPO in 2018, which engaged 29% of the total world CPO export (Daniel, 2019). Therefore, there is a higher chance for the palm oil industry to growth in the future as the world population is expecting to reach 9 billion by 2050 (Palm Oil Today, 2019). In short, this research is to determine the sustainability of Malaysia's palm oil industry by examine the factors that affects the CPO price in Malaysia via the aspects of economy, financial and environment. Thus, it will also partially achieve the Sustainable Development Goals (SDGs) that implemented by United Nations Member States in 2015 such as affordable and clean energy, decent work and economic growth as well as climate action by controlling these factors through this research (Sustainable Development Goals, 2020).

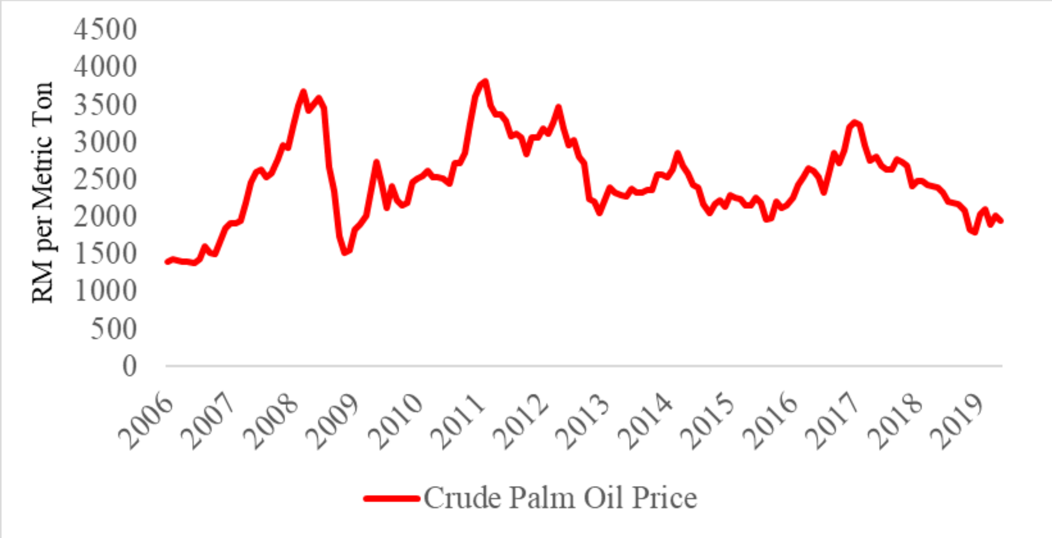
However, despite the rapid growth in palm oil industry, it is facing severe challenges today. Indonesia as the largest producer and exporter of CPO is one step ahead Malaysia. Government Malaysia has been restricted by the competitive pricing in Indonesia to expand its CPO into Indian and Chinese markets ("Improve the competiveness", 2018). Nevertheless, the government is optimistic in palm oil industry by identified potential new markets in Africa, Central Asia and South Asia

("M'sia To Switch", 2019). Moreover, additional funds were allocated by government for downstream projects, to make a development in oleochemical and biochemical sectors together with encouraging more manufactured palm-based food and health products that may generate higher income for the country and economic growth ("Govt Has Identified", 2019).

Therefore, by looking at the sustainability in palm oil industry, CPO price has become an important factor due to the intense competition and economy of Malaysia. According to Amir Hamzah Hashim (2017), majority of the CPO was taken into other industries such as food and cosmetic industry for further processing into cooking oil, soaps and others more. Therefore, a change in the CPO price will in turns lead to the change in the price of these final products. Moreover, a mandate by government for B5 blending has formulated the biodiesel to contain 5% of CPO starting 2011 (Johari et al., 2015). Therefore, transportation cost may be affected by the CPO price as it's made up of palm oil and it is environmentally friendly. Biodiesel is commonly used by trucks and busses; thus, the cost of public transport will be depending on CPOP.

In short, fluctuation of CPO price has a substantially affect the economic growth of Malaysia (Rafiq & Salim, 2014). The study done by Mohd Haziq Murshidi & Aralas (2017) has shown Malaysia is highly depends on CPO which resulted the volatility of CPO price will contribute a great impact on the financial development and affect the economic growth of the country. This also supported by the study in Mohd Hazip Murshidi and Aralas (2017), the CPO will affect the growth of GDP positively in Malaysia given the negative price changes is lesser than the positive changes in the particular period and vice versa. Thus, the CPO price is volatile over the period has brought the instability to the GDP of Malaysia. Besides, job opportunities and also export revenue gained from foreign countries which amounted to $8.7 billion will be affected (Daniel, 2019).

Figure 1.2 *Crude Palm Oil Monthly Price from 2006-2019*



Source: MPOB, 2019

As shown in Figure 1.2, CPO price was fluctuated over the past decade. Hence, CPO price has become the scope of study in this research. The main factors caused the volatility of CPO price involves the changing in economic, financial and also environment factors that drives the change in demand and supply of CPO. The average annual CPO price was dropped 20% in 2018 and the stock had piled up on the lower prices because of the reduced in demand of CPO from China (Tan, 2019). In 2019, the price was quite fluctuated due to different cases happened over the period such as implementation of B10 mandate on February and China-US trade war in April 2019 (Khoo, 2019). Therefore, there are few factors involving in Economic, Financial and Environment need to be concerned due to the issues towards CPO price in this research.

Economic, the one contributed the major impact on CPO price. Firstly, crude oil price has entered into their most volatile period in the history starting 2007. One of the common issues that emerge this happened is the higher demand from individuals and countries especially China and India (Mohd Shahidan Shaari, Tan & Hafizah Abdul Rahim, 2013). This has become a main concern issues in Malaysia due to the high crude oil dependency for activities in few sectors such as agriculture, construction, manufacturing and transportation (Mohd Shahidan Shaari et al., 2013). Crude oil is a basic input for variety of final output and it has a positive relationship with commodities prices (Moradkhani, Rashid, Hassan & Nassir, 2010). This has been supported Norlim Khalid, Hakimah Nur Ahmad Hamidi, Thinagar and Nur Fakhzan Marwan (2018), showing the crude oil price affected the movement of CPO price from 2008 to 2017.

Moreover, soybean oil (SBO) is a vegetable oil that can replace CPO (Sahra Mohammadi, Fatimah Mohamed Arshad, Bilash Kanti Bala, & Abdulla Ibragimov, 2015). SBO price will have an effect on the CPO price due to they have the similar usage in the food industry (Chuangchid, Wiboonpongse, Sriboonchitta & Chaiboonsri, 2012). Because of the substitutability factor, people know SBO is a strong opponent of CPO and it will affect CPO price. Based on M Ayatollah Khomeini Ab Rahman et al. (2017), the SBO price and CPO price will move in the same direction in the short-run analysis; however, in long-run estimations, the model reveals that a 1% rise in SBO price will cause a 0.39% increment in CPO price. Besides, other studies also foreboded them are close substitutes with a cross elasticity of 4.07 (Athikulrat, et al., 2015). Thus, SBO price will be determined as a factor that will affect CPO price.

Export of CPO is recognized as one of the major drivers of CPO price. Based on Ain Hassan, and N Balu (2016), CPO industry has contributed roughly 6% or RM 780 billion to the total exports of Malaysia, and generated around 25% to the economy output. The main importers of CPO from Malaysia in 2015 are India, European Union (EU), China, Pakistan and USA. EU contributed 2.43 million tonnes (13.94%) to the total import (Ain Hassan & N Balu, 2016). Recently, European Parliament is in the process of excluding CPO from biofuel mix and renewable energy sources by claiming that CPO cultivation will lead to deforestation and haze problem ("Palm Oil Export", 2018). Therefore, European take action on reducing the import of CPO from Malaysia after the European Parliament announced an EU nonbinding resolution that was passed in April 2017 to stop the utilise of CPO in biofuel by 2020 (Tan, 2019). European food producers even labelling their products with "No Palm Oil" to protect their markets and control edible oil market by making allegations that CPO is dangerous for consumption and unhealthy ("M'sia To Switch," 2019). Besides, export of CPO to the China from Malaysia was reduced in demand due to the slowdown economic growth since June 2016 (Fazlin Ali, 2019).

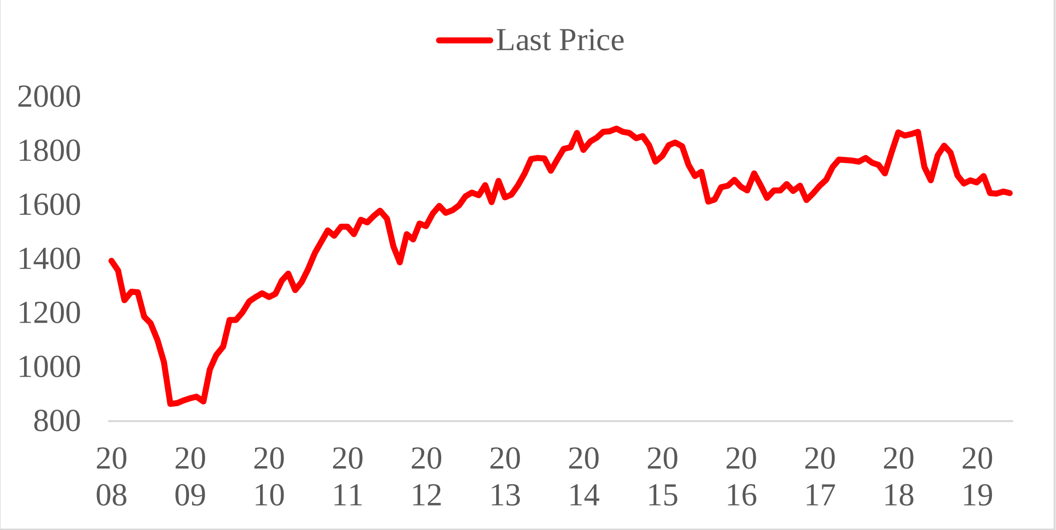
In addition, a bombastic news announced recently where India, one of the major importers of CPO in Malaysia decided to stop importing refined palm oil from Malaysia after Malaysia' prime minister, Mahathir Mohamad criticised and commented the policy (citizenship law) towards Kashmir (Rajendra, 2020). Therefore, Indian government has restricted the CPO from Malaysia due to the interference from Malaysia on the internal affairs of India. As a result, CPO export from Malaysia to India has drop drastically from around 500,000 tonnes in August 2019 to less than 100,000 tonnes in December 2019 (Chu & Rajendra, 2020). As this issue arisen, Malaysia historically will offer more expensive CPO compared to Indonesia has recently selling below Indonesia at US$800 compared to US$810 in Indonesia (Reuters, 2020). According to Soumya (2020), he mentioned that there are thousands of tonnes of CPO are now stuck at ports due to the restriction from India. Not only that, Indian government from the end of 2019 has informally persuaded importer not to buy CPO from Malaysian in any form and mentioned that the restriction may continue with other products (copper, aluminium wire, microprocessors, telecom products, etc) unless Malaysia stops commenting on the India's internal affairs (Delhi, 2020). They have also imposed a tariff on Malaysia palm oil import from 45% to 50% for a period of 6 months from September 2019 to beginning of March 2020 (Ganeshwaran, 2019). These issues have highly hurt Malaysia economy and also export of CPO.

Moreover, exchange rate is found to be affecting CPO price in Malaysia. China-US trade war has occurred in 2019 that has affected the exchange rate of Asian countries ("Palm Oil Being," 2019). According to Elias (2016), Britain decided to leave EU, also known as Brexit. This will affect the currency exchange and economic growth and impact the demand and price of CPO indirectly. Slower global growth will result a weaker demand in food and biodiesel. However, there was an increase of US dollar against ringgit rate after the news of Brexit (Elias, 2016). The fluctuation in ringgit exchange rate against US dollar recently also considered as the driver of CPO price. However, according to Chansuchai (2017), a study in Thailand, there is an argument that the ER baht per dollar US failed to identify the change in pure CPO price. This result may be caused by low demand of CPO as it only used in food industry at 60% in Thailand. Thus, ER may act as one of the variables to be identified in affecting CPO price in Malaysia.

CPO price is affected by its production throughout the year. According to Ain Hassan and N Balu (2016), Malaysia contributes 39% of CPO globally, ranked as the second largest producer of CPO in the world. According to Hanim Adnan (2018), the oversupply of CPO and weak export have caused the price being driven down about 14%. The increase in the supply of CPO can cause its price drops in the market and vice versa (M Ayatollah Khomeini Ab Rahman et al., 2017). Moreover, the production of CPO get hurts easily especially during the El Nino event (Lim, 2019). El Nino is a prolonged drought weather that will lower down around 6% the CPO production in Malaysia ("Dry Weather Could", 2016). This could be a main factor that help to bullish the CPO price. On the other hand, the expansion of CPO production has brought side effect to the environment which is deforestation, causes the temperature to be risen up. Besides, the carbon dioxide (CO_2) emission was increasing starting from 1970 to 2014, indicating the temperature of Malaysia is getting worsen (The World Bank, 2014). It also shown residents in Malaysia have to beware with their health condition due to this high temperature and high CO_2 emission.

Besides, the National Biofuel Policy (NBP) was forced in 2006 to establish Malaysian standard specification for B5 diesel, named biodiesel (International Energy Agency, 2015). That was mean the diesel should consist of 5% of palm methyl ester and 95% of petroleum diesel (Kana, 2019). The consumption of biodiesel is expanding with the increment of biodiesel blending ratios implicated by the government. On 1st February 2019, government increased the blending ratio from B7 to B10, raising the demand of the CPO thereby driving up the CPOP to RM2200 per metric tonne (Ayisy Yusof, 2019). In short, this may require a higher production of CPO to meet the policy. Hence, CPO production and biodiesel production will be investigated as the factor influencing the CPO price.

Figure 1.3 *FTSE Malaysia KLCI Stock Price 2008-2019*



Source: Bloomberg

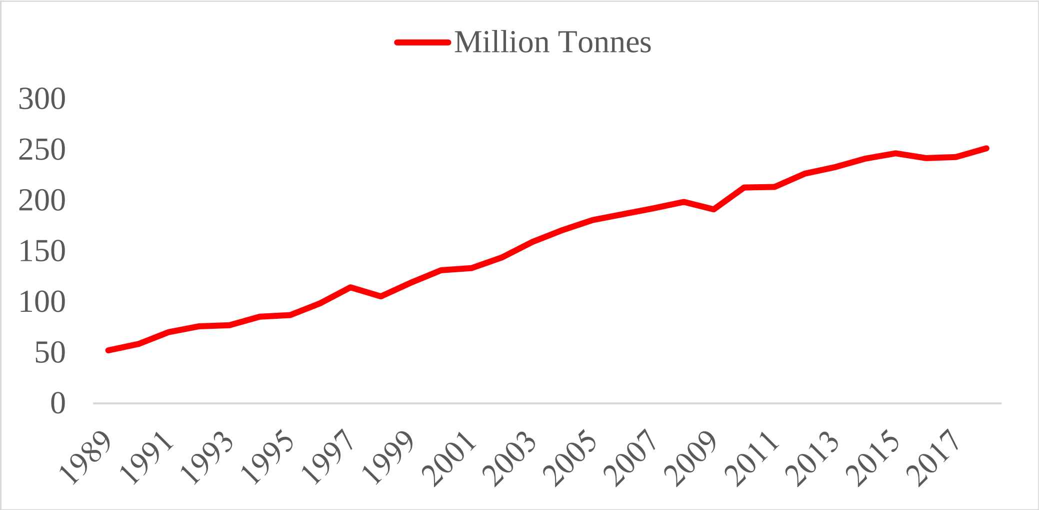
This study has included stock price as the Financial Variable is because Kuala Lumpur Composite Index (KLCI) reflecting the Malaysian market return. Besides, it also reflecting the market return of 30 largest companies which involves few large CPO plantation companies (Uma Murthy, Paul Anthony & Rubana Vighnesvaran, 2017). The CPO plantation companies involve in KLCI are Sime Darby, IOI Corporation, Kuala Lumpur Kepong, Genting Plantations, Felda Global Ventures Holdings and United Plantations (Lim, 2017). Therefore, KLCI has been chosen as the proxy of stock price as it reflects some minor relationship in palm oil industry which could enhance the effectiveness of this research.

Based on Gallegati (2008), he mentioned that stock market return will have a positive relationship with the economic activities such as agriculture production. This cause the agriculture products tend to have a lower price as the supply increased. According to Buerhan Saiti, Azlan Ali, Naziruddin Abdullah and Sulaiman Sajilan (2014), they mentioned that stock price and commodity price are not significant at the first four levels of wavelet-cross-correlation but it left skewed at the level of 5 which reflects stock price is leading the commodity price in the long run period for at least 16 months above. Based on Figure 1.3, there is an upward trend in KLCI after the financial crisis in 2008. However, it fluctuated at the range around 1400 to 1900 points from 2011 to 2019. According to Amir

Hisyam Rasid (2019), KLCI has dropped from 1692.07 to 1690.58 points at the last trading day of 2018 which contributed RM270 billion losses in value. Therefore, despite it might be less fluctuation in KLCI, but a minor change will bring a great impact to the economy in terms of value. This resulted the lower return from market and less investment towards economy and indirectly led to the low development in palm oil industry which will affect CPO price.

Environment acting as an important factor in CPO price as it is interrelated to the production. Climate change has come into a consideration as a certain temperature is required to generate the highest oil palm yield. For instance, having a temperature around 22℃ to 24℃ and 29℃ to 33℃ are considered the best minimum and maximum temperature to produce the highest yield of CPO. CPO is a tropical plant, it requires at least 5 hours of constant sunlight per day for a better oil palm yield (Nur Nadia Kamil & Syuhadatul Fatimah Omar, 2016). Furthermore, the climate change such as floods and drought have affected CPO production (Chandran, 2018). If the temperature goes up to 35℃ to 37℃, it will lead to drought condition and causes the flower drop and reduce the crop production (Corley & Tinker, 2003; Zahid Zainal, Mad Nasir Shamsudin, Zainal Abidin Mohamed & Shehu Usman Adam, 2012). Furthermore, the severe droughts occurred during episodes of El Nino in 2015 and 2016 have caused the shortage of the CPO stock and its price was rose from RM1800 to RM3200 (Fazlin Ali, 2019). Hence, the temperature will be the proxy of the climate change in this research as production of CPO will affect by the temperature and consequently drive the CPO price in the market.

Figure 1.4 *Carbon Dioxide Emissions - Malaysia (1989-2018)*



Source: Bloomberg

Malaysia is located in between two large ocean named Pacific Ocean (East to MY) and Indian Ocean (West to MY). Hence, Malaysia will easily get strong influence by the natural climate change with these oceans especially temperature and flood issues (Fredolin et al., 2012). Thus, to increase the accuracy of the research result, climate change has additionally added into the research as an interactive term due to its indirect relationship among all the variables including economic, financial and also environment. According to Fredolin et al. (2012), the increase of temperature is likely driven by the increase of anthropogenic greenhouse gas (GHG) concentrations that involving carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O). Natural system such as human, plantation, or even animals are highly affected by these harmful sources even the ecosystem of nationwide. By looking at Figure 1.4, there is an upward trend of CO_2 emissions in Malaysia since 1989, which reflecting the temperature concern should be taken into consideration. According to Chen, Li, Li & Shi (2014), they mentioned that in 1990 to 2008, CO_2 emissions has contributed 43.7% in the rise of temperature in Asia which implied that CO_2 is the important reason of global warming.

1.2 Research Problems

Malaysia CPO has made a great contribution towards the economy of Malaysia such as increasing RM45 billion to GDP in 2017, providing job opportunities and local development. Moreover, it also acts as one of the important suppliers in the world as it is the second largest exporter and also producer. However, high fluctuation of CPO price in this decade has become a serious issue for Malaysia. This is because CPO has been highly used as an input for further final goods such as biodiesel, ice cream, soap and others. Therefore, a price change in CPO will consequently increase the price of respective goods and reduce the purchasing power of consumers. Besides, economy growth of Malaysia may be affected due to the high contribution of CPO such as export revenue and local consumption. There are many factors cause fluctuation of CPO price including economy, financial and environment variables such as crude oil price, SBO price, production of CPO, export of CPO, exchange rate, biodiesel production, stock price and also climate change.

In Economic, Bergman, O’Connor & Thummel (2016) stated the fluctuation of COP has a direct impact on the agricultural commodity prices. The inevitably consumption on crude oil to operate machines such as tractors and croppers have brought the cost of input of CPO to increase and indirectly the CPO price will have the same price movement with the crude oil price (Mohd Shahidan Shaari, Tan & Hafizah, 2013). Besides, it has brought greater effect to CPO price after introduction of biodiesel mandate by Malaysian government (M Ayatollah Khomeini Ab Rahman et.al, 2017). The increment of crude oil price has made the consumers tend to use the cheaper palm biodiesel; higher demand has resulted a higher CPO price and vice versa.

Furthermore, an intense competition will be created among CPO and SBO due to their similar function. They are mainly targeting the same market share in China and India as they have the highest consumption. When the world population and GDP increase, demand for food applications will increase and this causes CPO and SBO have a competition in international market (Hassan & Balu, 2016). Besides, to avoid the environmental disaster and save the world, Non-Government Organizations (NGO) and some predominant bodies with their self-interest persuade the consumers to renounce the CPO and change to use the substitute vegetable oils, such as soybean oil ("Palm Oil Being", 2019). Thus, this has reduced the CPO demand and caused the price to decrease and vice versa.

In addition, anti-palm oil campaign by European countries, restricted CPO demand by India and lesser demand from China would highly affect CPO export of Malaysia as they were the major importers of Malaysia ("Govt Has Identified", 2019). However, this will cause the average annual CPO price to drop and the stock will be piled up on the lower prices due to decrease in demand of CPO (Tan, 2019). Therefore, CPO export requires special attention as the amount of export will affect CPO price. Besides, export of CPO is one of the main incomes for Malaysia, thus the economy of Malaysia will also be affected.

Moreover, changes in exchange rate due to the China-US trade war and Britain leaving EU will drive significant impacts to the economy of Malaysia and affect the CPO price. This is because CPO price of Malaysia for foreign countries are not solely depending on price, but also the currency rate in the respective countries. The higher the currency rate, the lower the demand of CPO. Thus, Malaysia as the second largest exporter could be highly affected with its intense competition among Asian countries especially Indonesia and also Thailand. As a result, CPO price is sensitive to the changes of exchange rate.

In terms of CPO production, the oversupplied issues together with the weak export recently have caused the price being driven down by about 14% in 2018 (Hanim Adnan, 2018). This is because suppliers unable to sell out their CPO and thus forced to lower down their price in order to avoid the issue of stock piling. Thus, when the oversupplied issue happened, the price will tend to drive down and vice versa.

Besides, rising in the demand of CPO has brought the both positive and negative impacts on the socio-economic. Recently, there are higher global biodiesel production across Indonesia, Malaysia, Thailand and Colombia due to the change in government policies in those countries (Ooi, 2019). As mentioned, biodiesel is a type of oil that consist CPO and crude oil. Hence, the main positive impacts of higher demand of biodiesel are boosting the CPO price and economic growth. This is primarily because majority of the countries are required to demand CPO from Asian countries such as Malaysia, Indonesia or Thailand. Thus, this will boost the CPO price as demand increase and indirectly led to a better economic growth of Malaysia. However, this rises of CPO price may burden the consumer as some of the daily products consist the usage of CPO.

In financial, fluctuation of KLCI has reflected the instability of financial level and also economy in Malaysia (Amir, 2019). In this scenario, the higher KLCI may reflect a better financial and economy of Malaysia and vice versa. When there is a better economy, people tend to consume and invest more, and thus lead to a higher demand and also supply of agriculture activities. Thus, the unstable KLCI will lead to the CPO price to be fluctuated.

In terms of Environment, inappropriate climate could adversely affect the crops yield of the CPO and affect the CPO price (Chandran, 2018). The better the climate could drive a better CPO production and thus the CPO price may reduce and vice versa. Consequently, when there is high supply, suppliers may sell CPO at a low pricing to avoid stock piling and vice versa. Hence, changes of climate can lead to the variations in CPO price. Moreover, the affiliation of the suppliers and their alliances may be jeopardized due to the breach of contract by suppliers. Thus, further development with its alliances may be restricted by this event.

The continuous increment in CO_2 may drive temperature to increase and lead to global warming which causes the climate to change. Moreover, large scale of forest fire is expected to happen especially in Sumatra and Kalimantan, which consequently lead to serious haze in Malaysia and the Southeast Asian region (Fredolin, et al., 2012). Besides, ocean acidification and carbon fertilization may occur due to the CO_2 absorption by ocean and plant respectively (Jain Manisha, 2018). These issues will harm the ecosystem especially crops yield and also human health. The seriousness of this issue can be led to heat stroke, heat cramps or even death of human, and people tend to have indoor activities which will lower down their consumption and will detriment the development of the businesses. This have proven that all the economic variables in our research will be affected and indirectly influence the CPO price. In terms of financial variable, it will be affected indirectly due to KLCI is partially depending the economy growth of the country such as export of CPO. Hence, KLCI will be indirectly affected and cause the CPO price to change. Besides, this will continue to affect the exchange rate of Malaysia as the purchasing power of Malaysia tends to reduce with the poor economy growth. Therefore, temperature representing the climate change will affect all the independent variables and indirectly affect the CPO price.

In conclusion, all these issues raised could be the factors affecting the change in CPO price. Therefore, all these issues should be taken into consideration for stabilizing the fluctuation of CPO price.

1.3 Research Questions

There are two research questions for this study, which are:

1.3.1 What are the factors that affects the Crude Palm Oil Price in Malaysia from January 2007 to May 2018?

1.3.2 How does the climate change act as an interaction term and overall affect the Crude Palm Oil Price in Malaysia from January 2007 to May 2018?

1.4 Research Objectives

1.4.1 General Objective

Southeast Asia with its strong dynamic geography has been highly depended by worldwide on Agriculture production. Agriculture is one of the backboned of Malaysia by having CPO as its main economic activity. More and more adoption in industries have brought CPO to be determined as an important and environment friendly product. Therefore, CPO price has come into concern. The combination of economic, financial and environmental variables of this research is to establish the potential variables that can manage the CPO price to achieve the sustainability of palm oil industry. In short, this study aims to identify the economic, financial and also environment factors that can affect the CPO price in Malaysia from January 2007 to May 2018.

1.4.2 Specific Objectives

To be specific, we would like to:

I. To determine the factors that affects the Crude Palm Oil Price in Malaysia from January 2007 to May 2018.

II. To examine the climate change act as an interaction term and overall affect the Crude Palm Oil Price in Malaysia from January 2007 to May 2018.

1.5 Scope of Study

This paper is to investigate the elements affecting CPO price in Malaysia according to monthly data from January 2007 to May 2018. This topic has been decided is due to CPO price has a larger fluctuation as compared to the past decade. Moreover, CPO is one of the main economic activities in Malaysia which contributing 5-7% of GDP in Malaysia. Thus, CPO price will be a main concern in Malaysia to be investigated. This study will be more comprehensive by concerning on the recent issues including economy, financial and also environment. Therefore, this study will focus on economic, financial and environmental variables including crude oil price, SBO price, production of CPO, export of CPO, exchange rate, biodiesel production, stock price and also climate change. Climate change and stock price will be our gap variables in this research study. Climate change is also expected to give a great contribution to this study due to its limited past studies and also the role of being interaction term in this research. Finally, few policies will be recommended to achieve the sustainability of the palm oil industry.

1.6 Research Significance

CPO price in Malaysia has been chosen as the main concern of this study. Selection of Malaysia is because CPO has become one of the main key contributors to the Malaysian economy. Moreover, the recent news and analysis depicts that CPO price of Malaysia vary significantly from time to time. This may be mainly driven by the causes of supply and demand of CPO, natural shocks and political changes (Sahra Mohammadi et al., 2015). Based on the history chart (Figure 1.2), the CPO price attained its new high in March 2008 at RM 3680.50, but it has dropped to RM 1516.50 in less than 8 months’ timeframe. By comparing with the past decades, CPO price shows a greater variation in current trends. This high volatility of CPO price creates uncertainties to the households (consumers), business (farmers, traders and producers) and also governments (exports and imports) (Bergmann, O’Connor & Thümmel, 2016). Moreover, CPO has been classified as an importance energy for consumption such as cooking oil, manufacturing margarine, confectionary fats, and so on. In short, this research is to analyse the factors that can impact CPO price in Malaysia and also identify relationship between dependent variables and independent variables. Thus, this research can effectively minimize the impact of significant CPO price shock on economy of Malaysia and benefit to user of CPO.

In this research, there are few variables have been chosen to study the relationship with CPO price. Firstly, a basic model has been adopted from previous study which include SBO price, CPO production and biodiesel production while it has been further extended with crude oil price, export of CPO, exchange rate, stock price and climate change. All these factors are chosen based on the aspect of Economy, Financial and Environment as they are representing the major pillars to achieve the sustainable development goals. Thus, this has become one of the contributions in this study where it may achieve the sustainable in palm oil industry and also at the same time achieve the Sustainable development goals in Malaysia. Besides, climate change has additionally taken as interaction term in this study to make this study become more comprehensive.

Moreover, the second contribution in this research is adopting climate change as environmental variables to examine the relationship with CPO price due to the limited literature review in the past studies. Including climate change in this research is because it will affect the CPO price due to the unstable climate change could drive an unstable crops yield. This will either drive to the issue of stock piling or shortage of stock and causing the relationship between suppliers and their alliances may be jeopardized due to the breach of contract by suppliers. Most importantly, the supplier will tend to minimize their loss or maximize their profit by selling at a higher price to avoid shortage of stock; and selling at a lower price to avoid stock piling. Therefore, this could highly affect the final consumers as the business will normally transfer the cost to their customers.

On the other hand, climate change will also act as an interaction term in this study by indirectly interact with all the independent variables and subsequently affect the CPO price. This has created the 3rd contribution in this research. Adopting climate change as interaction term is because Malaysia will easily get strong influence by the natural climate change due to Malaysia is located in between two large ocean named Pacific Ocean (East to MY) and Indian Ocean (West to MY). Therefore, temperature and flood issues could be the main concerns for Malaysia. Besides, the higher emission of greenhouse gases such as carbon dioxide and methane due to industrial revolution has led to a higher temperature and subsequently cause the earth gets warmer and warmer (Shamil Norshidi, 2018). This issue has adversely affected both of the Economic and Financial variables. This is because when there is a high temperature, there is approximated 208,000 ha of land or 12% of land are considered as unsuitable for oil palm cultivation and cause the crops yield to be reduced (Zahid Zainal et al., 2012). Besides, a high temperature will also potentially cause forest fire and subsequently lead to serious haze problem, for instance, the issue happens in Sumatra and Kalimantan. The seriousness of this issue can lead to heat stroke, heat cramps or even death of human. As a result, economy growth will tend to reduce while unemployment rate will tend to increase. Therefore, it is important to include climate change in this research to examine the relationship towards CPO price due to its huge impacts towards the economy, and also financial.

In conclusion, this research able to identify the ways to achieve sustainability of palm oil industry in Malaysia through the aspects of economy, financial and environment. This research will benefit households and business (farmers, traders and producers) on stability of CPO price without spending too much in purchasing or processing palm oil products. So, governments should take all these variables into consideration to control the stability of CPO price in order to achieve sustainability of palm oil industry. In addition, this research will also suggest few policies to increase the long-lasting demand of CPO in order to achieve a more sustainable palm oil industry. By achieving the sustainability of palm oil industry, this research could also achieve Sustainable Development Goals of Malaysia at the same time which shown a win-win situation in Malaysia.

1.7 Chapter Layout

The following chapter will include literature review about the previous researchers' studies regarding the determinants of CPO price in Malaysia. Moreover, Chapter 3 contains data description, theoretical framework and methodology. In Chapter 4, it will focus on the outputs and justifications of the extended model. Lastly, policy implications, limitations and recommendations will be discussed in Chapter 5.

1.8 Chapter Summary

All in all, the purpose of this research is to examine the effect of SBO price, CPO production, biodiesel production, crude oil price, CPO export, exchange rate, stock price and climate change towards the CPO price. Moreover, this chapter has provided a general understanding about the position of agriculture and palm oil industry in Malaysia with its background and problem statement. In addition, it also included research questions, research objectives and significance of study in this research to assist people to understand more about the purposes of conducting this research.

CHAPTER 2: LITERATURE REVIEW

2.0 Introduction

This chapter has covered theoretical review, empirical review, and theoretical framework. In theoretical review, there is discusses the theory behind the relationship between dependent and independent variables. Followed by empirical review which has provided the empirical evidence from results of previous studies. Lastly, a diagram has shown the explanatory variables directly and indirectly related to dependent variable under theoretical framework.

2.1 Underlying Theories

2.1.1 Principle of Supply and Demand

In 1808, John Stuart Mill published his Commerce Defended, he used the term of supply and demand linked with his exposition of the "law of markets". Besides, the term "the principle of supply and demand" was used in his textbook, Element of Political Economy. The term is directed to the discussion of the determination of relative prices, and had become a usual expression in the modern textbook (Groenewegen, 1973).

Law of demand is negative relationship between price and quantity demanded which is a raise of price of goods and services lead to decrease in quantity demanded. However, law of supply is positive relationship between price and quantity supplied which producer is willing to supply more when price increase. There are two basic laws of supply and demand. Firstly, when demand increase with holding supply constant, then it will stimulate the price to rise; secondly, when supply increase with holding demand constant, then it leads to price drop. Economist use law of supply and demand to show equilibrium between price and quantity adjustments (Humphrey, 1992).

One of the factors affecting demand is substitution effect. SBO are in competitive demand and act as a substitute for CPO due to food processors frequently exchange between CPO and SBO when their prices fluctuate. CPO and SBO acts as dominators of the edible oil market, and makes up more than 50% of the total world cooking oil production (Kalsom Zkaria, Kamalrudin Mohamed Salleh & Balu, 2017). Therefore, an increment in SBO price will reduce the consumption of SBO, consumers will choose CPO instead of SBO. Palm oil demand will rise and it will influence CPO price in the market.

Furthermore, exchange rate will affect the volume of export of CPO. Foreign currencies holders will enjoy the cheaper price of edible oil when CPO traded in a weaker ringgit. The recent exchange rate fluctuation decreased the value of Ringgit Malaysia, resulting a higher quantity demanded of CPO in foreign countries (Basri Abdul Talib & Zaimah Darawi, 2002). The greater volume of CPO demanded will tend to rise CPO price in Malaysia.

Government policy as one of the factors of affecting demand and supply of goods (Colander, 2008). The policy implemented by government is significantly influence the market environment and cause changing in the market price of particular goods (Kim and Choi, 2018). The case in South Korea, the government had implied a policy to rise the consumption of low-fat instead of high-fat pork cuts had caused the price of low-fat pork cuts increased (Kim and Choi, 2018). Similarly, in case of biodiesel production, government requires the biodiesel should contain a certain percentage of palm oil, the demand of palm oil will increase to comply with the government regulation which would change the CPO price in transaction between the buyers and sellers.

Moreover, government subsidies will affect supply of export of CPO in Malaysia. Government exempt export tax on CPO for three-month period to strengthen CPO market price. Due to tax exemption, CPO producers will export more CPO to foreign countries as cost of goods reduce. This has supported by Mohd Anwar Patho Rohman et al. (2018), export of CPO increased by approximately 5.6% to 1.51 million tonnes as compared to December 2018. Followed by the increase of export of CPO, CPO price increase to RM2486.50 per tonne in January 2019, compared to RM2408 in December 2018. This can be seen that government subsidies increase supply of export of CPO and strengthen its price.

The supply refers to production quantity that suppliers have brought into the market. As a common sense, the behaviour of the sellers would be influenced by the productivity of goods to ensure their profitability. If the goods supplied is higher than demand, suppliers would reduce the price to avoid losing from unsold products. Inversely, if demand is greater than supply, the suppliers would intent to raise the price to earn more from limited supplies. The Braekkan (n.d) have shown in his study that the price of salmon in 1980s and 1990s were rapidly decline due to productivity growth. Thus, if the productivity of CPO is higher than demand in the market, the sellers will sell it at a lower price and vice versa.

Besides, cost of production is one of the factors that influence the supply of commodity (Colander, 2008). The cost of production included land, labour, capital and materials. The willingness of producers to supply is dependent on the price of inputs necessary to produce the final goods (Eastin & Arbogast, 2011). The crude oil as one input in CPO production which used for harvesting and processing the CPO. When the crude oil becomes expensive, the cost to operate the tractors, croppers and oil presses would rise. Thus, this may result the producers intent to lower down the supply of CPO to reduce the cost and willing to supply the CPO with higher price in order to transform the cost to CPO consumers.

The supply of the goods will increase as following its productivity. Based on the research done by Gallegati (2008) had shown the relationship between stock return and growth rate of industrial productivity. When the KLCI turning bullish, the investors would expect a higher return from the stock. This has led the investor has intention to invest more to obtain higher returns. CPO as the main income of national and one of main driver of economy growth in Malaysia. Thus, palm oil plantation would become the target company to be invested especially Malaysia’s largest public listed palm oil company, IOI Corporation Berhad, Sime Darby Berhad, and Kuala Lumpur Kepong Berhad. This would enable those plantation company to getting sufficient fund for further development of CPO production. Thus, the productivity of CPO would be simulated and the supply expected to rise. Higher the supply causes the CPO price to decrease.

The sector sensitive to the weather include agriculture, horticulture, food industries. The extreme climate change includes extreme temperature, strong wind, excessive rainfall and flooding have a significant impact on the supply of commodity (Kovacs & Pato, 2014). This is because crops unable to grow well under an extreme temperature (Lee, Nadolnyak & Hartarska, 2017). Besides, the productivity of labour also falls under hot weather (Lee, Nadolnyak & Hartarska, 2017). Together with these 2 factors, the supply will be decrease and causes the CPO price to increase.

2.2 Review of Variables

2.2.1 Soybean Oil Price

SBO is the main substitute of CPO, thus the price of SOB can affect the CPO price. In the research carried out by a team of researchers, they found that there is a positive relationship between price of CPO and price of SBO by using VECM（Ayat K Ab Rahman et al., 2007). The result is proved by 69 observations with the quarterly data starting from first quarter 1989 until first quarter 2006 in Malaysia. System dynamic that conducted in the CPO market in Malaysia has shown a result of positive relationship. When the SBO price rises by 10%, CPO price will increase by 8% (Sahra Mohammadi et al., 2015). Besides, according to M Ayatollah Khomeini Ab Rahman et al. (2017), the long-term model and short-run ECM has shown the price of SBO and price of CPO are significant positively related, supported by the time series analysis by using E-views. The data is from MPOB database from January 2000 until December 2016. Also, ARIMAX have shown the SBO price and CPO price are significant and positive related with the yearly data from 2008 to 2017 (Norlim Khalid et al., 2018).

In the study of Santeramo and Searle (2019), the elasticity of CPO supply to price of SBO is positive and above 1 by using the estimation of supply elasticity model. This means that the increment in SBO price is higher than the amount risen in the CPO supply. The elasticity of SBO supply also depicts a significant positive relationship towards CPO. Moreover, the model estimation shows a result of price of both SBO and CPO in Thailand are statically significant at 4.07 elasticity by using the yearly data from 1992 to 2016 in US. In the research, an outcome from Augmented Dickey-Fuller (ADF) Test has showed the SBO price and CPO price are positively related (Athikulrat, Rungreunganun & Talabgaew, 2015). The research shows that CPO price and SBO price have a proportional relationship by using Bivariate Extreme Value (Bivariate Block Maxima) with the data from July 1988 to January 2012 in Malaysia. This is because they are dependence in extremes but not strong enough with r estimate, which is only 0.83 (Chuangchid et al., 2012). SBO price and CPO price are positively related as soybean is the substitutes of CPO. This is based on the data from 1994 to 2016 in Malaysia (Balu Nambiappan et al., 2018).

On the other hand, Norhayanti Mohamad (2018) has argued that the SBO price adversely related to CPO price with negative correlation of -0.2929 by using Grey incidence degree. This is proved by 385 observations with the data from 25 October 2012 to 13 November 2013. The result is consistently shown in the research done by Norlim Khalid et al. (2018). They have found that SBO price and CPO price are negatively related at 1% significance level by using the ARIMAX model. The data obtained consists of 120 observations which the monthly data collected from 2008 to 2017 in Malaysia.

Whereas, the researchers have used VAR which contains the sample size of 10 form year 2005 to 2014 to test the average growth of both SBO and CPO and it has an insignificant relationship at the level of α=5 percent (Buyung et al., 2017). Besides, Ain Hassan and N Balu (2016) claimed that CPO price and SBO price have no relationship by applying the Unit Root Test was from the time period 1988 to 2015 in Malaysia. In the study Dg Halimah Arasim and Abdul Aziz Karia (2015) also showed that CPO price and SBO price is unidirectional relationship at 1%

significant level in the Granger causality test. This research is conducted in Malaysia using monthly data consists of 84 observations which from January 2008 to December 2014.

2.2.2 Production of Crude Palm Oil

Production of CPO is one of the important variables to determine the CPO price. Based on Ayat K Ab Rahman et al. (2007), it proves negative relationship between CPO production and its price in Malaysia. The empirical result was determined by using VECM with coefficient -5.319749 at 1% significant level. The data was obtained from Malaysian Oil Palm Statistics by MPOB and Oil World by using quarterly data from first quarter 1989 to first quarter 2006 with 72 observations. Ayat K Ab Rahman, N Balu and Faizah Mohd Shariff (2013) supported that CPO production and CPO price have a negative relationship. This is mainly driven by CPO production will lead to decrease in supply of CPO, hence resulting inverse relationship between CPO price. Besides, Nur Nadia Kamil and Syuhadatul Fatimah Omar (2016) draw a conclusion that CPO production has negative relationship with its price. This has been proven by the regression analysis shown when the production decrease by 1%, will increase the CPO price by 0.04%. This study was carried out in Malaysia by using linear regression analysis for the period 1990 to 2015. Furthermore, the researchers applied monthly data which adopted from MPOB for 25 observations. The analysis result was compatible with M Ayatollah Khomeini Ab Rahman et al. (2017), showing the CPO production is found to be negatively related with price of CPO in Malaysia. The data for this study was based on the 204 sample sizes of monthly data from January 2000 to December 2006. The data was extracted from MPOB and Oil World Annual and researchers analysed the relationship between these two variables through long-run estimations.

Researchers had obtained 40 sample size of yearly data from 1982 to 2012 of CPO production to test on its impact on its price. The result obtained from the system dynamics method has shown there was a significant negative relationship between the CPO production and price (Sahra Mohammadi et al., 2015). Besides, CPO production did not affect the CPO price in the long run. This has been proven by the error correction coefficient (ECT) that shows statistically insignificant result. However, the short-run Granger causality test shown the CPO production was found to be influenced the CPO price in short-run period which significant at 1%. The result was supported by VECM which investigated from the period 1988 to 2015 using annual data from MPOB with 28 sample size (Ain Hassan & N Balu, 2016). By using multiple regression technique, it shows correlation index of -0.6683, which indicates negative relationship. The study was conducted in Malaysia by using monthly data 2009 to 2012 from MPOB.

2.2.3 Biodiesel Production

Palm oil is a source to produce biodiesel. According to a research done by Castiblanco, Moreno and Etter (2015) with the study area of Colombia, northwestern South America, it showed the CPO price would increase once the quantity of CPO destined for the biodiesel production increase. The researcher used vertical market model which introduced by Gardner to run the analysis with yearly observation data from 1994 to 2003. This also can be supported by the study done by Ong, Mahlia, Masjuki and Honnery (2012). In the paper, researchers had used life cycle cost model with 27 observations to obtain the result which had showed the biodiesel production was highly sensitivity to the change in the CPO price. There was a linear correlation between CPO price and biodiesel production cost. This research had taken a historical yearly data from 1986 to 2012 in Malaysia for analysing. However, based on the study of Sahra Mohammadi et al. (2015), it stated that CPO price has less effect on biodiesel production is because of the small amount of total CPO demand in Malaysia. It used Root Mean Square Percent Error (RMSPE) to prove it and the RMSPE for CPO price (120%) and biodiesel production (121%) is larger. The data for observations is taken from 1982 to 2012.

2.2.4 Crude Oil Price

One of the determinants that affect CPO price is crude oil price. This is proved by several past studies and it have different result in the relationship. Based on the research of Saghaian (2010), it expects that price of both commodity and crude oil are positively related with Vector Error Correction Model (VECM). When crude oil price increases, the level of commodity price will increase. The researcher had used time series data from period of January 1996 to December 2008 on monthly basis in this test. Nazlioglu and Soytas (2012) have used panel cointegration and Granger causality to test the relationship between price of crude oil and agricultural commodity. The data chose the test is a monthly data which is from January 1980 to February 2010. The result stated that crude oil price has a positive impact on agricultural commodity price. An increment of crude oil price will cause demand of agricultural product increases and this led to a higher agricultural price. Structural time series approach has been used to test the relationship between crude oil price and commodity price. The result shows that they have a positive effect. The test is using the monthly data from November 1992 to October 2012 (Rezitis and Sassi, 2013). Rezitis (2015) claimed that the relationship between crude oil price and the commodity prices are positive. This is proven by the panel Vector Autoregression Model (VAR) by using monthly data of period from June 1982 to June 2013. Besides, CPO price and crude oil price have a positive relationship in long term, which proven by Engle-Granger Cointegration test and Error Correction Model (ECM). The researchers have used sample size of 132 in Malaysia, which is from monthly data January 1995 until December 2015 in VAR and multivariate GARCH model to prove the shocks in crude oil market would have transmission on Oceania butter and CPO volatility. It shows crude oil market and CPO market have a direct volatility transmission at the confidence level of 1% (Bergmann, O'Connor & Thummel, 2016). Because of the B5 programme has been carried out in 2007, price of crude oil and CPO have positive related. This is shown by the method of multiple regression with monthly data from 2008 to 2012 (Balu Nambiappan et al., 2018).

According to Buyung et al. (2017), Granger causality test has been used to test and shows CPO price and world crude oil price are significant influence. Norlim Khalid et al. (2018) claimed that crude petroleum price is one of the most significant variables. Government has high probability to abolish the NBP if the petroleum price going down, this may cause the demand and price of CPO will be affected in the market. He has used Autoregressive Distributed Lag (ARDL), Autoregressive Integrated Moving Average (ARIMA) and Autoregressive Integrated Moving

Average with exogenous inputs (ARIMAX) to test with the monthly data from the period of 2008 to 2017. Thus, crude oil price is a significant variable to CPO price.

However, Norhayanti Mohamad (2018) claimed that Brent crude oil price and CPO price have a significant negative relationship. The study has run Grey incidence analysis by using the daily data from 25 October 2012 until 12 November 2013 in Malaysia (385 observations). Moreover, a research has shown the results that price of both crude oil and CPO are weakly correlated (Chuangchid et al., 2012). By using the Bivariate Extremes Value Approach, it showed a fair weak dependence or independence between the growth rate of CPO and crude oil price. This result is taken 723 observations in Malaysia, which is a daily source from July 1988 to January 2012.

2.2.5 Export of Crude Palm Oil

Furthermore, CPO price can be affected by the export of CPO. According to Nur Nadia Kamil and Syuhadatul Fatimah Omar (2016), export of CPO was significantly positive to the changes of selling price of CPO at significance level 1% by using linear regression analysis. The empirical result was obtained from 25 observations from year 1990 to 2015 in Malaysia. The monthly data within the period was obtained from MPOB. This empirical analysis was supported by Dg Halimah Arasim and Abdul Aziz Karia (2015). The researchers have used Granger causality test to examine the relationship between total export of CPO and CPO price according to monthly data collected from World Bank, Department of Statistics Malaysia and MPOB from January 2008 to December 2014 which including 84 sample sizes. The result shows that total export and CPO price in Malaysia are positively related and the variables have a bilateral relationship which can significantly impact each other. Moreover, M Ayatollah Khomeini Ab Rahman et al. (2017), prove that export of CPO is positive impact on Malaysia's CPO price. The long-run estimations model indicates that every 1% increase in export, CPO price will be increased by 0.80%. This study adopted monthly data from MPOB and Oil World Annual for January 2000 to December 2016 with 204 observations. The empirical analysis was agreeable by a team of researchers, showing the export of

CPO increase from 10.62 million tonnes in 2001 to 12.58 million tonnes in 2004, leading an increase in domestic CPO price from RM 894 per tonnes to RM 1610 per tonnes (Ayat K Ab Rahman et al., 2007). This has shown a positive relationship between two variables. The researcher was carried out in Malaysia by acquiring data from Malaysian Oil Palm Statistics by MPOB and Oil World by using quarterly data from first quarter 1989 to first quarter 2006 with 72 observations.

According to Ayat K Ab Rahman et al. (2013), multiple regression technique revealed the correlation index was -0.6568 between total volume of CPO export and its price. Total quantity of export served as a proxy of CPO demand have negative relationship with CPO price. The study was conducted in Malaysia by using monthly data 2009 to 2012 from MPOB. While, the analysis result obtained was inconsistent with Ain Hassan and N Balu (2016), showing that the CPO price insignificantly affected by the total export of Malaysian palm oil in long-run VECM. However, based on short-run Granger causality test, total export of CPO has related to CPO price which significant at 1%. The model estimation was carried out in Malaysia for the year 1988 to 2015 by using annual data from MPOB with 28 sample sizes.

2.2.6 Exchange rate

Exchange rate is considered one of the variables that affect the CPO price. Rifin (2010) claimed that there is positive coefficient between CPO price and exchange rate. Rupiah devaluates relative to Ringgit Malaysia causes the CPO price in Rupiah decreases. Saghaian (2010) have used Granger causality to test the relationship between exchange rate and commodity price. The monthly data from January 1996 to December 2012 had been used in test. The result shows that changes in exchange rate and changes in commodity price are strongly correlated. Buyung et al. (2017) have run an analysis of VAR to test the relationship between exchange rate and CPO price in Indonesia. From the result, it claimed that average growth of exchange rate and average growth of CPO price have a significant relationship in the previous month at the 5% significant level, but it also showed they have an insignificant relationship in the two to five months.

On the other points of view, Nazlioglu and Soytas (2012) stated that exchange rate have a negative impact on the agricultural prices. Depreciation in U.S dollar will increase the agricultural prices as the purchasing power and foreign demand increase. They have used panel cointegration and Granger causality with a monthly data from January 1980 to February 2010. Furthermore, Rezitis and Sassi (2013) have done a research on the relationship between commodity price and exchange rate. The result shows that they have a negative effect. This is supported by the analysis by using structural time series approach. It is using the monthly data from November 1992 to October 2012. In the research of Kiatmanaroch and Sriboonchitta (2014), it shows a result of negative relationship. Exchange rate increases will cause CPO price decreases and vice versa. It also shows they have a weak negative dependence between the two variables. This implies that changes in CPO price has slightly affected changes in exchange rate. This test has used GARCH approach with a daily data from June 2007 to March 2013. Rezitis (2015) showed that agricultural commodity price and US dollar exchange rate are negatively correlated and between -0.4220 and -0.4750. They have a significant negative relationship. This is proven by panel data method which is from the period of June 1983 to June 2013.

However, the study carried out by Chansuchai (2017) showed pure CPO price and the exchange rate of bath per dollar US have an insignificant relationship. This study consists of 60 sample sizes which used monthly data from 2011 to 2015 and the method used in this study was multiple regressions. Besides, there are other researchers also carried out wavelet cross-correlations between exchange rate and CPO price. They obtained the result by using monthly data from 1990 to 2012 which consist of 274 sample sizes. The result showed that there was no significant relationship between exchange rate and CPO price, it also implied that there was no lead-lag relationship between the two variables (Buerhan Saiti et al., 2014).

2.2.7 Stock Price

Commodity market and stock market have an interconnection. In the research, it has obtained the monthly data from January 1990 to December 2012 to run the wavelet cross-correlations. At level 5, the result skewed to the left, which means the stock price will affect the commodity price in the long run (16-32 months). The result shows a significant and negative relationship. However, in the first four level, it shows no significant wavelet-cross-correlation (Buerhan Saiti, Ali, Abdullah & Sajilan, 2014). When the variance of stock price and commodity price increase, the level will rise. It means it has lower volatility at a higher frequency and vice versa. Furthermore, it also shows the correlation between the two variables are insignificant at all levels, which is from level 1 to level 5 (Buerhan Saiti et al., 2014).

According to Creti, Jots, and Mignon (2012), their research result shown that there is an increased of correlation between stock market and commodities price including CPO after financial crisis in 2008. However, from the data analysed from the research, it also shown there is a correlation between stock market and CPO before financial crisis at the range of 0.1 to 0.3. These have been adapted by Liao, Qian and Xu (2018), mentioning that before Global Financial Crisis (GFC), China's stock market is insignificant to all commodities, but it turns positive significant after GFC without including gold. Besides, they have also found that there is a stock market crash in August 2015 and government of China has applied economic stimulus plan to restore the market confidence and thus increase the stock market price and commodity price. Moreover, demand of global commodities by China is increasing recently, which will more easily affect the commodity price trend, they said.

These have also supported by Joets, Mignon and Razafindrabe (2017), they have adapted nonlinear, structural threshold VAR to assess whether commodity price returns depend on the degree, variability and level of macroeconomic uncertainty. In their result, it shown the agricultural and industrial markets are highly sensitive to the uncertainty of macroeconomic.

2.2.8 Climate change

Climate change as one of variables that will impact on CPO price in Malaysia (Ronnback, 2014). This study consists of 31 sample sizes, which the data collected from 1730-1760 annually and carried out by utilizing standard ordinary least squares (OLS) regression. The outcome shows negative relationship between the climate change (temperature) and CPO price. The research showed when the temperature increase, the local crop yields will decline and thereby driving down the CPO price (Ronnback, 2014). The study also shown the CPO price will decrease by 60-80 per cent, if the temperature increased by one-degree-Celsius. Besides, the study conducted by Blanco et al. (2017) has proven that the CO_2 emission has positive relationship with the yields of agriculture product and finally reduce the price of agriculture and vice versa. This study has conducted by using bio-economic approach that involve assessing biophysical and socio-economic effects of climate change within EU.

On the other hand, climate change tends to affect other independent variables as well. A study done by Zahid Zainal, Mad Nasir Shamsudin, Zainal Abidin Mohamed and Shehu Usman Adam (2012) had proven the climate change has brought an economic impact on the production of CPO in three regions of Malaysia, namely Peninsular, Sabah and Sarawak using Ricardian model with the sample from 1980 to 2010. In this research, they estimated the sensitivity of CPO production to climate change with determinant of net revenue (RM ha^{-1}), average annual rainfall and temperature and concluded the high temperature has 5% level of statistically significant in reducing the palm oil revenue in Sabah and Sarawak.

The research done by Chatzopuolos, Dominguez, Zampieri and Toreti (2019) showed the result that the regional climate extremes have impact the domestic and global markets of soybean. They used multi-scenario analysis which the most extreme temperature has been tested on the crops in different regional countries from 1980 to 2010. They found that when there is extreme temperature, the SBO price tends to rise up.

Based on Dai, Yang, Huang, Sun, Jia, and Ma (2017), they have conducted a research about the climate change will affect production of biodiesel in China. In order to get a higher chance to success in the formulation and management of forest-based biodiesel production, they have included all climate change information. The researchers have conducted S.mukorossi in China with the period of July 2011 to November 2013. The result showed that the future likely distribution and planned growing area are unsuitable for around 41%.

According to Dike (2014) who has done the research of the crude oil price has been affected by the climate change mitigation activity by using carbon intensity as proxy. He has done the research according to region, such as country in Africa, Asia and Oceania, the Middle East and others by using an Arellano and Bond GMM dynamic model from 1980 to 2011. The researcher found that crude oil price is positively related to carbon intensity. This result showed that the carbon intensity will affect the CPO price especially in long run.

According to Zhang, Cai, Beach and McCarl (2014), there was a research carried out in United State (US) to study the relationship climate change and export of agricultural. This research using simulation method, which include many scenarios to analyse the relationship and the data was collected from USDA annual agricultural statistic by using year 1990-2000. This research was conducted in two forms, which is comparing US with the rest of world (ROW) such as Argentina, Brazil, USSR, W-Africa and Canada, as well as, determining only agricultural export of US (without ROW). Based on the study, relationship between climate change and export of agricultural (soybean, corn and wheat) have different relationship in different scenarios. Looking at the climate change affect US crop yields, climate change negatively affects dryland corn and soybeans yield, thus, export of corn and soybean is negative relationship with climate change. Also, climate change has negative relationship with spring wheat export, but positive relationship with winter wheat export. In short, corn export of US decreases further under ROW including scenario, showing negative relationship. However, US export volume for soybean increase further with ROW including, indicating positive relationship.

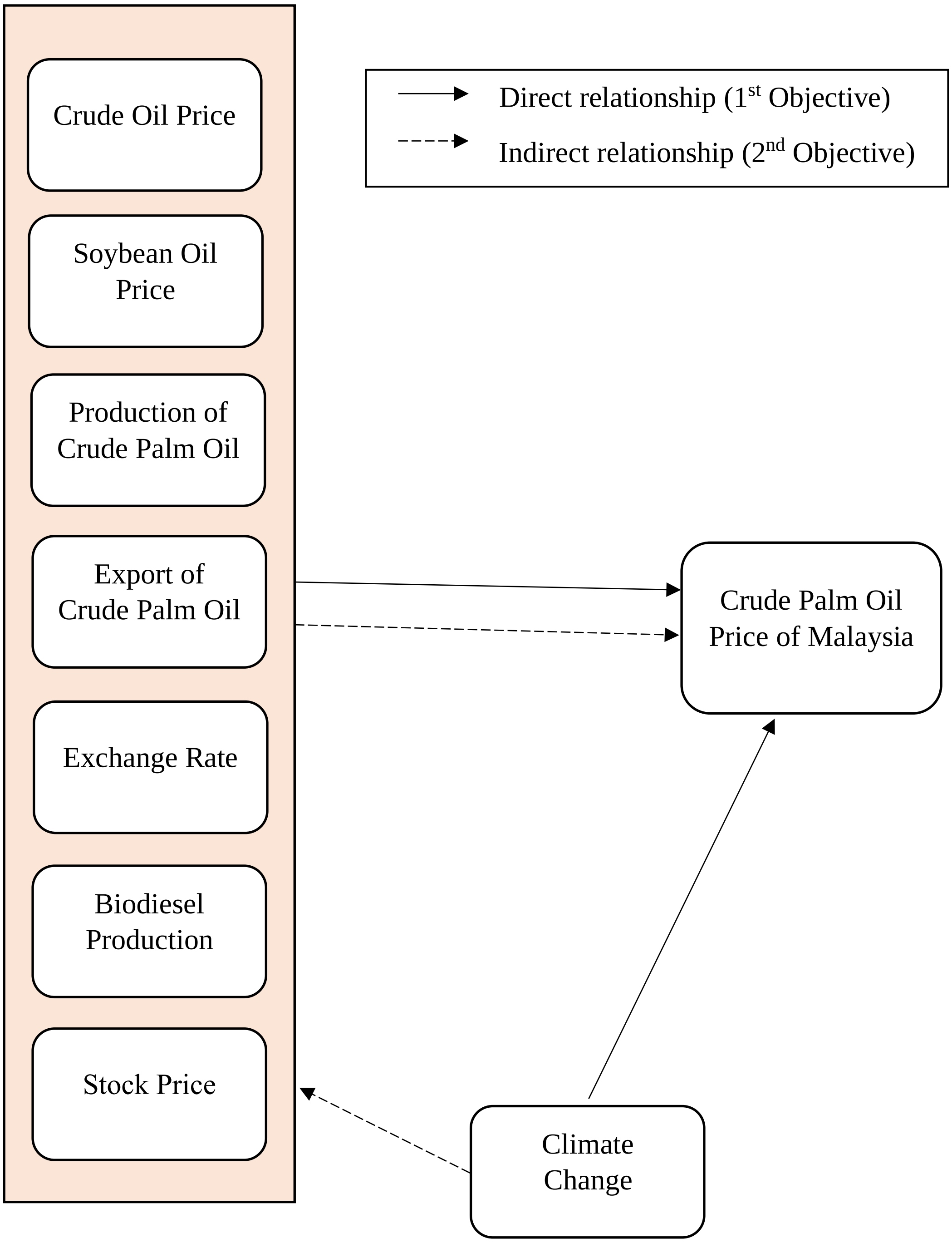
Climate change may indirectly impact on CPO price through influencing the exchange rate. According to a research done by Ogbuabor and Egwuchukwu (2017) in Nigeria, they discovered if climate change problem has mitigated, it would rise the overall output growth of Nigerian economy. When nation has a good economic performance with low inflation, it is bringing the significant positive impact on the naira-to-dollar exchange rate. The researchers had used the OLS method to estimate the relationship and the yearly data for the period 1981 to 2014 was using in test.

Furthermore, the research carried out by Gunasekara and Jayasinghe (2019) has proven that climate change will affect the stock price. This study utilized the rainfall and temperature as the proxy of climate change to examine the effect on All Share Price Index (ASPI) of Colombo Stock Exchange as the market index with monthly data from January 2009 to December 2016. A positive relationship can be concluded between stock price and climate change by using VAR in the research.

In short, climate change has an effect on all these variables stated. Therefore, this research paper will further examine how the determinants of CPO price affect CPO price through the interaction term, climate change to make this study more comprehensive and more contribution.

2.3 Theoretical Framework

Figure 2.1 *Theoretical Framework*



In the theoretical framework, the interaction variable, climate change is added to the whole framework to test the effect on the different independent variables stated above and have the overall consequential effect on the dependent variable, CPO price of Malaysia.

2.4 Chapter Summary

In conclusion, we have discussed theoretical review, empirical review and theoretical framework in Chapter 2. The common variables are crude oil price, SBO price, production of CPO, export of CPO, exchange rate and biodiesel production, while our contribution is stock price and climate change, climate change also acts as interactive term in this research. The theory applied in this chapter is supply and demand theory that shows that supply and demand of independent variables to affect CPO price in Malaysia. Moreover, the relationship among CPO price and all explanatory variables have been discussed in the empirical review. Theoretical framework has included all the independent variables affecting the CPO price in this research.

CHAPTER 3: METHODOLOGY

3.0 Introduction

In this chapter, description and unit measurement of each variable have been recorded. Furthermore, theoretical framework shows the basic model obtained from the main journal used, and the model has been extended to act as a contribution in this research. Lastly, the method used in this research will be discussed right after the Diagnostic Checking.

3.1 Source of Data

The determinants of CPO price are crude oil price, SBO price, CPO production, export of CPO, exchange rate, biodiesel production, stock price and climate change. This study included the monthly data with the collection period from January 2007 to May 2018. Table 3.1 shows the data description and the unit measurement.

Table 3.1 *Data Description and Unit Measurement*

Variables	**Definition**	**Unit measurement**
Crude Palm Oil Price (CPOP)	The value of the fruit of the CPO that refined from the pericarp. It is an oil which in a crude form.	Ringgit Malaysia (RM) per metric ton
Crude Oil Price (COP)	The amount of oil that included trace elements of sulphur, nitrogen and oxygen. It also known as petroleum. It is a massive black fluid mainly formed of hydrogen and carbon.	Ringgit Malaysia (RM) per metric ton

Soybean Oil Price (SBOP)	The cost of an oil that created from clear to moderate kind of oil. Most of the natural gums (phospholipids) have removed by hydration and automatically apart.	Ringgit Malaysia (RM) per metric ton
Crude Palm Oil Production (POP)	Creation of eatable vegetable oil. It can generate from mesocarp palm oil fruit and it cannot be mistaken with palm kernel oil gained from same fruit's kernel.	Metric Tonnes ('000)
Export of Crude Palm Oil (EPO)	The first milling process that used to remove CPO from the fresh fruit bunches. After that, it will be sent to each market destination and some selected countries will have the priority to send first.	Metric Tonnes ('000)
Exchange Rate (ER)	The official currency in Malaysia is Ringgit Malaysia (RM), however, the official currency in United States of America is US dollar ($).	$\frac{United\ Stated\ Dollar\ (\$)}{Ringgit\ Malaysia\ (RM)}$
Biodiesel Production (BP)	The procedure of making biodiesel inclusive a chemical react. This shows that biodiesel industry is considered as a chemical industry. The process of making biodiesel must have a good knowledge on the chemistry in order to make sure they are producing a good quality and safe fuel.	Metric Tonnes
Stock Price (SP)	The biggest 30 companies with full market capitalization on Bursa Malaysia's Main Board have formed the FTSE Bursa Malaysia	Index (Points)

	KLCI Index. Closing value on 3 July 2009 has replaced by the Bursa Malaysia KLCI Index on 6 July 2009 when launched.	
Climate Change (CC)	Temperature is to determine an object's heat quantity and usually use a thermometer to measure. The normal degree of heat in a human is 37 Degree Celsius. If exceed it, it means the person is getting fever. It can also measure the degree of heat at the atmosphere.	Degree Celsius (°C)

3.2 Econometric Framework

3.2.1 Basic Model

This research is adopted from Sahra Mohammadi, Fatimah Mohamed Arshad, Bilash Kanti Bala, & Abdulla Ibragimov (2015), the research has conducted the relationship between CPO price and production of CPO, SBO price and biodiesel production and these 3 variables will be the control variables under this research. The research shows SBO price and biodiesel production have positively affect CPO price, however, CPO production is negatively affect the CPO price.

Functional form:

$$CPOP = f(POP, SBOP, BP)$$

Econometric model:

$$CPOP = \beta_0 + \beta_1(POP_t) + \beta_2(SBOP_t) + \beta_3(BP_t) + \varepsilon_t$$

Where:

CPOP = Crude palm oil price
SBOP = Soybean oil price
POP = Crude palm oil production
BP = Biodiesel production

3.2.2 Extension Model

The new model has been extended by adding each of the conditional variable separately and also all together to study the relationship between dependent and independent variables. The conditional variables are crude oil price, export of CPO, exchange rate, stock price and climate change. For further clarification, the Econometric Model 1, 2, 3, 4 and 5 are to examine the determinants that impact the CPO price by taking 3 control variables together with 1 conditional variable while Model 6 is to measure the combine effect by including all independent variables towards the CPO price. In short, the first 6 model is to achieve the first objective in this research.

In terms of Econometric Model 7, 8, 9, and 10, they are to accommodate the 2nd objective where it has taken interaction term (climate change) into consideration to examine the indirect effect of climate change towards the dependent variable and lastly the Model 11 is the combination effect of all independent variables with interaction term towards CPO price. The purpose of establishing Model 6 and 11 is to achieve sustainability by detects the relationship of each variable on CPO price when all the independent variables are all exist. Besides, it also wants to examine whether the relationship will be difference between a separate model and also combined model. Lastly, this research will be more emphasis on climate change and stock price as there is the main contribution to this research due to the limited literature review in the past studies.

Functional form:

$$CPOP = f(POP, SBOP, BP, X_1)$$

Econometric model: Model 1

$$logCPOP_{t-n} = \beta_0 + \beta_1(logPOP_{t-n}) + \beta_2(logSBOP_{t-n}) + \beta_3(logBP_{t-n}) + \beta_4(logCOP_{t-n}) + \varepsilon_{t-n}$$

Econometric model: Model 2

$$logCPOP_{t-n} = \beta_0 + \beta_1(logPOP_{t-n}) + \beta_2(logSBOP_{t-n}) + \beta_3(logBP_{t-n}) + \beta_4(logEPO_{t-n}) + \varepsilon_{t-n}$$

Econometric model: Model 3

$$logCPOP_{t-n} = \beta_0 + \beta_1(logPOP_{t-n}) + \beta_2(logSBOP_{t-n}) + \beta_3(logBP_{t-n}) + \beta_4(logER_{t-n}) + \varepsilon_{t-n}$$

Econometric model: Model 4

$$logCPOP_{t-n} = \beta_0 + \beta_1(logPOP_{t-n}) + \beta_2(logSBOP_{t-n}) + \beta_3(logBP_{t-n}) + \beta_4(logSP_{t-n}) + \varepsilon_{t-n}$$

Econometric model: Model 5

$$logCPOP_{t-n} = \beta_0 + \beta_1(logPOP_{t-n}) + \beta_2(logSBOP_{t-n}) + \beta_3(logBP_{t-n}) + \beta_4(logCC_{t-n}) + \varepsilon_{t-n}$$

Econometric model: Model 6

$$logCPOP_{t-n} = \beta_0 + \beta_1(logPOP_{t-n}) + \beta_2(logSBOP_{t-n}) + \beta_3(logBP_{t-n}) + \beta_4(logCOP_{t-n}) + \beta_5(logEPO_{t-n}) + \beta_6(logER_{t-n}) + \beta_7(logSP_{t-n}) + \beta_8(logCC_{t-n}) + \varepsilon_{t-n}$$

Econometric model: Model 7

$$logCPOP_{t-n} = \beta_0 + \beta_1(\log(POP_{t-n} \times CC_{t-n})) + \beta_2(\log POP_{t-n})) + \beta_3(\log(SBOP_{t-n} \times CC_{t-n})) + \beta_4(log\ SBOP_{t-n}) + \beta_5(\log(BP_{t-n} \times CC_{t-n})) + \beta_6(logBP_{t-n}) + \beta_7(\log(COP_{t-n} \times CC_{t-n})) + \beta_8(log\ COP_{t-n}) + \varepsilon_{t-n}$$

Econometric model: Model 8

$$logCPOP_{t-n} = \beta_0 + \beta_1(\log(POP_{t-n} \times CC_{t-n})) + \beta_2(\log POP_{t-n})) + \beta_3(\log(SBOP_{t-n} \times CC_{t-n})) + \beta_4(log\ SBOP_{t-n}) + \beta_5(\log(BP_{t-n} \times CC_{t-n})) + \beta_6(logBP_{t-n}) + \beta_7(\log(EPO_{t-n} \times CC_{t-n})) + \beta_8(log\ EPO_{t-n}) + \varepsilon_{t-n}$$

Econometric model: Model 9

$$
\begin{aligned}
logCPOP_{t-n} = \beta_0 &+ \beta_1(\log(POP_{t-n} \times CC_{t-n})) + \beta_2(\log POP_{t-n})) \\
&+ \beta_3(\log(SBOP_{t-n} \times CC_{t-n})) + \beta_4(log\ SBOP_{t-n}) \\
&+ \beta_5(\log(BP_{t-n} \times CC_{t-n})) + \beta_6(logBP_{t-n}) \\
&+ \beta_7(\log(ER_{t-n} \times CC_{t-n})) + \beta_8(log\ ER_{t-n}) + \varepsilon_{t-n}
\end{aligned}
$$

Econometric model: Model 10

$$
\begin{aligned}
logCPOP_{t-n} = \beta_0 &+ \beta_1(\log(POP_{t-n} \times CC_{t-n})) + \beta_2(\log POP_{t-n})) \\
&+ \beta_3(\log(SBOP_{t-n} \times CC_{t-n})) + \beta_4(log\ SBOP_{t-n}) \\
&+ \beta_5(\log(BP_{t-n} \times CC_{t-n})) + \beta_6(logBP_{t-n}) \\
&+ \beta_7(\log(SP_{t-n} \times CC_{t-n})) + \beta_8(log\ SP_{t-n}) + \varepsilon_{t-n}
\end{aligned}
$$

Econometric model: Model 11

$$
\begin{aligned}
logCPOP_{t-n} = \beta_0 &+ \beta_1(\log(POP_{t-n} \times CC_{t-n})) + \beta_2(\log POP_{t-n})) \\
&+ \beta_3(\log(SBOP_{t-n} \times CC_{t-n})) + \beta_4(log\ SBOP_{t-n}) \\
&+ \beta_5(\log(BP_{t-n} \times CC_{t-n})) + \beta_6(logBP_{t-n}) \\
&+ \beta_7(\log(COP_{t-n} \times CC_{t-n})) + \beta_8(logCOP_{t-n}) \\
&+ \beta_9(\log(EPO_{t-n} \times CC_{t-n})) + \beta_{10}(logEPO_{t-n}) \\
&+ \beta_{11}(\log(ER_{t-n} \times CC_{t-n})) + \beta_{12}(logER_{t-n}) \\
&+ \beta_{13}(\log(SP_{t-n} \times CC_{t-n})) + \beta_{14}(logSP_{t-n}) + \varepsilon_{t-n}
\end{aligned}
$$

Where:

CPOP = Crude palm oil price

SBOP = Soybean oil price

COP = Crude oil price

ER = Exchange rate

CC = Climate change

POP = Crude palm oil production

BP = Biodiesel production

EPO = Export of crude palm oil

SP = Stock price

3.3 Expected Sign

Table 3.2 *Summary Relation of CPO Price with Other Variables from Past Studies*

Variables	Author	Sign
Crude Oil Price	Saghaian (2010)	Positive relationship
	Nazlioglu and Soytas (2012)	Positive relationship
	Rezitis and Sassi (2013)	Positive relationship
	Rezitis (2015)	Positive relationship
	Bergmann, O'ConnorFr & Thummel (2016)	Positive relationship
	Balu Nambiappan et al. (2018)	Positive relationship
	Buyung et al. (2017)	Significant relationship
	Norlim Khalid et al. (2018)	Significant relationship
	Norhayanti Mohamad (2018)	Negative relationship
	Chuangchid et al. (2012)	Fair weak dependence
Soybean Oil Price	Ayat K Ab Rahman et al. (2007)	Positive relationship
	Sahra Mohammadi et al. (2015)	Positive relationship
	M Ayatollah Khomeini Ab Rahman et al. (2017)	Positive relationship
	Norlim Khalid et al. (2018)	Positive relationship
	Santeramo & Searle (2019)	Positive relationship
	Athikulrat, Rungreunganun, & Talabgaew (2015)	Positive relationship
	Chuangchid et al. (2012)	Positive relationship
	Balu Nambiappan et al. (2018)	Positive relationship
	Norhayanti Mohamad (2018)	Negative relationship
	Norlim Khalid et al. (2018)	Negative relationship
	Buyung et al. (2017)	Insignificant relationship
	Ain Hassan & N Balu (2016)	Insignificant relationship

	Dg Halimah Arasim & Abdul Aziz Karia (2015)	Unidirectional relationship
Crude Palm Oil Production	Ayat K Ab Rahman et al. (2007)	Negative relationship
	Ayat K Ab Rahman, N Balu, & Faizah Mohd Shariff (2013)	Negative relationship
	Nur Nadia Kamil & Syuhadatul Fatimah Omar (2016)	Negative relationship
	M Ayatollah Khomeini Ab Rahman et al. (2017)	Negative relationship
	Sahra Mohammadi et al. (2015)	Negative relationship
	Ain Hassan & N Balu (2016)	Short run – Significant relationship Long run – Insignificant relationship
Export of Crude Palm Oil	Nur Nadia Kamil & Syuhadatul Fatimah Omar (2016)	Positive relationship
	Dg Halimah Arasim & Abdul Aziz Karia (2015)	Positive relationship
	M Ayatollah Khomeini Ab Rahman et al. (2017)	Positive relationship
	Ayat K Ab Rahman et al. (2007)	Positive relationship
	Ayat K Ab Rahman, N Balu, & Faizah Mohd Shariff (2013)	Negative relationship
	Ain Hassan & N Balu (2016)	Short run – Significant relationship Long run – Insignificant relationship
Exchange Rate	Rifin (2010)	Positive relationship
	Saghaian (2010)	Positive relationship
	Buyung et al. (2017)	Significant relationship

	Nazlioglu & Soytas (2012)	Negative relationship
	Rezitis & Sassi (2013)	Negative relationship
	Kiatmanaroch & Sriboonchitta (2014)	Negative relationship
	Rezitis (2015)	Negative relationship
	Chansuchai (2017)	Insignificant relationship
	Buerhan Saiti et al. (2014)	Insignificant relationship
Biodiesel Production	Castiblanco, Moreno, & Etter (2015)	Positive relationship
	Ong et al. (2012)	High sensitivity
	Sahra Mohammadi et al. (2015)	Less effect
Stock Price	Buerhan Saiti et al. (2014)	Short run – Insignificant relationship Long run – Negative relationship
	Liao, Qian, & Xu (2018)	With gold – Insignificant relationship Without gold – Positive relationship
	Creti, Jots, & Mignon (2012)	Correlation at the range of 0.1 and 0.3
	Joets, Mignon, & Razafindrabe (2017)	High sensitivity
Climate Change	Ronnback (2014)	Negative relationship
	Blanco et al. (2017)	Negative relationship

Table 3.3 *Relationship between Climate Change and Independent Variables*

Variables	**Author**	**Sign**
Crude Palm Oil Production (POP)	Zahid Zainal et al. (2012)	Significant relationship
Soybean Oil Price (SBOP)	Chatzopuolos et al. (2019)	Positive relationship
Biodiesel Production (BP)	Dai et al. (2017)	Significant relationship
Crude Oil Price (COP)	Dike (2014)	Positive relationship
Export of Crude Palm Oil (EPO)	Zhang et al. (2014)	Positive and negative relationship
Exchange Rate (ER)	Ogbuabor & Egwuchukwu (2017)	Positive relationship
Stock Price (SP)	Gunasekara & Jayasinghe (2019)	Positive relationship

3.4 Unit Root Test

Unit root test is used to examine the stationary of the variables in the time series model. If the model is not stationary, it will cause spurious regression which the equation will tend to mislead the conclusion. The results obtain may not accurate such as the t-ratios does not follow the t-distribution and the high r-squared values even though the data is uncorrelated (Wooldridge, 2009). Hence, it is important to perform the unit root test in order to avoid getting inaccurate result. The most common unit root test is the Dickey-Fuller (DF) test which developed by Dickey and Fuller in 1979. However, the time series data always tested with the additional of lagged term (p) of changes in Y_t to account for the dynamics in the process. Therefore, the Augmented Dickey-Fuller (ADF) test is introduced to detect the stationary of regression with the changes in lagged term.

There are two types of models, regression equation with constant without trend and constant and linear trend. The equations are shown as follow:

With constant without trend:

$$\Delta Y_t = \alpha + \delta Y_{t-1} + \sum_{i=1}^{k} \Delta Y_{t-1} + \varepsilon_t$$

With constant with trend:

$$\Delta Y_t = \alpha + \beta t + Y_{t-1} + \sum_{i=1}^{k} \delta_j \Delta Y_{t-1} + \varepsilon_t$$

Where Y_t refers to:

CPOP = Price of crude palm oil
SBOP = Soybean oil price
COP = Crude oil price
ER = Exchange rate
CC = Climate change
POP = Crude palm oil production
BP = Biodiesel production
EPO = Export of crude palm oil
SP = Stock price

The test statistic is calculated as below:

Test Statistic, t $= \frac{\hat{\delta}}{SE_{\hat{\delta}}}$

The decision rule for ADF test is to reject the null hypothesis when the test statistic is less than the critical value which indicates that the variable is stationary. Otherwise, the null hypothesis cannot be rejected since the data is non-stationary. Therefore, the negative number of critical values has the high possibility to reject the null hypothesis. If the null hypothesis is rejected, indicates the data is stationary. In order to determine the number of lag length should be chosen, it is referring to the Akaikes's information criterion (AIC) and Schwartz criterion (SC) (Seddighi, Lawler & Katos, 2000).

The second type of unit root test is the Dicker-Fuller General Least Squares (DF-GLS) test which is developed by Elliott, Rothenberg and Stock in 1996. The null hypothesis in the test stated that Y_t has a random walk trend a possibly with drift on the other hand, the alternative hypothesis is the Y_t is stationary around a linear time trend. It can be calculated in two steps, first, use the generalized least squares to estimate the intercept and trend. The second step includes the intercept or time trend in the Dickey-Fuller regression model. The critical value is calculated by:

Test Statistic, $Y_t^d = Y_t - \widehat{\delta}_0$

The critical value of ADF and DF-GLS are different due to the different estimation of the coefficients on the deterministic terms. The null hypothesis is rejected if the DF-GLS test statistic is less than the critical value (Stock & Watson, 2012).

Besides, Philips and Perron has developed a test has asymptotic distributions as similar to ADF z and t test called Philips-Perron (PP) Test in 1988. PP test is modifying the DF test statistic for any serial correlation and heteroskedasticity in the residuals, PP test ignore the serial correlation in the regression. The statistic is modified by applying a Newey-West correction for the serial correlation to obtain the Newey-West standard error of ρ. PP test does not specified any lag length for the regression, hence it is robust in residual in the form of heteroskedasticity. However, PP test perform worse in finite samples than ADF test due to different way in the correction of serial correlation (Davidson & MacKinnon, 2004).

3.5 Diagnostic Checking

3.5.1 Normality Test

Normality test is a statistical process used to determine whether the sample or a group of data fits a standard normal distribution. Normal distribution, also known as Gaussian distribution, is the basic assumption that applied on all the statistical tests such as correlation and regression (Das & Imon, 2016). First of all, normality can test by the graphical method and analytical method. Graphical method such as histogram, it is the easiest and simplest graphical plot by using frequency distribution. For the analytical method, there are two categories, which are empirical distribution functions tests and descriptive measures function test. Empirical distribution function test is tested based on the difference between empirical and hypothesis distributions. Besides, descriptive measure test is mainly to identify the standards for testing normality by utilizing the sample values of coefficients of skewness and kurtosis (Das & Imon, 2016).

The Jarque-Bera (JB) test is one of the famous goodness-of-fit tests being used in economics for normality testing. The error term will be determined whether is normally distributed based on the estimated model. This test is using coefficient of classical skewness and kurtosis, it leads to the JB test statistic (Brys, Hubert & Struyf, 2004). For the decision rule, if the JB test statistic ($JB= \frac{n}{6}[Skewness^2 + \frac{1}{4}(Kurtosis - 3)^2]$) is larger than the critical chi-square value ($\chi^2{}_{\alpha,2}$), it tend to reject null hypothesis which indicates the error term is normally distribution. On the other hand, if the JB test statistic does not exceed the critical chi-square value, the null hypothesis will be accepted. Other than that, the result can be determined using p-value approach. The p-value can be obtained from the Eviews result for the computed chi-square value where if the p-value is lower than the alpha value, the null hypothesis will be rejected, otherwise, the accept the null hypothesis (Gujarati, 2006).

It has violated the assumption of regression analysis where the error terms are not normally distributed. However, according to Cameron (2005), the OLS regression is still consider reliable in the presence of some non-normality in the error term. The non-normally distributed of the error term may cause by the data entry errors, which involved the outliers in the model. To curb the problem, the model canbe modified using weighted least square method to reduce the variation of the error term (Gujarati, 2006). On the other hand, the OLS estimators in the linear regression model still will be approximately normally distributed around true parameter values based on the central limit theorem. Hence, the model can remain valid if there is large sample size, even it violates the normality assumption rule (Li, Wong, Lamoureux & Wong, 2012).

3.5.2 Multicollinearity

Multicollinearity problem in a regression generally have been detected when there are high correlations between two or more independent variables. In other definition, it occurs when there is a relationship between the independent variables in the model. If model has multicollinearity problem, the estimation of unique effect of one independent variable to the other dependent variable will go wonky. This has resulted estimation for regression coefficients can be unreliable or misleading. In theory, there are two types of multicollinearity: Perfect Multicollinearity and Imperfect Multicollinearity. This is to examine the degree of correlation between independent variables. The difference is not between the presence and absence of multicollinearity, but is between its various degrees.

There is no formal way to measure the multicollinearity. However, there are few informal ways to detect the problem such as R-squared, t-ratios and Variance Inflation Factor (VIF). The easiest way to detect multicollinearity is by high pair-wise correlation analysis. It is to calculate correlation coefficients (r) for all pairs of predictor variables. Perfect multicollinearity refers to the correlation coefficient is exactly +1 or -1. While, if r is greater than 0.8, there is a highly correlated between the explanatory variables, a serious multicollinearity may exist. However, this criterion may not reliable sometimes since multicollinearity can exist even though simple correlations are comparatively low (Gujarati & Porter, 2009). Moreover, when the model has high R^2 of regression but few significant t ratios, it indicated that multicollinearity problem exists. When the partial slope coefficient s is close to zero or equal to zero, the F test will reject the null hypothesis. However, individual t test will show that none or very few partial slope coefficients are statistically different from zero (Gujarati & Porter, 2009). Another way to detect multicollinearity is depend on variance inflation factor (VIF). The formula used to compute VIF is $VIF_k = 1 / (1 - R^2_k)$. If VIF_k determined equal to 1, variable k is not correlated with another independent variable. A serious multicollinearity has been detected when VIF_k is greater than 10.

If model has detected multicollinearity, several ways can use to handle the problem. Firstly, the correlation between independent variables can be reduced by increasing the sample. For instance, lengthen the time range of all variables. Secondly, transformation of data as one of efficient way to minimise the multicollinearity in the regression. For example, adopt aggregate consumption expenditure per capita basis instead of the aggregate consumption expenditure (Gujarati & Porter, 2009). Thirdly, dropping one of highly correlated variable from the model as one of the methods to overcome multicollinearity problem. This may result the estimation of unique effect of one independent variable to the dependent variable can be more accurate. However, this way is discouraged since reduce independent variable in the model may cause model specification error. The result generated may biased.

3.5.3 Breusch–Godfrey LM Test

Serial correlation will be existed when autocorrelation appeared in time-series data and this is because the error terms in the model are correlated (Gujarati, 2006). This issue normally will exist in the time series model as it involved the error in a given period of time will bring forward into future time periods which is not existed in cross sectional data. For further clarification, the error term at time period t is correlated with error terms u_{t+1}, u_{t+2}…. and u_{t-1}, u_{t-2}….and so on (Maddala, 2005). There are different types of serial correlation problem which narrow down to pure and impure serial correlation. In terms of pure serial correlation, the error term for the next period will correlate to the error term in a given time directly given the model has specified correctly (Pindyck, Rubinfeld, Pindyck & Rubinfeld, 1998). A positive serial correlation implies that the error terms are correlated, and vice versa (Gujarati, 2009). On the other hand, impure serial correlation is occurred when there is a misspecification error such as omitted important relevant variable or incorrectly identify the functional form of model. There are few formal tests are allowed to identify the autocorrelation problem in a time-series model which including Durbin-Watson test, Durbin’s H test and Breush-Godfrey test (Azad Abdulhafedh, 2017). However, informal test can be used through graphical method such as scatter plot or line chart. It can be recognized by plotting the errors against time and plot errors against lagged errors and examine for the patterns of the trend.

Durbin Watson has proposed Durbin-Watson test in 1950. Even it is the most common and simplest way to test for autocorrelation problem, however it cannot detect higher-order autoregressive (AR) schemes in a model (Godfrey, 2006). In terms of Durbin’s H test, although it can accommodate with the higher-order autoregressive schemes, but it is not applicable for the lagged dependent variable (Godfrey, 2006). For these reasons, the best method that can accommodate all the cases above is Breusch–Godfrey LM Test (Godfrey, 2006). Thus, the Breusch–Godfrey LM Test is used to detect the serial correlation in the model.

By the hypothesis testing, it is required to transfer the estimated model into an estimate auxiliary model which can be performed the transformation through Eview (Gujarati, 2006). Then, the decision rule can be determined through 2 methods which the H_0 is rejected when the test statistic value (n-p)R^2 is greater than the critical value ($\chi^2{}_{\alpha,p}$). The second method is to look at the probability value where it is lower than the significance level, the H_0 tend to be rejected. Otherwise, it should not be rejected (Schmidt, 2005). The *p* in Critical Value is standing for the number of lags used in the model while using 1 minus confidence level derives the alpha value. The rejection rule using P-value is done based on common confidence intervals of 90%, 95% or 99% (Vynck, 2016).

Cochrane-Orcutt procedure is one of the ways to solve the serial correlation problem in the model that developed by the Cochrane and Orcutt in 1949. However, it only can tackle with the regression, which consist of pure autocorrelation problem (Azad Abdlhafedh, 2017). Firstly, using the estimated OLS regression to estimate the first-order autocorrelation coefficient residuals. Then, rescale the variables involved in the auxiliary regression derived to eliminate the serial correlation in the errors (Black, Hashimzade & Myles, 2009).

These 2 steps have to be repeated until the estimated *p* has small changes (<0.001) or constant.

Pure Autocorrelation : $Y_i = \beta_0 + \beta_1(X_t) + \varepsilon_t$
Solve Autocorrelation : $Y_i = \beta_0 + \beta_1(Z_t) + \varepsilon_t$

Moreover, transform the regression by replacing with instrumental or proxy variables is another way to solve the serial correlation problem. For instance, omit the X variable and replace it by other proxy variable, Z into our new model as shown above. The Z variable used should not be correlated with the error term or independent variables. Consequently, the model can be improved as well as the estimator will be unbiased, efficient and consistent (Gujarati, 2006). Increase the sample size could be another solution for autocorrelation given it is pure autocorrelation. This research can increase the frequency of data to increase the sample size, so it may reduce the time series correlation (Gujarati, 2006).

3.5.4 CUSUM Test

In CUSUM Test, the coefficients are assumed to be stable across all the regression models (Mills, 2014). Stability diagnostics is use to examine whether the parameters of a regression equation are stable across various subsamples of data (HIS Global Inc, 2017). For instance, consider the classical equation as shown as below:

$$\mathrm{Y_t} = \beta_1 + \beta_2 \mathrm{X}_{2t} + \cdots + \beta_k \mathrm{X}_{kt} + \varepsilon_t , t = 1, \ldots , T.$$

This equation is assumed that the model parameters (β) stability when parameters are constant over the entire sample period. However, if there is an abruptly changes at a point in time either change in mean or change in parameters in time series regression, it is known as structural break (Mills, 2014). Stability diagnostic checking is very important to recognise structural break in time series regression because it can result a misleading conclusions and inaccurate forecasts (Hansen, 2001).

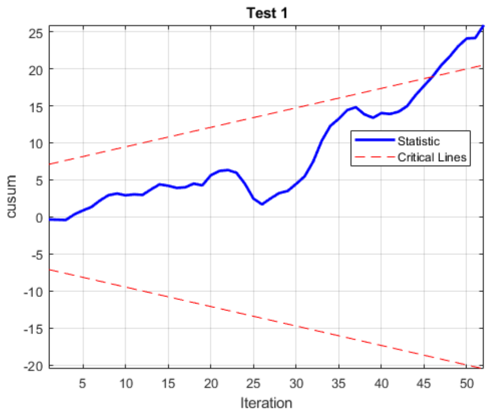
The CUSUM test established by Brown, Durbin, and Evans in 1975 is one of the stability tests with null hypothesis (H_0) of parameter stability. It is an appropriate way to examine parameter instability in the intercept term based on cumulative sum of recursive residuals (W_t). The CUSUM test is based on the statistic below:

$$W_t = \sum_{r=k+1}^{t} \frac{w_r}{s}$$

For t = k+1,…, T, where w is recursive residual and s is standard deviation of recursive residuals w_t.. If parameter remains constant over the period, $W_t = 0$. However, if parameter change, W_t will tend to diverge from zero mean value line and the distance of departure will increase with t. CUSUM test finds parameter instability when the cumulative sum of recursive residuals (W_t) goes outside the area between two critical lines. The 5% significant critical lines determine through formula below:

$$[\, k, \pm - 0.948\,(T-k)^{\frac{1}{2}}] \qquad \text{and} \qquad [T, \pm 3 \times 0.948\,(T-k)^{\frac{1}{2}}]$$

Figure 3.1: *A sample of CUSUM test as shown as below:*



The sample CUSUM above has clearly shown the coefficient instability in the equation during sample period.

3.6 Model Estimation

3.6.1 Autoregressive Distributed-lag (ARDL) model

Autoregressive Distributed-lag (ARDL) model contains the lagged value(s) of the dependent variable and current values of one or variables and its own lag value (Ghouse, Khan & Rehman, 2018). Begin estimating an ARDL model normally starts from reasonably general and large dynamic model. Then, the F-test and t-test can be utilized to pare down the model by eliminating unnecessary coefficients (Seddighi, Lawler & Katos, 2000). This model had been used by Davidson et al. in 1978 to form the consumption dynamic model in United Kingdom (UK) (Davidson, Hendry, Srba & Yeo, 1978). ARDL model can be specified if the combination of variables are I(0) and I(1) order of integration without integrated of order 2. I(0) simply means stationary variables and I(1) implies that there are difference stationary variables (Enders, 2010).

As compared to the VAR model, the ARDL model can be designed for endogenous and exogenous variables (Seddighi, Lawler, & Katos, 2000). The development of ARDL approach by Pesaran et al. (2001) was intended to overcome the limitation of cointegration approach based on either Engle and Granger (1987) cointegration test or Johansen and Jeselius (1990) maximum likelihood test which not be appropriate to test the model with small sample sizes (Odhiambo, 2009). ARDL model is relatively efficient in examining small and finite size of sample data. It allows to examine the cointegration relationship with the OLS method if the lag order of variables is known.

According to the bounds test result, it specifies only the short run ARDL model if the variables are not cointegrated. Otherwise, it should specify both short-run and long run ARDL model. Through model specification by using ARDL model, many econometric problems able to be tackled includes misspecification and autocorrelation and generate a most appropriate and unbiased long run interpretable model (Ghouse, Khan & Rehman, 2018).

The generalised ARDL (p,q) model is specified as:

Model without interaction term,

$$\begin{aligned} log\mathrm{CPOP_t} = \propto + \sum_{i=1}^{P} \delta_i \, log\mathrm{CPOP_{t-1}} \\ + \sum_{i=0}^{q} \beta_i' log\mathrm{POP_{t-i}} + \sum_{i=0}^{q} \beta_i' log\mathrm{SBOP_{t-i}} + \sum_{i=0}^{q} \beta_i' log\mathrm{BP_{t-i}} \\ + \sum_{i=0}^{q} \beta_i' log\chi_{t-i} + \varepsilon_t \end{aligned}$$

χ named as COP, EPO, ER, SP and CC.

Model with interaction terms,

$$
\begin{aligned}
log\mathrm{CPOP_t} = \propto + \sum_{i=1}^{P} \delta_i \, log\mathrm{CPOP_{t-1}} \\
+ \sum_{i=0}^{q} \beta_i' \log\,(\mathrm{POP_{t-i}} \times \mathrm{CC_{t-i}}) + \sum_{i=0}^{q} \beta_i' \log\,(\mathrm{SBOP_{t-i}} \times \mathrm{CC_{t-i}}) \\
+ \sum_{i=0}^{q} \beta_i' \log\,(\mathrm{BP_{t-i}} \times \mathrm{CC_{t-i}}) + \sum_{i=0}^{q} \beta_i' \log\,(\chi_{t-i} \times \mathrm{CC_{t-i}}) + \varepsilon_t
\end{aligned}
$$

χ named as COP, EPO, ER and SP.

Where:

CPOP = Price of crude palm oil

POP = Crude palm oil production

SBOP = Soybean oil price

BP = Biodiesel production

COP = Crude oil price

EPO = Export of crude palm oil

ER = Exchange rate

SP = Stock price

CC = Climate change

Yt is a vector and the variables in X' are allowed to be purely I(0) or I(1) or cointegrated; β and δ are coefficients; α is the constant, i = 1, 2, 3…, k; p and q are optimal lag orders, p lags used for dependent variable and q lags used for independent variables; ε_t is a vector of the error terms.

To perform the bounds test for cointegration, the conditional ARDL (p, q_1, q_2) model is specified as:

Model without interaction term,

$$\begin{aligned} logCPOP_t = {} & \propto_{1,0} + \beta_{1,1}\, logCPOP_{t-1} + \beta_{1,2}\, logPOP + \beta_{1,3}\, logSBOP_{t-1} \\ & + \beta_{1,4}\, logBP_{t-1} + \beta_{1,5}\, log\chi_{t-1} \\ & + \sum_{i=1}^{P} \alpha_{1i}\, logCPOP_{t-1} \\ & + \sum_{i=0}^{q} \propto_{2i}\, logPOP_{t-i} + \sum_{i=0}^{q} \propto_{3i}\, logSBOP_{t-i} + \sum_{i=0}^{q} \propto_{4i}\, logBP_{t-i} \\ & + \sum_{i=0}^{q} \propto_{5i}\, log\chi_{t-i} + \varepsilon_{1t} \end{aligned}$$

Model with interaction terms,

$$\begin{aligned} logCPOP_t = {} & \propto_{1,0} + \beta_{1,1}\, logCPOP_{t-1} + \beta_{1,2}\, (log(POP_{t-1} \times CC_{t-i})) \\ & + \beta_{1,3}\, (log(SBOP_{t-1} \times CC_{t-i})) + \beta_{1,4}\, (log(BP_{t-1} \times CC_{t-i})) \\ & + \beta_{1,5}\, (log(\chi_{t-1} \times CC_{t-i})) \\ & + \sum_{i=1}^{P} \alpha_{1i}\, logCPOP_{t-1} \\ & + \sum_{i=0}^{q} \propto_{2i}\, (log(POP_{t-i} \times CC_{t-i})) \\ & + \sum_{i=0}^{q} \propto_{3i}\, (log(SBOP_{t-i} \times CC_{t-i})) \\ & + \sum_{i=0}^{q} \propto_{4i}\, (\log\,(BP_{t-i} \times CC_{t-i})) + \sum_{i=0}^{q} \propto_{5i}\, (log(\chi_{t-i} \times CC_{t-i})) \\ & + \varepsilon_{1t} \end{aligned}$$

Hypothesis of bound test has shown as below:

H_0: $\beta_{1i} = \beta_{2i} = \beta_{3i} = \beta_{4i} = \beta_{5i} = 0$, (where i = 1, 2, 3)
H_1: At least one of the β_i not equal to 0

Bound test can be run by Eview. When the result show the F-statistic is greater than the figure of I(1), reject H_0 and conclude the model is statistically significant.

3.6.2 Error correction model (ECM)

Error correction model (ECM) is following test after testing the cointegration in bound test. Error correction model is standard way to model the cointegrated time series equation. It is a model derived from initially equation by replacing ARDL bound test long run tern with error correlation term (ECM_{t-1}). ECM is to estimate the speed of adjustment to long run equilibrium after deviation has occurred in the short run (Gujarati & Porter, 2009). The ECM is specified as following equation:

Model without interaction term,

$$\begin{aligned}\Delta log\text{CPOP}_\text{t} = {} & \propto_{1,0} \\ & + \sum_{i=1}^{P} \alpha_{1i}\, \Delta log\text{CPOP}_{t-i} \\ & + \sum_{i=0}^{q} \propto_{2i}\, \Delta(log\text{POP}_{\text{t-i}}) + \sum_{i=0}^{q} \propto_{3i}\, \Delta(log\text{SBOP}_{\text{t-i}}) \\ & + \sum_{i=0}^{q} \propto_{4i}\, \Delta(log\text{BP}_{\text{t-i}}) + \sum_{i=0}^{q} \propto_{5i}\, \Delta(log\chi_{\text{t-i}}) + \lambda\text{ECM}_{t-1} + e_t\end{aligned}$$

χ named as COP, EPO, ER, SP and CC.

Model with interaction terms,

$$\Delta log \mathrm{CPOP_t} = \propto_{1,0} + \sum_{i=1}^{P} \alpha_{1i}\, \Delta log \mathrm{CPOP}_{t-i} + \sum_{i=0}^{q} \propto_{2i}\, \Delta(log(\mathrm{POP_{t-i}} \times \mathrm{CC_{t-i}})) + \sum_{i=0}^{q} \propto_{3i}\, \Delta(log(\mathrm{SBOP_{t-i}} \times \mathrm{CC_{t-i}})) + \sum_{i=0}^{q} \propto_{4i}\, \Delta(log(\mathrm{BP_{t-i}} \times \mathrm{CC_{t-i}})) + \sum_{i=0}^{q} \propto_{5i}\, \Delta(log(\chi_{\mathrm{t-i}} \times \mathrm{CC_{t-i}})) + \lambda \mathrm{ECM}_{t-1} + e_t$$

χ named as COP, EPO, ER and SP.

$\mathrm{ECM_{t-1}}$ is error correlation term that added into the model to form ECM. It has used to measure the speed of adjustment (λ) in the direction of long-term equilibrium, which is time taken by the dependent variable to converge to long term equilibrium (Go, Lau, Yii & Lau, 2019). Based on the Eview result of ECM test, it should focus on the coefficient of CointEq (-1) to determine the speed of adjustment of model to long run equilibrium if p-value < 0.1.

3.6.3 Granger Causality Test

This test is to identify causal relationship between two variables in a time series analysis. Due to lags involved, distributed and autoregressive models increase the concern about causality among economic variables. Hence, Granger causality has been taken into consideration. Granger causality can show the direction of causal effect, such as $\mathcal{X}$ and $\mathcal{Y}$ have bidirectional causal effect or unidirectional causal effect. Bidirectional causal effect is $\mathcal{X}$ and $\mathcal{Y}$ granger cause each other, while unidirectional causal effect is either $\mathcal{X}$ granger cause $\mathcal{Y}$ or $\mathcal{Y}$ granger cause $\mathcal{X}$.

However, Granger causality cannot detect the effect whether it is direct or indirect causal effect and will not show positive or negative sign.

First of all, Granger causality can be categorized into simple Granger causality and multivariate Granger causality. Simple Granger causality is a statistical concept first proposed to determine whether one time series determinant is practical in forecasting another (Wang, 2016). It means that when only considering past values of $\mathcal{Y}$, $\mathcal{X}$ is able to rise the accuracy of the prediction of $\mathcal{Y}$ with respect to a forecast. More precisely, given interdependent variables $\mathcal{X}$ and $\mathcal{Y}$, and in a statistically suitable manner shows that "$\mathcal{X}$ Granger causes $\mathcal{Y}$", $\mathcal{X}$ assists in forecasting the future of $\mathcal{Y}$ beyond the degree of $\mathcal{Y}$ past values (Barrett, Barnett and Seth, 2010). Therefore, simple Granger causality test function in a single equation with two variables and their lags (Hayo, 1999).

Moreover, multivariate Granger causality test includes more than two variables due to it is supposed more than one variable can influence the results. In other words, it is to analyse different combinations of network nodes in autoregressive models. It is able to increase the probability for estimation errors and model parameter inconsistency. Besides, multivariate Granger causality approach central on the spectral density matrix. Spectral density matrix can be uniquely factorized to the transfer function as well as the covariance matrix of the corresponding autoregressive model, therefore, multivariate Granger causality allow to perform the subsystem without having to run through a new model fitting process (Wen, Rangarajan and Ding, 2013).

Furthermore, according to Damos (2016), the first step to carry out Granger causality test is to form restricted model (reduced model) from unrestricted model (full model). For instance, unrestricted model is as $Y_t = \beta_0 + \beta_1 X_t + \beta_2 X_{t-1} + \beta_3 X_{t-2} + \beta_4 X_{t-3} + \beta_5 X_{t-4} + \varepsilon_t$ and restricted the model to $Y_t = \beta_0 + \beta_1 X_t + \beta_2 X_{t-1} + \beta_3 X_{t-2} + \varepsilon_t$. After that, run Granger causality test via Eviews to obtain Sum of Square Errors (SSE) restricted and SSE unrestricted. Following, insert the data obtained into formula below to identify F statistic. The formula is show below:

$$F = \frac{(\mathrm{SSE}_{Restricted} - \mathrm{SSE}_{Unrestricted})/(k_{Unrestricted} - k_{Restricted})}{(\mathrm{SSE}_{Unrestricted})/(n - k_{Unrestricted} - 1)}$$

The decision rule of this test is to reject null hypothesis (H_0) when F test statistic is greater than critical value $F_{\alpha,}$ ($k_{full} - k_{reduced}$), (n-k_{full}-1), which indicates that $\mathcal{X}$ Granger causes $\mathcal{Y}$. Otherwise, the H_0 should not be rejected, it means $\mathcal{X}$ does not Granger causes $\mathcal{Y}$. In short, if H_0 is not rejected, it indicates $\mathcal{X}$ and $\mathcal{Y}$ are independent and there is no granger causality between the variables. On the other hand, second method to identify Granger causality is through probability value (p-value). P-value will be obtained through Eviews results. The H_0 tend to reject when p-value less than significance level (α), it represents $\mathcal{X}$ does not Granger causes $\mathcal{Y}$.

3.7 Chapter Summary

In short, the diagnostic test be carried out in this study are unit root test, normality test, multicollinearity Breusch–Godfrey LM and CUSUM test. ADF and PP test are specially selected to be tested under unit root test to examine the stationary of data. Besides, ARDL model will be conducted to identify the long run relationship between dependent and independent variables.

CHAPTER 4: DATA ANALYSIS & FINDINGS

4.0 Introduction

In this chapter, diagnostic checking will be conducted and the relationship between the CPO price and all the control and conditional variables will be examined via Eviews 10. The discussion will start with the 1st objective and followed by the 2nd objective in this research. All the results will be summarized in this chapter and outputs will be shown in appendices. The full outputs of each Model that located in Appendices is following with its own numbering. For instance, Model 1's results will show in Appendix 1.

4.1 Unit Root Test

Unit root test has been conducted for all the independent variables without interaction and with interaction. ADF and PP tests have been chosen to examine the stability of the variables under this research. The results of all variables without interaction have been shown in the Table 4.1 and Table 4.2 respectively. When the variable is stationary in the first difference, each of the variable can be proceed to the further stage for further investigation such as ARDL to study the long run relationship between dependent variable and independent variables. Otherwise, it will create a result that is invalid and bias.

Table 4.1 *ADF Test for Variables without Interaction*

Variables	Augmented Dickey-Fuller (ADF)			
	Individual Intercept		Individual Intercept and Trend	
	Level	1st Difference	Level	1st Difference
CPOP	-3.6660(1)***	-8.4691(0)***	-3.6963(1)**	-8.4647(0)***
COP	-2.9606(1)**	-7.6919(0)***	-3.0804(1)	-7.6582(0)***
SBOP	-2.3652(1)	-7.3277(0)***	-2.9864(1)	-7.3899(0)***
POP	-2.4347(12)	-4.4086(11)***	-3.2937(12)*	-4.3824(11)***
EPO	-5.6590(0)***	-14.4239(0)***	-5.8325(0)***	-14.4278(0)***
ER	-0.9022(0)	-11.3116(0)***	-1.7731(0)	-11.3307(0)***
BP	-0.6448(0)	-11.5844(0)***	-1.7641(0)	-11.5896(0)***
SP	-1.2980(0)	-9.6648(0)***	-1.8419(1)	-9.6370(0)***
CC	-7.3206(0)***	-16.1718(0)***	-7.5448(0)***	-16.1097(0)***

Notes: *, **, *** indicates the rejection of null hypothesis (presence of unit root in variable) at 10%, 5%, 1% of significance level. Number in parenthesis is the lag length of each variable which is identified based on Schwartz Criterion (SC). The unit root tests include a constant and linear time trend.

Table 4.2 *PP Test for Variables without Interaction*

Variables	Phillips-Perron (PP)			
	Individual Intercept		Individual Intercept and Trend	
	Level	1st Difference	Level	1st Difference
CPOP	-3.3285(5)**	-8.4615(5)***	-3.3355(5)*	-8.4566(5)***
COP	-2.6877(3)*	-7.7007(4)***	-2.8335(3)	-7.6673(4)***
SBOP	-2.4377(7)	-7.5299(5)***	-2.9144(6)	-7.5931(5)***
POP	-3.3644(9)**	-9.7419(16)***	-3.2928(9)*	-9.7539(16)***
EPO	-5.5618(2)***	-19.6650(14)***	-5.7696(2)***	-19.9076(15)***
ER	-0.9216(1)	-11.3115(1)***	-1.7882(1)	-11.3307(1)***
BP	-0.6448(0)	-11.5844(1)***	-1.7720(1)	-11.5896(2)***
SP	-1.5692(6)	-9.8503(4)***	-2.1204(6)	-9.8282(4)***
CC	-7.5009(5)***	-27.6724(13)***	-7.7092(4)***	-27.5947(13)***

Note: *, **, *** indicates the rejection of null hypothesis (presence of unit root in variable) at 10%, 5%, and 1% of significance level. Number in parentheses is the number of bandwidths that identified based on the Newey-West estimator using the Default (Barlett Kernel). The unit root test includes a constant and linear time trend.

Table 4.1 and Table 4.2 reveals variable of crude oil price, SBO price, CPO production, exchange rate, biodiesel production and stock price cannot obtain stationary in level form at either intercept or intercept and trend or both. However, all these results were significant at the 1st difference for individual intercept and individual intercept and trend. As overall, it can conclude that all the variables are stationary under the 1st difference of intercept and intercept and trend at 1% significant level.

Table 4.3 *ADF Test for Variables with Interaction*

Variables	Augmented Dickey-Fuller (ADF)			
	Individual Intercept		Individual Intercept and Trend	
	Level	1st Difference	Level	1st Difference
CPOP	-3.6424(1)***	-9.4429(0)***	-3.6472(1)**	-9.4342(0)***
CC*COP	-2.9566(1)**	-8.2019(0)***	-3.0588(1)	-8.1643(0)***
CC*SBOP	-2.7475(2)*	-8.7647(0)***	-3.3439(2)*	-8.8294(0)***
CC*POP	-2.1323(12)	-4.8987(11)***	-3.0317(12)	-4.8694(11)***
CC*EPO	-5.6149(0)***	-13.9929(0)***	-5.8250(0)***	-14.0011(0)***
CC*ER	-1.3580(0)	-14.1444(0)***	-2.0371(0)	-14.1320 (0)***
CC*BP	-0.6998(0)	-12.0190(0)***	-1.7759(0)	-12.0229(0)***
CC*SP	-1.5503(0)	-10.3851(0)***	-1.7926(0)	-10.3559(0)***

Notes: *, **, *** indicates the rejection of null hypothesis (presence of unit root in variable) at 10%, 5%, 1% of significance level. Number in parenthesis is the lag length of each variable which is identified based on Schwartz Criterion (SC). The unit root tests include a constant and linear time trend.

Table 4.4 *PP Test for Variables with Interaction*

Variables	Phillips-Perron (PP)			
	Individual Intercept		Individual Intercept and Trend	
	Level	1st Difference	Level	1st Difference
CPOP	-3.5903(5)***	-9.4447(5)***	-3.5739(5)**	-9.4356(5)***
CC*COP	-2.8285(3)*	-8.1579(1)***	-2.9738(3)	-8.1198(1)***
CC*SBOP	-2.5992(7)*	-9.0657(6)***	-3.0891(6)	-9.1245(6)***
CC*POP	-3.4257(10)**	-10.5377(18)***	-3.2853(10)*	-10.7606(19)***
CC*EPO	-5.4936(3)***	-18.4123(16)***	-5.7409(3)***	-19.3779(17)***
CC*ER	-1.1493(4)	-14.2324(4)***	-1.8550(5)	-14.2956(3)***
CC*BP	-0.6737(1)	-12.0189(1)***	-1.7640(2)	-12.0229(0)***
CC*SP	-1.6973(4)	-10.4068(2)***	-2.1681(4)	-10.3796(2)***

Note: *, **, *** indicates the rejection of null hypothesis (presence of unit root in variable) at 10%, 5%, and 1% of significance level. Number in parentheses is the number of bandwidths that identified based on the Newey-West estimator using the Default (Barlett Kernel). The unit root test includes a constant and linear time trend.

On the other hand, each of the variables is multiply with the interaction term to see the impact of climate change towards the independent variables and the result displayed in Table 4.3 and Table 4.4. From the result, when climate change times crude oil price, SBO price, CPO production, exchange rate, biodiesel production and stock price, it shown all these variables were unable to achieve stationary in the level form at either intercept or intercept and trend or both. However, all these results were significant at the 1st difference for individual intercept and individual intercept and trend. As overall, it can make a conclusion that all the variables are stationary under the 1st difference of intercept and intercept and trend at 1% significant level.

4.2 Diagnostic Checking

Table 4.5 *Result of Diagnostic Testing for Variables for Without Interaction*

	Normality Test [1]		Multicollinearity [3]		Breusch–Godfrey LM Test [2]	
	Jarque-Bera	Probability	VIF	Low/ High	Obs*R-squared	Probability
Model 1	12.8751	0.0016*	3.0141	Low	6.4944	0.3701
Model 2	4.0777	0.1302	2.1454	Low	28.8309	0.2110
Model 3	1.2925	0.5240	3.0677	Low	1.7104	0.1909
Model 4	2.2148	0.3304	1.4972	Low	20.8005	0.0534
Model 5	1.1427	0.5648	1.1040	Low	2.4810	0.2892
Model 6	3.2304	0.1989	$1 \leq VIF \leq 10$	Low	0.8502	0.9907

Note: * indicates the rejection of null hypothesis at 5% of significant level. The lag selection in each model is based on the lowest Akaike's Information Criterion (AIC).

[1] H_0: The error term is normally distributed

[2] H_0: The model has no serial correlation.

[3] Multicollinearity does not adopt hypothesis testing.

Table 4.6 *Result of Diagnostic Testing for Variables for With Interaction*

	Normality Test		Multicollinearity		Breusch–Godfrey LM Test	
	Jarque-Bera	Probability	VIF	Low/ High	Obs*R-squared	Probability
Model 7	8.9191	0.0116*	2.9275	Low	5.9951	0.4237
Model 8	5.4365	0.0660	2.1833	Low	20.1566	0.0642
Model 9	1.8234	0.4018	3.2955	Low	2.4248	0.1194
Model 10	1.2742	0.5288	1.5592	Low	12.6940	0.3917
Model 11	3.0530	0.2173	$1 \leq VIF \leq 10$	Low	4.6456	0.4606

Note: * indicates the rejection of null hypothesis at 5% of significant level. The lag selection in each model is based on the lowest Akaike's Information Criterion (AIC).

[1] H_0: The error term is normally distributed

[2] H_0: The model has no serial correlation.

[3] Multicollinearity does not adopt hypothesis testing.

4.2.1 Normality Test

This test is a popular test that used to determine whether the model has met the normality assumption. The tests have to meet two criteria, which are first model has to be independent random variables and second model has to be classical linear regression. In this testing, if p-value is larger than the significant level or when the JB statistic is smaller than the critical chi-square value, it derives a non-rejection of H_0 showing the error term is followed the normal distribution and vice versa.

To further clarify, Model 1, 2, 3, 4 and 5 are separated variable without interaction, however Model 6 is combined variables without interaction. The result of normality test for model 1 shows that it will reject the H_0 due to its p-value (0.0016) is smaller than the significant level (0.05). Moreover, the JB statistic (12.8751) is larger than the critical value (5.991), so the conclusion will be tied with the p-value. On the other hand, model 2, 3, 4, 5 and 6 have a conclusion of non-rejecting H_0, due to the p-value is insignificant at the 5% significant level. Besides, JB statistic is smaller compared to critical value of 5.991. Thus, it has the same conclusion where the models without interaction were normally distributed in error term.

Model 7, 8, 9, 10 and 11 have added interaction term (climate change) into the variables. Model 7, 8, 9, and 10 are separated model with interaction, while Model 11 is combined model with interaction. The result of normality test for model 7 shows that it will reject the H_0 due to its p-value (0.0116) is smaller than the significant level (0.05). Moreover, the JB statistic (8.9191) is larger than the critical value (5.991), so the conclusion will be tied with the p-value. On the other hand, model 8, 9, 10 and 11 that have added in the interaction term have generated the result of p-value is higher than the significant level 5%, indicating a non-rejection of H_0. Besides, JB statistic is smaller compared to critical value of 5.991. Thus, the conclusion will be the same as the p-value, indicating the models with interaction were normally distributed in error term.

4.2.2 Multicollinearity

Multicollinearity happens when there is presence of linear relationship among the explanatory variables in a model (Alin, 2010). The presence of multicollinearity will lead to an invalid and bias result. Therefore, this research has used VIF to detect the multicollinearity problem in the models. VIF is an indicator to measure the seriousness of the multicollinearity problem (Mansfield & Helms, 1982).

From the result shown in Table 4.5 and Table 4.6, the VIF for all variables in model 1 to model 11 are lower than 10. Thus, these results shown that the multicollinearity does not exist in all the models. Therefore, the results are valid and can be trusted.

4.2.3 Breusch–Godfrey LM Test

Autocorrelation implied there is correlation between the error terms in different time period. To ensure the stationary of the model, researchers have to make sure that constant mean and variance appear in the residuals of the trends (Monserud, & Marshall, 2001). The H_0 is there is no autocorrelation appears among the error terms, while the H_1 is autocorrelation exists among the error term. In short, if the p-value of the chi-square is higher than the critical value, it derives a non-rejection of H_0 showing there is no autocorrelation and vice versa.

From the result shown in Table 4.5 and Table 4.6, p-value for chi-square for model 1, 2, 3, 4, 5 and 6 are higher than the significant level of 5%. Thus, it has sufficient evidence to conclude that there is no autocorrelation problem in the error terms for the six models.

After the variables interact with climate change, it will show a different value for the p-value of chi-square. Even though the results are dissimilar, however the conclusion is the same, which is the autocorrelation problem does not exist in the model 7, 8, 9, 10 and 11 which have comprised the interaction term. This is because the p-value of chi-square are still higher than the significant level of 5%.

4.2.4 CUSUM Test

Below showing all the results of CUSUM test in each Model.

Figure 4.1: *Output for Model 1*

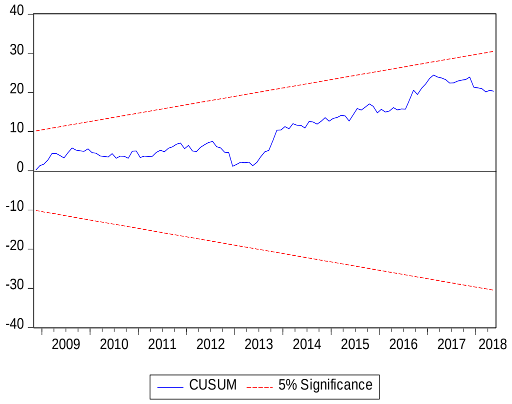


Figure 4.2: *Output for Model 2*

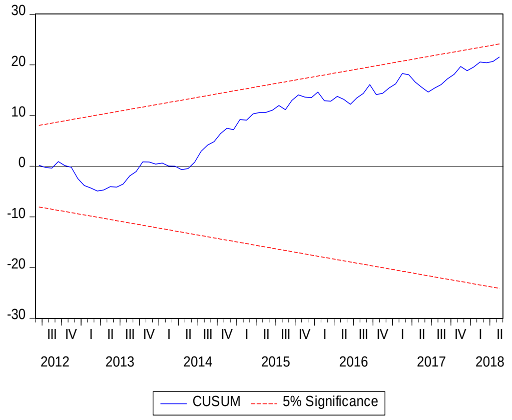


Figure 4.3: *Output for Model 3*

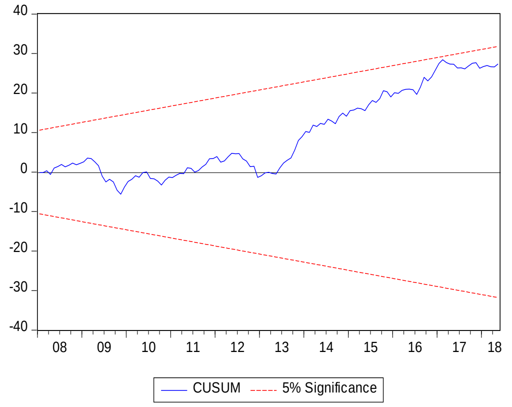


Figure 4.4: *Output for Model 4*

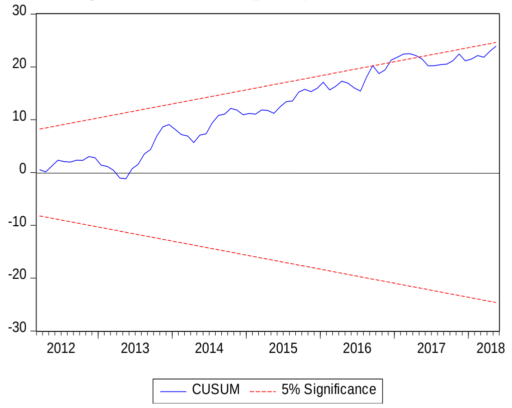


Figure 4.5: *Output for Model 5*

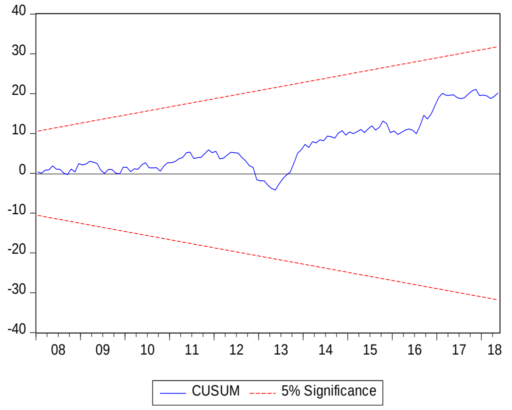


Figure 4.6: *Output for Model 6*

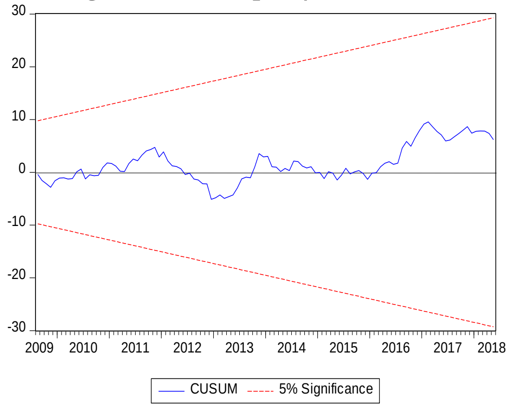


Figure 4.7: *Output for Model 7*

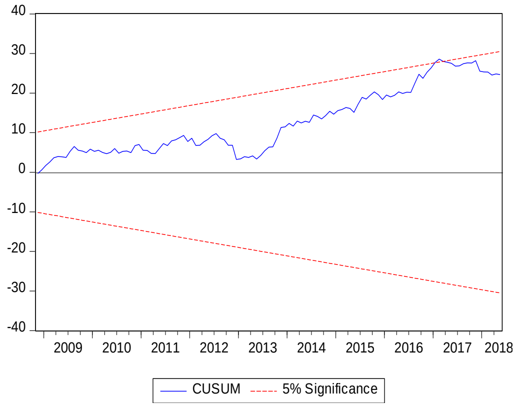


Figure 4.8: *Output for Model 8*

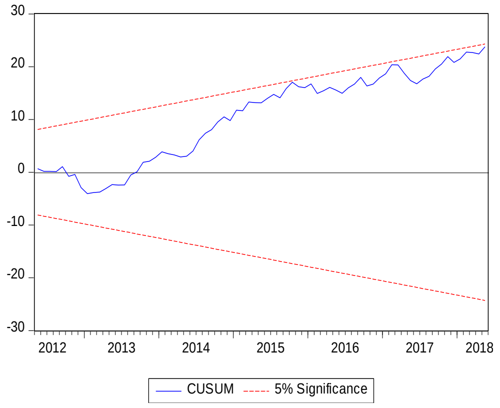


Figure 4.9: *Output for Model 9*

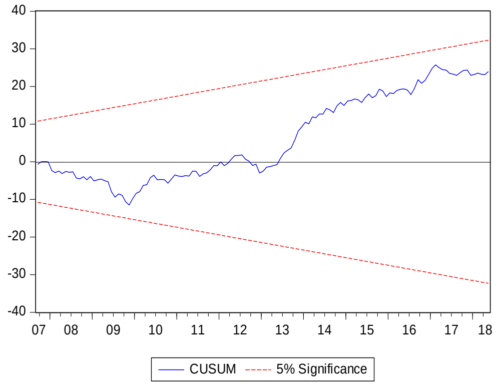


Figure 4.10: *Output for Model 10*

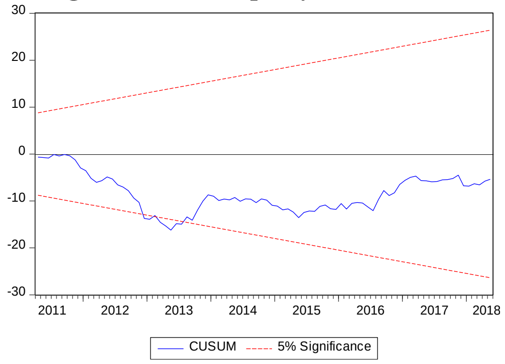
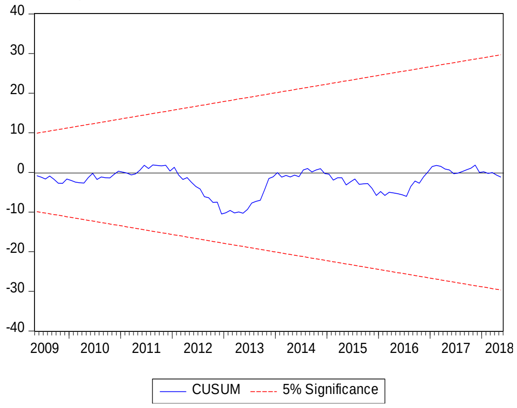


Figure 4.11: *Output for Model 11*



Note: H_0: The parameter is stable.

Brown et al. in 1975 have introduced CUSUM test, which also has known as cumulative sum control chart. It is used to detect the sudden changes in the time series models (Oh, & Lee, 2019). In order to test the stability of the model, this research has conducted CUSUM test. Null Hypothesis would not be rejected when the CUSUM statistics fall between the ranges of 5% significant level. The null hypothesis in this testing is the parameter is stable.

The result shown that model 1, 2, 3, 5 and 6 has clearly shown that the plot of CUSUM does not exceed the range of upper critical line and lower critical line at the significant level of 5%. Hence, it has sufficient evidence to conclude that the model is stable. However, from the result, it shows that model 4 is slightly inconstant. This is due to the plot of CUSUM has exceeded slightly between the year of 2016 to 2017 at a significant level of 5%.

Model 7, 8, 9, 10 and 11 have added in the interaction term into the models. The result has shown that the plot of CUSUM statistics for model 7 and 10 have slightly over the upper critical line and lower critical line. All in all, it can conclude that model 7 and 10 are not stable in the significant level of 5%. For model 8, 9 and 11, it gets a conclusion that the models are constant at the significant level of 5%. The reason is because of all the plot of CUSUM statistics are stay in between the upper critical line and lower critical line.

4.3 Model Estimation

4.3.1 Model 1: Control Variables + Crude Oil Price (COP)

Table 4.7: *Result of Bound Test for Model 1*

Test Statistic	Value	Signif.	I(0)	I(1)
F-statistic	3.271389*	10%	2.2	3.09
K	4	5%	2.56	3.49
		2.5%	2.88	3.87
		1%	3.29	4.37

Note: *, **, *** indicates the rejection of null hypothesis at 10%, 5%, 1% of significant level. Lag selection are based on the lowest AIC.
H_0: There is no long-run relationship in the model.

From the Table 4.7, the F-statistic in Bound Test for model 1 is 3.2714 which is greater than the Critical Value of 3.09 at 10% significance level. Thus, it indicates one of the variables in model 1 does exist long run effect on the CPO price.

Table 4.8: *Result of Long Run Parameter for COP in Model 1*

Long Run Parameter	Coefficient	-0.101305
	T-statistic	-0.447235
	P-value	0.6555

Note: *, **, *** indicates the rejection of null hypothesis at 10%, 5%, 1% of significant level. Lag selection are based on lowest AIC.
H_0: The Crude Oil Price is insignificant to the Crude Palm Oil Price.

The p-value (0.6555) of COP has shown a non-rejection in null hypothesis. Hence, it indicates the CPO price is not sensitive to the changes in COP in the long run as the p-value is higher than the 10% significant level. This could be due to the variable is not normally distributed, and thus lead to this bias and invalid result.

Table 4.9: *Result of ECM for Model 1*

ECM	Coefficient	-0.118359
	T-statistic	-4.525676***
	P-value	0.0000***

Note: *, **, *** indicates the rejection of null hypothesis at 10%, 5%, 1% of significant level. Lag selection are based on lowest AIC.
H_0: There is non-cointegration in the model.

Table 4.9 displays there is cointegration in the model. Thus, the coefficient (-0.118359), has indicated the speed of adjustment of model 1 to long run is 11.84% in one month.

Table 4.10: *Results of Granger Causality for Model 1*

		B				
		CPOP	BP	POP	SBOP	COP
A	CPOP		3.0419***	2.5938**	0.2295	3.5299***
	BP	0.8582		1.0871	3.2529***	1.3054
	POP	1.6582	1.5081		0.3841	0.9897
	SBOP	1.1700	3.3805***	2.1361*		2.5155**
	COP	0.8655	0.8345	0.5109	0.6629	

Note: *, **, *** indicates the rejection of null hypothesis at 10%, 5%, 1% of significant level.
H_0: A will not granger cause B.

The result in Table 4.10 has shown the CPO price will granger cause crude oil price at 1% significant level, while the crude oil price does not granger cause CPO price.

4.3.2 Model 2: Control Variables + Export of Crude Palm Oil (EPO)

Table 4.11: *Result of Bound Test for Model 2*

Test Statistic	Value	Signif.	I(0)	I(1)
F-statistic	3.714363**	10%	2.2	3.09
K	4	5%	2.56	3.49
		2.5%	2.88	3.87
		1%	3.29	4.37

Note: *, **, *** indicates the rejection of null hypothesis at 10%, 5%, 1% of significant level. Lag selection are based on the lowest AIC.
H_0: There is no long-run relationship in the model.

From the Table 4.11, the F-statistic in Bound Test for model 2 is 3.7144 which is greater than the Critical Value of 3.49 at 5% significance level. Thus, it indicates one of the variables in model 2 does exist long run effect on the CPO price.

Table 4.12: *Result of Long Run Parameter for EPO in Model 2*

Long Run Parameter	Coefficient	1.524644
	T-statistic	2.318698**
	P-value	0.0233**

Note: *, **, *** indicates the rejection of null hypothesis at 10%, 5%, 1% of significant level. Lag selection are based on the lowest AIC.
H_0: The Export of Crude Palm Oil is insignificant to the Crude Palm Oil Price.

The result in Table 4.12 illustrates that there is long run relationship exists between the CPO price and export of CPO where the p-value (0.0233) is lower than the level of significance (0.05). The coefficient for export of CPO is 1.524644 at the 5% level of significance. It also means the CPO price and export of CPO is positively related to each other according to the result. For every 1% change in export of CPO, the CPO price will change by 1.52%, ceteris paribus. This has proven by the research from Nur Nadia Kamil and Syuhadatul Fatimah Omar (2016) who also found the positive relationship between CPO price and export of CPO. When government reduce the tax charged on import between countries, it will encourage more import of goods from countries. Hence, the CPO price will rise due to the boost of demand in CPO. Furthermore, M Ayatollah Khomeini Ab Rahman et al. (2017) also supported the statement with their studies by showing CPO price would increase by 0.80% with every 1% increase in total export of CPO. The result is also consistent with the result from Ayat K Ab Rahman, et al. (2007), who has done the analysis of domestic CPO price in Malaysia.

Table 4.13: *Result of ECM for Model 2*

ECM	Coefficient	-0.1787
	T-statistic	-4.881991***
	P-value	0.0000***

Note: *, **, *** indicates the rejection of null hypothesis at 10%, 5%, 1% of significant level. Lag selection are based on the lowest AIC.
H_0: There is non-cointegration in the model.

Table 4.13 displays there is cointegration in the model. Thus, the coefficient (-0.1787), has indicated the speed of adjustment of model 2 to long run is 17.87% in one month.

Table 4.14: *Results of Granger Causality for Model 2*

		B				
		CPOP	BP	POP	SBOP	EPO
A	CPOP		2.1210**	1.5596	0.5931	2.1941**
	BP	1.3197		0.3538	2.0848**	0.5301
	POP	1.7133*	1.2710		0.8576	2.4781***

	SBOP	1.3223	2.3852***	1.1201		1.2422
	EPO	2.3722***	1.7580*	0.5870	0.9757	

Note: *, **, *** indicates the rejection of null hypothesis at 10%, 5%, 1% of significant level.

H_0: A will not granger cause B.

Results from Table 4.14 shows both CPO price and export of CPO are having granger causality to each other. This is because both of the test statistic is significance at 1% and 5% respectively.

4.3.3 Model 3: Control Variables + Exchange Rate (ER)

Table 4.15: *Result of Bound Test for Model 3*

Test Statistic	Value	Signif.	I(0)	I(1)
F-statistic	8.986036***	10%	2.2	3.09
k	4	5%	2.56	3.49
		2.5%	2.88	3.87
		1%	3.29	4.37

Note: *, **, *** indicates the rejection of null hypothesis at 10%, 5%, 1% of significant level. Lag selection are based on the lowest AIC.

H_0: There is no long-run relationship in the model.

From the Table 4.15, the F-statistic in Bound Test for model 3 is 8.9860 which is greater than the Critical Value of 4.37 at 1% significance level. Thus, it indicates one of the variables in model 3 does exist long run effect on the CPO price.

Table 4.16: *Result of Long Run Parameter for ER in Model 3*

Long Run Parameter	Coefficient	0.599980
	T-statistic	2.104351**
	P-value	0.0373**

Note: *, **, *** indicates the rejection of null hypothesis at 10%, 5%, 1% of significant level. Lag selection are based on lowest AIC.

H_0: The Exchange Rate is insignificant to the Crude Palm Oil Price.

Results from Table 4.16 shows that there is a long run relationship between CPO price and exchange rate at 5% significant level. The coefficient for exchange rate is 0.599980, indicating when the exchange rate ($\frac{Malaysian\ Ringgit}{US\ Dollar}$) rises for 1%, the CPO price will improve by 0.60%, ceteris paribus. This has been supported by Rifin (2010) by claiming the positive relationship was driven by the weaken currency of Rupiah as the demand of export of CPO will increase in Indonesia. Thus, leading the CPO price to raise. Apparently, the CPO price will become higher in the country when the exchange rate ($\frac{Malaysian\ Ringgit}{US\ Dollar}$) increased. Furthermore, the similar result obtained from the research done by Saghaian (2010) where he discovered that the exchange rate and commodity price are strongly correlated using Granger causality. Therefore, change in exchange rate will significantly affect the CPO price in a long period.

Table 4.17: *Result of ECM for Model 3*

ECM	Coefficient	-0.204992
	T-statistic	-7.483715***
	P-value	0.0000***

Note: *, **, *** indicates the rejection of null hypothesis at 10%, 5%, 1% of significant level. Lag selection are based on the lowest AIC.
H_0: There is non-cointegration in the model.

Table 4.17 displays there is cointegration in the model. Thus, the coefficient (-0.204992), has indicated the speed of adjustment of model 3 to long run is 20.50% in one month.

Table 4.18: *Results of Granger Causality for Model 3*

		B				
		CPOP	BP	POP	SBOP	ER
A	CPOP		2.4154	1.8911	7.7423***	1.2300
	BP	0.9981		0.1351	7.3384***	7.6083***
	POP	5.8206**	1.2667		1.3830	3.8316*
	SBOP	2.0884	0.2908	0.0973		0.6054
	ER	0.0006	0.2127	0.0561	2.8113*	

Note: *, **, *** indicates the rejection of null hypothesis at 10%, 5%, 1% of significant level.
H_0: A will not granger cause B.

Table 4.18 shows that both CPO price and exchange rate do not granger cause each other due to both of the test statistic for the variables are insignificant at all level of significance.

4.3.4 Model 4: Control Variables + Stock Price (SP)

Table 4.19: *Result of Bound Test for Model 4*

Test Statistic	Value	Signif.	I(0)	I(1)
F-statistic	2.677056	10%	2.2	3.09
K	4	5%	2.56	3.49
		2.5%	2.88	3.87
		1%	3.29	4.37

Note: *, **, *** indicates the rejection of null hypothesis at 10%, 5%, 1% of significant level. Lag selection are based on the lowest AIC.
H_0: There is no long-run relationship in the model.

From the Table 4.19, the F-statistic in Bound Test for model 4 is 2.6771 which is lower than the Critical Value of 3.09 at 10% significance level. Thus, it indicates the model does not exist long run relationship with CPO price.

Table 4.20: *Result of Long Run Parameter for SP in Model 4*

Long Run Parameter	Coefficient	0.316256
	T-statistic	1.587676
	P-value	0.1166

Note: *, **, *** indicates the rejection of null hypothesis at 10%, 5%, 1% of significant level. Lag selection are based on the lowest AIC.
H_0: The Stock Price is insignificant to the Crude Palm Oil Price.

The result in Table 4.20 shown there is no long run relationship between the CPO price and stock price. This is because the model is not significant in bound test.

Table 4.21: *Result of ECM for Model 4*

ECM	Coefficient	-0.161873
	T-statistic	-4.139222***
	P-value	0.0001***

Note: *, **, *** indicates the rejection of null hypothesis at 10%, 5%, 1% of significant level. Lag selection are based on the lowest AIC.
H_0: There is non-cointegration in the model.

Table 4.21 displays there is cointegration in the model. Thus, the coefficient (-0.161873), has indicated the speed of adjustment of model 4 to long run is 16.19% in one month. However, it is invalid due to the bound test was not significant. Therefore, the ECM test is inconclusive in this situation.

Table 4.22: *Results of Granger Causality for Model 4*

		B				
		CPOP	BP	POP	SBOP	SP
A	CPOP		2.1210**	1.5596	0.5931	2.0741**
	BP	1.3197		0.3538	2.0848**	0.3527
	POP	1.7133*	1.2710		0.8576	0.9874
	SBOP	1.3223	2.3852***	1.1201		3.1659***
	SP	2.6836***	1.5775	1.9514**	3.5944***	

Note: *, **, *** indicates the rejection of null hypothesis at 10%, 5%, 1% of significant level.
H_0: A will not granger cause B.

Table 4.22 shows that both CPO price and stock price will granger cause each other, as both of the variables are significant at 1% and 5% respectively.

4.3.5 Model 5: Control Variables + Climate Change (CC)

Table 4.23: *Results of Bound Test for Model 5*

Test Statistic	Value	Signif.	I(0)	I(1)
F-statistic	5.812853***	10%	2.2	3.09
K	4	5%	2.56	3.49
		2.5%	2.88	3.87
		1%	3.29	4.37

Note: *, **, *** indicates the rejection of null hypothesis at 10%, 5%, 1% of significant level. Lag selection are based on the lowest AIC.

H_0: There is no long-run relationship in the model.

Table 4.23 shows a result of 5.8129 for the F-statistic in the bound test. It is higher than the critical value 4.37 at the significant level of 1%. Thus, it can conclude that the model 5 does appear long run effect on the CPO price.

Table 4.24: *Results of Long Run Parameter for CC in Model 5*

Long Run Parameter	Coefficient	3.249844
	T-statistic	1.755580*
	P-value	0.0816*

Note: *, **, *** indicates the rejection of null hypothesis at 10%, 5%, 1% of significant level. Lag selection are based on the lowest AIC.

H_0: The Climate Change is insignificant to the Crude Palm Oil Price.

The output reveals a long run relationship has occurred in CPO price and climate change as the p-value of climate change (0.0816) is lower than 10% significance level. The coefficient for climate change is 3.249844 has reflected a positive relationship between the variables. For every 1% changes in climate change, on average, the CPO price will change by 3.25%, ceteris paribus. This is because CPO can only sustain at the optimal temperature. As the temperature increases too high, the production of CPO will decrease, and subsequently increase the price of CPO. In other words, the production will reduce was mainly due to the rise in temperature was not suitable for the growth of CPO. This can be supported by the research of

Nur Nadia Kamil and Syuhadatul Fatimah Omar (2016). They have done the analysis during the ENSO event. During the El Nino, the lack of rainfall and increase of temperature will affect the growth of CPO, as it required keeping the moisture of the soil. The strong El Nino occurred in 1997/1998 has pushed the CPO price increase. In short, the climate change and CPO price has positive significant relationship in this research.

Table 4.25: *Results of ECM for Model 5*

ECM	Coefficient	-0.127736
	T-statistic	-6.021722***
	P-value	0.0000***

Note: *, **, *** indicates the rejection of null hypothesis at 10%, 5%, 1% of significant level. Lag selection are based on the lowest AIC.

H_0: There is non-cointegration in the model.

Table 4.25 displays there is cointegration in the model 5. Thus, the coefficient (-0.127736), has indicated the speed of adjustment is 12.77% in one month towards the long run equilibrium.

Table 4.26: *Results of Granger Causality for Model 5*

		B				
		CPOP	BP	POP	SBOP	CC
A	CPOP		2.6331*	4.6061**	0.3853	1.0815
	BP	1.2560		1.4744	4.7607**	1.8126
	POP	3.4196**	1.5643		0.3566	5.5540***
	SBOP	2.1397	0.5616	2.0513		1.8106
	CC	3.1241**	1.2615	2.7502*	0.8630	

Note: *, **, *** indicates the rejection of null hypothesis at 10%, 5%, 1% of significant level.

H_0: A will not granger cause B.

Table 4.26 shows that the CPO price will not granger cause climate change as the test statistic is not significant in all level. On the other hand, the climate change does granger cause the CPO as the test statistic is significant at 5% significance level. Hence, it can conclude the climate change will granger cause CPO price.

4.3.6 Model 6: Control Variables + All the Conditional Variables (COP, EPO, ER, SP, CC)

Table 4.27: *Results of Bound Test for Model 6*

Test Statistic	Value	Signif.	I(0)	I(1)
F-statistic	3.300103**	10%	1.85	2.85
K	8	5%	2.11	3.15
		2.5%	2.33	3.42
		1%	2.62	3.77

Note: *, **, *** indicates the rejection of null hypothesis at 10%, 5%, 1% of significant level. Lag selection are based on the lowest AIC.

H_0: There is no long-run relationship in the model.

From the Table 4.27, the F-statistic in Bound Test for model 6 is 3.3001 which is greater than the Critical Value of 3.15 at 5% significance level. Thus, it indicates one of the variables in model 6 does exist long run effect on the CPO price.

Table 4.28: *Results of Long Run Parameter for all the Conditional Variables in Model 6*

Long Run Parameter	COP	Coefficient	0.191781
		T-statistic	1.167883
		P-value	0.2455
	EPO	Coefficient	1.213815
		T-statistic	2.022349**
		P-value	0.0457**
	ER	Coefficient	0.899719
		T-statistic	2.571721**
		P-value	0.0115**

	SP	Coefficient	0.194032
		T-statistic	1.408635
		P-value	0.1619
	CC	Coefficient	-3.481297
		T-statistic	-1.829830*
		P-value	0.0701*

Note: *, **, *** indicates the rejection of null hypothesis at 10%, 5%, 1% of significant level. Lag selection are based on the lowest AIC.

H_0: The variable X is insignificant to the Crude Palm Oil Price.

(where variable X represents COP, EPO, ER, SP or CC)

Table 4.28 shows that there is long run relationship exist in CPO price and export of CPO, exchange rate and also climate change. The results obtained are consistent with all the separated model, except for climate change. Climate change is positively significant in model 5 but it shows negative relationship in model 6. The coefficient for climate change is -3.481297, which is significant at 10%. It indicates that for every 1% increase in climate change, on average, CPO price will decrease by 3.48%. This can be supported by Ronnback (2014), who claimed that the increase in temperature will drive down the CPO price due to the poor growth of CPO. The researcher also proved that for every degree Celsius increase in temperature, the CPO price has decrease by 60 to 80 percent on average. Besides, Blanco, et. al (2017) also prove that the climate change and CPO price have negative relationship. The CO_2 emission has caused the temperature to increase and thereby affecting the crop yields and subsequently lead to the rise in CPO price.

Table 4.29: *Results of ECM for Model 6*

ECM	Coefficient	-0.176959
	T-statistic	-5.983561***
	P-value	0.0000***

Note: *, **, *** indicates the rejection of null hypothesis at 10%, 5%, 1% of significant level. Lag selection are based on the lowest AIC.

H_0: There is non-cointegration in the model.

Table 4.29 displays there is cointegration in the model 6. Thus, the coefficient (-0.176959), has indicated the speed of adjustment is 17.70% in one month towards the long run equilibrium.

Table 4.30: *Results of Granger Causality for Model 6*

		B								
		CPOP	BP	POP	SBOP	COP	EPO	ER	SP	CC
A	CPOP		3.0419	2.5938	0.2295	3.5299	3.8450	0.8116	1.3737	1.2893
	BP	0.8582		1.0871	3.2529	1.3054	0.3447	1.8354	0.5418	1.1225
	POP	1.6582	1.5081		0.3841	0.9897	8.9933	0.9580	1.1203	4.9616
	SBOP	1.1700	3.3805	2.1361		2.5155	1.6780	0.7044	1.7068	1.4262
	COP	0.8655	0.8345	0.5109	0.6629		1.5760	0.2433	1.3881	1.4762
	EPO	1.8876	2.0290	0.3901	0.2388	0.7069		1.8612	2.3370	3.9405
	ER	2.3374	1.1653	0.7502	3.1267	1.9253	0.5813		0.7036	0.5012
	SP	2.3752	1.9902	2.8881	3.3673	1.9845	2.2732	2.0638		0.3443
	CC	1.2417	0.8901	1.5470	0.9734	1.1452	2.2380	1.2463	1.8581	

Note: significance level at 1%, 5% and 10% respectively.

H_0: A will not granger cause B.

Table 4.30 shows that there is granger causality from CPO price to crude oil price and export of CPO. From the opposite side, CPO price also have a granger cause by other variables, which are export of CPO, exchange rate and stock price. The granger causality among the variables stated are due to the test statistic for these variables are at least significant at 10%.

4.3.7 Model 7: Control Variables + Climate Change*Crude Oil Price (CC*COP)

Table 4.31: *Result of Bound Test for Model 7*

Test Statistic	Value	Signif.	I(0)	I(1)
F-statistic	3.338249*	10%	2.2	3.09
k	4	5%	2.56	3.49
		2.5%	2.88	3.87
		1%	3.29	4.37

Note: *, **, *** indicates the rejection of null hypothesis at 10%, 5%, 1% of significant level. Lag selection are based on the lowest AIC.
H_0: There is no long-run relationship in the model.

From the Table 4.31, the F-statistic in Bound Test for model 7 is 3.3382 which is greater than the Critical Value of 3.09 at 10% significance level. Thus, it indicates one of the variables in model 7 does exist long run effect on the CPO price.

Table 4.32: *Result of Long Run Parameter for CC*COP in Model 7*

Long Run Parameter	Coefficient	-0.093301
	T-statistic	-0.440918
	P-value	0.6601

Note: *, **, *** indicates the rejection of null hypothesis at 10%, 5%, 1% of significant level. Lag selection are based on the lowest AIC.
H_0: The CC*COP is insignificant to the Crude Palm Oil Price.

The p-value (0.6601) of CC*COP has shown a non-rejection in null hypothesis. Hence, it indicates that CPO price is not sensitive to the changes in CC*COP in the long run. This is because the p-value is higher than the 10% significant level. Similarly with Model 1, this could be due to the variable is not normally distributed, and thus lead to this bias and invalid result.

Table 4.33: *Result of ECM for Model 7*

ECM	Coefficient	-0.125045
	T-statistic	-4.571689***
	P-value	0.0000***

Note: *, **, *** indicates the rejection of null hypothesis at 10%, 5%, 1% of significant level. Lag selection are based on the lowest AIC.
H_0: There is non-cointegration in the model.

Table 4.33 displays there is cointegration in the model. Thus, the coefficient (-0.125045), has indicated the speed of adjustment of model 7 to long run is 12.50% in one month.

Table 4.34: *Results of Granger Causality for Model 7*

		B				
		CPOP	BP	POP	SBOP	COP
A	CPOP		3.6607***	1.9389*	0.4540	3.5238***
	BP	1.0268		1.2136	2.8646**	1.0395
	POP	2.9539**	2.0114*		0.9293	1.3561
	SBOP	0.5737	3.4281***	1.4906		2.7376**
	COP	0.9568	1.3499	0.3956	1.1907	

Note: *, **, *** indicates the rejection of null hypothesis at 10%, 5%, 1% of significant level.
H_0: A will not granger cause B.

The result in Table 4.34 shown the CPO price will granger cause crude oil price at 1% significant level, while the crude oil price does not granger cause CPO price as shown in the table.

4.3.8 Model 8: Control Variables + Climate Change*Export of Crude Palm Oil (CC*EPO)

Table 4.35: *Result of Bound Test for Model 8*

Test Statistic	Value	Signif.	I(0)	I(1)
F-statistic	4.552087***	10%	2.2	3.09
k	4	5%	2.56	3.49
		2.5%	2.88	3.87
		1%	3.29	4.37

Note: *, **, *** indicates the rejection of null hypothesis at 10%, 5%, 1% of significant level. Lag selection are based on the lowest AIC.
H_0: There is no long-run relationship in the model.

For model 8, it gets a conclusion of the model has long effect on the CPO price. This is proven by the result shown in the Table 4.35 where the F-statistic (4.5521) is larger than the critical value (4.37) at 1% significance level.

Table 4.36: *Result of Long Run Parameter for CC*EPO in Model 8*

Long Run Parameter	Coefficient	1.688810
	T-statistic	2.674290***
	P-value	0.0092***

Note: *, **, *** indicates the rejection of null hypothesis at 10%, 5%, 1% of significant level. Lag selection are based on the lowest AIC.
H_0: The CC*EPO is insignificant to the Crude Palm Oil Price.

The result for model 8 exhibits that CPO price is sensitive towards the export of CPO with interaction in the long run at 1% significance level. The coefficient 1.6888 implied a positive relationship between CPO and EPO given that the climate change has a positive relationship towards the EPO. For instance, when the export of CPO increases by 1%, CPO price will have an increment of 1.69%, ceteris paribus. This has been supported by Zhang, Cai, Beach and McCarl (2014), it discovered that the climate change and the export of agriculture in US country are positively related. This is because the increment of temperature will boost the production given it is suitable for CPO production. Thus, CPO supply will rise and led to its price to drop. As a conclusion, export of CPO will increase and subsequently affect the CPO price to increase. Hence, it will show the relationship between CPO price and export of CPO after added in interaction is positive.

Table 4.37: *Result of ECM for Model 8*

ECM	Coefficient	-0.179180
	T-statistic	-5.402152***
	P-value	0.0000***

Note: *, **, *** indicates the rejection of null hypothesis at 10%, 5%, 1% of significant level. Lag selection are based on the lowest AIC.
H_0: There is non-cointegration in the model.

Table 4.37 displays there is cointegration in the model 8. Thus, the coefficient (-0.179180) has implied the model 8 has a long run adjustment speed about 17.92% in one month.

Table 4.38: *Result of Granger Causality for Model 8*

		B				
		CPOP	BP	POP	SBOP	EPO
A	CPOP		2.3584**	1.1658	0.8370	1.3903
	BP	1.33920		0.2742	1.7515*	0.5690
	POP	2.2956**	1.6952*		1.2030	2.1415**
	SBOP	0.8543	2.3275**	0.8593		0.7040
	EPO	2.1278**	1.7244*	0.6710	1.1560	

Note: *, **, *** indicates the rejection of null hypothesis at 10%, 5%, 1% of significant level.
H_0: A will not granger cause B.

From Table 4.38, the result shows that CPO price does not granger causes export of CPO as the null hypothesis is not rejected. On the other side, export of CPO will granger cause CPO price at 5% significant level.

4.3.9 Model 9: Control Variables + Climate Change*Exchange Rate (CC*ER)

Table 4.39: *Result of Bound Test for Model 9*

Test Statistic	Value	Signif.	I(0)	I(1)
F-statistic	9.161337***	10%	2.2	3.09
k	4	5%	2.56	3.49
		2.5%	2.88	3.87
		1%	3.29	4.37

Note: *, **, *** indicates the rejection of null hypothesis at 10%, 5%, 1% of significant level. Lag selection are based on the lowest AIC.
H_0: There is no long-run relationship in the model.

Based on the result in the Table 4.39, it showed that model 9 has a F-statistic of 9.1613. The value is greater than the critical value of 4.37 at 1% significant level. Thus, it indicates one of the variables in model 9 does exist long run effect on the CPO price.

Table 4.40: *Result of Long Run Parameter for CC*ER in Model 9*

Long Run Parameter	Coefficient	0.691185
	T-statistic	2.581471**
	P-value	0.0110**

Note: *, **, *** indicates the rejection of null hypothesis at 10%, 5%, 1% of significant level. Lag selection are based on the lowest AIC.
H_0: The CC*ER is insignificant to the Crude Palm Oil Price.

According to the Table 4.40, there is a long run relationship between the CPO price and exchange rate with interaction term at significant level of 5%. The result of coefficient (0.6912) has demonstrated a proportional relationship between both of the variables, given the climate change has a positive relationship towards the exchange rate. For every 1% increase in exchange rate together with interaction term, the CPO price will increase by 0.69%, given that other variables are constant. Based on the research done by Ogbuabor and Egwuchukwu (2017) in Nigeria, when the temperature reduced (problem of climate change decreased), it will strengthen the economics of the domestic country, thus it will show climate change and exchange rate ($\frac{\text{Domestic Currency}}{\text{Foreign Currency}}$) have a positive relationship. When the economy Malaysia is good, foreigners will tend to reduce their demand on the Malaysia's goods due to their currency is now weaker. To further clarify, when the Malaysian Ringgit is more strengthens than the foreign currency, it indicates 1 foreign currency can only exchange for a lesser Malaysia Ringgit. Therefore, this will lead the foreigners to demand lesser from Malaysia and subsequently reduce the CPO price. In short, when the temperature increase it will positively affect the exchange rate and lead to a higher demand of domestic goods from foreigners and lastly increase the CPO price.

Table 4.41: *Result of ECM for Model 9*

ECM	Coefficient	-0.211811
	T-statistic	-7.556359***
	P-value	0.0000***

Note: *, **, *** indicates the rejection of null hypothesis at 10%, 5%, 1% of significant level. Lag selection are based on lowest AIC.
H_0: There is non-cointegration in the model.

Table 4.41 displays there is cointegration in the model 9. Thus, the coefficient (-0.2118) has indicated the speed of adjustment to long run of the model 9 is 21.18% per month.

Table 4.42: *Results of Granger Causality for Model 9*

		B				
		CPOP	BP	POP	SBOP	ER
A	CPOP		3.2050*	2.3382	4.2875**	3.2810*
	BP	1.4446		0.3364	9.6505***	6.4656**
	POP	13.6498***	0.27573		7.8805***	0.9710
	SBOP	1.9778	0.6152	0.2396		3.5777*
	ER	0.4226	0.0214	0.1966	8.1554***	

Note: *, **, *** indicates the rejection of null hypothesis at 10%, 5%, 1% of significant level.
H_0: A will not granger cause B.

Refer to Table 4.42, the result shows that there is granger causality from CPOP to ER at 10% significant level. While from ER to CPOP, it does not have granger causality as it is insignificant at all level, implies no rejection of null hypothesis.

4.3.10 Model 10: Control Variables + Climate Change*Stock Price (CC*SP)

Table 4.43: *Result of Bound Test for Model 10*

Test Statistic	Value	Signif.	I(0)	I(1)
F-statistic	2.898679	10%	2.2	3.09
k	4	5%	2.56	3.49
		2.5%	2.88	3.87
		1%	3.29	4.37

Note: *, **, *** indicates the rejection of null hypothesis at 10%, 5%, 1% of significant level. Lag selection are based on the lowest AIC.
H_0: There is no long-run relationship in the model.

From the Table 4.43, the F-statistic in Bound Test for model 10 is 2.8987 which is lower than the Critical Value of 3.09 at 10% significance level. Thus, it indicates the model does not exist long run relationship with CPO price.

Table 4.44: *Result of Long Run Parameter for CC*SP in Model 10*

Long Run Parameter	Coefficient	0.406578
	T-statistic	2.331147**
	P-value	0.0221**

Note: *, **, *** indicates the rejection of null hypothesis at 10%, 5%, 1% of significant level. Lag selection are based on the lowest AIC.
H_0: The CC*SP is insignificant to the Crude Palm Oil Price.

The result in Table 4.44 shown there is long run relationship between the CPO price and the stock price after interacted with climate change as the P-Value (0.0221) is lower than the significance level of 5%. However, this is invalid as the bound test was insignificant in the model. Therefore, the long run parameter test is inconclusive in this situation.

Table 4.45: *Result of ECM for Model 10*

ECM	Coefficient	-0.181093
	T-statistic	-4.289900***
	P-value	0.0000***

Note: *, **, *** indicates the rejection of null hypothesis at 10%, 5%, 1% of significant level. Lag selection are based on the lowest AIC.
H_0: There is non-cointegration in the model.

Table 4.45 displays there is cointegration in the model. Thus, the coefficient (-0.1811), has indicated the speed of adjustment of model 10 to long run is 18.11% in one month. However, it is invalid due to the bound test was not significant. Therefore, the ECM test is inconclusive in this situation.

Table 4.46: *Results of Granger Causality for Model 10*

		B				
		CPOP	BP	POP	SBOP	SP
A	CPOP		2.3584**	1.1658	0.8370	2.4216***
	BP	1.3392		0.2742	1.7515*	0.1226
	POP	2.2956**	1.6952*		1.2030	1.6896*
	SBOP	0.8543	2.3275**	0.8593		3.1652***
	SP	0.9742	1.3828	1.2218	1.6077	

Note: *, **, *** indicates the rejection of null hypothesis at 10%, 5%, 1% of significant level.
H_0: A will not granger cause B.

Table 4.46 shows the result of CPO price will granger cause stock price at significant level of 1%, showing the rejection of the null hypothesis. In contrast, there is no granger causality from stock price to CPO price as the test statistic is insignificant towards all significance level.

4.3.11 Model 11: Control Variables + Conditional Variables (CC*COP, CC*EPO, CC*ER, CC*SP)

Table 4.47: *Result of Bound Test for Model 11*

Test Statistic	Value	Signif.	I(0)	I(1)
F-statistic	3.843868**	10%	1.92	2.89
k	7	5%	2.17	3.21
		2.5%	2.43	3.51
		1%	2.73	3.9

Note: *, **, *** indicates the rejection of null hypothesis at 10%, 5%, 1% of significant level. Lag selection are based on the lowest AIC.
H_0: There is no long-run relationship in the model.

From Table 4.47, it has sufficient evidence to conclude that there is long run effect on the CPO price for model 11 after all variables have interact with the climate change. This is supported by the result given in the table, which the F-statistic (3.8439) is greater than the critical value (3.51) in the 2.5% of significant level.

Table 4.48: *Result of Long Run Parameter for all the Conditional Variables interacted with Climate Change in Model 11*

Long Run Parameter	CC*COP	Coefficient	0.206734
		T-statistic	1.324153
		P-value	0.1882
	CC*EPO	Coefficient	0.458692
		T-statistic	1.127813
		P-value	0.2619
	CC*ER	Coefficient	0.949430
		T-statistic	3.203727
		P-value	0.0018***
	CC*SP	Coefficient	0.226984
		T-statistic	1.807215
		P-value	0.0735*

Note: *, **, *** indicates the rejection of null hypothesis at 10%, 5%, 1% of significant level. Lag selection are based on the lowest AIC.

H_0: The variable X is insignificant to the Crude Palm Oil Price.

(where variable X represents CC**COP,* CC**EPO,* CC**ER or* CC**SP)*

From Table 4.48, it shows that Climate Change*Exchange Rate and Climate Change*Stock Price have long run relationship, however, Climate Change*Crude Oil Price and Climate Change*Export of CPO do not have long run relationship as the significant level (10%) is lower than the p-value. The coefficient of CC*ER and CC*SP are 0.9494 and 0.2270 respectively, showing they can positively affect CPO price. After combined all the variables, the result of CC*ER is same as the separated model in Model 9. For every 1% increases in CC*ER, the CPO price will increase 0.9494%, ceteris paribus. For CC*SP, the result is different with the separated model in Model 10. In model 11, it shows there is positive relationship between CC*SP and CPO price at the significant level of 10%. According to Gunasekara & Jayasinghe (2019), they showed that stock price could be affected by climate change positively. Various weathers such as temperature, wind speed, humidity, sunshine hours and cloud covers will change the mood of the normal investors. When the temperature increase, the production of CPO will increase given the temperature is within the maximum temperature range 29°C to 33°C. When the supply of CPO rise, the sales return of the company will increase and thus this will attract investor to invest in stock market, and subsequently the KLCI will increase. When KLCI is high, this indicate the economy condition is good where consumer has a higher purchasing power. Hence, people will demand more products, and the CPO price will increase.

Table 4.49: *Result of ECM for Model 11*

ECM	Coefficient	-0.196643
	T-statistic	-6.093758
	P-value	0.0000***

Note: *, **, *** indicates the rejection of null hypothesis at 10%, 5%, 1% of significant level. Lag selection are based on the lowest AIC.

H_0: There is non-cointegration in the model.

Table 4.49 displays there is cointegration in the model 11. Thus, the coefficient (-0.1966), has indicated the speed of adjustment of model 11 to long run is 19.66% in one month.

Table 4.50: *Results of Granger Causality for Model 11*

		B							
		CPOP	CC* BP	CC* POP	CC* SBOP	CC* COP	CC* EPO	CC* ER	CC* SP
A	CPOP		2.5334	1.9188	0.4896	4.3189	3.0186	1.1403	1.5111
	CC*BP	1.2933		0.9352	3.6864	1.4895	0.6425	2.2883	0.0661
	CC*POP	4.3281	1.8024		1.1588	1.5988	9.8861	1.7690	1.9568
	CC*SBOP	0.8351	3.1612	1.1139		3.4269	0.9827	1.7610	0.8953
	CC*COP	1.3612	0.9181	0.4741	1.0725		1.2073	0.7980	1.0809
	CC*EPO	1.9835	2.1680	0.3713	0.5586	0.9823		0.5747	4.2000
	CC*ER	1.7505	1.8496	0.6049	6.3488	3.1868	0.3036		0.2577
	CC*SP	0.3790	0.5435	2.4326	1.2791	2.2123	1.9598	3.1607	

Note: significance level at 1%, 5% and 10% respectively.

H_0: A will not granger cause B.

Table 4.50 shows the CPO price will granger cause CC*COP and CC*EPO as the test statistic for both variables are significant at 5% significance level. Besides, there is also granger causality from CC*EPO to CPOP at 10% significant level.

4.4 Chapter Summary

In this chapter, a series of tests have been conducted. Unit root test and diagnostic checking have been engaged before the other tests to ensure the validity and unbiased results. All the results shown that all the variables are stationary at first difference level. After done the pre-test, we can make a conclusion that all the model that we have tested shown there is a long run relationship to the CPO price, except for the model 1,4,6 and 9. This chapter also has covered the result of ECM test (cointegration relationship) and granger causality. Lastly, the summary of the result, policy recommendation, limitation of the study and recommendations for the future research will be further explained in the next chapter.

CHAPTER 5: DISCUSSION, CONCLUSION AND IMPLICATION

5.0 Introduction

CPO plays a very critical role in Malaysia as it acts as one of the key drivers to derive Malaysia's economy today. Hence, this study has conducted in Malaysia with the sample size of 137 by adopting time series analysis from January 2007 to May 2018 with the objectives to examine the determinants that impact Malaysia's CPO price from January 2007 to May 2018. In order to make this study more comprehensive, this research has further added an objective to examine the climate change by acting as an interaction term and overall affect the CPO price in Malaysia from January 2007 to May 2018. In the model, it has included the variables from economy, financial and also environment, which can assist the study to achieve sustainability in palm oil industry. Therefore, this study may make a well contribution and also able to accomplish the goals targeted.

This chapter will be narrowed down into four parts and the first part will be the summary of findings. Then, a few policies will be proposed to achieve our objectives of this study and follow by the limitation and also recommendation on this study for the future researchers.

5.1 Discussions of Major Findings

In conclusion, this study has determined the relationship between CPO price and CPO price determinants that including the control variables: production of CPO, SBO price, biodiesel production and conditional variables: crude oil price, export of CPO, exchange rate, stock price, and also climate change. Also, taking interaction term (Climate Change) into consideration in separate model. In order to achieve a reliable output and meet the objectives of this research, this research has conducted variety of diagnostic checking, followed by model estimation using ARDL, ECM and Granger Causality Test.

Firstly, majority of the results from diagnostic checking have no issues arisen under 5% significant level except for Model 1, 4, 7 and 10. Under normality test, Model 1 and 7 were significant, which showing no equitable distributed in error term. This could lead to result tend to be biased and unreliable. On the other hand, Model 4, 7, and 10 shown a slight unstable in the CUSUM test at 5% significant level. The data was only exceeded slightly to the 5% intervals; thus, it might lead to a misleading conclusions and inaccurate forecasts. Nevertheless, this could not be a big issue under this research as both of the models were insignificant towards the CPO price in long run. Besides, the overall combined models (Model 6 and 11) does not have any issues throughout the diagnostic checking, so it can fill up the invalid and inconclusive result under Model 4, 7 and 10. In short, the issues arisen could not be influencing the validity or reliability of the research result on significant variables. As overall, the result driven from diagnostic checking was quite satisfied, as majority of the model have no econometric problems. Following, table below shows the empirical result of the relationship of the determinants with CPO price using ARDL with long-term test.

Table 5.1 *Summary Results of the Study*

Model	**Variable**	**Relationship**
1	Crude Oil Price	Insignificant
2	Export of CPO	Positive **
3	Exchange Rate	Positive**
4	Stock Price	Insignificant
5	Climate Change	Positive *
6	Crude Oil Price	Insignificant
	Export of CPO	Positive**
	Exchange Rate	Positive**
	Stock Price	Insignificant
	Climate Change	Negative*

7	Crude Oil Price & Climate Change	Insignificant
8	Export of CPO & Climate Change	Positive***
9	Exchange Rate & Climate Change	Positive **
10	Stock Price & Climate Change	Insignificant
11	Crude Oil Price & Climate Change	Insignificant
	Export of CPO & Climate Change	Insignificant
	Exchange Rate & Climate Change	Positive***
	Stock Price & Climate Change	Positive*

****refers to significant at 1%*

*** refers to significant at 5%*

** refers to significant at 10%*

This research has finally achieved both objectives in this research. Firstly, the factors affecting the CPO price have been determined which included production of CPO, SBO price, biodiesel production, export of CPO, exchange rate, stock price and also climate change. Only crude oil price and stock price unable to determine its relationship towards CPO price. Therefore, this has driven the reason to conduct the Model 6 (combine all variables together) is to fill up the limitation happened in Model 1 and 4 and also to detect as overall to determine whether the result will be different in manner. Therefore, from the result shown, conditional variables that run separately and all together have derived a similar result except for climate change. As a result, it can be concluded the separate model and combined model could derive a different result.

In terms of the second objectives, the research can conclude that when climate change act as an interaction term on all the independent variables, it will affect the CPO price in Malaysia. As shown in the table above, there are crude oil price and stock price is insignificant under the interaction term study while Model 11 shown both crude oil price and export of CPO were insignificant. Similarly, the insignificant of relationship are mainly due to the non-normality of error term in crude oil price and also the stock price has significant relationship under Cusum test. In terms of export of CPO in combined model, it could be due to there's no direct effect from climate change in the research study given all the variables exist.

To create more value in this research, this research has further analysed on speed of adjustment to long-run and short-term relationship using ECM and Granger Causality test in each of the variables towards CPO price respectively. All the results and details analysis has been shown in Chapter 4. In short, this study has made a well contribution to the society as it has achieved the objectives and goals targeted.

Lastly, this research has determined the sustainability of Malaysia's palm oil industry via the aspects of economy, financial and environment. From all these variables, government can implement the policies suggested to achieve a more sustainable palm oil industry by giving a more stable pricing and also more demand on CPO. For instance, government can impose tax or subsidies to control the CPO price. Besides, government can also implement Free Trade Agreements (FTAs) with more countries to encourage the demand on CPO. Besides, as Malaysia is getting more cautious with "green environment", it will encourage more demand of CPO as it is one of the renewable energies and also harmless to the environment. For instance, government is starting to implement a higher blending on biodiesel such as from B5 in 2011 to B20 in 2020. From these strategies, it could provide a more demand in CPO and thus maintain a sustainable palm oil industry. Besides, it will also partially achieve the SDGs that implemented by United Nations Member States in 2015 (Sustainable Development Goals, 2020). This is because from the policies suggested, some goals such as affordable and clean energy, decent work and economic growth and also climate action under SDGs will be able to achieve by controlling these factors through this research.

5.2 Implication of the Study

5.2.1 International Trade Policy

International trade policy is one of the oldest divisions of economic thought. A complete thought of international trade policy about specialization and division of labour was came from Adam Smith's "An Inquiry into the Nature and Causes of the Wealth of Nations", issued in year 1776 (Irwin, 2001). Specialization is to encourage greater productivity, which is important for attaining higher standards of living. Also, division of labour mean that only larger market is able to stimulate a great deal of specialization. Thus, all countries can gain from international trade since it increases the world's productivity and output. This is due to this policy increase the size of the market for any given country effectively, endorsed for more refined specialization and shaped an international division of labour.

First of all, there are few instruments under international trade policy that used to control export and import in Malaysia. One of the instruments is export tax and subsidy, which is mainly to tax or subsidy agriculture sector, consequently, increase or reduce the commodity prices. To further clarify, subsidy is a benefit given to supplier to reduce their burden or encourage their current actions; Export tax is a tax that will bear by the supplier to discourage export. Thus, those suppliers will tend to supply more with the benefits given (subsidy or lower export tax) and subsequently lowering down the price of CPO and vice versa (Balu & Ismail, 2011). As a result, government can actually control the CPO price from these 2 instruments.

On the other hand, Malaysia participated General Agreement on Trade and Tariff (GATT) in 1957, and after that it changed to World Trade Organization (WTO). Besides, Malaysia has built bilateral Free Trade Agreements (FTAs) with few countries, such as Australia, Chile, India, Japan, New Zealand, Pakistan and Turkey ("Malaysia Regulations, and Standard", 2019). FTA is under international trade policy which is an agreement between two or more countries, agree to get rid of tariff and non-tariff barriers affecting trade among them. FTA can be applied in export of CPO in Malaysia to boost the demand of CPO by removing or lowering import tariff. In fact, Malaysia had applied this policy by establishing bilateral FTA with Japan in 2005 and eliminated import tariff to Japan. It was successfully boost the demand of CPO export to Japan and 96.8% of the Japanese palm oil market was controlled by Malaysian palm oil in 2010. Malaysia's export of CPO and palm-based products to Japan has amounted to RM 1476.90 million (Balu & Ismail, 2011). Therefore, Malaysia may impose either lower import tariff or zero tariff with high CPO importing countries to solve the issue of low export of CPO from European countries and India. Moreover, it will not only attract more importers to demand the CPO from Malaysia but also maintain a better relationship between countries. As a result, CPO price will rise, as the export of CPO increase and vice versa. In addition, this policy can also reduce the costs from fluctuating exchange rate. This is because when the changes in exchange rate is not beneficial to the domestic country, this policy at least can lower down the cost incurred in the changes of exchange rate.

Furthermore, international trade policy is able to manage the terms of trade $(\frac{\text{export price index}}{\text{import price index}})$ in Malaysia by implementing tariffs, subsidy or import quotas and export restraints to eliminate the trade barriers among the world. If the government plans to reduce the exchange rate $(\frac{Malaysian\ Ringgit}{Foreign\ Currency})$, the government can reduce export tax, export restraint or impose import tariff and import quota and vice versa (Hayakawa, Kim & Yoshimi, 2017). These will able to increase the quantity of export and discourage the import due to the low export price and high import price and subsequently reduce the exchange rate. It has been proven by Jimoh (2006) who carried out a research in Nigeria, depicts that 10% rises in the terms of trade will causes approximately 11% appreciation in exchange rate. In short, if the government reduce export tax, the exchange rate $(\frac{Malaysian\ Ringgit}{Foreign\ Currency})$ will reduce, and causes the export of CPO reduce and subsequently reduce the CPO price and vice versa. As a result, it will not only solve the unstable exchange rate created from China-US trade war and Britain leaving EU issue, but also to control the CPO price as the policy implemented will affect the CPO demand and price for foreigners as well.

In addition, international trade policy is concerned with distribution and efficient use of economic resources among countries (Vijayasri, 2013). This policy will give rise to the economy of Malaysia by affecting demand and supply as well as the prices. By implementing import tariff or quota to remove trade barriers, Malaysia's economy will become better as import and export of goods and services increase. Moreover, it will also attract new investors from both domestic and foreign to invest due to the partnership between countries. Hence, the KLCI will increase, implying the economy is good and the consumers have a higher purchasing power. Consumers will tend to increase their standard of living and demand more in daily products. CPO as the main income of national and one of main driver of economy growth in Malaysia, it dominates the market by transforming CPO into various products in our daily life. It has widely adopted as cooking oil, personal care products, beauty and cosmetic products, as well as biofuels used in transportation and industrials (Tullis, 2019). Thus, the higher demand of daily product can actually increase the CPO price and vice versa. Besides, stock market in Malaysia will be more stable when Malaysia establishes bilateral FTA with other countries. These frequent traded countries can ensure the export and import volume of Malaysia to avoid stock market directly impacted by other economic factors. However, stock market fluctuation still involves other factors that beyond our control. Bilateral FTA is one of the methods to influence stock market and consequently affect CPO price in Malaysia.

In short, this policy is mainly adopting FTA, export tax, subsidy, import tariff and import quotas to control the CPO price and solving the issues occurred in each independent variable. From the discussion above, this policy has adopted direct impact and indirect impact to influence the CPO price. Firstly, the direct impact is mainly focus on domestic country where it will affect the suppliers and influence the CPO price. On the other hand, the indirect impact will be focused on the demand of foreign investors or buyers. By implementing each policy, it will derive the same result. For instance, when the government increase export tax, the domestic supplier will tend to reduce their supply, and thus increase the CPO price. In terms of foreign buyers, they will demand lesser of CPO due to the higher price provided by Malaysia. This is because the seller will normally transfer the additional cost charged by government towards the consumer. Therefore, the export of CPO will reduce. This will continue lead to the increment of exchange rate ($\frac{Malaysian\ Ringgit}{Foreign\ Currency}$) and subsequently the foreign will demand more CPO from Malaysia due to their currency has appreciated. Lastly, the CPO price increase. These have shown that the policy implement, will bring the same effect at the end of the day.

5.2.2 National Green Technology Policy (NGTP)

NGTP has launched on 24th July 2009 in Malaysia, acting as an initial step for Malaysia toward green technology (Chua & Oh, 2011). The objective of this policy is to promote the green technology in six key sectors including Energy, Manufacturing, Transportation, Building, Waste and Water in order to enhance growth of national economic and sustainable development. Many scientific studies had discovered green technology as one of the efficient environment friendly mechanism that help to reduce the consequence of greenhouse gases to climate change and impact of energy-intensive economic growth ("Green Technology Master Plan", 2017). Green technology is an application and enrichment of product, system and equipment which can save the environment and natural resources by minimising negative impact of human activities ("Green Technology Master Plan", 2017). The reduction of atmosphere greenhouse gases (GHGs) able to moderate the average surface temperature and then mitigate the climate change. Therefore, under this policy, government aim to reduce the GHGs emission by adopting renewable energy to replace non-renewable energy which has generated by consuming of natural resources in those six key sectors. Renewable energy was introduced under Malaysian Fifth Fuel policy and included in the 8th Malaysia plan for 2000 to 2005 with a target of 5% total generation capacity by renewable energy (Maulud & Saidi, 2012). In Malaysia, majority renewable energy come from large hydro and minority has generated by biomass, biogas and solar.

Green Technology Master Plan (GTMP) is one of the national plans that provide operation outline to achieve the goals of NGTP. The aim of GTMP is to spur the Malaysia green growth as to achieve sustainable development and economic grow by reducing 40% carbon intensity by 2020 ("Green Technology Master Plan", 2017). Government expects to improve national income as well as life quality of Malaysian by 2020 and position Malaysia as a Green Technology hub by 2030 through implementation of GTMP. GTMP has provided the framework to adopt and use of green technology in six key sectors. The energy sector and transportation sector have the major contribution in GTMP as they are mainly focusing on low-carbon activity, energy capacity and efficiency as well as GHGs emission reduction. In energy sector, government has put efforts on resource diversification, continuous investment in renewable energy infrastructure and state-of-the-art technology deployment to achieve the targets of installing 20% renewable energy capacity and increase 10% of installed capacity within 10 years. As a result, it will increase 15% energy efficiency and reduce electricity consumption ("Green Technology Master Plan", 2017). The installation of the capacity enables most of industries and manufactories to generate energy with renewable resource instead of utilizing non-renewable natural resources such as fossil fuels. The step moves toward the renewable energy generation not only increase the energy efficiency, but also reduce the cost of production. Based on Minister of Energy, Green Technology, Science, Climate Change and Environment, nation able to save minimum of RM47 billion since the renewable energy is potential to minimize the consumption to 137 thousand-Gigawatt hour of energy (Carvalho, 2018). Besides, the energy generated from hydropower can efficient reduce 30 to 60 times of GHGs emissions generated from fossil fuels (Gagnon, 1997). This has proved the renewable energy can lead the average temperature maintained at normal level as the GHGs emissions reduce.

Besides, transport sector is the second highest carbon dioxide (CO_2) emission sector in Malaysia that shared around 20% over the year ("Malaysia Biennial Update Report", 2015). Under GTMP, government has targeted to increase energy efficient vehicle (EEV) such as hybrid, electric and plain oil fuel-efficient vehicles up to 85% by 2020 and increase 40% of public transport in all cities by 2025. Moreover, another transportation technology that can be emerged to mitigate climate change is intelligent transportation systems (ITS) which is an efficient system for traffic signal control, electronic toll collection and bus rapid transit (Shaheen & Finson, 2013). Both green technologies provide better energy efficiency and reduce the CO_2 emission (Chai, Abidin, Ibrahim & Ping 2013).

NGTP focus on four primary pillars: energy, environment, social and economic perspectives (Chua & Oh, 2011). Energy as an instrument of policy that play an important role in transition of green technology by promoting efficient and sustainable utilisation of energy. This policy is significant positive impact on environment as it reduces the emission of GHGs especially CO_2 which prevent the increment of temperature. This has successfully improved the climate change problem and upgrade the citizen quality of life. The implementation of green technology has resulted a lower cost of living since better energy efficiency. Moreover, it also reduces the air pollution that build a cleaner cities, comfortable environment and healthier society. Under green development, the replacement of natural resource by renewable resources able to avoid natural resources depletion and stimulate the national economy performance. Hence, there is a positive relationship between the economic growth and environmental protection since a healthy environment and sufficient resource are vital elements to promote GDP growth. Many researchers believe that per capita GDP grows faster in resource rich countries than in resource poor countries (Vaghefi, Siwar & Aziz, 2015).

As a result, the government able to mitigate the climate change problem through carry out NGTP and then reduce the impact of high temperature on some economic and financial variables which would directly affect the CPO price. The implementation of NGTP has increased the awareness of eco-friendly and most of industries and manufactories may be more efficiently in utilizing its resources such as using low carbon energy resources. Therefore, the stabilize climate may be created through this policy and subsequently reduce the impact of climate change on the independent variables that will influence the CPO price. For instance, through the implementation of NGTP, the effect of climate change on export of CPO can be reduced. This is because the government can avoid the continuous increasing of temperatures and extremities in weather patterns that bring negative impact on the agriculture production and crop yield. As a result, it will stimulate the production of CPO and suppliers will less likely to face shortage of stock for export. Besides, the exchange rate and stock price will also less likely get affected by climate change. For instance, with a better quality of environment and lower air pollution, people will remain their usual daily activities. People will have less concern on their purchasing actions when the economy condition is better. As a result, stock price and exchange rate will not be easily interfered by the stabilized climate change.

In short, both policies are highly recommended to the government to achieve the sustainability of palm oil industry. This is because if the government adopted these 2 policies, the first thing is International Trade Policy can control the CPO price and demand easily by implementing subsidies or tax on palm oil producers. Moreover, this policy can also create a long-term relationship with those countries having a frequent trading transaction with Malaysia. This will not only encourage a more frequent trading for both countries, but also maintain a healthy relationship between both countries. As a result, the economy for both countries will be increase and this will also encourage more countries to be involved in this policy with Malaysia. On the other hand, National Green Technology Policy will reduce the use of natural resources which allow the country to sustain longer. Besides, it will also attract countries who are emphasis on environment friendly to invest in or import from our country which boosted the country's economy. Moreover, a better used in resources will help in stabilizing the climate condition where the production of agriculture products will be stabilized and also the health condition of humans will also turn better.

As overall, there might have more policy that could cope with all these issues stated, however this research has suggested these 2 policies are mainly due to its function and impacts are more useful to the country and also able to achieve the objectives in this research. Besides, these policies will not only boost the economy of Malaysia, but also create a sustainable palm oil industry. In addition, it also heading to the achievement of Sustainable Development Goals.

5.3 Limitation of the Study

In this research, the main problem faced is the limitation of secondary data. To increase the reliability of the result, the more the sample size is better (given 30 is the minimum requirement) while a small sample size will tend to lead to a bias result in the research study. This is because the result or relationship defined will be only based on the small sample period, which is not really reliable. To further clarify, the sample size is the number of data applied in the study. At the beginning of the concept, this research is planned to use yearly data for examining the relationship, unfortunately, there are only few variables used in this research are containing more than 30 years annual data, while the others are less than 30 years or even less than 10 years. Therefore, this research has adopted monthly data from January 2007 to May 2018 to achieve the minimum 30-sample size required in order to become more reliable.

Furthermore, this research was planned to adopt CO_2 emissions to act as the proxy variable of Climate Change at the beginning. However, the limitation of secondary data has caused to adopt temperature to be the proxy variable of climate change. Even there are journals have proven temperature will affect the CPO price, but it could be better for this research to adopt CO_2 emissions due to the fact that the climate change issues are mainly driven from the high CO_2 emissions. Nevertheless, the used of temperature also make a well contribution to the study.

In a nutshell, the error term under crude oil price are not normally distributed is another limitation in this study. This issue has created insignificant relationship towards the CPO price under Model 1, 6, 7 and 11. This was mainly due to the crude oil price is not normally distributed. As the monthly data used has created a less variation in the model estimation. This can be further clarified by the example of using yearly data and monthly data. The variation with yearly data most probably is higher than monthly or daily data. Therefore, the data will most likely be crowded at either tail of the distribution and showing an unbalanced distribution under the model estimation. Under these 4 models, the data used for crude oil price was crowded in the right tail and showing the histogram is skewing to the right due to the uneven distribution of data. Therefore, this issue could be a reason that causes crude oil price to have an insignificant relationship to the CPO price in this research study. Besides, omitted unimportant variables could be other reasons that lead to the model not normally distributed.

5.4 Recommendation for the Future Research

Future researcher is advised to adopt panel data in their research to solve the problem of limited secondary data. Panel data is the number of observations derived from a given time period on a number of cross-sectional units such as country, state and others (Moffatt, 2018). Hence it will be much easier to achieve the 30 minimum sample size to derive a reliable result as the sample size is driven from number of period times cross sectional units. Therefore, this will allow the researcher to have variety choices on the data needed such as yearly, monthly or daily to obtain a more accurate and unbiased result. However, future researcher is encouraged to use yearly data to conduct their research in future. This is because the result determine will be much more accurate and reliable. Moreover, the future researcher can also consider to get some historical data from the respective institution in charged. For instance, in this research, the variables such as CPO price have limited data available. Thus, it is suggested to go for MPOB to request for the data for further study. This will not only create a more accurate result, but also the reliable result.

Moreover, different proxy variables for climate change could be considered for future researcher. However, it will be encouraged to adopt CO_2 emissions as the proxy for climate change in the future related research study. Adopting CO_2 emission does not guarantee it will derive a better result, but the main purpose behind is to derive a different result and contribute further information to the researchers in future. Other than CO_2 emissions, rainfall can also be used as one of the proxy variables. As a result, this will be helpful in enhancing the contribution of studies and development due to the limited historical studies conducted.

On the other hand, the future researcher can solve the non-normality error term by adopting the yearly data instead of monthly data to reduce the possibility of data crowded in either part of the tails. If the samples size unable to satisfy, or the yearly data unable to obtain, quarterly data is still acceptable as it will be more reliable than monthly data. This is because the longer the gap between periods, it will show a larger variation compared to a shorter gap. Hence, this will increase the chance for data to be normally distributed.

Furthermore, it is encouraged for future researcher to examine other determinants that could influence CPO price to achieve sustainability of palm oil industry towards share prosperity vision 2030. For instance, future researcher could adopt primary data in research to examine the factors that required surveys such as behavioural of consumers, political factors towards palm oil products, FTSE Bursa Malaysia Palm Oil Plantation Index and others. As to make the study more comprehensive, the researcher should adopt all the related factors into consideration in order to achieve a more sustainability of palm oil industry.

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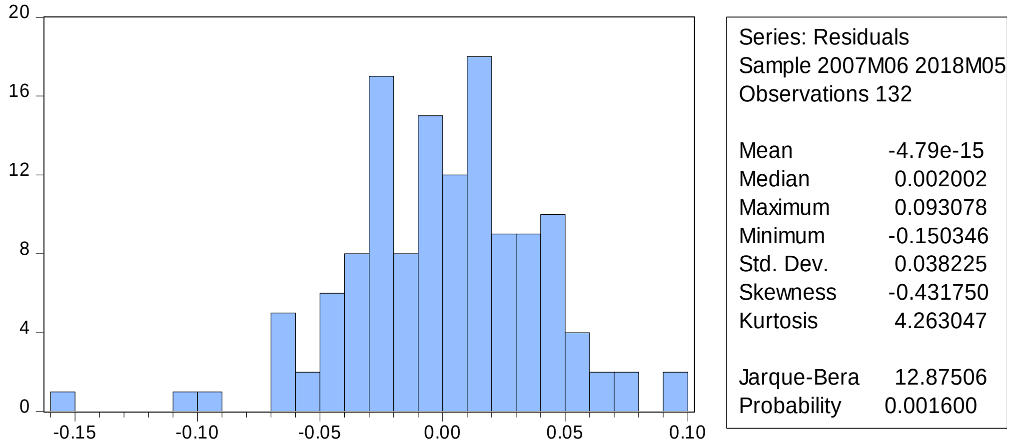
APPENDICES

Appendix 1: Model 1 – Crude Oil Price

Appendix 1.1: *Output for Normality Test*



Appendix 1.2: *Output for Multicollinearity Test*

Variance Inflation Factors
Date: 02/04/20 Time: 14:56
Sample: 2007M01 2018M05
Included observations: 137

Variable	Coefficient Variance	Uncentered VIF	Centered VIF
LOG_BP_	0.000284	279.6187	1.881920
LOG_POP_	0.004330	2274.895	1.161017
LOG_SBOP_	0.009277	4297.619	3.899085
LOG_COP_	0.004753	1438.268	3.014053
C	0.499261	4893.904	NA

Appendix 1.3: *Output for Breusch-Godfrey Serial Correlation LM Test*

Breusch-Godfrey Serial Correlation LM Test:

F-statistic	0.940056	Prob. F(6,109)	0.4696
Obs*R-squared	6.494435	Prob. Chi-Square(6)	0.3701

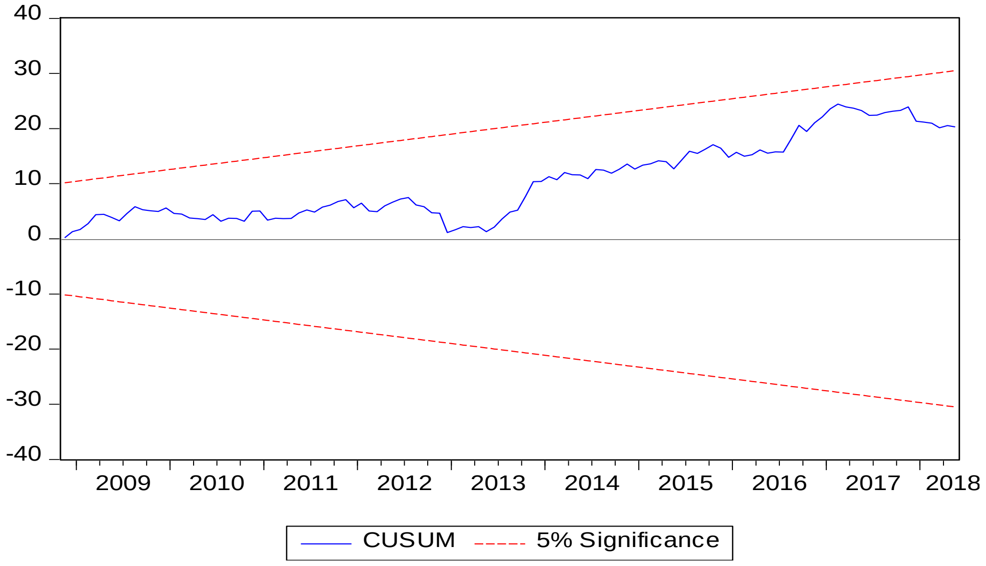
Test Equation:
Dependent Variable: RESID
Method: ARDL
Date: 02/04/20 Time: 14:53

Sample: 2007M06 2018M05
Included observations: 132
Presample missing value lagged residuals set to zero.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOG_CPOP_(-1)	-0.004571	0.085719	-0.053323	0.9576
LOG_CPOP_(-2)	-0.021239	0.117965	-0.180047	0.8575
LOG_CPOP_(-3)	0.008784	0.075673	0.116079	0.9078
LOG_BP_	0.001087	0.024673	0.044051	0.9649
LOG_BP_(-1)	-0.006249	0.034164	-0.182917	0.8552
LOG_BP_(-2)	0.007197	0.024922	0.288796	0.7733
LOG_POP_	0.003661	0.045613	0.080264	0.9362
LOG_POP_(-1)	0.001065	0.057336	0.018580	0.9852
LOG_POP_(-2)	-0.002998	0.057900	-0.051777	0.9588
LOG_POP_(-3)	-0.016902	0.060893	-0.277565	0.7819
LOG_POP_(-4)	0.019748	0.062807	0.314422	0.7538
LOG_POP_(-5)	-0.008844	0.044598	-0.198310	0.8432
LOG_SBOP_	0.011632	0.093162	0.124856	0.9009
LOG_SBOP_(-1)	0.008338	0.098634	0.084530	0.9328
LOG_COP_	-0.008096	0.062133	-0.130303	0.8966
LOG_COP_(-1)	0.003192	0.062119	0.051385	0.9591
C	0.034777	0.445439	0.078073	0.9379
RESID(-1)	0.009949	0.127736	0.077886	0.9381
RESID(-2)	0.031234	0.125593	0.248691	0.8041
RESID(-3)	0.110541	0.107733	1.026065	0.3071
RESID(-4)	0.028675	0.107870	0.265826	0.7909
RESID(-5)	0.118926	0.105765	1.124431	0.2633
RESID(-6)	-0.170645	0.106420	-1.603509	0.1117

R-squared	0.049200	Mean dependent var	-4.79E-15
Adjusted R-squared	-0.142704	S.D. dependent var	0.038225
S.E. of regression	0.040861	Akaike info criterion	-3.400233
Sum squared resid	0.181992	Schwarz criterion	-2.897926
Log likelihood	247.4153	Hannan-Quinn criter.	-3.196118
F-statistic	0.256379	Durbin-Watson stat	2.021812
Prob(F-statistic)	0.999710		

Appendix 1.4: *Output for CUSUM Test*



Appendix 1.5: *Output for Long Run Parameter and Bound Test*

ARDL Long Run Form and Bounds Test
Dependent Variable: D(LOG_CPOP_)
Selected Model: ARDL(3, 2, 5, 1, 1)
Case 2: Restricted Constant and No Trend
Date: 02/04/20 Time: 14:53
Sample: 2007M01 2018M05
Included observations: 132

Conditional Error Correction Regression

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.942808	0.414622	2.273897	0.0248
LOG_CPOP_(-1)*	-0.118359	0.036246	-3.265385	0.0014
LOG_BP_(-1)	-0.001115	0.007260	-0.153613	0.8782
LOG_POP_(-1)	-0.022016	0.047385	-0.464621	0.6431
LOG_SBOP_(-1)	0.033091	0.050096	0.660562	0.5102
LOG_COP_(-1)	-0.011990	0.026872	-0.446198	0.6563
D(LOG_CPOP_(-1))	0.039469	0.063245	0.624065	0.5338
D(LOG_CPOP_(-2))	-0.149934	0.061027	-2.456868	0.0155
D(LOG_BP_)	0.017458	0.023335	0.748132	0.4559
D(LOG_BP_(-1))	-0.044181	0.023889	-1.849414	0.0670
D(LOG_POP_)	-0.126331	0.044261	-2.854243	0.0051
D(LOG_POP_(-1))	-0.201112	0.044022	-4.568484	0.0000
D(LOG_POP_(-2))	0.027751	0.042318	0.655783	0.5133
D(LOG_POP_(-3))	-0.051005	0.043150	-1.182028	0.2396
D(LOG_POP_(-4))	-0.097851	0.043239	-2.263015	0.0255
D(LOG_SBOP_)	0.970881	0.091123	10.65460	0.0000
D(LOG_COP_)	0.117135	0.060139	1.947737	0.0539

* p-value incompatible with t-Bounds distribution.

Levels Equation
Case 2: Restricted Constant and No Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOG_BP_	-0.009422	0.062336	-0.151148	0.8801
LOG_POP_	-0.186013	0.393781	-0.472378	0.6376
LOG_SBOP_	0.279585	0.376296	0.742992	0.4590
LOG_COP_	-0.101305	0.226515	-0.447235	0.6555
C	7.965696	3.615642	2.203121	0.0296

EC = LOG_CPOP_ - (-0.0094*LOG_BP_ -0.1860*LOG_POP_ + 0.2796
*LOG_SBOP_ -0.1013*LOG_COP_ + 7.9657)

F-Bounds Test — Null Hypothesis: No levels relationship

Test Statistic	Value	Signif.	I(0)	I(1)
			Asymptotic: n=1000	
F-statistic	3.271389	10%	2.2	3.09
k	4	5%	2.56	3.49
		2.5%	2.88	3.87
		1%	3.29	4.37
			Finite Sample: n=80	
Actual Sample Size	132			
		10%	2.303	3.22
		5%	2.688	3.698
		1%	3.602	4.787

Appendix 1.6: *Output for Error Correlation Model*

ARDL Error Correction Regression
Dependent Variable: D(LOG_CPOP_)
Selected Model: ARDL(3, 2, 5, 1, 1)
Case 2: Restricted Constant and No Trend
Date: 02/04/20 Time: 14:54
Sample: 2007M01 2018M05
Included observations: 132

ECM Regression
Case 2: Restricted Constant and No Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LOG_CPOP_(-1))	0.039469	0.059671	0.661444	0.5097
D(LOG_CPOP_(-2))	-0.149934	0.057180	-2.622150	0.0099
D(LOG_BP_)	0.017458	0.022450	0.777616	0.4384
D(LOG_BP_(-1))	-0.044181	0.022649	-1.950620	0.0535
D(LOG_POP_)	-0.126331	0.037303	-3.386636	0.0010
D(LOG_POP_(-1))	-0.201112	0.037157	-5.412538	0.0000

D(LOG_POP_(-2))	0.027751	0.037005	0.749935	0.4548
D(LOG_POP_(-3))	-0.051005	0.037430	-1.362658	0.1757
D(LOG_POP_(-4))	-0.097851	0.037122	-2.635913	0.0095
D(LOG_SBOP_)	0.970881	0.084727	11.45892	0.0000
D(LOG_COP_)	0.117135	0.056412	2.076430	0.0401
CointEq(-1)*	-0.118359	0.026153	-4.525676	0.0000

R-squared	0.731803	Mean dependent var	-0.000192
Adjusted R-squared	0.707218	S.D. dependent var	0.073811
S.E. of regression	0.039938	Akaike info criterion	-3.516447
Sum squared resid	0.191409	Schwarz criterion	-3.254374
Log likelihood	244.0855	Hannan-Quinn criter.	-3.409953
Durbin-Watson stat	2.020245		

* p-value incompatible with t-Bounds distribution.

F-Bounds Test — Null Hypothesis: No levels relationship

Test Statistic	Value	Signif.	I(0)	I(1)
F-statistic	3.271389	10%	2.2	3.09
k	4	5%	2.56	3.49
		2.5%	2.88	3.87
		1%	3.29	4.37

Appendix 1.7: *Output for Granger Causality*

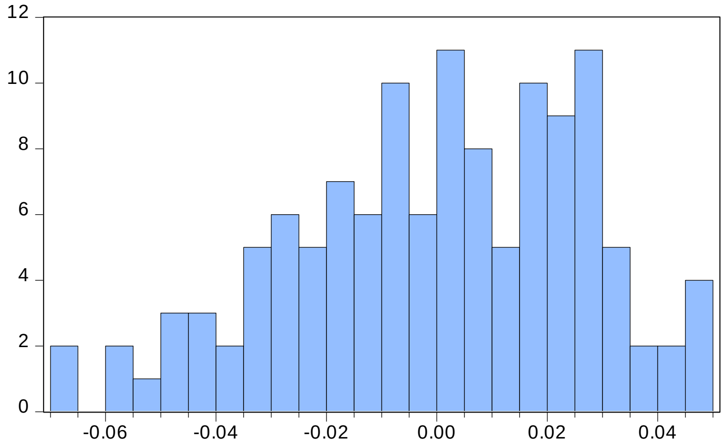
Pairwise Granger Causality Tests
Date: 02/04/20 Time: 14:55
Sample: 2007M01 2018M05
Lags: 6

Null Hypothesis:	Obs	F-Statistic	Prob.
LOG_BP_ does not Granger Cause LOG_CPOP_	131	0.85819	0.5279
LOG_CPOP_ does not Granger Cause LOG_BP_		3.04190	0.0084
LOG_POP_ does not Granger Cause LOG_CPOP_	131	1.65822	0.1373
LOG_CPOP_ does not Granger Cause LOG_POP_		2.59375	0.0214
LOG_SBOP_ does not Granger Cause LOG_CPOP_	131	1.17004	0.3270
LOG_CPOP_ does not Granger Cause LOG_SBOP_		0.22945	0.9664
LOG_COP_ does not Granger Cause LOG_CPOP_	131	0.86552	0.5225
LOG_CPOP_ does not Granger Cause LOG_COP_		3.52988	0.0030
LOG_POP_ does not Granger Cause LOG_BP_	131	1.50808	0.1814
LOG_BP_ does not Granger Cause LOG_POP_		1.08705	0.3742
LOG_SBOP_ does not Granger Cause LOG_BP_	131	3.38052	0.0041
LOG_BP_ does not Granger Cause LOG_SBOP_		3.25290	0.0054

LOG_COP_ does not Granger Cause LOG_BP_	131	0.83446	0.5456
LOG_BP_ does not Granger Cause LOG_COP_		1.30543	0.2601
LOG_SBOP_ does not Granger Cause LOG_POP_	131	2.13610	0.0542
LOG_POP_ does not Granger Cause LOG_SBOP_		0.38413	0.8879
LOG_COP_ does not Granger Cause LOG_POP_	131	0.51088	0.7991
LOG_POP_ does not Granger Cause LOG_COP_		0.98968	0.4355
LOG_COP_ does not Granger Cause LOG_SBOP_	131	0.66290	0.6797
LOG_SBOP_ does not Granger Cause LOG_COP_		2.51552	0.0251

Appendix 2: Model 2 – Export of CPO

Appendix 2.1: *Output for Normality Test*



Series: Residuals
Sample 2008M01 2018M05
Observations 125

Mean	8.75e-17
Median	0.002577
Maximum	0.049678
Minimum	-0.069616
Std. Dev.	0.026647
Skewness	-0.391897
Kurtosis	2.589404
Jarque-Bera	4.077727
Probability	0.130177

Appendix 2.2: *Output for Multicollinearity Test*

Variance Inflation Factors
Date: 02/04/20 Time: 15:52
Sample: 2007M01 2018M05
Included observations: 137

Variable	Coefficient Variance	Uncentered VIF	Centered VIF
LOG_BP_	0.000279	279.3218	1.879922
LOG_POP_	0.008099	4329.578	2.209647
LOG_SBOP_	0.004285	2019.612	1.832326
LOG_EPO_	0.010938	5696.386	2.145448
C	0.499655	4983.684	NA

Appendix 2.3: *Output for Breusch-Godfrey Serial Correlation LM Test*

Breusch-Godfrey Serial Correlation LM Test:

F-statistic	1.498968	Prob. F(12,60)	0.4029
Obs*R-squared	28.83089	Prob. Chi-Square(12)	0.2110

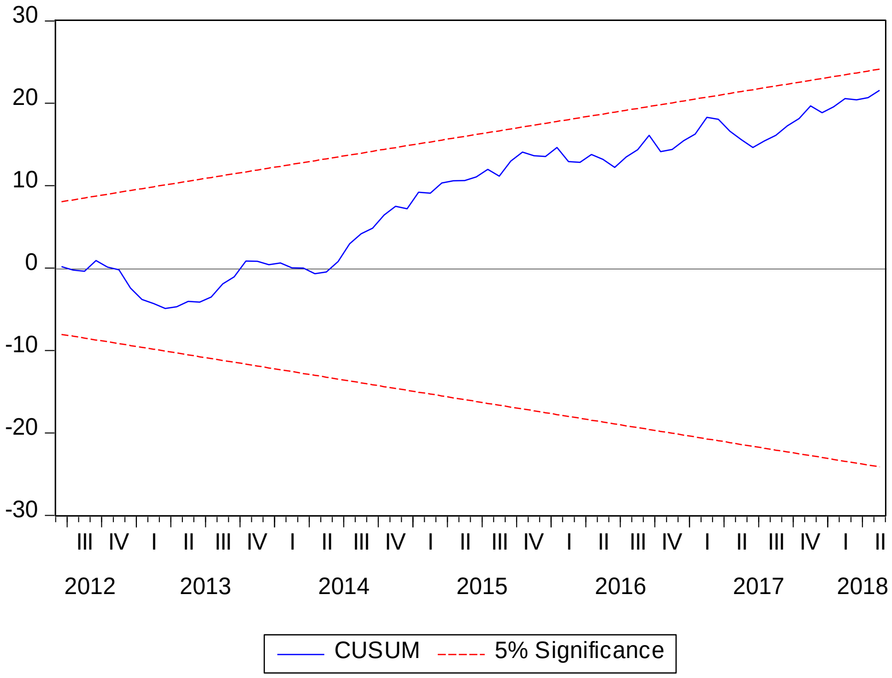
Test Equation:
Dependent Variable: RESID
Method: ARDL
Date: 02/04/20 Time: 15:46
Sample: 2008M01 2018M05
Included observations: 125
Presample missing value lagged residuals set to zero.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOG_CPOP_(-1)	-0.069360	0.203785	-0.340359	0.7348
LOG_CPOP_(-2)	0.033873	0.261738	0.129416	0.8975
LOG_CPOP_(-3)	0.161226	0.248903	0.647746	0.5196
LOG_CPOP_(-4)	0.123177	0.263045	0.468274	0.6413
LOG_CPOP_(-5)	-0.202269	0.252878	-0.799868	0.4269
LOG_CPOP_(-6)	0.079543	0.204935	0.388135	0.6993
LOG_CPOP_(-7)	-0.046010	0.147684	-0.311544	0.7565
LOG_CPOP_(-8)	-0.004103	0.129551	-0.031671	0.9748
LOG_CPOP_(-9)	0.106069	0.110621	0.958847	0.3415
LOG_CPOP_(-10)	-0.070959	0.108790	-0.652257	0.5167
LOG_CPOP_(-11)	0.054375	0.112447	0.483556	0.6305
LOG_CPOP_(-12)	-0.079312	0.077304	-1.025964	0.3090
LOG_BP_	-0.003719	0.024747	-0.150270	0.8811
LOG_BP_(-1)	0.015554	0.035633	0.436510	0.6640
LOG_BP_(-2)	-0.004988	0.035795	-0.139342	0.8896
LOG_BP_(-3)	0.005063	0.036546	0.138551	0.8903
LOG_BP_(-4)	-0.015044	0.036396	-0.413326	0.6808
LOG_BP_(-5)	0.002215	0.035316	0.062730	0.9502
LOG_BP_(-6)	-0.010108	0.035676	-0.283333	0.7779
LOG_BP_(-7)	0.003183	0.035376	0.089968	0.9286
LOG_BP_(-8)	0.002957	0.035954	0.082231	0.9347
LOG_BP_(-9)	-0.013631	0.033365	-0.408553	0.6843
LOG_BP_(-10)	-0.008514	0.033720	-0.252508	0.8015
LOG_BP_(-11)	-0.000526	0.033999	-0.015460	0.9877
LOG_BP_(-12)	-0.011894	0.024285	-0.489761	0.6261
LOG_POP_	-0.002072	0.052093	-0.039782	0.9684
LOG_POP_(-1)	0.058944	0.071361	0.826000	0.4121
LOG_POP_(-2)	-0.018771	0.083655	-0.224388	0.8232
LOG_POP_(-3)	0.025688	0.079410	0.323484	0.7475
LOG_POP_(-4)	0.107798	0.082890	1.300497	0.1984
LOG_POP_(-5)	0.014044	0.083586	0.168015	0.8671
LOG_POP_(-6)	-0.000498	0.080448	-0.006195	0.9951
LOG_POP_(-7)	0.070878	0.073707	0.961626	0.3401
LOG_POP_(-8)	0.033389	0.070494	0.473640	0.6375
LOG_POP_(-9)	0.013934	0.064324	0.216624	0.8292
LOG_POP_(-10)	0.026412	0.058939	0.448124	0.6557
LOG_SBOP_	-0.032612	0.084954	-0.383877	0.7024
LOG_SBOP_(-1)	0.064761	0.247677	0.261473	0.7946
LOG_SBOP_(-2)	-0.026212	0.294734	-0.088933	0.9294
LOG_SBOP_(-3)	-0.225009	0.278974	-0.806560	0.4231
LOG_SBOP_(-4)	-0.079501	0.288738	-0.275339	0.7840
LOG_SBOP_(-5)	0.220353	0.276092	0.798114	0.4280
LOG_SBOP_(-6)	-0.073559	0.196541	-0.374267	0.7095

LOG_EPO_	-0.019752	0.052283	-0.377789	0.7069
LOG_EPO_(-1)	0.020390	0.056716	0.359506	0.7205
LOG_EPO_(-2)	-0.005947	0.070557	-0.084291	0.9331
LOG_EPO_(-3)	-0.024375	0.066919	-0.364249	0.7170
LOG_EPO_(-4)	-0.059545	0.061117	-0.974280	0.3338
LOG_EPO_(-5)	-0.025332	0.063172	-0.401002	0.6898
LOG_EPO_(-6)	-0.019107	0.063145	-0.302597	0.7632
LOG_EPO_(-7)	-0.007036	0.057628	-0.122091	0.9032
LOG_EPO_(-8)	-0.045715	0.052497	-0.870808	0.3873
C	-0.311867	0.667921	-0.466922	0.6422
RESID(-1)	0.019639	0.232826	0.084352	0.9331
RESID(-2)	0.029555	0.215741	0.136995	0.8915
RESID(-3)	-0.369011	0.219106	-1.684163	0.0973
RESID(-4)	-0.410722	0.228388	-1.798353	0.0772
RESID(-5)	-0.191483	0.228196	-0.839117	0.4047
RESID(-6)	-0.245877	0.179083	-1.372979	0.1749
RESID(-7)	-0.269380	0.175432	-1.535526	0.1299
RESID(-8)	-0.153630	0.181428	-0.846782	0.4005
RESID(-9)	-0.451042	0.186273	-2.421406	0.0185
RESID(-10)	-0.018034	0.187749	-0.096052	0.9238
RESID(-11)	-0.318749	0.181901	-1.752317	0.0848
RESID(-12)	-0.355130	0.158762	-2.236870	0.0290

R-squared	0.230647	Mean dependent var	8.75E-17
Adjusted R-squared	-0.589996	S.D. dependent var	0.026647
S.E. of regression	0.033601	Akaike info criterion	-3.642519
Sum squared resid	0.067740	Schwarz criterion	-2.171796
Log likelihood	292.6574	Hannan-Quinn criter.	-3.045042
F-statistic	0.281057	Durbin-Watson stat	2.050023
Prob(F-statistic)	0.999999		

Appendix 2.4: *Output for CUSUM Test*



Appendix 2.5: *Output for Long Run Parameter and Bound Test*

ARDL Long Run Form and Bounds Test
Dependent Variable: D(LOG_CPOP_)
Selected Model: ARDL(12, 12, 10, 6, 8)
Case 2: Restricted Constant and No Trend
Date: 02/04/20 Time: 15:49
Sample: 2007M01 2018M05
Included observations: 125

Conditional Error Correction Regression

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.766740	0.637918	1.201942	0.2333
LOG_CPOP_(-1)*	-0.178700	0.046202	-3.867835	0.0002
LOG_BP_(-1)	0.029026	0.012437	2.333845	0.0224
LOG_POP_(-1)	-0.340969	0.128356	-2.656432	0.0097
LOG_SBOP_(-1)	0.127360	0.055051	2.313502	0.0236
LOG_EPO_(-1)	0.272454	0.101509	2.684034	0.0090
D(LOG_CPOP_(-1))	0.175775	0.103548	1.697529	0.0939
D(LOG_CPOP_(-2))	-0.056435	0.103144	-0.547147	0.5860
D(LOG_CPOP_(-3))	0.120907	0.105334	1.147844	0.2548
D(LOG_CPOP_(-4))	0.056761	0.103523	0.548291	0.5852
D(LOG_CPOP_(-5))	0.288409	0.105209	2.741291	0.0077
D(LOG_CPOP_(-6))	-0.116997	0.071935	-1.626427	0.1082
D(LOG_CPOP_(-7))	0.054338	0.071293	0.762182	0.4484
D(LOG_CPOP_(-8))	0.022744	0.064383	0.353263	0.7249
D(LOG_CPOP_(-9))	0.143533	0.063857	2.247728	0.0277
D(LOG_CPOP_(-10))	-0.053228	0.063327	-0.840525	0.4034
D(LOG_CPOP_(-11))	0.204627	0.062026	3.299062	0.0015
D(LOG_BP_)	0.032054	0.024946	1.284939	0.2029
D(LOG_BP_(-1))	-0.019504	0.028194	-0.691754	0.4913
D(LOG_BP_(-2))	-0.028665	0.028280	-1.013583	0.3142
D(LOG_BP_(-3))	-0.016812	0.026802	-0.627261	0.5325
D(LOG_BP_(-4))	-0.032767	0.024982	-1.311634	0.1938
D(LOG_BP_(-5))	-0.030495	0.025172	-1.211466	0.2297
D(LOG_BP_(-6))	0.039923	0.025067	1.592667	0.1156
D(LOG_BP_(-7))	-0.053323	0.024600	-2.167595	0.0335
D(LOG_BP_(-8))	-0.005585	0.024081	-0.231937	0.8172
D(LOG_BP_(-9))	-0.011356	0.023294	-0.487489	0.6274
D(LOG_BP_(-10))	-0.016065	0.023477	-0.684270	0.4960
D(LOG_BP_(-11))	-0.092686	0.023113	-4.010170	0.0001
D(LOG_POP_)	-0.114335	0.048141	-2.375033	0.0202
D(LOG_POP_(-1))	0.024355	0.116099	0.209774	0.8344
D(LOG_POP_(-2))	0.254012	0.101255	2.508645	0.0144
D(LOG_POP_(-3))	0.090521	0.095913	0.943790	0.3484
D(LOG_POP_(-4))	0.088413	0.086864	1.017826	0.3122
D(LOG_POP_(-5))	0.090394	0.082623	1.094054	0.2776
D(LOG_POP_(-6))	0.187798	0.070317	2.670723	0.0094
D(LOG_POP_(-7))	0.064941	0.061868	1.049661	0.2974
D(LOG_POP_(-8))	0.172370	0.051839	3.325104	0.0014
D(LOG_POP_(-9))	-0.067488	0.050960	-1.324326	0.1896
D(LOG_SBOP_)	1.083481	0.084831	12.77220	0.0000
D(LOG_SBOP_(-1))	-0.117163	0.135215	-0.866491	0.3891
D(LOG_SBOP_(-2))	-0.159774	0.133227	-1.199261	0.2344
D(LOG_SBOP_(-3))	0.005946	0.137807	0.043146	0.9657
D(LOG_SBOP_(-4))	-0.044751	0.139178	-0.321536	0.7487
D(LOG_SBOP_(-5))	-0.357489	0.141540	-2.525718	0.0137
D(LOG_EPO_)	0.069633	0.051615	1.349094	0.1815
D(LOG_EPO_(-1))	-0.064238	0.096139	-0.668180	0.5062

D(LOG_EPO_(-2))	-0.125144	0.089917	-1.391773	0.1683
D(LOG_EPO_(-3))	-0.113051	0.089544	-1.262517	0.2108
D(LOG_EPO_(-4))	-0.098032	0.082448	-1.189015	0.2383
D(LOG_EPO_(-5))	-0.050831	0.071577	-0.710149	0.4799
D(LOG_EPO_(-6))	-0.157123	0.062153	-2.527984	0.0137
D(LOG_EPO_(-7))	-0.083564	0.050270	-1.662279	0.1008

* p-value incompatible with t-Bounds distribution.

Levels Equation
Case 2: Restricted Constant and No Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOG_BP_	0.162430	0.070279	2.311212	0.0237
LOG_POP_	-1.908048	0.837179	-2.279140	0.0256
LOG_SBOP_	0.712701	0.244760	2.911839	0.0048
LOG_EPO_	1.524644	0.657543	2.318698	0.0233
C	4.290644	3.567600	1.202670	0.2330

EC = LOG_CPOP_ - (0.1624*LOG_BP_ -1.9080*LOG_POP_ + 0.7127
*LOG_SBOP_ + 1.5246*LOG_EPO_ + 4.2906)

F-Bounds Test			Null Hypothesis: No levels relationship	
Test Statistic	Value	Signif.	I(0)	I(1)
			Asymptotic: n=1000	
F-statistic	3.714363	10%	2.2	3.09
k	4	5%	2.56	3.49
		2.5%	2.88	3.87
		1%	3.29	4.37
			Finite Sample:	
Actual Sample Size	125		n=80	
		10%	2.303	3.22
		5%	2.688	3.698
		1%	3.602	4.787

Appendix 2.6: *Output for Error Correlation Model*

ARDL Error Correction Regression
Dependent Variable: D(LOG_CPOP_)
Selected Model: ARDL(12, 12, 10, 6, 8)
Case 2: Restricted Constant and No Trend
Date: 02/04/20 Time: 15:50
Sample: 2007M01 2018M05
Included observations: 125

ECM Regression
Case 2: Restricted Constant and No Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LOG_CPOP_(-1))	0.175775	0.094862	1.852958	0.0680
D(LOG_CPOP_(-2))	-0.056435	0.096545	-0.584540	0.5607

D(LOG_CPOP_(-3))	0.120907	0.098905	1.222460	0.2255
D(LOG_CPOP_(-4))	0.056761	0.097876	0.579926	0.5638
D(LOG_CPOP_(-5))	0.288409	0.098217	2.936449	0.0045
D(LOG_CPOP_(-6))	-0.116997	0.068459	-1.709019	0.0918
D(LOG_CPOP_(-7))	0.054338	0.067706	0.802567	0.4249
D(LOG_CPOP_(-8))	0.022744	0.061212	0.371559	0.7113
D(LOG_CPOP_(-9))	0.143533	0.060266	2.381643	0.0199
D(LOG_CPOP_(-10))	-0.053228	0.059996	-0.887184	0.3779
D(LOG_CPOP_(-11))	0.204627	0.058381	3.505011	0.0008
D(LOG_BP_)	0.032054	0.023663	1.354592	0.1798
D(LOG_BP_(-1))	-0.019504	0.023751	-0.821179	0.4143
D(LOG_BP_(-2))	-0.028665	0.023692	-1.209862	0.2303
D(LOG_BP_(-3))	-0.016812	0.023283	-0.722061	0.4726
D(LOG_BP_(-4))	-0.032767	0.022737	-1.441109	0.1539
D(LOG_BP_(-5))	-0.030495	0.022880	-1.332837	0.1868
D(LOG_BP_(-6))	0.039923	0.022938	1.740502	0.0860
D(LOG_BP_(-7))	-0.053323	0.022727	-2.346216	0.0217
D(LOG_BP_(-8))	-0.005585	0.022053	-0.253269	0.8008
D(LOG_BP_(-9))	-0.011356	0.021875	-0.519112	0.6053
D(LOG_BP_(-10))	-0.016065	0.022089	-0.727271	0.4694
D(LOG_BP_(-11))	-0.092686	0.021835	-4.244770	0.0001
D(LOG_POP_)	-0.114335	0.044536	-2.567253	0.0123
D(LOG_POP_(-1))	0.024355	0.079255	0.307297	0.7595
D(LOG_POP_(-2))	0.254012	0.071593	3.547990	0.0007
D(LOG_POP_(-3))	0.090521	0.071586	1.264513	0.2101
D(LOG_POP_(-4))	0.088413	0.068813	1.284826	0.2030
D(LOG_POP_(-5))	0.090394	0.066734	1.354537	0.1798
D(LOG_POP_(-6))	0.187798	0.058770	3.195497	0.0021
D(LOG_POP_(-7))	0.064941	0.053019	1.224858	0.2246
D(LOG_POP_(-8))	0.172370	0.046073	3.741216	0.0004
D(LOG_POP_(-9))	-0.067488	0.046779	-1.442684	0.1534
D(LOG_SBOP_)	1.083481	0.074198	14.60264	0.0000
D(LOG_SBOP_(-1))	-0.117163	0.127304	-0.920339	0.3605
D(LOG_SBOP_(-2))	-0.159774	0.125080	-1.277376	0.2056
D(LOG_SBOP_(-3))	0.005946	0.131309	0.045282	0.9640
D(LOG_SBOP_(-4))	-0.044751	0.130407	-0.343162	0.7325
D(LOG_SBOP_(-5))	-0.357489	0.127863	-2.795889	0.0066
D(LOG_EPO_)	0.069633	0.047823	1.456046	0.1497
D(LOG_EPO_(-1))	-0.064238	0.073437	-0.874746	0.3846
D(LOG_EPO_(-2))	-0.125144	0.073030	-1.713597	0.0909
D(LOG_EPO_(-3))	-0.113051	0.077614	-1.456580	0.1496
D(LOG_EPO_(-4))	-0.098032	0.074216	-1.320906	0.1907
D(LOG_EPO_(-5))	-0.050831	0.066263	-0.767106	0.4455
D(LOG_EPO_(-6))	-0.157123	0.058867	-2.669125	0.0094
D(LOG_EPO_(-7))	-0.083564	0.048048	-1.739161	0.0863
CointEq(-1)*	-0.178700	0.036604	-4.881991	0.0000

R-squared	0.873899	Mean dependent var	-0.001597
Adjusted R-squared	0.796928	S.D. dependent var	0.075039
S.E. of regression	0.033815	Akaike info criterion	-3.652314
Sum squared resid	0.088048	Schwarz criterion	-2.566241
Log likelihood	276.2696	Hannan-Quinn criter.	-3.211100
Durbin-Watson stat	1.906741		

* p-value incompatible with t-Bounds distribution.

F-Bounds Test Null Hypothesis: No levels relationship

Test Statistic	Value	Signif.	I(0)	I(1)

F-statistic	3.714363	10%	2.2	3.09
k	4	5%	2.56	3.49
		2.5%	2.88	3.87
		1%	3.29	4.37

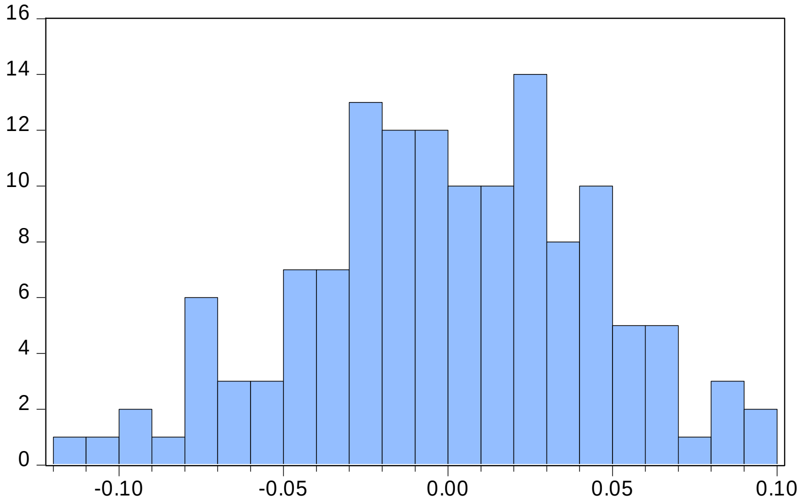
Appendix 2.7: *Output for Granger Causality*

Pairwise Granger Causality Tests
Date: 02/04/20 Time: 15:51
Sample: 2007M01 2018M05
Lags: 12

Null Hypothesis:	Obs	F-Statistic	Prob.
LOG_BP_ does not Granger Cause LOG_CPOP_	125	1.31972	0.2193
LOG_CPOP_ does not Granger Cause LOG_BP_		2.12099	0.0218
LOG_POP_ does not Granger Cause LOG_CPOP_	125	1.71331	0.0749
LOG_CPOP_ does not Granger Cause LOG_POP_		1.55959	0.1159
LOG_SBOP_ does not Granger Cause LOG_CPOP_	125	1.32229	0.2179
LOG_CPOP_ does not Granger Cause LOG_SBOP_		0.59310	0.8432
LOG_EPO_ does not Granger Cause LOG_CPOP_	125	2.37224	0.0099
LOG_CPOP_ does not Granger Cause LOG_EPO_		2.19414	0.0173
LOG_POP_ does not Granger Cause LOG_BP_	125	1.27096	0.2476
LOG_BP_ does not Granger Cause LOG_POP_		0.35384	0.9760
LOG_SBOP_ does not Granger Cause LOG_BP_	125	2.38518	0.0095
LOG_BP_ does not Granger Cause LOG_SBOP_		2.08478	0.0244
LOG_EPO_ does not Granger Cause LOG_BP_	125	1.75796	0.0657
LOG_BP_ does not Granger Cause LOG_EPO_		0.53012	0.8905
LOG_SBOP_ does not Granger Cause LOG_POP_	125	1.12008	0.3527
LOG_POP_ does not Granger Cause LOG_SBOP_		0.85757	0.5918
LOG_EPO_ does not Granger Cause LOG_POP_	125	0.58703	0.8481
LOG_POP_ does not Granger Cause LOG_EPO_		2.47811	0.0070
LOG_EPO_ does not Granger Cause LOG_SBOP_	125	0.97570	0.4771
LOG_SBOP_ does not Granger Cause LOG_EPO_		1.24219	0.2656

Appendix 3: Model 3 – Exchange Rate

Appendix 3.1: *Output for Normality Test*



Series: Residuals
Sample 2007M02 2018M05
Observations 136

Mean	-4.19e-16
Median	-2.51e-05
Maximum	0.097287
Minimum	-0.119835
Std. Dev.	0.044119
Skewness	-0.199911
Kurtosis	2.738807
Jarque-Bera	1.292450
Probability	0.524020

Appendix 3.2: *Output for Multicollinearity Test*

Variance Inflation Factors
Date: 02/04/20 Time: 15:32
Sample: 2007M01 2018M05
Included observations: 137

Variable	Coefficient Variance	Uncentered VIF	Centered VIF
LOG_BP_	0.000320	426.5530	2.870834
LOG_POP_	0.002924	2078.218	1.060641
LOG_SBOP_	0.003780	2369.400	2.149677
LOG_ER_	0.016401	342.0161	3.067728
C	0.370988	4920.420	NA

Appendix 3.3: *Output for Breusch-Godfrey Serial Correlation LM Test*

Breusch-Godfrey Serial Correlation LM Test:

F-statistic	1.630323	Prob. F(1,128)	0.2040
Obs*R-squared	1.710433	Prob. Chi-Square(1)	0.1909

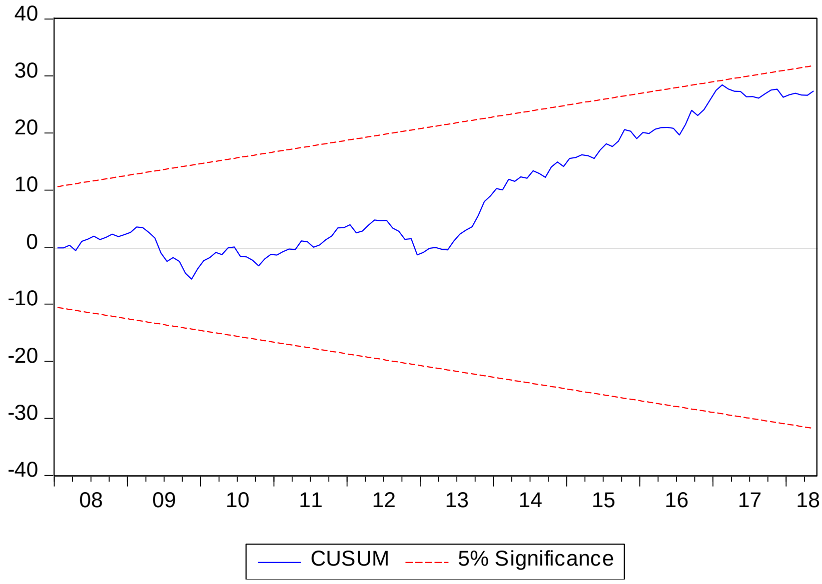
Test Equation:
Dependent Variable: RESID
Method: ARDL
Date: 02/04/20 Time: 15:30
Sample: 2007M02 2018M05
Included observations: 136
Presample missing value lagged residuals set to zero.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOG_CPOP_(-1)	-0.021036	0.042008	-0.500749	0.6174

LOG_BP_	0.000172	0.008043	0.021338	0.9830
LOG_POP_	-0.000691	0.024607	-0.028062	0.9777
LOG_SBOP_	0.012574	0.085218	0.147553	0.8829
LOG_SBOP_(-1)	0.007097	0.077498	0.091576	0.9272
LOG_ER_	0.014643	0.068287	0.214427	0.8306
C	0.015061	0.281762	0.053452	0.9575
RESID(-1)	0.122759	0.096143	1.276841	0.2040

R-squared	0.012577	Mean dependent var	-4.19E-16
Adjusted R-squared	-0.041423	S.D. dependent var	0.044119
S.E. of regression	0.045023	Akaike info criterion	-3.306249
Sum squared resid	0.259469	Schwarz criterion	-3.134916
Log likelihood	232.8249	Hannan-Quinn criter.	-3.236624
F-statistic	0.232903	Durbin-Watson stat	1.953394
Prob(F-statistic)	0.976599		

Appendix 3.4: *Output for CUSUM Test*



Appendix 3.5: *Output for Long Run Parameter and Bound Test*

ARDL Long Run Form and Bounds Test
Dependent Variable: D(LOG_CPOP_)
Selected Model: ARDL(1, 0, 0, 1, 0)
Case 2: Restricted Constant and No Trend
Date: 02/04/20 Time: 15:30
Sample: 2007M01 2018M05
Included observations: 136

Conditional Error Correction Regression

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	1.365184	0.282202	4.837621	0.0000
LOG_CPOP_(-1)*	-0.204992	0.038737	-5.291828	0.0000
LOG_BP_**	0.001906	0.008062	0.236408	0.8135
LOG_POP_**	-0.119198	0.024661	-4.833379	0.0000

LOG_SBOP_(-1)	0.137513	0.046480	2.958556	0.0037
LOG_ER_**	0.122991	0.067482	1.822583	0.0707
D(LOG_SBOP_)	1.110973	0.084854	13.09277	0.0000

* p-value incompatible with t-Bounds distribution.
** Variable interpreted as Z = Z(-1) + D(Z).

Levels Equation
Case 2: Restricted Constant and No Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOG_BP_	0.009297	0.039581	0.234892	0.8147
LOG_POP_	-0.581476	0.149775	-3.882334	0.0002
LOG_SBOP_	0.670820	0.146945	4.565110	0.0000
LOG_ER_	0.599980	0.285114	2.104351	0.0373
C	6.659702	1.721188	3.869247	0.0002

EC = LOG_CPOP_ - (0.0093*LOG_BP_ -0.5815*LOG_POP_ + 0.6708
*LOG_SBOP_ + 0.6000*LOG_ER_ + 6.6597)

F-Bounds Test — Null Hypothesis: No levels relationship

Test Statistic	Value	Signif.	I(0)	I(1)
			Asymptotic: n=1000	
F-statistic	8.986036	10%	2.2	3.09
k	4	5%	2.56	3.49
		2.5%	2.88	3.87
		1%	3.29	4.37
			Finite Sample:	
Actual Sample Size	136		n=80	
		10%	2.303	3.22
		5%	2.688	3.698
		1%	3.602	4.787

Appendix 3.6: *Output for Error Correlation Model*

ARDL Error Correction Regression
Dependent Variable: D(LOG_CPOP_)
Selected Model: ARDL(1, 0, 0, 1, 0)
Case 2: Restricted Constant and No Trend
Date: 02/04/20 Time: 15:31
Sample: 2007M01 2018M05
Included observations: 136

ECM Regression
Case 2: Restricted Constant and No Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LOG_SBOP_)	1.110973	0.075520	14.71101	0.0000
CointEq(-1)*	-0.204992	0.027392	-7.483715	0.0000
R-squared	0.645115	Mean dependent var		0.001617

Adjusted R-squared	0.642467	S.D. dependent var	0.074059
S.E. of regression	0.044283	Akaike info criterion	-3.381828
Sum squared resid	0.262774	Schwarz criterion	-3.338995
Log likelihood	231.9643	Hannan-Quinn criter.	-3.364421
Durbin-Watson stat	1.757207		

* p-value incompatible with t-Bounds distribution.

F-Bounds Test　　Null Hypothesis: No levels relationship

Test Statistic	Value	Signif.	I(0)	I(1)
F-statistic	8.986036	10%	2.2	3.09
k	4	5%	2.56	3.49
		2.5%	2.88	3.87
		1%	3.29	4.37

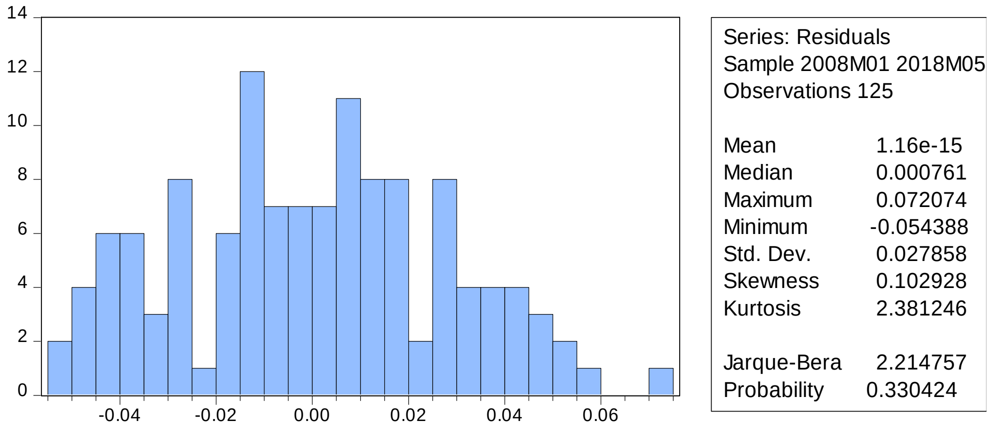
Appendix 3.7: *Output for Granger Causality*

Pairwise Granger Causality Tests
Date: 02/04/20 Time: 15:31
Sample: 2007M01 2018M05
Lags: 1

Null Hypothesis:	Obs	F-Statistic	Prob.
LOG_BP_ does not Granger Cause LOG_CPOP_	136	0.99806	0.3196
LOG_CPOP_ does not Granger Cause LOG_BP_		2.41544	0.1225
LOG_POP_ does not Granger Cause LOG_CPOP_	136	5.82057	0.0172
LOG_CPOP_ does not Granger Cause LOG_POP_		1.89109	0.1714
LOG_SBOP_ does not Granger Cause LOG_CPOP_	136	2.08841	0.1508
LOG_CPOP_ does not Granger Cause LOG_SBOP_		7.74229	0.0062
LOG_ER_ does not Granger Cause LOG_CPOP_	136	0.00059	0.9807
LOG_CPOP_ does not Granger Cause LOG_ER_		1.23001	0.2694
LOG_POP_ does not Granger Cause LOG_BP_	136	1.26669	0.2624
LOG_BP_ does not Granger Cause LOG_POP_		0.13514	0.7137
LOG_SBOP_ does not Granger Cause LOG_BP_	136	0.29082	0.5906
LOG_BP_ does not Granger Cause LOG_SBOP_		7.33836	0.0076
LOG_ER_ does not Granger Cause LOG_BP_	136	0.21266	0.6454
LOG_BP_ does not Granger Cause LOG_ER_		7.60826	0.0066
LOG_SBOP_ does not Granger Cause LOG_POP_	136	0.09730	0.7556
LOG_POP_ does not Granger Cause LOG_SBOP_		1.38295	0.2417
LOG_ER_ does not Granger Cause LOG_POP_	136	0.05605	0.8132
LOG_POP_ does not Granger Cause LOG_ER_		3.83159	0.0524
LOG_ER_ does not Granger Cause LOG_SBOP_	136	2.81130	0.0960
LOG_SBOP_ does not Granger Cause LOG_ER_		0.60541	0.4379

Appendix 4: Model 4 – Stock Price

Appendix 4.1: *Output for Normality Test*



Appendix 4.2: *Output for Multicollinearity Test*

Variance Inflation Factors
Date: 02/04/20 Time: 15:41
Sample: 2007M01 2018M05
Included observations: 137

Variable	Coefficient Variance	Uncentered VIF	Centered VIF
LOG_BP_	0.000352	380.4620	2.560627
LOG_POP_	0.003750	2159.815	1.102285
LOG_SBOP_	0.004476	2273.285	2.062475
LOG_SP_	0.003807	2193.873	1.497247
C	0.408299	4387.860	NA

Appendix 4.3: *Output for Breusch-Godfrey Serial Correlation LM Test*

Breusch-Godfrey Serial Correlation LM Test:

F-statistic	1.048013	Prob. F(12,63)	0.4182
Obs*R-squared	20.80047	Prob. Chi-Square(12)	0.0534

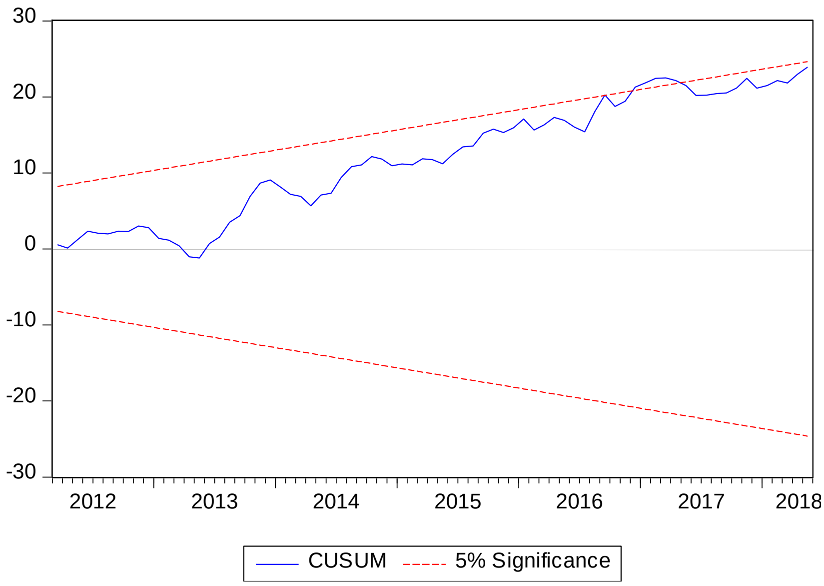
Test Equation:
Dependent Variable: RESID
Method: ARDL
Date: 02/04/20 Time: 15:45
Sample: 2008M01 2018M05
Included observations: 125
Presample missing value lagged residuals set to zero.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOG_CPOP_(-1)	-0.032352	0.216627	-0.149344	0.8818
LOG_CPOP_(-2)	0.051078	0.291259	0.175371	0.8614
LOG_CPOP_(-3)	0.101328	0.290385	0.348944	0.7283
LOG_CPOP_(-4)	-0.230326	0.295029	-0.780690	0.4379
LOG_CPOP_(-5)	0.294098	0.289971	1.014231	0.3144
LOG_CPOP_(-6)	-0.099599	0.183606	-0.542459	0.5894
LOG_BP_	0.022023	0.027867	0.790310	0.4323
LOG_BP_(-1)	-0.012828	0.038388	-0.334177	0.7394
LOG_BP_(-2)	-0.003454	0.038290	-0.090214	0.9284
LOG_BP_(-3)	-0.007802	0.038479	-0.202763	0.8400
LOG_BP_(-4)	0.034827	0.038115	0.913727	0.3643
LOG_BP_(-5)	-0.038490	0.038655	-0.995732	0.3232
LOG_BP_(-6)	0.018836	0.037453	0.502922	0.6168
LOG_BP_(-7)	-0.000148	0.035685	-0.004157	0.9967
LOG_BP_(-8)	-0.007929	0.039002	-0.203296	0.8396
LOG_BP_(-9)	-0.003863	0.037346	-0.103439	0.9179
LOG_BP_(-10)	0.020206	0.036975	0.546492	0.5867
LOG_BP_(-11)	-0.035586	0.037507	-0.948804	0.3463
LOG_BP_(-12)	0.015078	0.027071	0.556961	0.5795
LOG_POP_	-0.039437	0.056696	-0.695589	0.4892
LOG_POP_(-1)	-0.005292	0.078466	-0.067448	0.9464
LOG_POP_(-2)	0.037306	0.076706	0.486357	0.6284
LOG_POP_(-3)	0.003688	0.086010	0.042884	0.9659
LOG_POP_(-4)	-0.032242	0.092689	-0.347853	0.7291
LOG_POP_(-5)	-0.001341	0.092347	-0.014526	0.9885
LOG_POP_(-6)	0.040285	0.090816	0.443594	0.6589
LOG_POP_(-7)	0.011552	0.084323	0.136999	0.8915
LOG_POP_(-8)	-0.049785	0.069561	-0.715703	0.4768
LOG_POP_(-9)	0.021395	0.068605	0.311860	0.7562
LOG_POP_(-10)	0.011078	0.059540	0.186063	0.8530
LOG_SBOP_	-0.012529	0.107396	-0.116666	0.9075
LOG_SBOP_(-1)	0.035654	0.275366	0.129479	0.8974
LOG_SBOP_(-2)	-0.079318	0.351916	-0.225390	0.8224
LOG_SBOP_(-3)	0.021460	0.345528	0.062109	0.9507
LOG_SBOP_(-4)	0.145331	0.345461	0.420686	0.6754
LOG_SBOP_(-5)	-0.319086	0.344505	-0.926217	0.3579
LOG_SBOP_(-6)	0.091005	0.262244	0.347022	0.7297
LOG_SBOP_(-7)	0.079411	0.116401	0.682221	0.4976
LOG_SP_	0.083393	0.144442	0.577342	0.5658
LOG_SP_(-1)	-0.078273	0.200801	-0.389805	0.6980
LOG_SP_(-2)	-0.027517	0.209347	-0.131441	0.8958
LOG_SP_(-3)	0.064301	0.247193	0.260126	0.7956
LOG_SP_(-4)	-0.158692	0.259572	-0.611360	0.5432
LOG_SP_(-5)	0.202001	0.256676	0.786989	0.4342
LOG_SP_(-6)	-0.063383	0.241033	-0.262966	0.7934
LOG_SP_(-7)	-0.005680	0.230281	-0.024665	0.9804
LOG_SP_(-8)	-0.016007	0.209358	-0.076458	0.9393
LOG_SP_(-9)	0.094126	0.202719	0.464320	0.6440
LOG_SP_(-10)	-0.114474	0.145756	-0.785381	0.4352
C	-0.242363	0.970388	-0.249758	0.8036
RESID(-1)	0.074122	0.252557	0.293486	0.7701
RESID(-2)	-0.053306	0.221454	-0.240709	0.8106
RESID(-3)	-0.237537	0.226221	-1.050021	0.2977
RESID(-4)	0.089689	0.226944	0.395203	0.6940
RESID(-5)	-0.249736	0.227879	-1.095916	0.2773
RESID(-6)	-0.311199	0.164128	-1.896068	0.0625
RESID(-7)	-0.167626	0.162112	-1.034010	0.3051
RESID(-8)	-0.025552	0.148778	-0.171744	0.8642

RESID(-9)	-0.082079	0.154673	-0.530663	0.5975
RESID(-10)	-0.218222	0.154024	-1.416806	0.1615
RESID(-11)	0.101370	0.150290	0.674498	0.5025
RESID(-12)	-0.371087	0.158202	-2.345651	0.0222

R-squared	0.166404	Mean dependent var	1.16E-15
Adjusted R-squared	-0.640729	S.D. dependent var	0.027858
S.E. of regression	0.035683	Akaike info criterion	-3.521451
Sum squared resid	0.080217	Schwarz criterion	-2.118607
Log likelihood	282.0907	Hannan-Quinn criter.	-2.951550
F-statistic	0.206166	Durbin-Watson stat	2.057502
Prob(F-statistic)	1.000000		

Appendix 4.4: *Output for CUSUM Test*



Appendix 4.5: *Output for Long Run Parameter and Bound Test*

ARDL Long Run Form and Bounds Test
Dependent Variable: D(LOG_CPOP_)
Selected Model: ARDL(6, 12, 10, 7, 10)
Case 2: Restricted Constant and No Trend
Date: 02/04/20 Time: 15:45
Sample: 2007M01 2018M05
Included observations: 125

Conditional Error Correction Regression

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	1.454772	0.862205	1.687270	0.0957
LOG_CPOP_(-1)*	-0.161873	0.047859	-3.382313	0.0011
LOG_BP_(-1)	0.027423	0.012861	2.132265	0.0363
LOG_POP_(-1)	-0.267077	0.118301	-2.257596	0.0269

LOG_SBOP_(-1)	0.164237	0.061493	2.670825	0.0093
LOG_SP_(-1)	0.051193	0.035315	1.449606	0.1513
D(LOG_CPOP_(-1))	0.154788	0.099242	1.559715	0.1230
D(LOG_CPOP_(-2))	-0.183783	0.097205	-1.890673	0.0625
D(LOG_CPOP_(-3))	0.166520	0.098176	1.696140	0.0940
D(LOG_CPOP_(-4))	0.061818	0.096517	0.640490	0.5238
D(LOG_CPOP_(-5))	0.197977	0.097841	2.023463	0.0466
D(LOG_BP_)	0.014205	0.025827	0.549993	0.5840
D(LOG_BP_(-1))	-0.053843	0.027449	-1.961544	0.0535
D(LOG_BP_(-2))	-0.026773	0.027392	-0.977378	0.3315
D(LOG_BP_(-3))	-0.019102	0.028296	-0.675079	0.5017
D(LOG_BP_(-4))	-0.054880	0.025521	-2.150368	0.0347
D(LOG_BP_(-5))	-0.016847	0.024159	-0.697322	0.4878
D(LOG_BP_(-6))	0.021173	0.023542	0.899349	0.3713
D(LOG_BP_(-7))	-0.051370	0.023361	-2.198933	0.0310
D(LOG_BP_(-8))	-0.021749	0.023443	-0.927749	0.3565
D(LOG_BP_(-9))	-0.024953	0.022908	-1.089274	0.2795
D(LOG_BP_(-10))	-0.022583	0.023015	-0.981227	0.3296
D(LOG_BP_(-11))	-0.104639	0.023401	-4.471539	0.0000
D(LOG_POP_)	-0.162385	0.050260	-3.230876	0.0018
D(LOG_POP_(-1))	-0.008940	0.103799	-0.086126	0.9316
D(LOG_POP_(-2))	0.203569	0.093054	2.187639	0.0318
D(LOG_POP_(-3))	0.070064	0.089155	0.785863	0.4344
D(LOG_POP_(-4))	0.053137	0.080170	0.662809	0.5095
D(LOG_POP_(-5))	0.106797	0.074788	1.428005	0.1574
D(LOG_POP_(-6))	0.133965	0.063135	2.121868	0.0372
D(LOG_POP_(-7))	0.045237	0.055460	0.815661	0.4173
D(LOG_POP_(-8))	0.122222	0.051704	2.363891	0.0207
D(LOG_POP_(-9))	-0.061238	0.051761	-1.183095	0.2405
D(LOG_SBOP_)	1.186586	0.102289	11.60030	0.0000
D(LOG_SBOP_(-1))	-0.141645	0.151258	-0.936448	0.3520
D(LOG_SBOP_(-2))	-0.060816	0.148631	-0.409175	0.6836
D(LOG_SBOP_(-3))	-0.218061	0.150100	-1.452767	0.1505
D(LOG_SBOP_(-4))	-0.165652	0.147415	-1.123715	0.2647
D(LOG_SBOP_(-5))	-0.322545	0.152154	-2.119852	0.0373
D(LOG_SBOP_(-6))	-0.287136	0.106160	-2.704735	0.0085
D(LOG_SP_)	-0.093436	0.127381	-0.733516	0.4655
D(LOG_SP_(-1))	0.154809	0.126990	1.219063	0.2266
D(LOG_SP_(-2))	-0.465836	0.127570	-3.651594	0.0005
D(LOG_SP_(-3))	0.070989	0.137482	0.516351	0.6071
D(LOG_SP_(-4))	-0.069774	0.138261	-0.504653	0.6153
D(LOG_SP_(-5))	0.073184	0.136271	0.537048	0.5928
D(LOG_SP_(-6))	0.127788	0.137983	0.926114	0.3574
D(LOG_SP_(-7))	0.293725	0.143249	2.050457	0.0438
D(LOG_SP_(-8))	0.230181	0.128154	1.796138	0.0765
D(LOG_SP_(-9))	-0.162540	0.133718	-1.215549	0.2280

* p-value incompatible with t-Bounds distribution.

Levels Equation
Case 2: Restricted Constant and No Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOG_BP_	0.169408	0.085213	1.988052	0.0505
LOG_POP_	-1.649919	0.729860	-2.260595	0.0267
LOG_SBOP_	1.014608	0.344078	2.948776	0.0043
LOG_SP_	0.316256	0.199194	1.587676	0.1166
C	8.987135	4.987452	1.801949	0.0756

EC = LOG_CPOP_ - (0.1694*LOG_BP_ -1.6499*LOG_POP_ + 1.0146
*LOG_SBOP_ + 0.3163*LOG_SP_ + 8.9871)

F-Bounds Test			Null Hypothesis: No levels relationship	
Test Statistic	Value	Signif.	I(0)	I(1)
			Asymptotic: n=1000	
F-statistic	2.677056	10%	2.2	3.09
k	4	5%	2.56	3.49
		2.5%	2.88	3.87
		1%	3.29	4.37
			Finite Sample:	
Actual Sample Size	125		n=80	
		10%	2.303	3.22
		5%	2.688	3.698
		1%	3.602	4.787

Appendix 4.6: *Output for Error Correlation Model*

ARDL Error Correction Regression
Dependent Variable: D(LOG_CPOP_)
Selected Model: ARDL(6, 12, 10, 7, 10)
Case 2: Restricted Constant and No Trend
Date: 02/04/20 Time: 15:46
Sample: 2007M01 2018M05
Included observations: 125

ECM Regression
Case 2: Restricted Constant and No Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LOG_CPOP_(-1))	0.154788	0.093279	1.659415	0.1012
D(LOG_CPOP_(-2))	-0.183783	0.093126	-1.973495	0.0521
D(LOG_CPOP_(-3))	0.166520	0.093519	1.780590	0.0790
D(LOG_CPOP_(-4))	0.061818	0.092685	0.666969	0.5068
D(LOG_CPOP_(-5))	0.197977	0.093206	2.124072	0.0370
D(LOG_BP_)	0.014205	0.023952	0.593069	0.5549
D(LOG_BP_(-1))	-0.053843	0.023986	-2.244780	0.0277
D(LOG_BP_(-2))	-0.026773	0.024260	-1.103585	0.2733
D(LOG_BP_(-3))	-0.019102	0.023872	-0.800203	0.4261
D(LOG_BP_(-4))	-0.054880	0.022233	-2.468460	0.0158
D(LOG_BP_(-5))	-0.016847	0.022154	-0.760425	0.4494
D(LOG_BP_(-6))	0.021173	0.021807	0.970929	0.3347
D(LOG_BP_(-7))	-0.051370	0.021727	-2.364348	0.0207
D(LOG_BP_(-8))	-0.021749	0.022017	-0.987836	0.3264
D(LOG_BP_(-9))	-0.024953	0.021808	-1.144230	0.2562
D(LOG_BP_(-10))	-0.022583	0.022003	-1.026363	0.3080
D(LOG_BP_(-11))	-0.104639	0.022158	-4.722415	0.0000
D(LOG_POP_)	-0.162385	0.045407	-3.576202	0.0006

D(LOG_POP_(-1))	-0.008940	0.068311	-0.130869	0.8962
D(LOG_POP_(-2))	0.203569	0.061697	3.299488	0.0015
D(LOG_POP_(-3))	0.070064	0.062362	1.123507	0.2648
D(LOG_POP_(-4))	0.053137	0.059411	0.894394	0.3740
D(LOG_POP_(-5))	0.106797	0.056636	1.885690	0.0632
D(LOG_POP_(-6))	0.133965	0.050310	2.662809	0.0095
D(LOG_POP_(-7))	0.045237	0.043744	1.034135	0.3044
D(LOG_POP_(-8))	0.122222	0.044613	2.739587	0.0077
D(LOG_POP_(-9))	-0.061238	0.047283	-1.295126	0.1992
D(LOG_SBOP_)	1.186586	0.090333	13.13574	0.0000
D(LOG_SBOP_(-1))	-0.141645	0.139936	-1.012213	0.3147
D(LOG_SBOP_(-2))	-0.060816	0.136847	-0.444411	0.6580
D(LOG_SBOP_(-3))	-0.218061	0.138681	-1.572393	0.1201
D(LOG_SBOP_(-4))	-0.165652	0.139929	-1.183829	0.2402
D(LOG_SBOP_(-5))	-0.322545	0.141385	-2.281320	0.0254
D(LOG_SBOP_(-6))	-0.287136	0.093880	-3.058554	0.0031
D(LOG_SP_)	-0.093436	0.120111	-0.777911	0.4391
D(LOG_SP_(-1))	0.154809	0.121316	1.276079	0.2059
D(LOG_SP_(-2))	-0.465836	0.122504	-3.802628	0.0003
D(LOG_SP_(-3))	0.070989	0.128253	0.553510	0.5816
D(LOG_SP_(-4))	-0.069774	0.131494	-0.530626	0.5972
D(LOG_SP_(-5))	0.073184	0.128536	0.569369	0.5708
D(LOG_SP_(-6))	0.127788	0.127984	0.998472	0.3213
D(LOG_SP_(-7))	0.293725	0.134112	2.190145	0.0316
D(LOG_SP_(-8))	0.230181	0.121268	1.898129	0.0615
D(LOG_SP_(-9))	-0.162540	0.121127	-1.341903	0.1837
CointEq(-1)*	-0.161873	0.039107	-4.139222	0.0001

R-squared	0.862180	Mean dependent var	-0.001597
Adjusted R-squared	0.786378	S.D. dependent var	0.075039
S.E. of regression	0.034683	Akaike info criterion	-3.611445
Sum squared resid	0.096231	Schwarz criterion	-2.593252
Log likelihood	270.7153	Hannan-Quinn criter.	-3.197807
Durbin-Watson stat	1.986604		

* p-value incompatible with t-Bounds distribution.

F-Bounds Test Null Hypothesis: No levels relationship

Test Statistic	Value	Signif.	I(0)	I(1)
F-statistic	2.677056	10%	2.2	3.09
k	4	5%	2.56	3.49
		2.5%	2.88	3.87
		1%	3.29	4.37

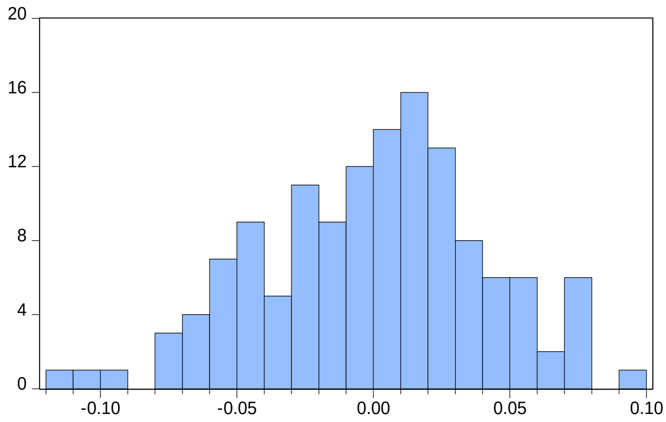
Appendix 4.7: *Output for Granger Causality*

Pairwise Granger Causality Tests
Date: 02/04/20 Time: 15:40
Sample: 2007M01 2018M05
Lags: 12

Null Hypothesis:	Obs	F-Statistic	Prob.
LOG_BP_ does not Granger Cause LOG_CPOP_	125	1.31972	0.2193
LOG_CPOP_ does not Granger Cause LOG_BP_		2.12099	0.0218
LOG_POP_ does not Granger Cause LOG_CPOP_	125	1.71331	0.0749
LOG_CPOP_ does not Granger Cause LOG_POP_		1.55959	0.1159
LOG_SBOP_ does not Granger Cause LOG_CPOP_	125	1.32229	0.2179
LOG_CPOP_ does not Granger Cause LOG_SBOP_		0.59310	0.8432
LOG_SP_ does not Granger Cause LOG_CPOP_	125	2.68363	0.0036
LOG_CPOP_ does not Granger Cause LOG_SP_		2.07411	0.0253
LOG_POP_ does not Granger Cause LOG_BP_	125	1.27096	0.2476
LOG_BP_ does not Granger Cause LOG_POP_		0.35384	0.9760
LOG_SBOP_ does not Granger Cause LOG_BP_	125	2.38518	0.0095
LOG_BP_ does not Granger Cause LOG_SBOP_		2.08478	0.0244
LOG_SP_ does not Granger Cause LOG_BP_	125	1.57749	0.1103
LOG_BP_ does not Granger Cause LOG_SP_		0.35274	0.9763
LOG_SBOP_ does not Granger Cause LOG_POP_	125	1.12008	0.3527
LOG_POP_ does not Granger Cause LOG_SBOP_		0.85757	0.5918
LOG_SP_ does not Granger Cause LOG_POP_	125	1.95139	0.0368
LOG_POP_ does not Granger Cause LOG_SP_		0.98740	0.4663
LOG_SP_ does not Granger Cause LOG_SBOP_	125	3.59441	0.0002
LOG_SBOP_ does not Granger Cause LOG_SP_		3.16587	0.0007

Appendix 5: Model 5 – Climate Change

Appendix 5.1: *Output for Normality Test*



Series: Residuals
Sample 2007M03 2018M05
Observations 135

Mean	1.02e-16
Median	0.004245
Maximum	0.096504
Minimum	-0.118098
Std. Dev.	0.041375
Skewness	-0.200548
Kurtosis	2.794417
Jarque-Bera	1.142678
Probability	0.564769

Appendix 5.2: *Output for Multicollinearity Test*

Variance Inflation Factors
Date: 02/04/20 Time: 15:21
Sample: 2007M01 2018M05
Included observations: 137

Variable	Coefficient Variance	Uncentered VIF	Centered VIF
LOG_BP_	0.000291	281.2988	1.893228
LOG_POP_	0.004034	2077.717	1.060385
LOG_SBOP_	0.004531	2057.645	1.866832
LOG_CC_	0.221570	23532.91	1.103976
C	3.049430	29306.20	NA

Appendix 5.3: *Output for Breusch-Godfrey Serial Correlation LM Test*

Breusch-Godfrey Serial Correlation LM Test:

F-statistic	1.160751	Prob. F(2,124)	0.3166
Obs*R-squared	2.480994	Prob. Chi-Square(2)	0.2892

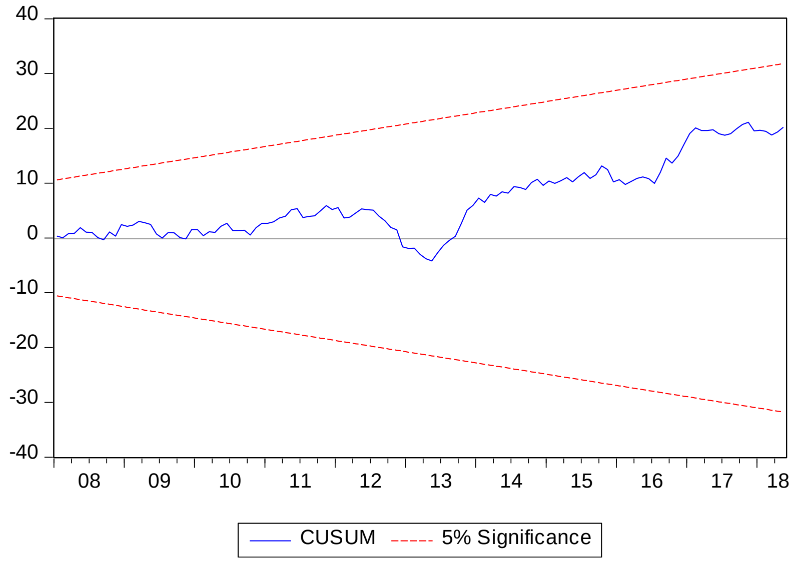
Test Equation:
Dependent Variable: RESID
Method: ARDL
Date: 02/04/20 Time: 15:14
Sample: 2007M03 2018M05
Included observations: 135
Presample missing value lagged residuals set to zero.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOG_CPOP_(-1)	0.000126	0.038347	0.003281	0.9974
LOG_BP_	0.000140	0.006929	0.020222	0.9839
LOG_POP_	0.006569	0.041526	0.158197	0.8746

LOG_POP_(-1)	-0.008977	0.057378	-0.156447	0.8759
LOG_POP_(-2)	0.002847	0.041224	0.069063	0.9451
LOG_SBOP_	-0.002602	0.080169	-0.032455	0.9742
LOG_SBOP_(-1)	0.002355	0.074378	0.031665	0.9748
LOG_CC_	-0.023247	0.197189	-0.117892	0.9063
C	0.073348	0.789134	0.092948	0.9261
RESID(-1)	0.095064	0.097367	0.976340	0.3308
RESID(-2)	-0.107093	0.097776	-1.095297	0.2755

R-squared	0.018378	Mean dependent var	1.02E-16
Adjusted R-squared	-0.060785	S.D. dependent var	0.041375
S.E. of regression	0.042614	Akaike info criterion	-3.395303
Sum squared resid	0.225177	Schwarz criterion	-3.158577
Log likelihood	240.1830	Hannan-Quinn criter.	-3.299105
F-statistic	0.232150	Durbin-Watson stat	1.965380
Prob(F-statistic)	0.992593		

Appendix 5.4: *Output for CUSUM Test*



Appendix 5.5: *Output for Long Run Parameter and Bound Test*

ARDL Long Run Form and Bounds Test
Dependent Variable: D(LOG_CPOP_)
Selected Model: ARDL(1, 0, 2, 1, 0)
Case 2: Restricted Constant and No Trend
Date: 02/04/20 Time: 15:16
Sample: 2007M01 2018M05
Included observations: 135

Conditional Error Correction Regression

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.250506	0.786526	-0.318497	0.7506
LOG_CPOP_(-1)*	-0.127736	0.033492	-3.813935	0.0002
LOG_BP_**	-0.000450	0.006773	-0.066471	0.9471
LOG_POP_(-1)	-0.054179	0.029793	-1.818516	0.0714

LOG_SBOP_(-1)	0.040191	0.036672	1.095961	0.2752
LOG_CC_**	0.415122	0.194193	2.137679	0.0345
D(LOG_POP_)	-0.133559	0.041346	-3.230291	0.0016
D(LOG_POP_(-1))	-0.146611	0.040908	-3.583937	0.0005
D(LOG_SBOP_)	1.085539	0.079182	13.70933	0.0000

* p-value incompatible with t-Bounds distribution.
** Variable interpreted as Z = Z(-1) + D(Z).

Levels Equation
Case 2: Restricted Constant and No Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOG_BP_	-0.003525	0.053336	-0.066083	0.9474
LOG_POP_	-0.424147	0.223915	-1.894226	0.0605
LOG_SBOP_	0.314641	0.234709	1.340559	0.1825
LOG_CC_	3.249844	1.851151	1.755580	0.0816
C	-1.961121	6.324348	-0.310091	0.7570

EC = LOG_CPOP_ - (-0.0035*LOG_BP_ -0.4241*LOG_POP_ + 0.3146
*LOG_SBOP_ + 3.2498*LOG_CC_ -1.9611)

F-Bounds Test — Null Hypothesis: No levels relationship

Test Statistic	Value	Signif.	I(0)	I(1)
			Asymptotic: n=1000	
F-statistic	5.812853	10%	2.2	3.09
k	4	5%	2.56	3.49
		2.5%	2.88	3.87
		1%	3.29	4.37
			Finite Sample:	
Actual Sample Size	135		n=80	
		10%	2.303	3.22
		5%	2.688	3.698
		1%	3.602	4.787

Appendix 5.6: *Output for Error Correlation Model*

ARDL Error Correction Regression
Dependent Variable: D(LOG_CPOP_)
Selected Model: ARDL(1, 0, 2, 1, 0)
Case 2: Restricted Constant and No Trend
Date: 02/04/20 Time: 15:17
Sample: 2007M01 2018M05
Included observations: 135

ECM Regression
Case 2: Restricted Constant and No Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LOG_POP_)	-0.133559	0.035407	-3.772145	0.0002
D(LOG_POP_(-1))	-0.146611	0.035362	-4.146001	0.0001

D(LOG_SBOP_)	1.085539	0.071217	15.24279	0.0000
CointEq(-1)*	-0.127736	0.021213	-6.021722	0.0000

R-squared	0.690193	Mean dependent var	0.001642
Adjusted R-squared	0.683098	S.D. dependent var	0.074335
S.E. of regression	0.041846	Akaike info criterion	-3.480458
Sum squared resid	0.229393	Schwarz criterion	-3.394376
Log likelihood	238.9309	Hannan-Quinn criter.	-3.445477
Durbin-Watson stat	1.811023		

* p-value incompatible with t-Bounds distribution.

F-Bounds Test   Null Hypothesis: No levels relationship

Test Statistic	Value	Signif.	I(0)	I(1)
F-statistic	5.812853	10%	2.2	3.09
k	4	5%	2.56	3.49
		2.5%	2.88	3.87
		1%	3.29	4.37

Appendix 5.7: *Output for Granger Causality*

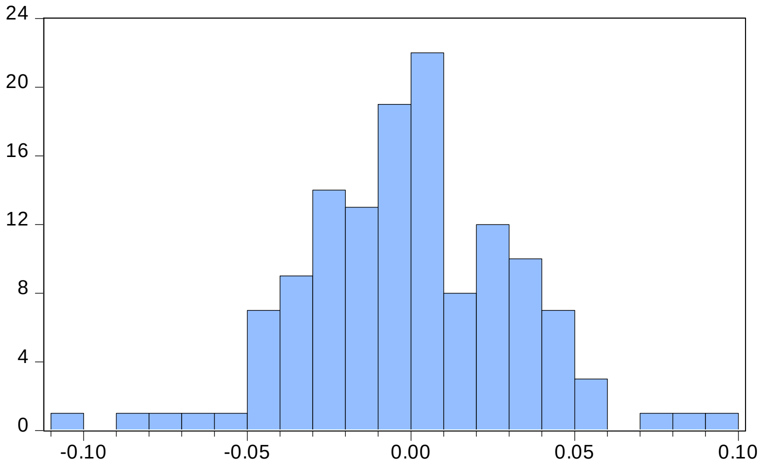
Pairwise Granger Causality Tests
Date: 02/04/20 Time: 15:26
Sample: 2007M01 2018M05
Lags: 2

Null Hypothesis:	Obs	F-Statistic	Prob.
LOG_BP_ does not Granger Cause LOG_CPOP_	135	1.25595	0.2882
LOG_CPOP_ does not Granger Cause LOG_BP_		2.63313	0.0757
LOG_POP_ does not Granger Cause LOG_CPOP_	135	3.41956	0.0357
LOG_CPOP_ does not Granger Cause LOG_POP_		4.60611	0.0117
LOG_SBOP_ does not Granger Cause LOG_CPOP_	135	2.13972	0.1218
LOG_CPOP_ does not Granger Cause LOG_SBOP_		0.38532	0.6810
LOG_CC_ does not Granger Cause LOG_CPOP_	135	3.12405	0.0473
LOG_CPOP_ does not Granger Cause LOG_CC_		1.08148	0.3421
LOG_POP_ does not Granger Cause LOG_BP_	135	1.56425	0.2132
LOG_BP_ does not Granger Cause LOG_POP_		1.47442	0.2327
LOG_SBOP_ does not Granger Cause LOG_BP_	135	0.56160	0.5717
LOG_BP_ does not Granger Cause LOG_SBOP_		4.76071	0.0101
LOG_CC_ does not Granger Cause LOG_BP_	135	1.26146	0.2867
LOG_BP_ does not Granger Cause LOG_CC_		1.81255	0.1673
LOG_SBOP_ does not Granger Cause LOG_POP_	135	2.05126	0.1327
LOG_POP_ does not Granger Cause LOG_SBOP_		0.35656	0.7008
LOG_CC_ does not Granger Cause LOG_POP_	135	2.75023	0.0676
LOG_POP_ does not Granger Cause LOG_CC_		5.55403	0.0048
LOG_CC_ does not Granger Cause LOG_SBOP_	135	0.86296	0.4243

LOG_SBOP_ does not Granger Cause LOG_CC_	1.81057	0.1677

Appendix 6: Model 6 – Combined Model

Appendix 6.1: *Output for Normality Test*



Series: Residuals
Sample 2007M06 2018M05
Observations 132

Mean	3.22e-16
Median	-0.000182
Maximum	0.095900
Minimum	-0.103827
Std. Dev.	0.031632
Skewness	-0.068640
Kurtosis	3.753989
Jarque-Bera	3.230395
Probability	0.198851

Appendix 6.2: *Output for Multicollinearity Test*

Variance Inflation Factors
Date: 02/04/20 Time: 15:12
Sample: 2007M01 2018M05
Included observations: 137

Variable	Coefficient Variance	Uncentered VIF	Centered VIF
LOG_POP_	0.004491	4985.638	2.544474
LOG_SBOP_	0.004616	4518.536	4.099516
LOG_BP_	0.000326	678.6352	4.567425
LOG_COP_	0.003400	2173.865	4.555580
LOG_EPO_	0.005721	6187.697	2.330492
LOG_ER_	0.015732	512.3800	4.595814
LOG_SP_	0.002226	2471.917	1.687002
LOG_CC_	0.106731	24432.93	1.146198
C	1.538533	31869.05	NA

Appendix 6.3: *Output for Breusch-Godfrey Serial Correlation LM Test*

Breusch-Godfrey Serial Correlation LM Test:

F-statistic	0.108043	Prob. F(6,100)	0.9953
Obs*R-squared	0.850187	Prob. Chi-Square(6)	0.9907

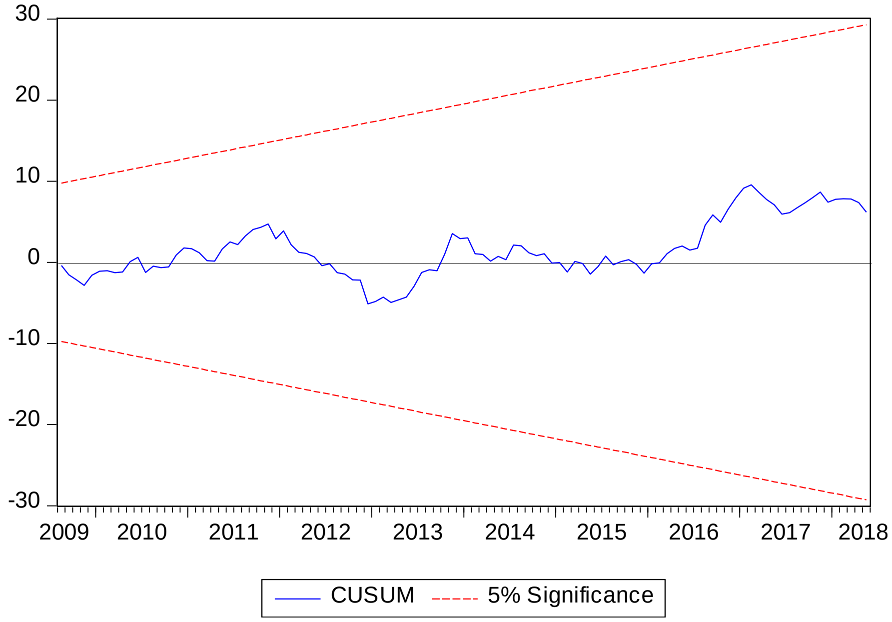
Test Equation:
Dependent Variable: RESID
Method: ARDL
Date: 02/04/20 Time: 15:14

Sample: 2007M06 2018M05
Included observations: 132
Presample missing value lagged residuals set to zero.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOG_CPOP_(-1)	-0.026937	0.104496	-0.257779	0.7971
LOG_CPOP_(-2)	0.009530	0.096684	0.098563	0.9217
LOG_CPOP_(-3)	-0.022349	0.066624	-0.335451	0.7380
LOG_POP_	0.002578	0.043526	0.059225	0.9529
LOG_POP_(-1)	-0.002211	0.056050	-0.039442	0.9686
LOG_POP_(-2)	-0.006869	0.054291	-0.126512	0.8996
LOG_POP_(-3)	-0.001466	0.055036	-0.026644	0.9788
LOG_POP_(-4)	-0.004773	0.055857	-0.085447	0.9321
LOG_POP_(-5)	-0.000105	0.040808	-0.002562	0.9980
LOG_SBOP_	0.009749	0.082820	0.117718	0.9065
LOG_SBOP_(-1)	0.028334	0.117038	0.242092	0.8092
LOG_BP_	-0.002003	0.012597	-0.158966	0.8740
LOG_COP_	-0.007180	0.036198	-0.198348	0.8432
LOG_EPO_	-0.000850	0.047855	-0.017756	0.9859
LOG_EPO_(-1)	0.003350	0.047512	0.070499	0.9439
LOG_ER_	-0.015162	0.169836	-0.089274	0.9290
LOG_ER_(-1)	0.014297	0.214927	0.066521	0.9471
LOG_ER_(-2)	0.030247	0.170821	0.177068	0.8598
LOG_SP_	-0.007141	0.117920	-0.060556	0.9518
LOG_SP_(-1)	-0.000646	0.163082	-0.003962	0.9968
LOG_SP_(-2)	0.020384	0.162149	0.125711	0.9002
LOG_SP_(-3)	-0.001069	0.114307	-0.009348	0.9926
LOG_CC_	-0.022924	0.200528	-0.114317	0.9092
LOG_CC_(-1)	0.009379	0.203626	0.046059	0.9634
LOG_CC_(-2)	0.024517	0.203726	0.120343	0.9045
C	0.028748	1.073826	0.026771	0.9787
RESID(-1)	0.022305	0.145868	0.152914	0.8788
RESID(-2)	-0.005201	0.145198	-0.035819	0.9715
RESID(-3)	0.050606	0.141461	0.357739	0.7213
RESID(-4)	0.088005	0.135670	0.648672	0.5180
RESID(-5)	0.065067	0.126555	0.514139	0.6083
RESID(-6)	0.025515	0.120806	0.211210	0.8332

R-squared	0.006441	Mean dependent var	3.22E-16
Adjusted R-squared	-0.301563	S.D. dependent var	0.031632
S.E. of regression	0.036088	Akaike info criterion	-3.598485
Sum squared resid	0.130236	Schwarz criterion	-2.899624
Log likelihood	269.5000	Hannan-Quinn criter.	-3.314500
F-statistic	0.020911	Durbin-Watson stat	1.988375
Prob(F-statistic)	1.000000		

Appendix 6.4: *Output for CUSUM Test*



Appendix 6.5: *Output for Long Run Parameter and Bound Test*

ARDL Long Run Form and Bounds Test
Dependent Variable: D(LOG_CPOP_)
Selected Model: ARDL(3, 5, 1, 0, 0, 1, 2, 3, 2)
Case 2: Restricted Constant and No Trend
Date: 02/04/20 Time: 15:16
Sample: 2007M01 2018M05
Included observations: 132

Conditional Error Correction Regression

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	2.804256	1.036876	2.704523	0.0080
LOG_CPOP_(-1)*	-0.176959	0.062223	-2.843953	0.0053
LOG_POP_(-1)	-0.237954	0.067636	-3.518138	0.0006
LOG_SBOP_(-1)	0.040365	0.056238	0.717749	0.4745
LOG_BP_**	-0.009169	0.011400	-0.804281	0.4230
LOG_COP_**	0.033937	0.030997	1.094852	0.2761
LOG_EPO_(-1)	0.214795	0.063311	3.392708	0.0010
LOG_ER_(-1)	0.159213	0.098040	1.623955	0.1074
LOG_SP_(-1)	0.034336	0.031078	1.104831	0.2717
LOG_CC_(-1)	-0.616045	0.280980	-2.192487	0.0305
D(LOG_CPOP_(-1))	0.135538	0.056304	2.407240	0.0178
D(LOG_CPOP_(-2))	-0.083937	0.055361	-1.516172	0.1325
D(LOG_POP_)	-0.140420	0.041789	-3.360201	0.0011
D(LOG_POP_(-1))	-0.035084	0.049492	-0.708874	0.4800
D(LOG_POP_(-2))	0.115796	0.042356	2.733866	0.0073
D(LOG_POP_(-3))	-0.015703	0.039980	-0.392759	0.6953
D(LOG_POP_(-4))	-0.095479	0.038851	-2.457531	0.0156
D(LOG_SBOP_)	1.125961	0.077743	14.48303	0.0000
D(LOG_EPO_)	0.052898	0.045194	1.170468	0.2444
D(LOG_ER_)	0.061980	0.161921	0.382779	0.7027
D(LOG_ER_(-1))	0.389361	0.156325	2.490708	0.0143

D(LOG_SP_)	-0.123020	0.114151	-1.077694	0.2836
D(LOG_SP_(-1))	0.275118	0.114540	2.401925	0.0180
D(LOG_SP_(-2))	-0.337857	0.105130	-3.213707	0.0017
D(LOG_CC_)	0.245849	0.189442	1.297754	0.1972
D(LOG_CC_(-1))	0.532108	0.191928	2.772440	0.0066

* p-value incompatible with t-Bounds distribution.
** Variable interpreted as Z = Z(-1) + D(Z).

Levels Equation
Case 2: Restricted Constant and No Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOG_POP_	-1.344690	0.507207	-2.651164	0.0093
LOG_SBOP_	0.228104	0.264250	0.863213	0.3900
LOG_BP_	-0.051814	0.055448	-0.934464	0.3522
LOG_COP_	0.191781	0.164213	1.167883	0.2455
LOG_EPO_	1.213815	0.600201	2.022349	0.0457
LOG_ER_	0.899719	0.349851	2.571721	0.0115
LOG_SP_	0.194032	0.137745	1.408635	0.1619
LOG_CC_	-3.481297	1.902525	-1.829830	0.0701
C	15.84697	6.906879	2.294374	0.0237

EC = LOG_CPOP_ - (-1.3447*LOG_POP_ + 0.2281*LOG_SBOP_ -0.0518
*LOG_BP_ + 0.1918*LOG_COP_ + 1.2138*LOG_EPO_ + 0.8997
*LOG_ER_ + 0.1940*LOG_SP_ -3.4813*LOG_CC_ + 15.8470)

F-Bounds Test — Null Hypothesis: No levels relationship

Test Statistic	Value	Signif.	I(0)	I(1)
			Asymptotic: n=1000	
F-statistic	3.300103	10%	1.85	2.85
k	8	5%	2.11	3.15
		2.5%	2.33	3.42
		1%	2.62	3.77
			Finite Sample:	
Actual Sample Size	132		n=80	
		10%	-1	-1
		5%	-1	-1
		1%	-1	-1

Appendix 6.6: *Output for Error Correlation Model*

ARDL Error Correction Regression
Dependent Variable: D(LOG_CPOP_)
Selected Model: ARDL(3, 5, 1, 0, 0, 1, 2, 3, 2)
Case 2: Restricted Constant and No Trend
Date: 02/04/20 Time: 15:16
Sample: 2007M01 2018M05
Included observations: 132

ECM Regression
Case 2: Restricted Constant and No Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LOG_CPOP_(-1))	0.135538	0.051247	2.644811	0.0094
D(LOG_CPOP_(-2))	-0.083937	0.049397	-1.699243	0.0922
D(LOG_POP_)	-0.140420	0.032927	-4.264599	0.0000
D(LOG_POP_(-1))	-0.035084	0.039426	-0.889867	0.3756
D(LOG_POP_(-2))	0.115796	0.034974	3.310947	0.0013
D(LOG_POP_(-3))	-0.015703	0.033951	-0.462504	0.6447
D(LOG_POP_(-4))	-0.095479	0.031847	-2.998058	0.0034
D(LOG_SBOP_)	1.125961	0.071565	15.73331	0.0000
D(LOG_EPO_)	0.052898	0.035002	1.511284	0.1337
D(LOG_ER_)	0.061980	0.143494	0.431934	0.6667
D(LOG_ER_(-1))	0.389361	0.145246	2.680696	0.0085
D(LOG_SP_)	-0.123020	0.102837	-1.196265	0.2343
D(LOG_SP_(-1))	0.275118	0.106162	2.591499	0.0109
D(LOG_SP_(-2))	-0.337857	0.096221	-3.511251	0.0007
D(LOG_CC_)	0.245849	0.158325	1.552811	0.1234
D(LOG_CC_(-1))	0.532108	0.161772	3.289247	0.0014
CointEq(-1)*	-0.176959	0.029574	-5.983561	0.0000

R-squared	0.816335	Mean dependent var	-0.000192
Adjusted R-squared	0.790781	S.D. dependent var	0.073811
S.E. of regression	0.033761	Akaike info criterion	-3.819296
Sum squared resid	0.131080	Schwarz criterion	-3.448026
Log likelihood	269.0735	Hannan-Quinn criter.	-3.668429
Durbin-Watson stat	1.993493		

* p-value incompatible with t-Bounds distribution.

F-Bounds Test — Null Hypothesis: No levels relationship

Test Statistic	Value	Signif.	I(0)	I(1)
F-statistic	3.300103	10%	1.85	2.85
k	8	5%	2.11	3.15
		2.5%	2.33	3.42
		1%	2.62	3.77

Appendix 6.7: *Output for Granger Causality*

Pairwise Granger Causality Tests
Date: 02/04/20 Time: 15:17
Sample: 2007M01 2018M05
Lags: 6

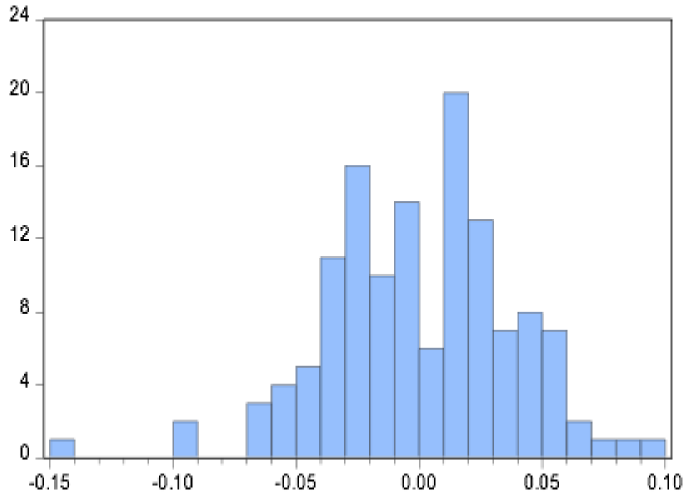
Null Hypothesis:	Obs	F-Statistic	Prob.
LOG_POP_ does not Granger Cause LOG_CPOP_	131	1.65822	0.1373
LOG_CPOP_ does not Granger Cause LOG_POP_		2.59375	0.0214
LOG_SBOP_ does not Granger Cause LOG_CPOP_	131	1.17004	0.3270
LOG_CPOP_ does not Granger Cause LOG_SBOP_		0.22945	0.9664
LOG_BP_ does not Granger Cause LOG_CPOP_	131	0.85819	0.5279
LOG_CPOP_ does not Granger Cause LOG_BP_		3.04190	0.0084
LOG_COP_ does not Granger Cause LOG_CPOP_	131	0.86552	0.5225

LOG_CPOP_ does not Granger Cause LOG_COP_		3.52988	0.0030
LOG_EPO_ does not Granger Cause LOG_CPOP_	131	1.88755	0.0885
LOG_CPOP_ does not Granger Cause LOG_EPO_		3.84501	0.0015
LOG_ER_ does not Granger Cause LOG_CPOP_	131	2.33737	0.0361
LOG_CPOP_ does not Granger Cause LOG_ER_		0.81156	0.5630
LOG_SP_ does not Granger Cause LOG_CPOP_	131	2.37521	0.0334
LOG_CPOP_ does not Granger Cause LOG_SP_		1.37368	0.2308
LOG_CC_ does not Granger Cause LOG_CPOP_	131	1.24166	0.2901
LOG_CPOP_ does not Granger Cause LOG_CC_		1.28930	0.2674
LOG_SBOP_ does not Granger Cause LOG_POP_	131	2.13610	0.0542
LOG_POP_ does not Granger Cause LOG_SBOP_		0.38413	0.8879
LOG_BP_ does not Granger Cause LOG_POP_	131	1.08705	0.3742
LOG_POP_ does not Granger Cause LOG_BP_		1.50808	0.1814
LOG_COP_ does not Granger Cause LOG_POP_	131	0.51088	0.7991
LOG_POP_ does not Granger Cause LOG_COP_		0.98968	0.4355
LOG_EPO_ does not Granger Cause LOG_POP_	131	0.39011	0.8841
LOG_POP_ does not Granger Cause LOG_EPO_		8.99325	4.E-08
LOG_ER_ does not Granger Cause LOG_POP_	131	0.75017	0.6105
LOG_POP_ does not Granger Cause LOG_ER_		0.95802	0.4568
LOG_SP_ does not Granger Cause LOG_POP_	131	2.88810	0.0116
LOG_POP_ does not Granger Cause LOG_SP_		1.12025	0.3548
LOG_CC_ does not Granger Cause LOG_POP_	131	1.54697	0.1689
LOG_POP_ does not Granger Cause LOG_CC_		4.96163	0.0001
LOG_BP_ does not Granger Cause LOG_SBOP_	131	3.25290	0.0054
LOG_SBOP_ does not Granger Cause LOG_BP_		3.38052	0.0041
LOG_COP_ does not Granger Cause LOG_SBOP_	131	0.66290	0.6797
LOG_SBOP_ does not Granger Cause LOG_COP_		2.51552	0.0251
LOG_EPO_ does not Granger Cause LOG_SBOP_	131	0.23883	0.9629
LOG_SBOP_ does not Granger Cause LOG_EPO_		1.67797	0.1323
LOG_ER_ does not Granger Cause LOG_SBOP_	131	3.12666	0.0070
LOG_SBOP_ does not Granger Cause LOG_ER_		0.70436	0.6467
LOG_SP_ does not Granger Cause LOG_SBOP_	131	3.36727	0.0042
LOG_SBOP_ does not Granger Cause LOG_SP_		1.70682	0.1253
LOG_CC_ does not Granger Cause LOG_SBOP_	131	0.97338	0.4464
LOG_SBOP_ does not Granger Cause LOG_CC_		1.42623	0.2103
LOG_COP_ does not Granger Cause LOG_BP_	131	0.83446	0.5456
LOG_BP_ does not Granger Cause LOG_COP_		1.30543	0.2601
LOG_EPO_ does not Granger Cause LOG_BP_	131	2.02900	0.0671
LOG_BP_ does not Granger Cause LOG_EPO_		0.34470	0.9117
LOG_ER_ does not Granger Cause LOG_BP_	131	1.16529	0.3296
LOG_BP_ does not Granger Cause LOG_ER_		1.83544	0.0979

LOG_SP_ does not Granger Cause LOG_BP_	131	1.99024	0.0724
LOG_BP_ does not Granger Cause LOG_SP_		0.54182	0.7755
LOG_CC_ does not Granger Cause LOG_BP_	131	0.89005	0.5046
LOG_BP_ does not Granger Cause LOG_CC_		1.12251	0.3535
LOG_EPO_ does not Granger Cause LOG_COP_	131	0.70688	0.6447
LOG_COP_ does not Granger Cause LOG_EPO_		1.57596	0.1601
LOG_ER_ does not Granger Cause LOG_COP_	131	1.92526	0.0822
LOG_COP_ does not Granger Cause LOG_ER_		0.24331	0.9611
LOG_SP_ does not Granger Cause LOG_COP_	131	1.98454	0.0732
LOG_COP_ does not Granger Cause LOG_SP_		1.38812	0.2250
LOG_CC_ does not Granger Cause LOG_COP_	131	1.14521	0.3406
LOG_COP_ does not Granger Cause LOG_CC_		1.47622	0.1922
LOG_ER_ does not Granger Cause LOG_EPO_	131	0.58130	0.7446
LOG_EPO_ does not Granger Cause LOG_ER_		1.86115	0.0932
LOG_SP_ does not Granger Cause LOG_EPO_	131	2.27323	0.0411
LOG_EPO_ does not Granger Cause LOG_SP_		2.33700	0.0361
LOG_CC_ does not Granger Cause LOG_EPO_	131	2.23803	0.0442
LOG_EPO_ does not Granger Cause LOG_CC_		3.94054	0.0013
LOG_SP_ does not Granger Cause LOG_ER_	131	2.06378	0.0626
LOG_ER_ does not Granger Cause LOG_SP_		0.70359	0.6473
LOG_CC_ does not Granger Cause LOG_ER_	131	1.24627	0.2878
LOG_ER_ does not Granger Cause LOG_CC_		0.50116	0.8064
LOG_CC_ does not Granger Cause LOG_SP_	131	1.85814	0.0937
LOG_SP_ does not Granger Cause LOG_CC_		0.34427	0.9120

Appendix 7: Model 7 – Crude Oil Price*Climate Change

Appendix 7.1: *Output for Normality Test*



Series: Residuals	
Sample 2007M06 2018M05	
Observations 132	
Mean	5.33e-16
Median	4.07e-05
Maximum	0.090831
Minimum	-0.148801
Std. Dev.	0.038119
Skewness	-0.406692
Kurtosis	3.979825
Jarque-Bera	8.919088
Probability	0.011568

Appendix 7.2: *Output for Multicollinearity Test*

Variance Inflation Factors
Date: 02/04/20 Time: 15:18
Sample: 2007M01 2018M05
Included observations: 137

Variable	Coefficient Variance	Uncentered VIF	Centered VIF
LOG_BP_	0.000276	479.1545	1.849427
LOG_POP_	0.004316	4763.184	1.175251
LOG_SBOP_	0.009462	9584.312	3.750602
LOG_COP_	0.004783	3672.025	2.927497
C	1.022815	9962.711	NA

Appendix 7.3: *Output for Breusch-Godfrey Serial Correlation LM Test*

Breusch-Godfrey Serial Correlation LM Test:

F-statistic	0.864341	Prob. F(6,109)	0.5237
Obs*R-squared	5.995113	Prob. Chi-Square(6)	0.4237

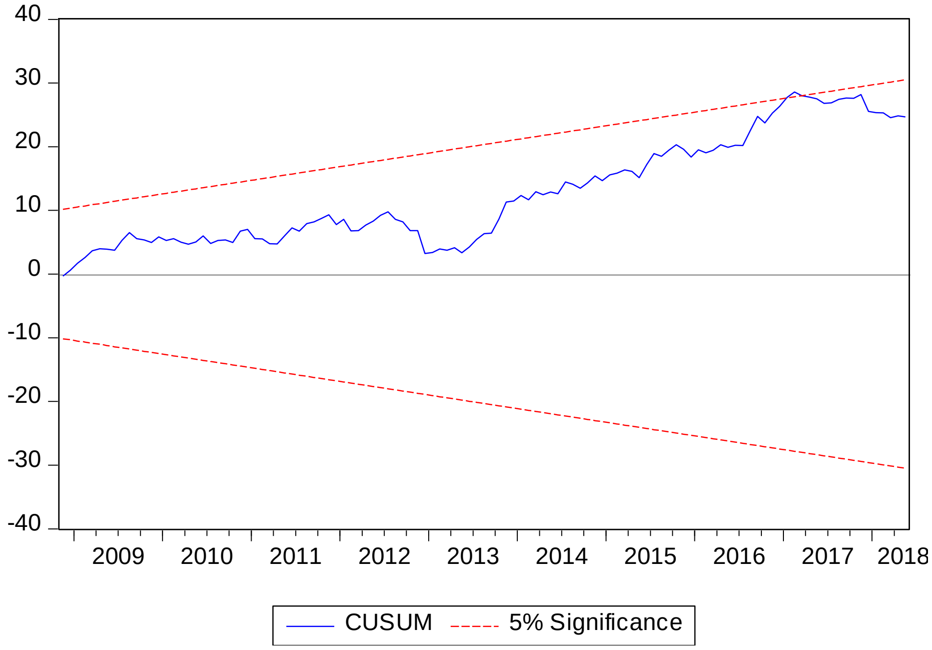
Test Equation:
Dependent Variable: RESID
Method: ARDL
Date: 02/04/20 Time: 15:28
Sample: 2007M06 2018M05
Included observations: 132
Presample missing value lagged residuals set to zero.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOG_CPOP_(-1)	0.008024	0.074797	0.107276	0.9148
LOG_CPOP_(-2)	-0.020383	0.099377	-0.205107	0.8379
LOG_CPOP_(-3)	-2.62E-05	0.065287	-0.000401	0.9997
LOG_BP_	-8.87E-05	0.024513	-0.003620	0.9971
LOG_BP_(-1)	-0.005544	0.033724	-0.164391	0.8697
LOG_BP_(-2)	0.007681	0.024930	0.308126	0.7586
LOG_POP_	0.000135	0.042997	0.003150	0.9975
LOG_POP_(-1)	0.003704	0.054456	0.068012	0.9459
LOG_POP_(-2)	0.002880	0.057275	0.050292	0.9600
LOG_POP_(-3)	-0.017573	0.060374	-0.291067	0.7716
LOG_POP_(-4)	0.017432	0.059944	0.290801	0.7718
LOG_POP_(-5)	-0.009471	0.041626	-0.227530	0.8204
LOG_SBOP_	0.007198	0.091560	0.078619	0.9375
LOG_SBOP_(-1)	0.010463	0.097448	0.107374	0.9147
LOG_COP_	-0.013372	0.060758	-0.220088	0.8262
LOG_COP_(-1)	0.009021	0.061479	0.146728	0.8836
C	0.000615	0.625829	0.000983	0.9992
RESID(-1)	-0.018444	0.121803	-0.151426	0.8799

RESID(-2)	0.018717	0.122466	0.152834	0.8788
RESID(-3)	0.098217	0.110342	0.890112	0.3754
RESID(-4)	0.037875	0.107918	0.350966	0.7263
RESID(-5)	0.108821	0.105053	1.035869	0.3026
RESID(-6)	-0.167463	0.105662	-1.584897	0.1159

R-squared	0.045418	Mean dependent var	1.26E-15
Adjusted R-squared	-0.147251	S.D. dependent var	0.038119
S.E. of regression	0.040829	Akaike info criterion	-3.401819
Sum squared resid	0.181704	Schwarz criterion	-2.899512
Log likelihood	247.5200	Hannan-Quinn criter.	-3.197705
F-statistic	0.235729	Durbin-Watson stat	2.011506
Prob(F-statistic)	0.999855		

Appendix 7.4: *Output for CUSUM Test*



Appendix 7.5: *Output for Long Run Parameter and Bound Test*

ARDL Long Run Form and Bounds Test
Dependent Variable: D(LOG_CPOP_)
Selected Model: ARDL(3, 2, 5, 1, 1)
Case 2: Restricted Constant and No Trend
Date: 02/04/20 Time: 15:30
Sample: 2007M01 2018M05
Included observations: 132

Conditional Error Correction Regression

Variable	Coefficient	Std. Error	t-Statistic	Prob.

C	1.313208	0.592526	2.216287	0.0286
LOG_CPOP_(-1)*	-0.125045	0.036265	-3.448045	0.0008
LOG_BP_(-1)	-0.000427	0.007198	-0.059287	0.9528
LOG_POP_(-1)	-0.016762	0.045538	-0.368092	0.7135
LOG_SBOP_(-1)	0.036673	0.049764	0.736935	0.4627
LOG_COP_(-1)	-0.011667	0.026529	-0.439770	0.6609
D(LOG_CPOP_(-1))	0.076694	0.056401	1.359800	0.1766
D(LOG_CPOP_(-2))	-0.165685	0.054862	-3.020024	0.0031
D(LOG_BP_)	0.022617	0.023184	0.975551	0.3313
D(LOG_BP_(-1))	-0.040106	0.023648	-1.695944	0.0926
D(LOG_POP_)	-0.100709	0.041954	-2.400439	0.0180
D(LOG_POP_(-1))	-0.176027	0.043050	-4.088916	0.0001
D(LOG_POP_(-2))	0.023824	0.041388	0.575628	0.5660
D(LOG_POP_(-3))	-0.068317	0.041453	-1.648061	0.1021
D(LOG_POP_(-4))	-0.107576	0.040530	-2.654251	0.0091
D(LOG_SBOP_)	0.996727	0.088447	11.26917	0.0000
D(LOG_COP_)	0.105104	0.058341	1.801548	0.0742

* p-value incompatible with t-Bounds distribution.

Levels Equation
Case 2: Restricted Constant and No Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOG_BP_	-0.003413	0.057896	-0.058946	0.9531
LOG_POP_	-0.134049	0.357562	-0.374898	0.7084
LOG_SBOP_	0.293279	0.353262	0.830202	0.4081
LOG_COP_	-0.093301	0.211606	-0.440918	0.6601
C	10.50188	4.713477	2.228053	0.0278

EC = LOG_CPOP_ - (-0.0034*LOG_BP_ -0.1340*LOG_POP_ + 0.2933
*LOG_SBOP_ -0.0933*LOG_COP_ + 10.5019)

F-Bounds Test — Null Hypothesis: No levels relationship

Test Statistic	Value	Signif.	I(0)	I(1)
			Asymptotic: n=1000	
F-statistic	3.338249	10%	2.2	3.09
k	4	5%	2.56	3.49
		2.5%	2.88	3.87
		1%	3.29	4.37
			Finite Sample:	
Actual Sample Size	132		n=80	
		10%	2.303	3.22
		5%	2.688	3.698
		1%	3.602	4.787

Appendix 7.6: *Output for Error Correlation Model*

ARDL Error Correction Regression
Dependent Variable: D(LOG_CPOP_)
Selected Model: ARDL(3, 2, 5, 1, 1)
Case 2: Restricted Constant and No Trend
Date: 02/04/20 Time: 15:31
Sample: 2007M01 2018M05
Included observations: 132

ECM Regression
Case 2: Restricted Constant and No Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LOG_CPOP_(-1))	0.076694	0.053531	1.432696	0.1547
D(LOG_CPOP_(-2))	-0.165685	0.051753	-3.201440	0.0018
D(LOG_BP_)	0.022617	0.022298	1.014290	0.3126
D(LOG_BP_(-1))	-0.040106	0.022443	-1.787009	0.0766
D(LOG_POP_)	-0.100709	0.035949	-2.801435	0.0060
D(LOG_POP_(-1))	-0.176027	0.035489	-4.960030	0.0000
D(LOG_POP_(-2))	0.023824	0.035655	0.668198	0.5053
D(LOG_POP_(-3))	-0.068317	0.036721	-1.860422	0.0654
D(LOG_POP_(-4))	-0.107576	0.035639	-3.018473	0.0031
D(LOG_SBOP_)	0.996727	0.081996	12.15576	0.0000
D(LOG_COP_)	0.105104	0.055173	1.904970	0.0593
CointEq(-1)*	-0.125045	0.027352	-4.571689	0.0000

R-squared	0.772727	Mean dependent var	-0.000262
Adjusted R-squared	0.751894	S.D. dependent var	0.079959
S.E. of regression	0.039828	Akaike info criterion	-3.522004
Sum squared resid	0.190349	Schwarz criterion	-3.259931
Log likelihood	244.4523	Hannan-Quinn criter.	-3.415510
Durbin-Watson stat	2.047491		

* p-value incompatible with t-Bounds distribution.

F-Bounds Test — Null Hypothesis: No levels relationship

Test Statistic	Value	Signif.	I(0)	I(1)
F-statistic	3.338249	10%	2.2	3.09
k	4	5%	2.56	3.49
		2.5%	2.88	3.87
		1%	3.29	4.37

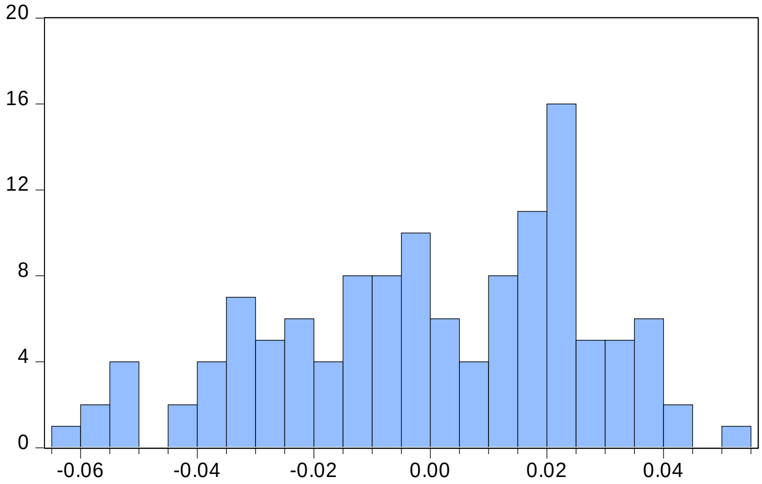
Appendix 7.7: *Output for Granger Causality*

Pairwise Granger Causality Tests
Date: 02/04/20 Time: 15:31
Sample: 2007M01 2018M05
Lags: 6

Null Hypothesis:	Obs	F-Statistic	Prob.
LOG_BP_ does not Granger Cause LOG_CPOP_	131	1.02677	0.4114
LOG_CPOP_ does not Granger Cause LOG_BP_		3.66069	0.0023
LOG_POP_ does not Granger Cause LOG_CPOP_	131	2.95389	0.0101
LOG_CPOP_ does not Granger Cause LOG_POP_		1.93887	0.0801
LOG_SBOP_ does not Granger Cause LOG_CPOP_	131	0.57373	0.7506
LOG_CPOP_ does not Granger Cause LOG_SBOP_		0.45403	0.8409
LOG_COP_ does not Granger Cause LOG_CPOP_	131	0.95678	0.4577
LOG_CPOP_ does not Granger Cause LOG_COP_		3.52384	0.0030
LOG_POP_ does not Granger Cause LOG_BP_	131	2.01142	0.0694
LOG_BP_ does not Granger Cause LOG_POP_		1.21358	0.3042
LOG_SBOP_ does not Granger Cause LOG_BP_	131	3.42807	0.0037
LOG_BP_ does not Granger Cause LOG_SBOP_		2.86457	0.0122
LOG_COP_ does not Granger Cause LOG_BP_	131	1.34991	0.2407
LOG_BP_ does not Granger Cause LOG_COP_		1.03950	0.4034
LOG_SBOP_ does not Granger Cause LOG_POP_	131	1.49085	0.1871
LOG_POP_ does not Granger Cause LOG_SBOP_		0.92929	0.4767
LOG_COP_ does not Granger Cause LOG_POP_	131	0.39555	0.8806
LOG_POP_ does not Granger Cause LOG_COP_		1.35608	0.2381
LOG_COP_ does not Granger Cause LOG_SBOP_	131	1.19074	0.3160
LOG_SBOP_ does not Granger Cause LOG_COP_		2.73756	0.0159

Appendix 8: Model 8 – Export of CPO*Climate Change

Appendix 8.1: *Output for Normality Test*



Series: Residuals
Sample 2008M01 2018M05
Observations 125

Mean	9.37e-16
Median	0.001992
Maximum	0.051490
Minimum	-0.064880
Std. Dev.	0.026076
Skewness	-0.409131
Kurtosis	2.388229
Jarque-Bera	5.436543
Probability	0.065989

Appendix 8.2: *Output for Multicollinearity Test*

Variance Inflation Factors
Date: 02/04/20 Time: 15:56
Sample: 2007M01 2018M05
Included observations: 137

Variable	Coefficient Variance	Uncentered VIF	Centered VIF
LOG_BP_	0.000273	477.5039	1.843056
LOG_POP_	0.008225	9171.069	2.262838
LOG_SBOP_	0.004443	4547.023	1.779374
LOG_EPO_	0.010825	11856.49	2.183252
C	1.038238	10216.75	NA

Appendix 8.3: *Output for Breusch-Godfrey Serial Correlation LM Test*

Breusch-Godfrey Serial Correlation LM Test:

F-statistic	0.977295	Prob. F(12,61)	0.4802
Obs*R-squared	20.15663	Prob. Chi-Square(12)	0.0642

Test Equation:
Dependent Variable: RESID
Method: ARDL
Date: 02/04/20 Time: 15:57
Sample: 2008M01 2018M05
Included observations: 125
Presample missing value lagged residuals set to zero.

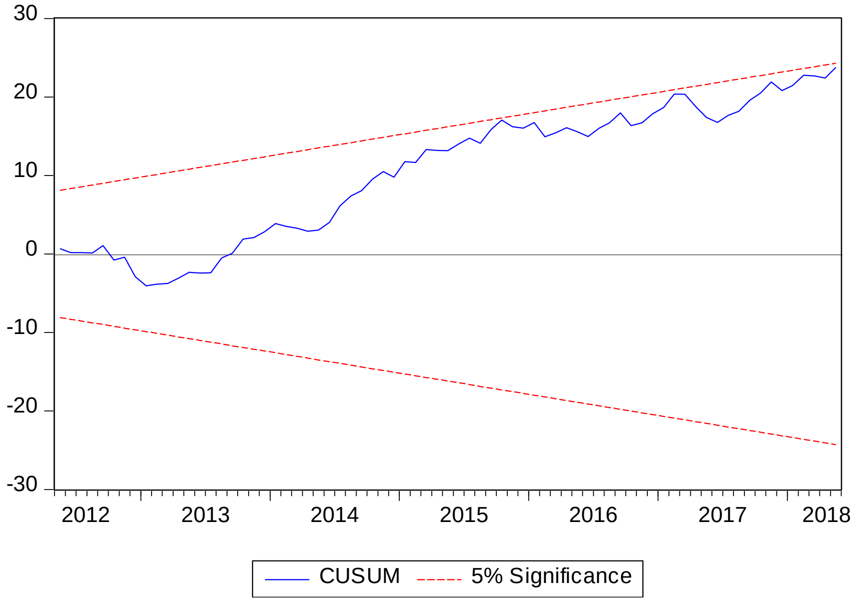
Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOG_CPOP_(-1)	-0.203798	0.202438	-1.006718	0.3180
LOG_CPOP_(-2)	0.227166	0.286599	0.792625	0.4311

LOG_CPOP_(-3)	0.094302	0.264426	0.356629	0.7226
LOG_CPOP_(-4)	0.069947	0.248894	0.281030	0.7796
LOG_CPOP_(-5)	-0.014437	0.245000	-0.058926	0.9532
LOG_CPOP_(-6)	-0.075872	0.191985	-0.395197	0.6941
LOG_CPOP_(-7)	-0.035893	0.122727	-0.292460	0.7709
LOG_CPOP_(-8)	0.019846	0.108544	0.182835	0.8555
LOG_CPOP_(-9)	0.048706	0.100394	0.485153	0.6293
LOG_CPOP_(-10)	0.006267	0.096986	0.064617	0.9487
LOG_CPOP_(-11)	-0.000870	0.097577	-0.008911	0.9929
LOG_CPOP_(-12)	-0.069951	0.071013	-0.985058	0.3285
LOG_BP_	-0.000660	0.025621	-0.025747	0.9795
LOG_BP_(-1)	0.015943	0.036909	0.431953	0.6673
LOG_BP_(-2)	-0.008294	0.037215	-0.222879	0.8244
LOG_BP_(-3)	0.008691	0.037749	0.230225	0.8187
LOG_BP_(-4)	-0.014562	0.038130	-0.381907	0.7039
LOG_BP_(-5)	0.000471	0.037322	0.012608	0.9900
LOG_BP_(-6)	-0.009022	0.036460	-0.247451	0.8054
LOG_BP_(-7)	0.014263	0.036838	0.387181	0.7000
LOG_BP_(-8)	-0.009926	0.037429	-0.265201	0.7917
LOG_BP_(-9)	-0.012516	0.035354	-0.354030	0.7245
LOG_BP_(-10)	-0.002314	0.034689	-0.066716	0.9470
LOG_BP_(-11)	-0.011139	0.034274	-0.325009	0.7463
LOG_BP_(-12)	-0.000493	0.023991	-0.020529	0.9837
LOG_POP_	0.013938	0.049546	0.281312	0.7794
LOG_POP_(-1)	0.022072	0.061179	0.360781	0.7195
LOG_POP_(-2)	-0.026574	0.071662	-0.370820	0.7121
LOG_POP_(-3)	0.055767	0.080443	0.693248	0.4908
LOG_POP_(-4)	0.046695	0.075618	0.617507	0.5392
LOG_POP_(-5)	0.029445	0.074437	0.395569	0.6938
LOG_POP_(-6)	0.043780	0.075402	0.580619	0.5636
LOG_POP_(-7)	0.038186	0.074196	0.514667	0.6086
LOG_POP_(-8)	0.017193	0.072286	0.237852	0.8128
LOG_POP_(-9)	0.030259	0.053646	0.564058	0.5748
LOG_SBOP_	-0.030186	0.076714	-0.393484	0.6953
LOG_SBOP_(-1)	0.228227	0.246257	0.926785	0.3577
LOG_SBOP_(-2)	-0.240729	0.326931	-0.736329	0.4644
LOG_SBOP_(-3)	-0.191391	0.312462	-0.612524	0.5425
LOG_SBOP_(-4)	0.012623	0.300817	0.041963	0.9667
LOG_SBOP_(-5)	0.026035	0.284371	0.091553	0.9274
LOG_SBOP_(-6)	0.087362	0.192458	0.453928	0.6515
LOG_EPO_	-0.023677	0.050829	-0.465823	0.6430
LOG_EPO_(-1)	0.030432	0.054637	0.556980	0.5796
LOG_EPO_(-2)	0.027437	0.068266	0.401918	0.6891
LOG_EPO_(-3)	-0.035199	0.071843	-0.489947	0.6259
LOG_EPO_(-4)	-0.052896	0.063218	-0.836727	0.4060
LOG_EPO_(-5)	-0.026350	0.062628	-0.420733	0.6754
LOG_EPO_(-6)	-0.024137	0.064062	-0.376768	0.7077
LOG_EPO_(-7)	-0.003512	0.059274	-0.059256	0.9529
LOG_EPO_(-8)	-0.031577	0.050165	-0.629466	0.5314
C	-0.651506	0.966812	-0.673870	0.5029
RESID(-1)	0.179253	0.238848	0.750491	0.4558
RESID(-2)	-0.084254	0.243058	-0.346642	0.7301
RESID(-3)	-0.335971	0.230808	-1.455631	0.1506
RESID(-4)	-0.312525	0.239427	-1.305301	0.1967
RESID(-5)	-0.359344	0.231410	-1.552843	0.1256
RESID(-6)	-0.137121	0.179587	-0.763533	0.4481
RESID(-7)	-0.239774	0.171621	-1.397115	0.1674
RESID(-8)	-0.159134	0.181985	-0.874435	0.3853
RESID(-9)	-0.355016	0.185163	-1.917311	0.0599
RESID(-10)	-0.086333	0.183494	-0.470496	0.6397
RESID(-11)	-0.241705	0.176653	-1.368247	0.1763

RESID(-12)	-0.258106	0.156983	-1.644161	0.1053

R-squared	0.161253	Mean dependent var	9.37E-16
Adjusted R-squared	-0.704994	S.D. dependent var	0.026076
S.E. of regression	0.034049	Akaike info criterion	-3.615477
Sum squared resid	0.070719	Schwarz criterion	-2.167380
Log likelihood	289.9673	Hannan-Quinn criter.	-3.027191
F-statistic	0.186151	Durbin-Watson stat	2.071501
Prob(F-statistic)	1.000000		

Appendix 8.4: *Output for CUSUM Test*



Appendix 8.5: *Output for Long Run Parameter and Bound Test*

ARDL Long Run Form and Bounds Test
Dependent Variable: D(LOG_CPOP_)
Selected Model: ARDL(12, 12, 9, 6, 8)
Case 2: Restricted Constant and No Trend
Date: 02/04/20 Time: 15:57
Sample: 2007M01 2018M05
Included observations: 125

Conditional Error Correction Regression

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	1.382981	0.863306	1.601959	0.1135
LOG_CPOP_(-1)*	-0.179180	0.044721	-4.006643	0.0001
LOG_BP_(-1)	0.030795	0.011576	2.660195	0.0096
LOG_POP_(-1)	-0.396521	0.119650	-3.314020	0.0014
LOG_SBOP_(-1)	0.121550	0.052862	2.299367	0.0243
LOG_EPO_(-1)	0.302601	0.091304	3.314225	0.0014
D(LOG_CPOP_(-1))	0.151196	0.101612	1.487963	0.1411
D(LOG_CPOP_(-2))	-0.024642	0.103285	-0.238579	0.8121
D(LOG_CPOP_(-3))	0.056361	0.103247	0.545884	0.5868
D(LOG_CPOP_(-4))	0.074466	0.102262	0.728187	0.4688

D(LOG_CPOP_(-5))	0.293412	0.102585	2.860197	0.0055
D(LOG_CPOP_(-6))	-0.093577	0.062998	-1.485406	0.1417
D(LOG_CPOP_(-7))	0.032936	0.062728	0.525054	0.6011
D(LOG_CPOP_(-8))	0.011630	0.057780	0.201286	0.8410
D(LOG_CPOP_(-9))	0.150074	0.058713	2.556065	0.0127
D(LOG_CPOP_(-10))	-0.044679	0.057511	-0.776886	0.4397
D(LOG_CPOP_(-11))	0.188713	0.056142	3.361380	0.0012
D(LOG_BP_)	0.021866	0.024021	0.910301	0.3657
D(LOG_BP_(-1))	-0.013143	0.026587	-0.494352	0.6225
D(LOG_BP_(-2))	-0.029059	0.026580	-1.093283	0.2779
D(LOG_BP_(-3))	-0.017539	0.026018	-0.674109	0.5024
D(LOG_BP_(-4))	-0.027347	0.024388	-1.121361	0.2658
D(LOG_BP_(-5))	-0.039415	0.024388	-1.616150	0.1104
D(LOG_BP_(-6))	0.049031	0.024089	2.035356	0.0454
D(LOG_BP_(-7))	-0.053752	0.023892	-2.249737	0.0275
D(LOG_BP_(-8))	-0.015198	0.023500	-0.646699	0.5199
D(LOG_BP_(-9))	-0.008208	0.022902	-0.358419	0.7211
D(LOG_BP_(-10))	-0.014378	0.022927	-0.627089	0.5326
D(LOG_BP_(-11))	-0.090863	0.022102	-4.111043	0.0001
D(LOG_POP_)	-0.099501	0.044628	-2.229580	0.0289
D(LOG_POP_(-1))	0.095079	0.100939	0.941950	0.3493
D(LOG_POP_(-2))	0.298240	0.094260	3.163998	0.0023
D(LOG_POP_(-3))	0.112110	0.084730	1.323142	0.1899
D(LOG_POP_(-4))	0.111003	0.078753	1.409501	0.1629
D(LOG_POP_(-5))	0.136282	0.068116	2.000726	0.0491
D(LOG_POP_(-6))	0.206936	0.060260	3.434034	0.0010
D(LOG_POP_(-7))	0.063776	0.054612	1.167797	0.2467
D(LOG_POP_(-8))	0.172618	0.046643	3.700874	0.0004
D(LOG_SBOP_)	1.076534	0.074589	14.43286	0.0000
D(LOG_SBOP_(-1))	-0.070415	0.130816	-0.538278	0.5920
D(LOG_SBOP_(-2))	-0.215700	0.134435	-1.604487	0.1129
D(LOG_SBOP_(-3))	0.029075	0.136692	0.212707	0.8321
D(LOG_SBOP_(-4))	-0.031213	0.135023	-0.231165	0.8178
D(LOG_SBOP_(-5))	-0.366226	0.133361	-2.746131	0.0076
D(LOG_EPO_)	0.064335	0.048572	1.324542	0.1895
D(LOG_EPO_(-1))	-0.076158	0.086228	-0.883215	0.3800
D(LOG_EPO_(-2))	-0.136077	0.081835	-1.662827	0.1006
D(LOG_EPO_(-3))	-0.114424	0.080253	-1.425790	0.1582
D(LOG_EPO_(-4))	-0.102964	0.074594	-1.380323	0.1717
D(LOG_EPO_(-5))	-0.047112	0.064761	-0.727467	0.4693
D(LOG_EPO_(-6))	-0.141306	0.056307	-2.509557	0.0143
D(LOG_EPO_(-7))	-0.097073	0.046667	-2.080088	0.0410

* p-value incompatible with t-Bounds distribution.

Levels Equation
Case 2: Restricted Constant and No Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOG_BP_	0.171866	0.066652	2.578559	0.0119
LOG_POP_	-2.212979	0.834520	-2.651799	0.0098
LOG_SBOP_	0.678369	0.237154	2.860452	0.0055
LOG_EPO_	1.688810	0.631498	2.674290	0.0092
C	7.718399	4.882951	1.580683	0.1183

EC = LOG_CPOP_ - (0.1719*LOG_BP_ -2.2130*LOG_POP_ + 0.6784
*LOG_SBOP_ + 1.6888*LOG_EPO_ + 7.7184)

F-Bounds Test		Null Hypothesis: No levels relationship		
Test Statistic	Value	Signif.	I(0)	I(1)
			Asymptotic: n=1000	
F-statistic	4.552087	10%	2.2	3.09
k	4	5%	2.56	3.49
		2.5%	2.88	3.87
		1%	3.29	4.37
			Finite Sample:	
Actual Sample Size	125		n=80	
		10%	2.303	3.22
		5%	2.688	3.698
		1%	3.602	4.787

Appendix 8.6: *Output for Error Correlation Model*

ARDL Error Correction Regression
Dependent Variable: D(LOG_CPOP_)
Selected Model: ARDL(12, 12, 9, 6, 8)
Case 2: Restricted Constant and No Trend
Date: 02/04/20 Time: 15:58
Sample: 2007M01 2018M05
Included observations: 125

ECM Regression
Case 2: Restricted Constant and No Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LOG_CPOP_(-1))	0.151196	0.094929	1.592715	0.1155
D(LOG_CPOP_(-2))	-0.024642	0.095962	-0.256785	0.7981
D(LOG_CPOP_(-3))	0.056361	0.097644	0.577204	0.5656
D(LOG_CPOP_(-4))	0.074466	0.096542	0.771327	0.4430
D(LOG_CPOP_(-5))	0.293412	0.095050	3.086914	0.0029
D(LOG_CPOP_(-6))	-0.093577	0.059460	-1.573794	0.1199
D(LOG_CPOP_(-7))	0.032936	0.059717	0.551529	0.5830
D(LOG_CPOP_(-8))	0.011630	0.054873	0.211950	0.8327
D(LOG_CPOP_(-9))	0.150074	0.055346	2.711571	0.0083
D(LOG_CPOP_(-10))	-0.044679	0.054415	-0.821080	0.4143
D(LOG_CPOP_(-11))	0.188713	0.052977	3.562172	0.0007
D(LOG_BP_)	0.021866	0.022554	0.969492	0.3355
D(LOG_BP_(-1))	-0.013143	0.022600	-0.581552	0.5627
D(LOG_BP_(-2))	-0.029059	0.022616	-1.284873	0.2029
D(LOG_BP_(-3))	-0.017539	0.022762	-0.770535	0.4435
D(LOG_BP_(-4))	-0.027347	0.022317	-1.225398	0.2244
D(LOG_BP_(-5))	-0.039415	0.022310	-1.766708	0.0815
D(LOG_BP_(-6))	0.049031	0.022152	2.213368	0.0300
D(LOG_BP_(-7))	-0.053752	0.022101	-2.432143	0.0175
D(LOG_BP_(-8))	-0.015198	0.021599	-0.703608	0.4839
D(LOG_BP_(-9))	-0.008208	0.021458	-0.382536	0.7032
D(LOG_BP_(-10))	-0.014378	0.021517	-0.668184	0.5061
D(LOG_BP_(-11))	-0.090863	0.020802	-4.368051	0.0000
D(LOG_POP_)	-0.099501	0.039251	-2.535019	0.0134
D(LOG_POP_(-1))	0.095079	0.074135	1.282509	0.2037
D(LOG_POP_(-2))	0.298240	0.070885	4.207382	0.0001
D(LOG_POP_(-3))	0.112110	0.066744	1.679694	0.0973

D(LOG_POP_(-4))	0.111003	0.064629	1.717547	0.0901
D(LOG_POP_(-5))	0.136282	0.056969	2.392198	0.0193
D(LOG_POP_(-6))	0.206936	0.052265	3.959371	0.0002
D(LOG_POP_(-7))	0.063776	0.048259	1.321539	0.1904
D(LOG_POP_(-8))	0.172618	0.041823	4.127330	0.0001
D(LOG_SBOP_)	1.076534	0.066446	16.20175	0.0000
D(LOG_SBOP_(-1))	-0.070415	0.123478	-0.570264	0.5702
D(LOG_SBOP_(-2))	-0.215700	0.126457	-1.705718	0.0923
D(LOG_SBOP_(-3))	0.029075	0.129952	0.223738	0.8236
D(LOG_SBOP_(-4))	-0.031213	0.126431	-0.246874	0.8057
D(LOG_SBOP_(-5))	-0.366226	0.120578	-3.037251	0.0033
D(LOG_EPO_)	0.064335	0.044533	1.444661	0.1528
D(LOG_EPO_(-1))	-0.076158	0.069036	-1.103161	0.2736
D(LOG_EPO_(-2))	-0.136077	0.068905	-1.974850	0.0521
D(LOG_EPO_(-3))	-0.114424	0.071095	-1.609467	0.1118
D(LOG_EPO_(-4))	-0.102964	0.067827	-1.518041	0.1333
D(LOG_EPO_(-5))	-0.047112	0.060326	-0.780949	0.4374
D(LOG_EPO_(-6))	-0.141306	0.053489	-2.641769	0.0101
D(LOG_EPO_(-7))	-0.097073	0.044673	-2.172968	0.0330
CointEq(-1)*	-0.179180	0.033168	-5.402152	0.0000

R-squared	0.898061	Mean dependent var	-0.001403
Adjusted R-squared	0.837943	S.D. dependent var	0.081672
S.E. of regression	0.032878	Akaike info criterion	-3.711630
Sum squared resid	0.084315	Schwarz criterion	-2.648185
Log likelihood	278.9769	Hannan-Quinn criter.	-3.279609
Durbin-Watson stat	1.864953		

* p-value incompatible with t-Bounds distribution.

F-Bounds Test — Null Hypothesis: No levels relationship

Test Statistic	Value	Signif.	I(0)	I(1)
F-statistic	4.552087	10%	2.2	3.09
k	4	5%	2.56	3.49
		2.5%	2.88	3.87
		1%	3.29	4.37

Appendix 8.7: *Output for Granger Causality*

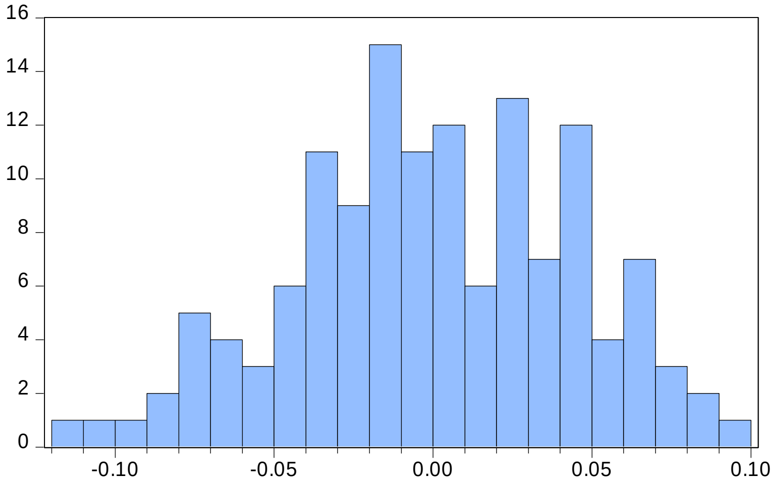
Pairwise Granger Causality Tests
Date: 02/04/20 Time: 15:58
Sample: 2007M01 2018M05
Lags: 12

Null Hypothesis:	Obs	F-Statistic	Prob.
LOG_BP_ does not Granger Cause LOG_CPOP_	125	1.33920	0.2088
LOG_CPOP_ does not Granger Cause LOG_BP_		2.35836	0.0103
LOG_POP_ does not Granger Cause LOG_CPOP_	125	2.29561	0.0126
LOG_CPOP_ does not Granger Cause LOG_POP_		1.16580	0.3180
LOG_SBOP_ does not Granger Cause LOG_CPOP_	125	0.85431	0.5951
LOG_CPOP_ does not Granger Cause LOG_SBOP_		0.83697	0.6124
LOG_EPO_ does not Granger Cause LOG_CPOP_	125	2.12783	0.0214

LOG_CPOP_ does not Granger Cause LOG_EPO_		1.39034	0.1830
LOG_POP_ does not Granger Cause LOG_BP_	125	1.69519	0.0789
LOG_BP_ does not Granger Cause LOG_POP_		0.27423	0.9920
LOG_SBOP_ does not Granger Cause LOG_BP_	125	2.32746	0.0114
LOG_BP_ does not Granger Cause LOG_SBOP_		1.75151	0.0670
LOG_EPO_ does not Granger Cause LOG_BP_	125	1.72439	0.0725
LOG_BP_ does not Granger Cause LOG_EPO_		0.56902	0.8622
LOG_SBOP_ does not Granger Cause LOG_POP_	125	0.85929	0.5901
LOG_POP_ does not Granger Cause LOG_SBOP_		1.20304	0.2916
LOG_EPO_ does not Granger Cause LOG_POP_	125	0.67104	0.7753
LOG_POP_ does not Granger Cause LOG_EPO_		2.14147	0.0205
LOG_EPO_ does not Granger Cause LOG_SBOP_	125	1.15597	0.3253
LOG_SBOP_ does not Granger Cause LOG_EPO_		0.70396	0.7443

Appendix 9: Model 9 – Exchange Rate*Climate Change

Appendix 9.1: *Output for Normality Test*



Series: Residuals
Sample 2007M02 2018M05
Observations 136

Mean	-2.04e-15
Median	-0.000913
Maximum	0.092235
Minimum	-0.115215
Std. Dev.	0.043693
Skewness	-0.176997
Kurtosis	2.556755
Jarque-Bera	1.823408
Probability	0.401839

Appendix 9.2: *Output for Multicollinearity Test*

Variance Inflation Factors
Date: 02/04/20 Time: 16:07
Sample: 2007M01 2018M05
Included observations: 137

Variable	Coefficient Variance	Uncentered VIF	Centered VIF
LOG_POP_	0.002872	4352.407	1.073898
LOG_SBOP_	0.003860	5368.996	2.101034
LOG_BP_	0.000327	778.3491	3.004250
LOG_ER_	0.015851	4435.821	3.295457
C	1.120808	14989.93	NA

Appendix 9.3: *Output for Breusch-Godfrey Serial Correlation LM Test*

Breusch-Godfrey Serial Correlation LM Test:

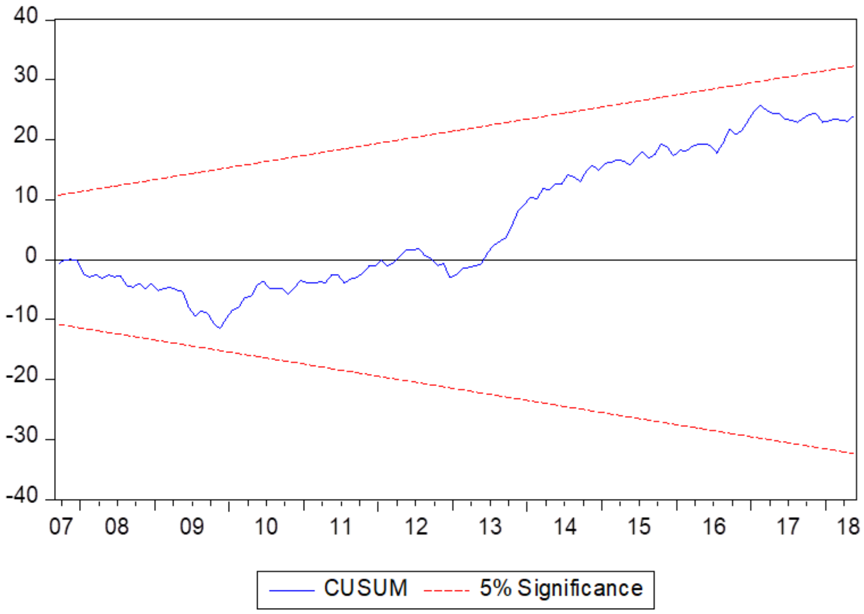
F-statistic	2.323595	Prob. F(1,128)	0.1299
Obs*R-squared	2.424802	Prob. Chi-Square(1)	0.1194

Test Equation:
Dependent Variable: RESID
Method: ARDL
Date: 02/04/20 Time: 16:08
Sample: 2007M02 2018M05
Included observations: 136
Presample missing value lagged residuals set to zero.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOG_CPOP_(-1)	-0.026167	0.040597	-0.644566	0.5204
LOG_POP_	0.000290	0.024526	0.011805	0.9906
LOG_SBOP_	0.020512	0.078088	0.262681	0.7932
LOG_SBOP_(-1)	0.005625	0.073655	0.076372	0.9392
LOG_BP_	-0.000143	0.008040	-0.017821	0.9858
LOG_ER_	0.022212	0.066649	0.333269	0.7395
C	-0.076806	0.491969	-0.156120	0.8762
RESID(-1)	0.148402	0.097355	1.524334	0.1299

R-squared	0.017829	Mean dependent var	-2.04E-15
Adjusted R-squared	-0.035883	S.D. dependent var	0.043693
S.E. of regression	0.044470	Akaike info criterion	-3.331000
Sum squared resid	0.253126	Schwarz criterion	-3.159667
Log likelihood	234.5080	Hannan-Quinn criter.	-3.261375
F-statistic	0.331942	Durbin-Watson stat	1.947805
Prob(F-statistic)	0.938143		

Appendix 9.4: *Output for CUSUM Test*



Appendix 9.5: *Output for Long Run Parameter and Bound Test*

ARDL Long Run Form and Bounds Test
Dependent Variable: D(LOG_CPOP_)
Selected Model: ARDL(1, 0, 1, 0, 0)
Case 2: Restricted Constant and No Trend
Date: 02/04/20 Time: 16:07
Sample: 2007M01 2018M05
Included observations: 136

Conditional Error Correction Regression

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	1.337140	0.491887	2.718390	0.0075
LOG_CPOP_(-1)*	-0.211811	0.036977	-5.728176	0.0000
LOG_POP_**	-0.109082	0.024650	-4.425163	0.0000
LOG_SBOP_(-1)	0.148448	0.045722	3.246741	0.0015
LOG_BP_**	0.000650	0.008081	0.080394	0.9360
LOG_ER_**	0.146401	0.065370	2.239582	0.0268
D(LOG_SBOP_)	1.151541	0.077313	14.89445	0.0000

* p-value incompatible with t-Bounds distribution.
** Variable interpreted as Z = Z(-1) + D(Z).

Levels Equation
Case 2: Restricted Constant and No Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOG_POP_	-0.514995	0.136753	-3.765891	0.0003
LOG_SBOP_	0.700851	0.142832	4.906832	0.0000
LOG_BP_	0.003067	0.038224	0.080240	0.9362
LOG_ER_	0.691185	0.267748	2.581471	0.0110
C	6.312890	2.674462	2.360433	0.0198

EC = LOG_CPOP_ - (-0.5150*LOG_POP_ + 0.7009*LOG_SBOP_ + 0.0031
*LOG_BP_ + 0.6912*LOG_ER_ + 6.3129)

F-Bounds Test — Null Hypothesis: No levels relationship

Test Statistic	Value	Signif.	I(0)	I(1)
			Asymptotic: n=1000	
F-statistic	9.161337	10%	2.2	3.09
k	4	5%	2.56	3.49
		2.5%	2.88	3.87
		1%	3.29	4.37
			Finite Sample:	
Actual Sample Size	136		n=80	
		10%	2.303	3.22
		5%	2.688	3.698
		1%	3.602	4.787

Appendix 9.6: *Output for Error Correlation Model*

ARDL Error Correction Regression
Dependent Variable: D(LOG_CPOP_)
Selected Model: ARDL(1, 0, 1, 0, 0)
Case 2: Restricted Constant and No Trend
Date: 02/04/20 Time: 16:07
Sample: 2007M01 2018M05
Included observations: 136

ECM Regression
Case 2: Restricted Constant and No Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LOG_SBOP_)	1.151541	0.069164	16.64940	0.0000
CointEq(-1)*	-0.211811	0.028031	-7.556359	0.0000

R-squared	0.703199	Mean dependent var	0.002060
Adjusted R-squared	0.700984	S.D. dependent var	0.080200
S.E. of regression	0.043855	Akaike info criterion	-3.401245
Sum squared resid	0.257721	Schwarz criterion	-3.358412
Log likelihood	233.2847	Hannan-Quinn criter.	-3.383839
Durbin-Watson stat	1.714943		

* p-value incompatible with t-Bounds distribution.

F-Bounds Test — Null Hypothesis: No levels relationship

Test Statistic	Value	Signif.	I(0)	I(1)
F-statistic	9.161337	10%	2.2	3.09
k	4	5%	2.56	3.49
		2.5%	2.88	3.87
		1%	3.29	4.37

Appendix 9.7: *Output for Granger Causality*

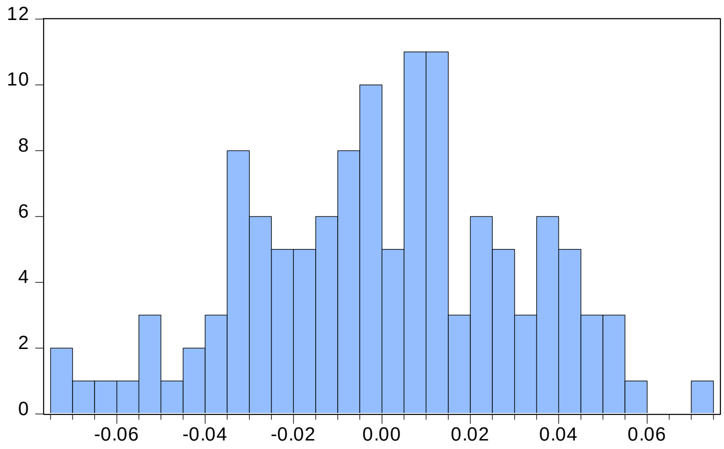
Pairwise Granger Causality Tests
Date: 02/04/20 Time: 16:08
Sample: 2007M01 2018M05
Lags: 1

Null Hypothesis:	Obs	F-Statistic	Prob.
LOG_POP_ does not Granger Cause LOG_CPOP_	136	13.6498	0.0003
LOG_CPOP_ does not Granger Cause LOG_POP_		2.33818	0.1286
LOG_SBOP_ does not Granger Cause LOG_CPOP_	136	1.97781	0.1620
LOG_CPOP_ does not Granger Cause LOG_SBOP_		4.28753	0.0403
LOG_BP_ does not Granger Cause LOG_CPOP_	136	1.44458	0.2315
LOG_CPOP_ does not Granger Cause LOG_BP_		3.20504	0.0757
LOG_ER_ does not Granger Cause LOG_CPOP_	136	0.42264	0.5167
LOG_CPOP_ does not Granger Cause LOG_ER_		3.28101	0.0723
LOG_SBOP_ does not Granger Cause LOG_POP_	136	0.23959	0.6253

LOG_POP_ does not Granger Cause LOG_SBOP_		7.88047	0.0057
LOG_BP_ does not Granger Cause LOG_POP_	136	0.33639	0.5629
LOG_POP_ does not Granger Cause LOG_BP_		0.27573	0.6004
LOG_ER_ does not Granger Cause LOG_POP_	136	0.19657	0.6582
LOG_POP_ does not Granger Cause LOG_ER_		0.97101	0.3262
LOG_BP_ does not Granger Cause LOG_SBOP_	136	9.65051	0.0023
LOG_SBOP_ does not Granger Cause LOG_BP_		0.61518	0.4342
LOG_ER_ does not Granger Cause LOG_SBOP_	136	8.15539	0.0050
LOG_SBOP_ does not Granger Cause LOG_ER_		3.57765	0.0607
LOG_ER_ does not Granger Cause LOG_BP_	136	0.02135	0.8841
LOG_BP_ does not Granger Cause LOG_ER_		6.46562	0.0121

Appendix 10: Model 10 – Stock Price*Climate Change

Appendix 10.1: *Output for Normality Test*



Series: Residuals
Sample 2008M01 2018M05
Observations 125

Mean	-6.07e-15
Median	0.000120
Maximum	0.071398
Minimum	-0.074054
Std. Dev.	0.030160
Skewness	-0.162448
Kurtosis	2.627051
Jarque-Bera	1.274212
Probability	0.528821

Appendix 10.2: *Output for Multicollinearity Test*

Variance Inflation Factors
Date: 02/04/20 Time: 15:52
Sample: 2007M01 2018M05
Included observations: 137

Variable	Coefficient Variance	Uncentered VIF	Centered VIF
LOG_BP_	0.000349	667.5336	2.576527
LOG_POP_	0.003739	4549.451	1.122516
LOG_SBOP_	0.004603	5139.760	2.011328
LOG_SP_	0.003776	4595.582	1.559164
C	0.851189	9140.417	NA

Appendix 10.3: *Output for Breusch-Godfrey Serial Correlation LM Test*

Breusch-Godfrey Serial Correlation LM Test:

F-statistic	0.697021	Prob. F(12,74)	0.7493
Obs*R-squared	12.69399	Prob. Chi-Square(12)	0.3917

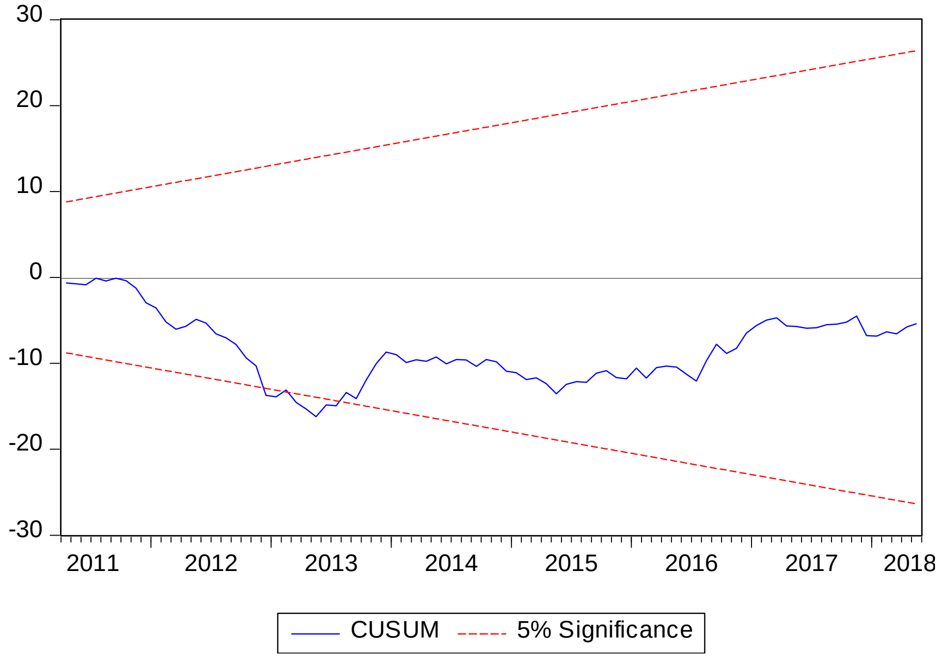
Test Equation:
Dependent Variable: RESID
Method: ARDL
Date: 02/04/20 Time: 15:53
Sample: 2008M01 2018M05
Included observations: 125
Presample missing value lagged residuals set to zero.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOG_CPOP_(-1)	-0.015009	0.185242	-0.081021	0.9356
LOG_CPOP_(-2)	0.034648	0.181443	0.190960	0.8491
LOG_CPOP_(-3)	-0.013727	0.115724	-0.118620	0.9059
LOG_CPOP_(-4)	0.028401	0.113895	0.249364	0.8038
LOG_CPOP_(-5)	-0.047681	0.105386	-0.452436	0.6523
LOG_CPOP_(-6)	0.045159	0.103135	0.437858	0.6628
LOG_CPOP_(-7)	0.001716	0.066106	0.025951	0.9794
LOG_BP_	-0.002896	0.024636	-0.117559	0.9067
LOG_BP_(-1)	-0.002023	0.035612	-0.056819	0.9548
LOG_BP_(-2)	0.006940	0.034682	0.200096	0.8420
LOG_BP_(-3)	-0.001087	0.034031	-0.031940	0.9746
LOG_BP_(-4)	0.015445	0.034119	0.452682	0.6521
LOG_BP_(-5)	-0.017621	0.034533	-0.510273	0.6114
LOG_BP_(-6)	0.005656	0.033992	0.166391	0.8683
LOG_BP_(-7)	-0.005393	0.031798	-0.169603	0.8658
LOG_BP_(-8)	0.010384	0.031841	0.326113	0.7453
LOG_BP_(-9)	-0.008213	0.029878	-0.274891	0.7842
LOG_BP_(-10)	0.003050	0.029699	0.102696	0.9185
LOG_BP_(-11)	-0.008459	0.029609	-0.285703	0.7759
LOG_BP_(-12)	0.003982	0.022444	0.177396	0.8597
LOG_POP_	-0.013104	0.051244	-0.255726	0.7989
LOG_POP_(-1)	0.009603	0.065826	0.145878	0.8844
LOG_POP_(-2)	-0.006083	0.066478	-0.091504	0.9273
LOG_POP_(-3)	0.010336	0.070612	0.146379	0.8840
LOG_POP_(-4)	-0.005178	0.067080	-0.077192	0.9387
LOG_POP_(-5)	0.012285	0.066826	0.183835	0.8546
LOG_POP_(-6)	-0.029979	0.067268	-0.445658	0.6571
LOG_POP_(-7)	0.033100	0.064518	0.513042	0.6095
LOG_POP_(-8)	-0.019538	0.063831	-0.306092	0.7604
LOG_POP_(-9)	0.011603	0.062097	0.186855	0.8523
LOG_POP_(-10)	-0.003529	0.052986	-0.066594	0.9471
LOG_SBOP_	0.006364	0.085781	0.074194	0.9411
LOG_SBOP_(-1)	-0.007219	0.231474	-0.031185	0.9752
LOG_SBOP_(-2)	-0.013797	0.208321	-0.066229	0.9474
LOG_SP_	0.030880	0.117351	0.263139	0.7932
LOG_SP_(-1)	-0.000802	0.149525	-0.005363	0.9957
LOG_SP_(-2)	-0.006953	0.155535	-0.044702	0.9645
LOG_SP_(-3)	-0.022274	0.118169	-0.188491	0.8510
C	-0.226451	1.542656	-0.146793	0.8837
RESID(-1)	0.003570	0.208819	0.017098	0.9864
RESID(-2)	-0.049332	0.147743	-0.333903	0.7394
RESID(-3)	-0.024361	0.143029	-0.170321	0.8652
RESID(-4)	-0.076706	0.140199	-0.547121	0.5859

RESID(-5)	0.107711	0.141202	0.762814	0.4480
RESID(-6)	-0.170128	0.138684	-1.226734	0.2238
RESID(-7)	-0.125953	0.135887	-0.926891	0.3570
RESID(-8)	-0.087552	0.131980	-0.663374	0.5092
RESID(-9)	0.004317	0.131055	0.032944	0.9738
RESID(-10)	-0.083780	0.130378	-0.642591	0.5225
RESID(-11)	0.001846	0.131650	0.014025	0.9888
RESID(-12)	-0.256436	0.134715	-1.903549	0.0609

R-squared	0.101552	Mean dependent var	-6.07E-15
Adjusted R-squared	-0.505508	S.D. dependent var	0.030160
S.E. of regression	0.037006	Akaike info criterion	-3.463695
Sum squared resid	0.101342	Schwarz criterion	-2.309743
Log likelihood	267.4810	Hannan-Quinn criter.	-2.994906
F-statistic	0.167285	Durbin-Watson stat	2.081964
Prob(F-statistic)	1.000000		

Appendix 10.4: *Output for CUSUM Test*



Appendix 10.5: *Output for Long Run Parameter and Bound Test*

ARDL Long Run Form and Bounds Test
Dependent Variable: D(LOG_CPOP_)
Selected Model: ARDL(7, 12, 10, 2, 3)
Case 2: Restricted Constant and No Trend
Date: 02/04/20 Time: 15:54
Sample: 2007M01 2018M05
Included observations: 125

Conditional Error Correction Regression

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	2.959003	1.314764	2.250596	0.0270

LOG_CPOP_(-1)*	-0.181093	0.048574	-3.728168	0.0003
LOG_BP_(-1)	0.009957	0.010297	0.967008	0.3363
LOG_POP_(-1)	-0.248720	0.124428	-1.998910	0.0488
LOG_SBOP_(-1)	0.078713	0.050524	1.557930	0.1229
LOG_SP_(-1)	0.073629	0.034321	2.145265	0.0348
D(LOG_CPOP_(-1))	0.201201	0.090896	2.213532	0.0295
D(LOG_CPOP_(-2))	-0.114355	0.058239	-1.963537	0.0528
D(LOG_CPOP_(-3))	0.083059	0.060312	1.377151	0.1720
D(LOG_CPOP_(-4))	-0.025265	0.057743	-0.437541	0.6628
D(LOG_CPOP_(-5))	0.032430	0.056353	0.575468	0.5665
D(LOG_CPOP_(-6))	-0.154301	0.055961	-2.757291	0.0071
D(LOG_BP_)	0.038855	0.023029	1.687184	0.0952
D(LOG_BP_(-1))	-0.045999	0.024076	-1.910590	0.0594
D(LOG_BP_(-2))	-0.004261	0.023555	-0.180889	0.8569
D(LOG_BP_(-3))	0.002275	0.023634	0.096247	0.9235
D(LOG_BP_(-4))	-0.037520	0.023279	-1.611762	0.1107
D(LOG_BP_(-5))	-0.011174	0.023219	-0.481224	0.6316
D(LOG_BP_(-6))	0.028928	0.022533	1.283807	0.2027
D(LOG_BP_(-7))	-0.040306	0.021719	-1.855843	0.0669
D(LOG_BP_(-8))	-0.031236	0.021387	-1.460553	0.1478
D(LOG_BP_(-9))	0.000121	0.021427	0.005654	0.9955
D(LOG_BP_(-10))	-0.033671	0.021308	-1.580200	0.1177
D(LOG_BP_(-11))	-0.075159	0.020927	-3.591513	0.0005
D(LOG_POP_)	-0.156055	0.047258	-3.302206	0.0014
D(LOG_POP_(-1))	0.002200	0.105561	0.020843	0.9834
D(LOG_POP_(-2))	0.246835	0.095711	2.578951	0.0116
D(LOG_POP_(-3))	0.043743	0.089430	0.489126	0.6260
D(LOG_POP_(-4))	0.033484	0.079368	0.421875	0.6742
D(LOG_POP_(-5))	0.061713	0.071031	0.868808	0.3874
D(LOG_POP_(-6))	0.086472	0.060152	1.437555	0.1542
D(LOG_POP_(-7))	-0.007439	0.054109	-0.137476	0.8910
D(LOG_POP_(-8))	0.110286	0.048566	2.270852	0.0257
D(LOG_POP_(-9))	-0.094898	0.048249	-1.966824	0.0524
D(LOG_SBOP_)	1.067675	0.081340	13.12607	0.0000
D(LOG_SBOP_(-1))	-0.207907	0.129387	-1.606870	0.1117
D(LOG_SP_)	0.077831	0.107818	0.721878	0.4723
D(LOG_SP_(-1))	0.215766	0.108170	1.994690	0.0492
D(LOG_SP_(-2))	-0.352011	0.105504	-3.336458	0.0013

* p-value incompatible with t-Bounds distribution.

Levels Equation
Case 2: Restricted Constant and No Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOG_BP_	0.054984	0.054645	1.006213	0.3171
LOG_POP_	-1.373438	0.643922	-2.132927	0.0358
LOG_SBOP_	0.434657	0.229368	1.895023	0.0614
LOG_SP_	0.406578	0.174411	2.331147	0.0221
C	16.33968	6.731012	2.427522	0.0173

EC = LOG_CPOP_ - (0.0550*LOG_BP_ -1.3734*LOG_POP_ + 0.4347
*LOG_SBOP_ + 0.4066*LOG_SP_ + 16.3397)

F-Bounds Test — Null Hypothesis: No levels relationship

Test Statistic	Value	Signif.	I(0)	I(1)

			Asymptotic: n=1000	
F-statistic	2.898679	10%	2.2	3.09
k	4	5%	2.56	3.49
		2.5%	2.88	3.87
		1%	3.29	4.37
			Finite Sample:	
Actual Sample Size	125		n=80	
		10%	2.303	3.22
		5%	2.688	3.698
		1%	3.602	4.787

Appendix 10.6: *Output for Error Correlation Model*

ARDL Error Correction Regression
Dependent Variable: D(LOG_CPOP_)
Selected Model: ARDL(7, 12, 10, 2, 3)
Case 2: Restricted Constant and No Trend
Date: 02/04/20 Time: 15:54
Sample: 2007M01 2018M05
Included observations: 125

ECM Regression
Case 2: Restricted Constant and No Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LOG_CPOP_(-1))	0.201201	0.084887	2.370228	0.0200
D(LOG_CPOP_(-2))	-0.114355	0.055278	-2.068718	0.0416
D(LOG_CPOP_(-3))	0.083059	0.057302	1.449496	0.1508
D(LOG_CPOP_(-4))	-0.025265	0.053565	-0.471663	0.6384
D(LOG_CPOP_(-5))	0.032430	0.053531	0.605804	0.5462
D(LOG_CPOP_(-6))	-0.154301	0.052131	-2.959867	0.0040
D(LOG_BP_)	0.038855	0.021605	1.798398	0.0756
D(LOG_BP_(-1))	-0.045999	0.020982	-2.192341	0.0311
D(LOG_BP_(-2))	-0.004261	0.021029	-0.202621	0.8399
D(LOG_BP_(-3))	0.002275	0.020950	0.108574	0.9138
D(LOG_BP_(-4))	-0.037520	0.020760	-1.807300	0.0742
D(LOG_BP_(-5))	-0.011174	0.021181	-0.527524	0.5992
D(LOG_BP_(-6))	0.028928	0.020673	1.399367	0.1653
D(LOG_BP_(-7))	-0.040306	0.020250	-1.990412	0.0497
D(LOG_BP_(-8))	-0.031236	0.020056	-1.557479	0.1230
D(LOG_BP_(-9))	0.000121	0.020357	0.005951	0.9953
D(LOG_BP_(-10))	-0.033671	0.020256	-1.662322	0.1001
D(LOG_BP_(-11))	-0.075159	0.020174	-3.725610	0.0003
D(LOG_POP_)	-0.156055	0.042202	-3.697829	0.0004
D(LOG_POP_(-1))	0.002200	0.062548	0.035175	0.9720
D(LOG_POP_(-2))	0.246835	0.055980	4.409360	0.0000
D(LOG_POP_(-3))	0.043743	0.055611	0.786575	0.4337
D(LOG_POP_(-4))	0.033484	0.053020	0.631523	0.5294
D(LOG_POP_(-5))	0.061713	0.049131	1.256076	0.2125
D(LOG_POP_(-6))	0.086472	0.044313	1.951411	0.0543
D(LOG_POP_(-7))	-0.007439	0.042127	-0.176576	0.8603
D(LOG_POP_(-8))	0.110286	0.040421	2.728432	0.0077
D(LOG_POP_(-9))	-0.094898	0.043542	-2.179433	0.0320
D(LOG_SBOP_)	1.067675	0.074739	14.28538	0.0000
D(LOG_SBOP_(-1))	-0.207907	0.116419	-1.785846	0.0776
D(LOG_SP_)	0.077831	0.096352	0.807784	0.4214

D(LOG_SP_(-1))	0.215766	0.096243	2.241882	0.0275
D(LOG_SP_(-2))	-0.352011	0.099581	-3.534919	0.0007
CointEq(-1)*	-0.181093	0.042214	-4.289900	0.0000

R-squared	0.863626	Mean dependent var	-0.001403
Adjusted R-squared	0.814172	S.D. dependent var	0.081672
S.E. of regression	0.035207	Akaike info criterion	-3.628609
Sum squared resid	0.112796	Schwarz criterion	-2.859308
Log likelihood	260.7881	Hannan-Quinn criter.	-3.316082
Durbin-Watson stat	1.974340		

* p-value incompatible with t-Bounds distribution.

F-Bounds Test — Null Hypothesis: No levels relationship

Test Statistic	Value	Signif.	I(0)	I(1)
F-statistic	2.898679	10%	2.2	3.09
k	4	5%	2.56	3.49
		2.5%	2.88	3.87
		1%	3.29	4.37

Appendix 10.7: *Output for Granger Causality*

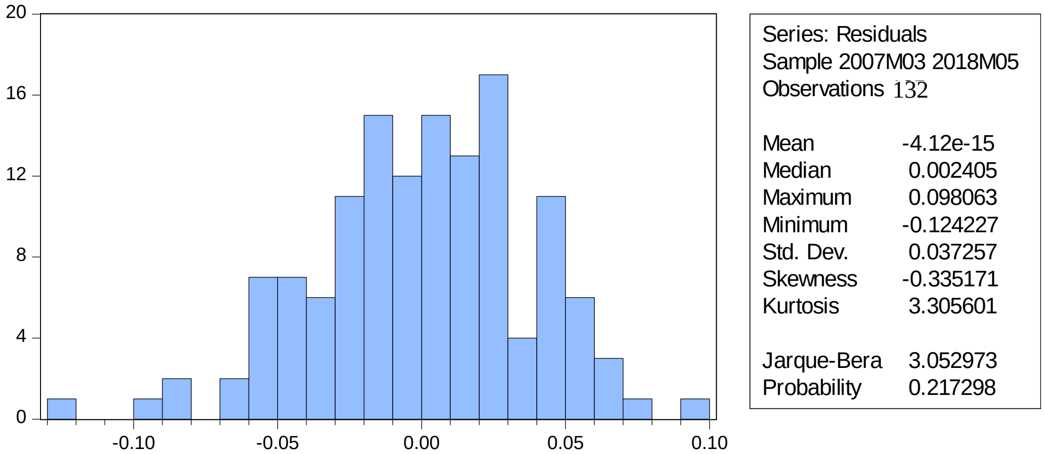
Pairwise Granger Causality Tests
Date: 02/04/20 Time: 15:54
Sample: 2007M01 2018M05
Lags: 12

Null Hypothesis:	Obs	F-Statistic	Prob.
LOG_BP_ does not Granger Cause LOG_CPOP_	125	1.33920	0.2088
LOG_CPOP_ does not Granger Cause LOG_BP_		2.35836	0.0103
LOG_POP_ does not Granger Cause LOG_CPOP_	125	2.29561	0.0126
LOG_CPOP_ does not Granger Cause LOG_POP_		1.16580	0.3180
LOG_SBOP_ does not Granger Cause LOG_CPOP_	125	0.85431	0.5951
LOG_CPOP_ does not Granger Cause LOG_SBOP_		0.83697	0.6124
LOG_SP_ does not Granger Cause LOG_CPOP_	125	0.97421	0.4785
LOG_CPOP_ does not Granger Cause LOG_SP_		2.42160	0.0084
LOG_POP_ does not Granger Cause LOG_BP_	125	1.69519	0.0789
LOG_BP_ does not Granger Cause LOG_POP_		0.27423	0.9920
LOG_SBOP_ does not Granger Cause LOG_BP_	125	2.32746	0.0114
LOG_BP_ does not Granger Cause LOG_SBOP_		1.75151	0.0670
LOG_SP_ does not Granger Cause LOG_BP_	125	1.38277	0.1866
LOG_BP_ does not Granger Cause LOG_SP_		0.12264	0.9999
LOG_SBOP_ does not Granger Cause LOG_POP_	125	0.85929	0.5901
LOG_POP_ does not Granger Cause LOG_SBOP_		1.20304	0.2916
LOG_SP_ does not Granger Cause LOG_POP_	125	1.22184	0.2789
LOG_POP_ does not Granger Cause LOG_SP_		1.68957	0.0802

LOG_SP_ does not Granger Cause LOG_SBOP_	125	1.60768	0.1013
LOG_SBOP_ does not Granger Cause LOG_SP_		3.16515	0.0007

Appendix 11: Model 11 – Combined Model with Interaction Term

Appendix 11.1: *Output for Normality Test*



Appendix 11.2: *Output for Multicollinearity Test*

Variance Inflation Factors
Date: 02/05/20 Time: 11:49
Sample: 2007M01 2018M05
Included observations: 137

Variable	Coefficient Variance	Uncentered VIF	Centered VIF
LOG_POP_	0.004463	10396.86	2.565284
LOG_SBOP_	0.004639	9918.563	3.881404
LOG_BP_	0.000326	1194.243	4.609507
LOG_COP_	0.003380	5476.966	4.366474
LOG_EPO_	0.005559	12720.51	2.342353
LOG_ER_	0.014700	6323.606	4.697929
LOG_SP_	0.002203	5133.914	1.741806
C	0.835357	17174.51	NA

Appendix 11.3: *Output for Breusch-Godfrey Serial Correlation LM Test*

Breusch-Godfrey Serial Correlation LM Test:

F-statistic	0.758742	Prob. F(5,104)	0.5816
Obs*R-squared	4.645633	Prob. Chi-Square(5)	0.4606

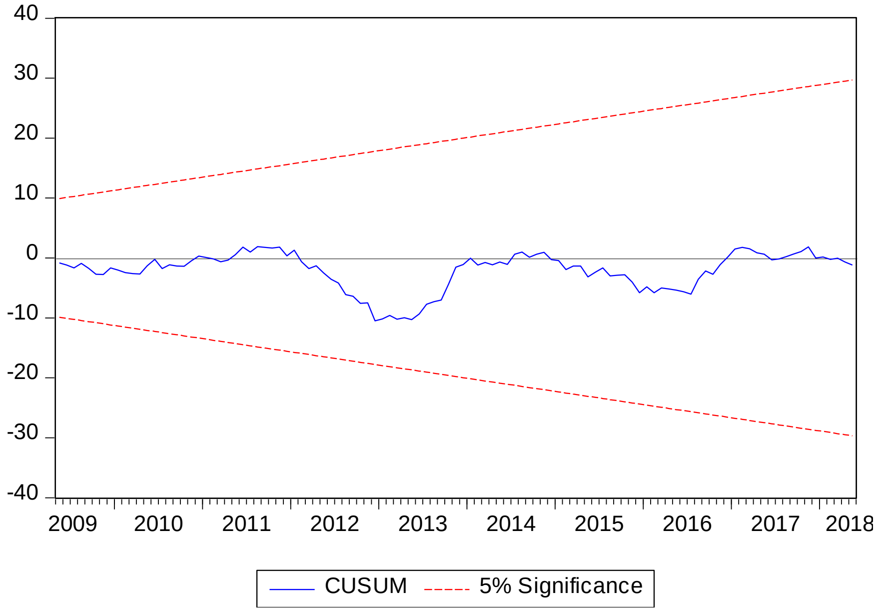
Test Equation:
Dependent Variable: RESID
Method: ARDL
Date: 02/05/20 Time: 11:49
Sample: 2007M06 2018M05

Included observations: 132
Presample missing value lagged residuals set to zero.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOG_CPOP_(-1)	0.005227	0.081222	0.064352	0.9488
LOG_CPOP_(-2)	-0.025935	0.088422	-0.293312	0.7699
LOG_CPOP_(-3)	-0.013066	0.059967	-0.217888	0.8279
LOG_POP_	-0.003020	0.042982	-0.070267	0.9441
LOG_POP_(-1)	-0.000260	0.052036	-0.004987	0.9960
LOG_POP_(-2)	-0.002709	0.054708	-0.049521	0.9606
LOG_POP_(-3)	-0.016089	0.053877	-0.298618	0.7658
LOG_POP_(-4)	-0.000280	0.053974	-0.005183	0.9959
LOG_POP_(-5)	-0.004143	0.038845	-0.106662	0.9153
LOG_SBOP_	0.015453	0.090578	0.170609	0.8649
LOG_SBOP_(-1)	0.023075	0.103577	0.222786	0.8241
LOG_BP_	0.002016	0.011421	0.176558	0.8602
LOG_COP_	-0.002454	0.055604	-0.044135	0.9649
LOG_COP_(-1)	-0.014721	0.057186	-0.257428	0.7974
LOG_EPO_	0.004630	0.045973	0.100715	0.9200
LOG_EPO_(-1)	0.010997	0.046690	0.235540	0.8143
LOG_EPO_(-2)	0.009161	0.046103	0.198697	0.8429
LOG_ER_	-0.003899	0.088119	-0.044244	0.9648
LOG_SP_	-0.032810	0.103501	-0.317006	0.7519
LOG_SP_(-1)	-0.007079	0.137311	-0.051552	0.9590
LOG_SP_(-2)	0.032328	0.135244	0.239033	0.8116
LOG_SP_(-3)	0.014267	0.105588	0.135118	0.8928
C	0.077113	0.604470	0.127571	0.8987
RESID(-1)	-0.056834	0.125993	-0.451090	0.6529
RESID(-2)	0.026007	0.126452	0.205667	0.8375
RESID(-3)	0.141419	0.115800	1.221237	0.2248
RESID(-4)	0.099786	0.115077	0.867131	0.3879
RESID(-5)	0.168300	0.112533	1.495560	0.1378

R-squared	0.035194	Mean dependent var	2.49E-15
Adjusted R-squared	-0.215284	S.D. dependent var	0.033189
S.E. of regression	0.036587	Akaike info criterion	-3.592392
Sum squared resid	0.139219	Schwarz criterion	-2.980889
Log likelihood	265.0979	Hannan-Quinn criter.	-3.343905
F-statistic	0.140508	Durbin-Watson stat	1.996903
Prob(F-statistic)	1.000000		

Appendix 11.4: *Output for CUSUM Test*



Appendix 11.5: *Output for Long Run Parameter and Bound Test*

ARDL Long Run Form and Bounds Test
Dependent Variable: D(LOG_CPOP_)
Selected Model: ARDL(3, 5, 1, 0, 1, 2, 0, 3)
Case 2: Restricted Constant and No Trend
Date: 02/05/20 Time: 11:46
Sample: 2007M01 2018M05
Included observations: 132

Conditional Error Correction Regression

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.946595	0.594641	1.591876	0.1143
LOG_CPOP_(-1)*	-0.196643	0.054429	-3.612834	0.0005
LOG_POP_(-1)	-0.152004	0.063118	-2.408234	0.0177
LOG_SBOP_(-1)	0.048849	0.053653	0.910450	0.3646
LOG_BP_**	-0.020116	0.011240	-1.789634	0.0763
LOG_COP_(-1)	0.040653	0.031262	1.300394	0.1962
LOG_EPO_(-1)	0.090199	0.066331	1.359834	0.1767
LOG_ER_**	0.186699	0.083934	2.224345	0.0282
LOG_SP_(-1)	0.044635	0.030701	1.453856	0.1489
D(LOG_CPOP_(-1))	0.098496	0.055009	1.790524	0.0761
D(LOG_CPOP_(-2))	-0.081162	0.052361	-1.550037	0.1240
D(LOG_POP_)	-0.147331	0.042178	-3.493083	0.0007
D(LOG_POP_(-1))	-0.145531	0.051058	-2.850329	0.0052
D(LOG_POP_(-2))	0.065206	0.041593	1.567719	0.1198
D(LOG_POP_(-3))	-0.040268	0.039698	-1.014341	0.3127
D(LOG_POP_(-4))	-0.083064	0.037745	-2.200642	0.0299
D(LOG_SBOP_)	1.056648	0.087887	12.02274	0.0000
D(LOG_COP_)	0.130601	0.053121	2.458556	0.0155
D(LOG_EPO_)	0.031653	0.044283	0.714789	0.4763
D(LOG_EPO_(-1))	0.075545	0.043635	1.731312	0.0862
D(LOG_SP_)	-0.029193	0.101056	-0.288875	0.7732
D(LOG_SP_(-1))	0.102060	0.096505	1.057570	0.2926

D(LOG_SP_(-2))	-0.321472	0.099643	-3.226226	0.0017

* p-value incompatible with t-Bounds distribution.
** Variable interpreted as Z = Z(-1) + D(Z).

Levels Equation
Case 2: Restricted Constant and No Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOG_POP_	-0.772992	0.369510	-2.091938	0.0388
LOG_SBOP_	0.248413	0.230078	1.079690	0.2827
LOG_BP_	-0.102296	0.047627	-2.147869	0.0339
LOG_COP_	0.206734	0.156126	1.324153	0.1882
LOG_EPO_	0.458692	0.406709	1.127813	0.2619
LOG_ER_	0.949430	0.296352	3.203727	0.0018
LOG_SP_	0.226984	0.125599	1.807215	0.0735
C	4.813768	3.077100	1.564385	0.1206

EC = LOG_CPOP_ - (-0.7730*LOG_POP_ + 0.2484*LOG_SBOP_ -0.1023
*LOG_BP_ + 0.2067*LOG_COP_ + 0.4587*LOG_EPO_ + 0.9494
*LOG_ER_ + 0.2270*LOG_SP_ + 4.8138)

F-Bounds Test — Null Hypothesis: No levels relationship

Test Statistic	Value	Signif.	I(0)	I(1)
			Asymptotic: n=1000	
F-statistic	3.843868	10%	1.92	2.89
k	7	5%	2.17	3.21
		2.5%	2.43	3.51
		1%	2.73	3.9
			Finite Sample:	
Actual Sample Size	132		n=80	
		10%	2.017	3.052
		5%	2.336	3.458
		1%	3.021	4.35

Appendix 11.6: *Output for Error Correlation Model*

ARDL Error Correction Regression
Dependent Variable: D(LOG_CPOP_)
Selected Model: ARDL(3, 5, 1, 0, 1, 2, 0, 3)
Case 2: Restricted Constant and No Trend
Date: 02/05/20 Time: 11:46
Sample: 2007M01 2018M05
Included observations: 132

ECM Regression
Case 2: Restricted Constant and No Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LOG_CPOP_(-1))	0.098496	0.050279	1.958985	0.0527
D(LOG_CPOP_(-2))	-0.081162	0.047623	-1.704249	0.0912

D(LOG_POP_)	-0.147331	0.033824	-4.355761	0.0000
D(LOG_POP_(-1))	-0.145531	0.039802	-3.656396	0.0004
D(LOG_POP_(-2))	0.065206	0.034343	1.898652	0.0603
D(LOG_POP_(-3))	-0.040268	0.033634	-1.197234	0.2338
D(LOG_POP_(-4))	-0.083064	0.032085	-2.588854	0.0109
D(LOG_SBOP_)	1.056648	0.076967	13.72856	0.0000
D(LOG_COP_)	0.130601	0.049116	2.659055	0.0090
D(LOG_EPO_)	0.031653	0.034710	0.911921	0.3638
D(LOG_EPO_(-1))	0.075545	0.035939	2.102011	0.0379
D(LOG_SP_)	-0.029193	0.091522	-0.318970	0.7504
D(LOG_SP_(-1))	0.102060	0.089829	1.136158	0.2584
D(LOG_SP_(-2))	-0.321472	0.092681	-3.468569	0.0008
CointEq(-1)*	-0.196643	0.032270	-6.093758	0.0000

R-squared	0.827712	Mean dependent var	-0.000262
Adjusted R-squared	0.807097	S.D. dependent var	0.079959
S.E. of regression	0.035118	Akaike info criterion	-3.753534
Sum squared resid	0.144297	Schwarz criterion	-3.425943
Log likelihood	262.7332	Hannan-Quinn criter.	-3.620416
Durbin-Watson stat	2.083214		

* p-value incompatible with t-Bounds distribution.

F-Bounds Test Null Hypothesis: No levels relationship

Test Statistic	Value	Signif.	I(0)	I(1)
F-statistic	3.843868	10%	1.92	2.89
k	7	5%	2.17	3.21
		2.5%	2.43	3.51
		1%	2.73	3.9

Appendix 11.7: *Output for Granger Causality*

Pairwise Granger Causality Tests
Date: 02/05/20 Time: 11:50
Sample: 2007M01 2018M05
Lags: 5

Null Hypothesis:	Obs	F-Statistic	Prob.
LOG_POP_ does not Granger Cause LOG_CPOP_	132	4.32808	0.0012
LOG_CPOP_ does not Granger Cause LOG_POP_		1.91878	0.0960
LOG_SBOP_ does not Granger Cause LOG_CPOP_	132	0.83507	0.5273
LOG_CPOP_ does not Granger Cause LOG_SBOP_		0.48959	0.7835
LOG_BP_ does not Granger Cause LOG_CPOP_	132	1.29326	0.2713
LOG_CPOP_ does not Granger Cause LOG_BP_		2.53339	0.0322
LOG_COP_ does not Granger Cause LOG_CPOP_	132	1.36122	0.2437
LOG_CPOP_ does not Granger Cause LOG_COP_		4.31888	0.0012
LOG_EPO_ does not Granger Cause LOG_CPOP_	132	1.98349	0.0858
LOG_CPOP_ does not Granger Cause LOG_EPO_		3.01858	0.0133
LOG_ER_ does not Granger Cause LOG_CPOP_	132	1.75048	0.1282
LOG_CPOP_ does not Granger Cause LOG_ER_		1.14030	0.3429

LOG_SP_ does not Granger Cause LOG_CPOP_	132	0.37904	0.8623
LOG_CPOP_ does not Granger Cause LOG_SP_		1.51113	0.1913
LOG_SBOP_ does not Granger Cause LOG_POP_	132	1.11393	0.3566
LOG_POP_ does not Granger Cause LOG_SBOP_		1.15879	0.3335
LOG_BP_ does not Granger Cause LOG_POP_	132	0.93523	0.4608
LOG_POP_ does not Granger Cause LOG_BP_		1.80237	0.1174
LOG_COP_ does not Granger Cause LOG_POP_	132	0.47409	0.7950
LOG_POP_ does not Granger Cause LOG_COP_		1.59881	0.1655
LOG_EPO_ does not Granger Cause LOG_POP_	132	0.37131	0.8675
LOG_POP_ does not Granger Cause LOG_EPO_		9.88612	6.E-08
LOG_ER_ does not Granger Cause LOG_POP_	132	0.60485	0.6963
LOG_POP_ does not Granger Cause LOG_ER_		1.76897	0.1243
LOG_SP_ does not Granger Cause LOG_POP_	132	2.43262	0.0387
LOG_POP_ does not Granger Cause LOG_SP_		1.95679	0.0899
LOG_BP_ does not Granger Cause LOG_SBOP_	132	3.68638	0.0039
LOG_SBOP_ does not Granger Cause LOG_BP_		3.16115	0.0102
LOG_COP_ does not Granger Cause LOG_SBOP_	132	1.07248	0.3791
LOG_SBOP_ does not Granger Cause LOG_COP_		3.42693	0.0062
LOG_EPO_ does not Granger Cause LOG_SBOP_	132	0.55855	0.7316
LOG_SBOP_ does not Granger Cause LOG_EPO_		0.98268	0.4313
LOG_ER_ does not Granger Cause LOG_SBOP_	132	6.34883	3.E-05
LOG_SBOP_ does not Granger Cause LOG_ER_		1.76101	0.1260
LOG_SP_ does not Granger Cause LOG_SBOP_	132	1.27910	0.2773
LOG_SBOP_ does not Granger Cause LOG_SP_		0.89531	0.4866
LOG_COP_ does not Granger Cause LOG_BP_	132	0.91813	0.4718
LOG_BP_ does not Granger Cause LOG_COP_		1.48951	0.1982
LOG_EPO_ does not Granger Cause LOG_BP_	132	2.16798	0.0620
LOG_BP_ does not Granger Cause LOG_EPO_		0.64248	0.6677
LOG_ER_ does not Granger Cause LOG_BP_	132	1.84958	0.1082
LOG_BP_ does not Granger Cause LOG_ER_		2.28825	0.0501
LOG_SP_ does not Granger Cause LOG_BP_	132	0.54345	0.7430
LOG_BP_ does not Granger Cause LOG_SP_		0.06611	0.9970
LOG_EPO_ does not Granger Cause LOG_COP_	132	0.98230	0.4315
LOG_COP_ does not Granger Cause LOG_EPO_		1.20725	0.3098
LOG_ER_ does not Granger Cause LOG_COP_	132	3.18683	0.0097
LOG_COP_ does not Granger Cause LOG_ER_		0.79796	0.5532
LOG_SP_ does not Granger Cause LOG_COP_	132	2.21229	0.0573
LOG_COP_ does not Granger Cause LOG_SP_		1.08090	0.3744
LOG_ER_ does not Granger Cause LOG_EPO_	132	0.30357	0.9099
LOG_EPO_ does not Granger Cause LOG_ER_		0.57465	0.7193

LOG_SP_ does not Granger Cause LOG_EPO_	132	1.95976	0.0894
LOG_EPO_ does not Granger Cause LOG_SP_		4.20003	0.0015
LOG_SP_ does not Granger Cause LOG_ER_	132	3.16065	0.0102
LOG_ER_ does not Granger Cause LOG_SP_		0.25773	0.9352