FOOD SECURITY ANALYSIS: MACROECONOMICS VIEW IN MALAYSIA

BY

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DECLARATION

We hereby declare that:

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

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

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

(4) The word count of this research report is 14,049.

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Abstract

This study investigates the short run and long run relationship between Climate Change, Gross Domestic Product, Population, Corruption and Food security in Malaysia over the period from 1984 to 2013. This study will determine the channels of transmission such as government spending, subsidies, income level and how all these affect the food security in Malaysia. Autoregressive Distributed Lag (ARDL) approach is utilized in the research models to examine the present of long-run relationship between Climate Change, Gross Domestic Product, Population, Corruption and Food security. In the study result, it founds out that there is negative relationship between climate change and food security whilst gross domestic product and population maintained positive relationship with the food security in the long run. From the findings, it suggests that climate change (from carbon dioxide's perspective) will worsen the food security problem in the long run and thus, government should try to control the carbon dioxide emissions by setting a limit to each environmental polluting firm to maintain the food security in Malaysia. Besides that, Population and GDP will aid the food security problem in the long-run; government can come up with policies that improve GDP which lead to better food security.

Chapter 1: Overview

1.0 Introduction

Since the world food conference in year 1974, the concept of 'food security' was introduced because there are famine and food crises happening around the world. The researchers worldwide define the term 'food security' differently but lying still to the basic concepts. However, in view of the academic community, the term 'food security' has been redefined and developed into different categories and become more diversified. According to Food and Agriculture Organization (FAO), the problem of 'food insecurity' exists when people do not have sufficient access to food either physically, socially or economically. Khee, Mee and Keong (2011) stated that are four components of 'food security' stated by the FAO, which are food availability, accessibility, utilization and stability. This study begins with the introduction on the definitions of food security, follows by the issues of climate change, economic growth, population growth, and corruption with food security in Malaysia. With the aid of available data, this research accesses the severity of the climate change happening around the world that is continuously affecting the food security.

1.1 Food Security

1.1.1 Definition of 'Food Security' and 'Food Insecurity'

'Food secure' is where westerners always take it as there is sufficient food for people to achieve healthy and active lifestyle (Anderson, 1990; Hamelin, Beaudry and Habich, 2002). The term 'food insecurity' is often confused by people and most people would relate it as the same as poverty, but that is not the case (Rose, 1999). The poor might be more likely to experience 'food insecurity' but it is not necessary that all the poor has experienced 'food insecurity', it might be that the poor has access to food security if they are able to manage their spending behavior and income portion wisely as well as able to low-cost and nutritious meals.

Next session will further discuss the definition of 'Food Insecurity' and 'Food Security' in the way of to what extent that the people will be considered in either of these two. Food insecurity holds when the ability of a person to get safe foods (nutritious) is inconsistent, such as when the person is demanding/resorting the emergency food supplies or needing to beg or steal for food to meet his dietary needs (Bickel, Nord, Price, Hamilton and Cook, 2000). The person is considered to have 'Food Security' when he can get sufficient amount of safe and nutritious food at all times to meet his dietary needs for and healthy and active lifestyle (FAO, 2006; Maxwell, 2001).

1.2 Background of Food Security and the Issue in Malaysia

The climate change has been a major issue for many countries recently in many aspects which affected some sectors such as agricultures, forestry, ecosystem and health (Pearce, Cline, Achanta, Fankhauser, Pachauri, Tol and Vellinga, 1996; Watson, Zinyowera and Moss, 1996; McCarthy, Canziani, Leary,

Dokken, White, 2001). Since 1980s, there is an increasing trend in the global warming where the earth's average temperature has been increased by 1.2°F – 1.4°F in the last century (Mendelshon, 2007).

The climate change regime started at 1980s until 1990s after the discovery of 'o-zone hole' in year 1987 published by World Commission on Environment and Development (1987). This development regime until the conclusion of the Kyoto Protocol in 1997 which can finally be divided into 5 periods: Foundational when scientific concern about climate change; The agenda-setting phase where climate change transformed from scientific to policy issue during 1985 – 1988; When government start to concern heavily on this issue during 1988 – 1990; Formal intergovernmental negotiation-phase which lead to the adoption of FCCC in May 1992; Lastly the adoption of Kyoto Protocol in December 1997.

When the scientists have learnt about the greenhouse effect, the climate change issue started to take place. Through remote area observations, the scientists have found that the Co2 concentration is increased since the early 1960s. This has led to the uprising concern of scientists in 1960s until 1970s. In addition, the reports by U.S. Academy of Science (1979) states that "There is no reason to doubt that the climate change will result and no reason to believe that these changes will be negligible' if the carbon dioxide concentration continues to increase.

In Mahathir's vision 2020 where Malaysia targeted to achieve high income status, the industrial policy was introduced by Hirschman (2013). Malaysia aimed to produce high value added products to become an industrialized nation but it resulted in a contraction of agriculture sector, therefore the food security and sustainability was affected as well (Hill, Yean and Zin, 2012). There are shortages of food from domestic production with the increasing population despite the staple foods such as rice that grown in most states (Hossan, Mahmudul, Ali, Islam, Hoque, Bari and Emran, 2013). The rapid rise in population in 2014 had also

brought more pressure to Malaysia. All these have led the Malaysian government to the decision of importing foods from foreign countries, such as China and Thailand (Ministry of Finance Malaysia, 2011).

These recent crises arise the concern from around the world that it is necessary to have close monitoring the food sustainability on regular basis. Because of these acute rice crises, it forced the country from all over the world to reconsider the agriculture sustainability which is having strong negative relationship to the climate change. This is even forced the countries to develop an appraisal system to monitor the state of economic sustainability system from time to time.

Those major-rice producing company located in SEA region such as Thailand, Cambodia and Vietnam who had chosen to produce rice for the worldwide countries. They have now started to talk about export control, this implementation will be affecting many rice importing countries Indonesia as well as Malaysia. Consumer has to bear with the reduced domestic supply of rice which drives the price up further by several folds. Malaysia government had announced that they will be holding more rice stock by BERNAS (Padiberas National Berhad). Same with the neighboring countries, Philippines who has to beg its neighbor, Vietnam to supply them the rice they needed. The export control implemented by Thailand not only affected ASEAN but global rice exporting country by leading them into taking negative measures and the other rice importing countries to seek for alternative food sources.

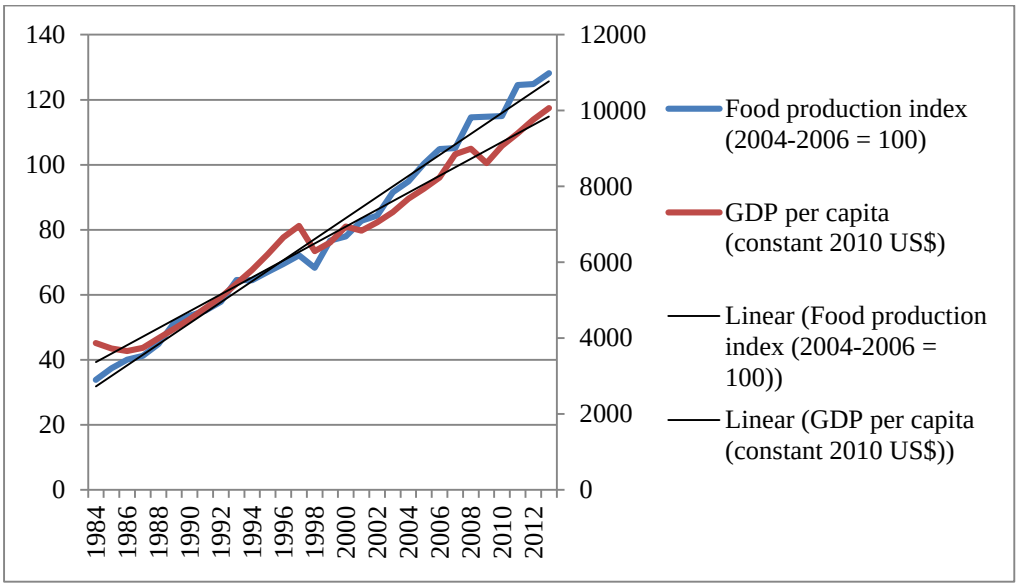
The food security issue has been concerned by Malaysian government because Malaysia is a net importer of staple food. The domestic agricultural sector can only supply the food to meet 70% - 80% of the people needs and therefore, BERNAS obtain the remaining food sources by importing. In Malaysia, the production of food commodity such as rice has faced several issues which are the increasing production cost, inefficiencies and also climate change problem, these

factors have led to lower production capability and typically the domestic production is costlier when compared to production in international markets (Arshad, 2011). In mid-2008, due to the height of crisis, Malaysia had difficulty in obtaining food supplies in the international markets; hence it forced the government to implement Malaysia Food Security Policy. It managed to reveal the food security problem in Malaysia. Food security problem has become so important that it is believed to affect the human security eventually, which is this had encouraged Malaysia to take a more proactive action. An important dependence has made Malaysia vulnerable to the market price sensitivity.

Malaysian corruption has ranked 55/175 countries and according to Political Risk Services Group (2016), the corruption rank has gone down to 23. Under Prime Minister Najib Rajak's governance, Malaysia formed a comprehensive anti-corruption program which is by using Hong Kong Independent Commission Against Corruption (ICAC)'s structure, the Malaysian Anti-Corruption Agency (MACC) as part of the Government Transformation Program (GTP). MACC has made an outstanding progress since 2008; Malaysian government has worked very hard in anti-corruption efforts (Hershman, n.d.). According to TradingEconomics, the decrease in corruption perception index during 2011 to 2014 has led to an increase in Food Production Index during this period (Worldbank, n.d.). However, according to actual survey done by PricewaterhouseCooper's(PwC) instead of using corruption perception index, Malaysia has ranked second highest in corruption level which is 30% as compared to her trading partners China, Japan and Singapore which are 46%, 24% and 17% respectively.

1.2.1 Gross Domestic Product and Food Security in Malaysia

Figure 1.1: Food Production Index vs GDP Per Capita



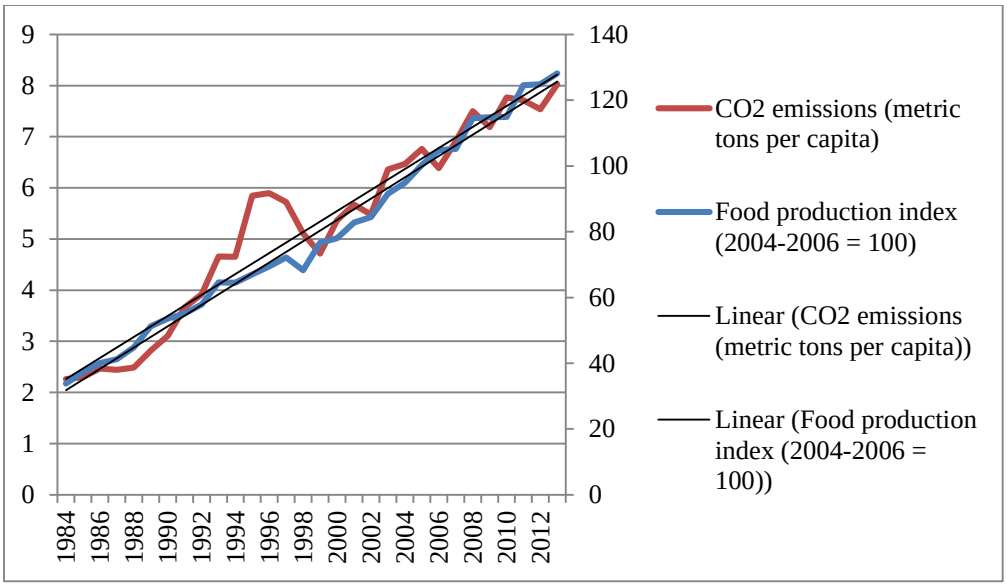
Sources: World Bank (2016)

The Figure 1.1 above demonstrated the comparison between Food Production Index with GDP per capita from 1984 to 2013. In this research, food security was represented by food production index. Over 30 years, both series also postulate upward trends. Hence, both series show that Malaysian Food Production Index and GDP per capita tend to move together.

Malaysia's economic growth can be observed from the steady growth in GDP level for years, 6% for 2012, and 4% for 2017. The agriculture productivity growth has been a driving source to the economic growth in developing country such as Malaysia. In sustainable economic growth or long-term growth, it requires the resources to be switched from agriculture sector to non-agriculture sector. As many developing economies growth, it leads to a decline in total agriculture output, however it does vary across different countries depending on how agriculture plays in structural transformation alongside with economic development (UKAid, 2014).

1.2.2 Climate change and Food Securityin Malaysia

Figure 1.2: Food Production Index vs Co2 emissions



Sources: World Bank (2016)

The Figure 1.2 above illustrates positive relationship between Food Production Index with GDP per capita over the 30-year period. Based on the graph above, both series also show growing trend. Therefore, upward trends of both data demonstrated that Co2 emissions and Food Production Index are both increasing.

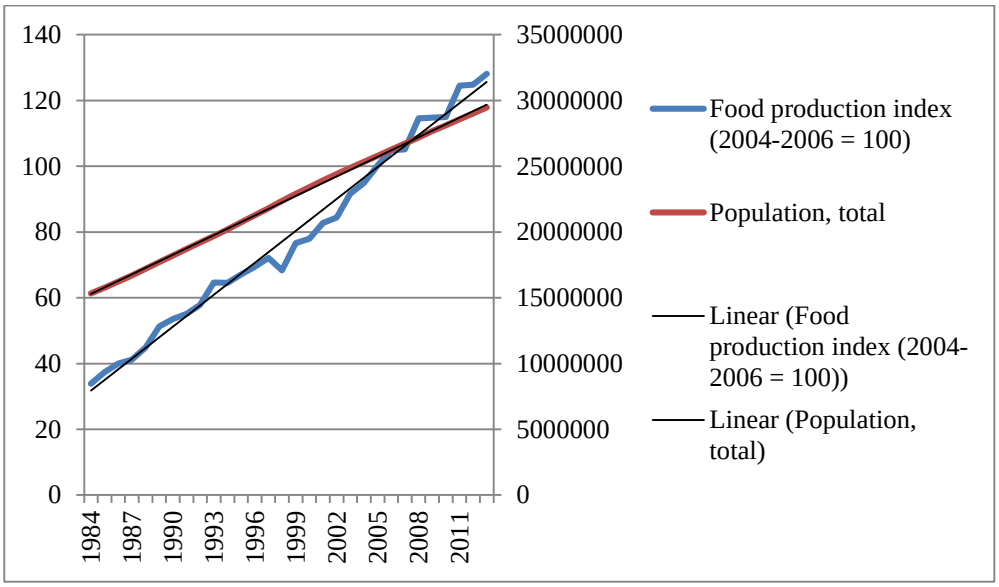
Malaysia is located in the South-East Asia (SEA) region bordered by Singapore and surrounded by Thailand, Indonesia and Brunei. The tropical weather of Malaysia is a best suitable condition for Malaysia to grow corps and generate production of fruits and vegetables. However, the Sabah and Sarawak's continent are not so suitable for planting corps and agriculture production because the area is covered with dense jungles.

There will be general effects of climate change that affect Malaysia's agriculture sectors such as reducing the corps yield, the oil palm plantation with 100,000 hectares and rubber plantation with 80,000 hectares will be flooded. There are dry months like monsoon season in Malaysia with very less rainfall, the increase in temperature will further growth the rate of evapotranspiration, which causes reduction in water availability and exacerbate the agriculture sector during this season.

The climate change impacts on the agricultural sustainability do vary between developed and developing countries and the economic condition between the countries as well. In the poorer area, the climate change is able to bring devastated losses in agriculture productivity caused by great reduction of crop yield, more effects shall befall on the poor in Malaysia. (Chamhuri, Mahmudul, Wahid and Abul, 2009).

1.2.3 Population and Food Security in Malaysia

Figure 1.3: Food Production Index vs Total Population



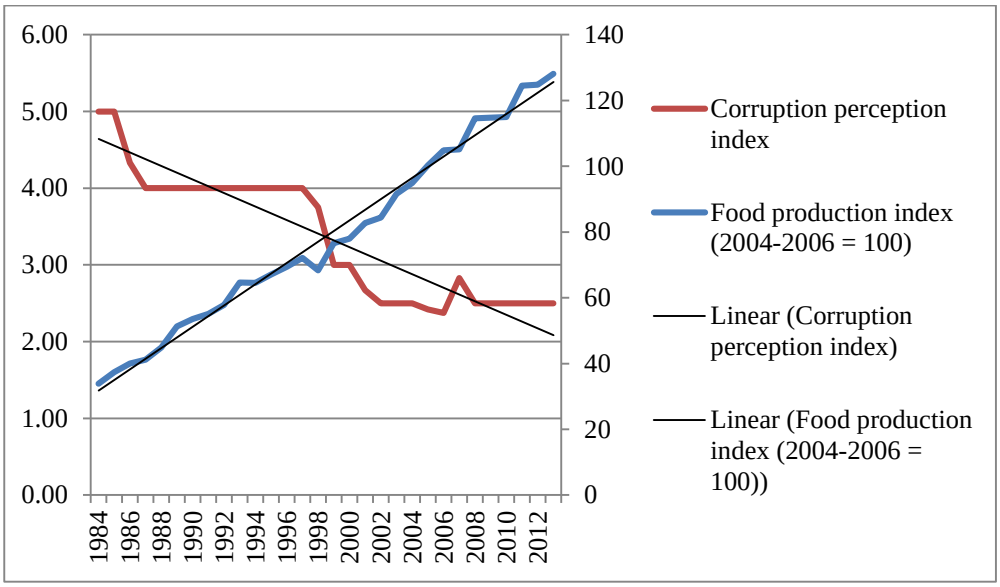
Sources: World Bank (2016)

Based on Figure 1.3, Malaysia total population showing increasing trend same result as Food Production Index. Population in Malaysia has been increasing steadily since 1984, 15 million until year 2013, and 29.5 million according to WorldBank (2016).

There is one study shows that the population growth will matches with agricultural production in locality, however if there are poor land management, more people being added will compete against the farm lands for other purposes such as building houses or commercial properties instead of utilizing it for the farming purposes, hence it will lower the productivity as the same farm land is used repeatedly (Kemjika, 2012). According to U.S. Department of Agriculture, Malaysian agricultural productivity has been decreased as comparison between year 1970 and 2000 and then start to show the increasing trend right after 2000 to year 2010.

1.2.4 Corruption and Food Security in Malaysia

Figure 1.4: Food Production Index vs Corruption Perception Index



Sources: Political Risk Services (PRS) Group (2016)

The Figure 1.4 demonstrated the inverse relationship among indices. Food production illustrates upward trend while corruption index showing negative trend at the same period. When corruption index decreases, it indicated that Malaysia corruption perception was increased over years, which means corruption and food production have the co-relationship.

Corruption is the abuse of public office for private benefits such as bribes and solicits. It brings negative impact to economic growth, FDI and human security (food security included) (Melis and Giudici, 2013). In one of the corruption and growth research done by Leite and Weidmann (1999), the results showed that the existence of corruption will always bring negative impact toward the growth effect of natural resources as compared to the case of non-existence of corruption and natural resources include agriculture production. In Malaysia, the corruption index has been decreased since 1984 to year 2013 (Political Risk Service Group), it indicates the good sign toward the agriculture production to present day.

1.2.5 The Viewpoint from Macroeconomic Variable Perspective on the Food Security in Malaysia

Malaysian economy was predominantly based on the primary commodities in the past in includes agricultural sector and mining activities. In agriculture, it is mainly rubber and timber which dominated 50% of the GDP. In 1987, the agriculture sector started to contract and the manufacturing sector dominated 23% of the GDP became a leading sector in Malaysia. In 2010, the food commodity has agriculture GDP of 43.6%. This implies that almost half of the agriculture GDP depends on the food commodities, a fall in the rice production would lead to fall in the consumption, and finally it brings significant impacts to the GDP itself. The fall of the rice productivity would lead to demand-pull inflation as well.

From the Macroeconomics viewpoint, it will analyze based on three perspectives of which are Expenditure approach, Production approach and Income approach. The expenditure approach consists of Household Spending, Investment, Government Spending and Net Exports. Government spending will help an economy to growth. For a developing country like Malaysia, Sinha (1998) found that government spending does not actually influencing Malaysia's economy. However, Tang (2001) found that the government spending effect on economy only in short-run.

Next, this session discusses the household consumption pattern of food. From October 2002 to December 2003, the Malaysian Adults Nutrition Survey (MANS) conducted a survey toward adults aged from 18 – 59 years. The results have shown that 97% of cooked rice was consumed daily (average of 2.5 plates per day), marine fish which was one medium fish per day and green leafy vegetables which was one cup per day. This consumption is higher in the rural area in comparison with the urban area's adults. Every country has a different consumption pattern, or even the gender, religious and

geographical area within the same country will have different consumption level. Thus, World Health Organization (WHO) mentioned that each country should estimate their own food consumption pattern in their country. Sook (2003) and Le, Le and Ngyen (2003) both stated that there are reduced in rice intake trends and Tee (1999) reported that there are steady declines in the calories intake by cereal from 1960s – 1990s in Malaysia. Majority of Malaysian consumes rice every day, the paddy field production is very important to the consumption of the Malaysian people, and of course so are the Marine fish and Leafy Green Vegetables. Sugar is the second highest consumption for Malaysian which usually being added into beverages, therefore the agricultural sectors regarding few sectors is important, especially the Paddy plantation, say there are accident occurred and dropped in production, the major decrease in the consumption will affect the economic growth of Malaysia (Norimah, Safiah, Jamal, Siti, Zuhaida, Rohida, Fatimah, Siti, Poh, Kandiah, Zalilah, Wan, Fatimah and Azmi, 2008).

In 1990, the paddy farming has increased to RM 248.10 per ton from 1980 which was RM 168 per tonnes, government has spent about RM 450 million annually. The fertilizer subsidy has increased overtime and it is meant to increase the productivity. The government spending (subsidy) has increased from RM 186 million in 2004 to RM 271 million in 2008 (World Trade Organization, n.d.). These fertilizer subsidies were aimed to encourage the farmers for using the fertilizer to reduce the production cost and to increase their income. The investment into the capital totaled RM 4.2 billion from 1956 to 1996.

During 2009, Malaysian government has spent RM 1.74 billion in various forms as subsidies for the fertilizer and incentives and increased the buffer stock from 92,000 mega tonnes (mt) to 292,000 mega tonnes (mt) since the rice crisis in 2009. Government also imposed high import duties on rice commodity in order to protect the domestic firm. Not only in fertilizer, government also allocated RM 40 million for the yield increase incentives

(RM 650 / 1 MT increase in yield), RM 250 million for rice miller subsidy (RM 750/MT in peninsula Malaysia, RM600/MT in Sabah & Sarawak) and total of government spending RM 1736.06 million as in year 2009 to get improvement in the food security. (Vengedasalam, Harris and MacAulay, 2011).

The Foreign Direct Investment (FDI) is related closely to the relative productivity performance in a country. There are foreign companies who invested in Malaysia's food sector and dominated certain number of shares.

1.3 Problem Statement

The relationship between food security and country economic growth is always an arguable issue over the past decade. Some studies have claimed that food security caused country economic growth while some have claimed otherwise that country economic growth caused food security. The relationship is still ambiguous. In fact, developed countries generally have excellent food security while developing countries are in general lacking in terms of food security. In order to have excellent food security, developing countries should not just focus on government expenditure or taxation, meanwhile countries needed to focus on three main factor of the country – production factor, expenditure factor and income factor. If a nation has impressive food security, it is expected to balance the composition of the economic structure and eventually enhance the potential of that particular country to grow further, such as Malaysia in achieving the Vision 2020.

High attention should be paid to food security because it carries positive impact to economy. Along with bad food security, country consumption will

reduce due to low food quality and unsafely. Meanwhile, consumption reduced will lead to taxation decreased and deduction of government spending. Bad food availability also impedes investment either foreign or private. Low investment indicated that low nation income, lesser corporate profit and eventually country will import quality food and net export dropped.

Food security was an issue and challenges for each developing country such as Malaysia. Malaysia economic growth is slow down partly due to food insecurity. According To Global Food Security Index (GFSI), Malaysia is in the top-tier of the 2015 with placing 34th out of 109 countries, but was far behind those developed countries such as Australia at the ninth spot with a score of 83.8, New Zealand at the 13th spot (82.8), Japan at the 21st rank (77.4), South Korea at the 26th place (74.8) while Singapore took second place in the ladder with an overall score of 88.2.Meanwhile, according to Economist Intelligence Unit (EIU), EIU did not comment specifically on Malaysia's performance, but noted that Gross Domestic Product growth and food security gains are driven by strong economic fundamentals in the Asia Pacific region. Thus, food security and economic growth surely having a strong relationship link each other.

Despite the ups and downs trend of Malaysia food security, Malaysia economy still was developing persistently over past 30 years. This has left a question about why Malaysia cannot become developed country such as Singapore and Taiwan. Therefore, it contributed the reason to believe that there might be have some factors that contribute to the food security with high degree of influence. While those factors were indirectly affect Malaysia economic growth through food security. If those factors have been overcome, could Malaysia acquire a state of the art food security meanwhile economic growth achieve to the next level? As a result, those factors should to strongly take into consideration whether it will have a negative or positive impact on food security and economic growth.

Last but not least, another issue is food security might have influence on economy growth at different periods. Having bad food security certainly will affect economy growth in long run, but in fact, food insecurity also will be certain impact in short run too. For example, according to Agboola (n.d.), African countries have been identified as donation countries from developed countries; these donations will affect the food market at African countries and discourages the farmers to produce crops. Therefore, agricultural production lesser in the short run and thereby making these countries even more food insecure instead of ensuring food security in the long run. Unfortunately, most of the policymakers put her sight on long run effect but frequently ignore the short run effect on economic growth. The result is unawareness of the food insecurity's crisis in the short run will increasing the impact on economic growth slowly just like a snowball getting bigger and eventually it might become a serious problem to control due to it has become rampant in long run.

1.4 Research Objective

The general objective of this study is to examine the ambiguous relationship between food security and the macroeconomics, namely factor such as economic growth, climate change, population and corruption in Malaysia from 1984 to 2013. The specific objectives are:

-To study how economic growth, climate change, population and corruption affect Malaysia food security.

-To investigate the long run relationship between economic growth, climate change, population, corruption and food security.

-To compare between models with and without the factor of corruption.

1.5 Significance of study

To the best of our knowledge, there is lack of empirical research which is focus on food security and growth in Malaysia. Majority of the previous studieson the relationship between food security with economic growth, climate change, population and corruption were mostly focus on other developing countries such as Africa countries or developing countries as a whole rather than Malaysia specifically. Due to it, Malaysia to obtain food security might still inconclusive. Therefore, it has caused those researchers' savor to conduct an in-depth study for Malaysia in order to close the gap between those previous studies in result.

Meanwhile, the various channel of transmission such as gross domestic product, population, climate change index, corruption perceived index that affect economic growth through food security might help those policymakers to obtain excellent food security efficiently and effectively. Therefore, policymakers might focus on various transmission channels with well management of government expenditure in order to drive Malaysia economic growth.

Moreover, this study found that majority of the previous researchers have used short period of data instead of longer period of data in examining the relationship between food security and its macroeconomics namely factor in country such as ten years or fifteen years. Hence, as suggested by Anderson, Burnham, Gould and Cherry (2001), this study uses the latest data available and prolong the time frame for longer period that may enhance the research results such as thirteen years or fifteen years.

All contributions in this paper are important in assisting those policymakers to implement better planning and policies in the future and have a chance to form a substantial foundation for policymakers to makeup policy for her country.

1.6 Chapter Layout

In This study, Chapter 1 discuss about the conspectus of food security with economic growth, climate change, population and corruption as well as its key issue in this study. Chapter 2 indicates the literature review that previous researchers have done. Meanwhile, chapter 3 was depicts of the data and methodology used in chapter 3, followed by empirical result was discussed in Chapter 4 before close out conclusion in chapter 5.

1.7 Conclusion

This chapter is an introduction to the study that will be conducted in the future chapter. It starts with the explanation of the research background, climate issues faced by Malaysia today, the relationship between economic growth, climate change, population, corruption and food security. Furthermore, it continues to examine the significance of the study and the objective of the study. This chapter provides the direction on the way that the study will be conducted in the later chapter.

Chapter Two: Literature Review

2.0 Gross Domestic Product in Leaps

Based on studies found, the purpose and objective of the journals were researched about the relationship between gross domestic product (GDP) and food security. For examples, Ruel, Garrett, Morris, Maxwell, Oshaug, Engle, Menon, Slack and Haddad (1998); Godfray, Beddington, Crute, Haddad, Lawrence, Muir and Toulmin(2010) explored about the relationship between the urban food availability and the nutrition security of the citizens. Besides that, Timmer (2004) interpreted about economic growth and food security was mutually interacted over the course of development which this consist of the income of citizens with the food security.

Moreover, Alila and Atieno (2006) studied about the agricultural sector strategy positive impact toward agricultural growth and seen as important for raising rural incomes and ensuring income equality. Additionally, Tey, et al. (2008) figured out the Malaysia's food demand system through econometric model by estimating expenditure elasticity on food commodity. Whereas, Wahid, et al. (2008) argued about latest Malaysian agricultural policies are compatible with stand of sustainable agriculture while Siwar, et al. (2009) tried to find out the economic condition and income level of Malaysia that effect the food security in Malaysia.

On the other hands, Van Dijk and Meijerink (2014) summarize, compare and evaluate global scenarios with a focus on global food security. Burchi and Muro (2015) figured out the functional of policy and the approaches of food security. But, Poulsen, et al. (2015) found that the impact of food security toward

poor country. However, Brankov and Milovanovic (2015) focused on study about Serbian food security system through a set of indicators.

Based on Ruel, et al. (1998); Timmer (2004); Tey, et al.(2008); Wahid, et al.(2008); Siwar, et al.(2009); Godfray, et al. (2010);VanDijk and Meijerink (2014);Burchi and Muro (2015); Poulsen, et al. (2015) all of them found out the result about the income level of citizens will directly affect the food security.

Ruel, et al. (1998) claimed that the household in the urban areas will mostly attempt to buy their food for consumption; low income level of citizens will pose challenges to the food security problem. However, Timmer (2004) proved that low income citizens will be the victim who always facing the food insecurity and unable to access of food. Besides that, Tey, et al. (2008); Wahid, et al. (2008) showed that increase in income level of citizens also lead to increase in domestic production. When domestic production increases will eventually increase in crop production while farmer's income will also increase due to crop production increases.

However, Siwar, et al. (2009); Godfray, et al. (2010) presented their results as income growth will allows food importing from other regions and countries which will improve the food production capabilities. There are projects showed that their yield has been doubled, especially increasing the income of both farm and rural non-farm household. Lack of land rights will discourage small holders to use the land productively. Thence, Burchi and Muro (2015); Poulsen, et al. (2015) also supported the viewpoint which increase in income of citizens will lead to food security. Unfortunately, Van Dijk and Meijerink (2014) found out another view which the increase in income of citizens will lead to another trouble which is food unequal distribution.

On the other hand, Alila and Atieno (2006) found out the public investments that caused agricultural production, costs and revenues and allocation of resources will be affected food production. Van Dijk and Meijerink (2014) proved that the investment affected the food production efficiency through the advance technology available in the agricultural sector and also the infrastructures provided. All those investment is use in technology and food accessibility of citizens.

2.1 Consequences of Carbon Dioxide Emission

Based on the journals, the purpose and objective of researches found out the relationship between carbon dioxide (CO2) with other variable. For examples, Lewis (n.d)found out the impact of the climate change toward China and what challenge should be face by the China when climate change is happening. Besides that, Gregory, Ingram, and Brklacich (2005) also analyzed the link between climate change with the food security issue and Schmidhuber and Tubiella (2007) tried to analyze the climate change affect food security through 4 dimensions like food availability, accessibility, stability and utilization.

Moreover, some researchers analyzed food security with different ways. For examples, Godfray, et al. (2010) went through the ways of analysis the strategy of sustainable and equitable food security. However, Mittal (2009) focused on factor that affected the crop production of the country. Furthermore, Siwar, Alam, Murad and Amin (2009) showed that there are finding the risk of food production stability of Malaysia which will affect by the factor of temperature, rainfall, pests, insect and disease attract. On the hands, Wahab, Applanaidu and Bakar (2015) found out the factors that have affected Malaysia's food security during 1982-2011 which include Co2 emissions, population and foreign workers.

Similarly, Gregory et al. (2005),Schmidhuber and Tubiella (2007),Godfrayet al. (2010), Mittal (2009), Siwar et al. (2009), and Wahab et al. (2015) found the same results which the climate change will affect the food production and the carbon dioxide will affect the food production in long run.

Besides that, Gregory et al. (2005) also showed the result of climate change will reduce the food production. Factors that affected food security is changing in rainfall that lead to flooding or the unpredictable change of the temperature thus change in the length of the growing season plus other factor which is change in markets, food prices and supply chain infrastructure. Besides that, region of a country also part of the reason that food production affected. Schmidhuber and Tubiella (2007) claimed that when the temperature more than 32 degree Celsius will impact the food production reduced by 5%. The climate change will bring benefit to developed country but negative impact to developing country. Meanwhile, increased agricultural productivity is a key step in reducing rural poverty. Godfray et al. (2010) showed the increase in Co2 will raise the crop yield. However, this is ambiguous in real agricultural production. The negative impact brought by Co2 emissions such as temperature, drought, pollutants, new disease pressure will reduce the benefits of plant growth and yields.

Moreover, Mittal (2009) also found out the result food production will be reduced due to the sensitivity of the temperature, weather, water supply and the rainfall. Nonetheless, the season of the country also will lead to reduce of food production. Siwar et al. (2009) also proved that grain production in Malaysia was heavily affected by the changing in climate, uncertainty in seasonal rainfall, fluctuations in temperature. In addition, economic development situation, population density, food availability and income level will directly affect the food security. According to Wahab et al. (2015) showed that carbon dioxide emissions will affects food security in the long run.

For examples, Lewis (n.d) stated that China scientist found out that the climate change of the country will be affected the ecosystem and also the agricultural production in the country. When temperature increase, it will cause the glacial melt and also arctic ice melt, both will cause the sea level increases. When sea level increases it will lead to flood and will reduce the food production of china. In survey said that the growth of the population and food consumption of the china already peaked which will directly affect the food security problem. When higher level of carbon dioxide will increase the crop growth but the high temperature will decrease the yield. Hence, high temperature also brings up the disease, weed and prevalence of pests. Those entire factors will directly affect the production of crop.

2.2 Population Multiplied in a World of Finite

According to the entire journal studied, the relationship between population and food security showed positive relationship which population and food security will increase or decrease jointly. For examples, Simon (2012) reviewed on food security and analyzed the dimensions of food security. Moreover, Van Dijk and Meijerink (2014) studied the relationship about the global scenario with global food security problem. Whereas Wahab et al. (2015) figured out the factor that will cause food security problem in Malaysia such as carbon dioxide, population and foreign workers. In addition, Istikoma, Ain and Dahlan (2015) found out the benefit of transforming one country from agricultural based economy to industrial based.

Based on the journal studied, Delgado (1999),Trostle (2008),Siwar, Alam, et al. (2009), Simon (2012),Van Dijk and Meijerink (2014),Wahab, et al. (2015), and Istikoma, et al. (2015) showed the results which the growth population will lead to

increase in food production due to the demand will be increased and food production or supply must be increased at the same time.

According to Delgado (1999), the demand of agricultural product will be increased due to the increase in population. Furthermore, Trostle (2008) also claimed that in developing countries, the demand for agricultural commodities have strong relationship with income and rising population. For examples, Siwar, et al. (2009) showed that Malaysian grains production has been in risk due to population density will direct affect the food security. Staal, Steeg and Herrero (2010) showed that the farm sizes has increased due to increase in food production when rural population getting lower whilst Godfray et al. (2010)proved that by increasing in population also implies that the global demand for food will be increased as well.

Besides that, Simon (2012) said that population has grew more rapidly as the population was increasing during the last decades. Even now, more food has produced to enough feed the world population than ever before. Therefore, Van Dijk and Meijerink (2014) found out the rapid growth of population will be hampering the food availability. However, Wahab et al. (2015) argued that foreign workers were the only factor that would affect food security in long run and short run. Other than that, the determinants such as population, carbon dioxide emissions and food price also will affect food security in long run.

Istikoma et al. (2015) mentioned that the global requirement of agriculture expected to expand rapidly with growing population as well as rising property. Thus, Malaysia agriculture get a lot of benefits from the growing demand but still lagged behind countries such as Vietnam and Indonesia. For examples, Malaysia's average yield per hectare of rice production only has 3.7 tons as compared to 4.9 tons and 4.7 tons in Vietnam and Indonesia respectively and it also providing rural development including the increasing in income of the rural population will ensuring the national food security.

2.3 Corruption Severity

From the journal review the objectives is to find out how corruption can be related to causes and consequences such as to analyze the relationship between poverty and corruption. For example, Tanzi (1998) stated that the government ability to necessary rule implementation and market failures inspection. For example, the government created monopolies for personal purpose and interest; it will be contributed to the prevailing market failures. Arunachalam (2003) also stated that the corruption will leads to increase in the poverty level and this effect would reduce the agricultural output growth.

Meanwhile, analyzing the cost of corruption and to find out is corruption will paralyze government from meeting her obligation to respect, fulfill and protect the human rights of her citizen. Cost of corruption included that community or society will feels insecure when military and government are found to be corrupted when there is lack of food security (Prasad, 2008). Research done by Gathii (2009), corruption causes resources to be depleted instead of going to fund the access of adequate food as corruption will bring the public interest toward self-sufficiency or private consumption.

According to Peter (2011) research it tries to identify the problems that are militating effective mechanism to combat corruption. Behavior that considered to be corrupted is likely to be more prominent in developing countries. Vice versa, in developed countries is less likely affected by corruption. A corrupt government may not necessarily impede social development. For example, Corruption impact toward Russian and American economic development which in turn improving food production (Peter, 2011).

This study also examined a case study in Florida on political corruption and relationship between corruption human securities in Arab countries as well as how

it undermines the economy security. Wilson (2013) claimed that political corruption can brings negative impact toward food security for the case such as the international aid shipments are seized and resold by corrupt actors. Corruption has negatively affect human security in Arab countries in many ways, and the human security revolves around three aspects such as freedom from fear, want, and shame. In result, these aspects will roughly corresponds to freedom from violence, deprivation, and loss of dignity (Jamali, Lanteri and Walburn, 2013).

Besides that, linking human security and corruption as well as to analyze the risks and forms of corruption in the land sector citing some documented by taking the examples from the world and from Serbia. According to Melis and Giudici (2013), corruption has been regarded to affect human development negatively such as public services (goods). In the example of Serbia, corruption has reduced the fund for the public sector maintenance which leads to increase in inaccessibility rural area to food (Brankov and Tanjevic, 2013).

According to Igbaekemen, Abbah and Geidam (2014), they identified to what extend does corruption affected the socio-economic development of Nigeria and found out that corruption will reduce the accessibility of people to the few food crops that are produced by the peasant farmers in the rural areas. It creates big gap between rich and poor plus inequality of the food accessibility. Lack of money to provide infrastructures lead to the poor image of the country to attract Foreign Direct Investment (FDI) and reduce the convenience of food availability. In Folarin (2014)'s research also examines the policies implication of corruption for governance in Nigeria since independent. It founds out that the corruption actually drive up the price of foods which could affect food security due to the high price. Consumers with lower income will be affected more severely as the foods' cost dominated a large proportion in their income.

Additionally, this study examined how corruption in both the public sector affects to the food security and how it brings impact on the right of food in Kenya.

Malota (2015) found that in public sector, the benefits of food aid projects will continue to suffer as it is affected the theft and presence of corruption. For example, the government in Zimbabwe failed to achieve greater transparency in diamond production and revenue collection affected its ability to invest in desperately needed such as food. In Kenya, large amount of contracts gave opportunities for corruption such as grabbing resources from public spending and Kakeeto and Losoncz (2015) mentioned that corruption is indirectly affected food security not directly and as important factor eventually violated the human rights.

The issue of corruption also threatens the democracy and the market economy and it is one of the objectives to determine how corruption affected it. Oyadiran and Success (2015) claimed that corruption which manifests itself in weak governance and patronage based politics has caused unproductive public spending and investment in the agricultural sectors and thus threatens to achieve goals of the world which included the Millennium Development Goals for year 2015.

2.4 The Gap of Study

After the study found that the research normally is studying about oversea country which is lack of study on Malaysia's context, so the result cannot really perform well in Malaysia. Moreover, the data of the study also not suitable for Malaysia study while the Malaysia also lacks of the research and journal to conduct this study. Besides that, there are no specific journal mentioned corruption will affects the food security in Malaysia. Hence, tests will be conducted in Chapter 3 and the results will be shown in chapter 4.

Chapter 3: Methodology

3.0 Introduction

The purpose of this methodology is to conduct a research on the relationship of Food Security, GDP, CO2 emissions, Population and Corruption. The study and analysis of the literature review has been accomplished in the Chapter 2 has provide critical information to construct an econometric model in this study. Meanwhile, Econometric Model and various type of econometric technique and diagnose checking will be further discuss in this chapter.

Econometric Technique applied in this research is ARDL approach. Purpose of using ARDL approach is to examine the long run and short run effect between food security and variables. To ensure that ARDL approach can be suitable model in this study, few procedures were established. Firstly, Augmented Dickey Fuller (ADF) test and Phillips–Perron Test is applied to ensure variables are stationary in the model in order to avoid spurious regression problem. Besides that, diagnostic checking used to avoid the results become biased, inconsistent and inefficient. Test used for diagnostic checking are Autoregressive conditional heteroscedasticity (ARCH) and serial correlation LM test. Whereas, tests for stability in ARDL parameters are cumulative sum of recursive residuals test (CUSUM) and cumulative sum of recursive residuals of squares test (CUSUMSQ).In addition, secondary data was collected from sources such as World Bank and Political Risk Services (PRS) Group for analysis purpose in this research from 1984 to 2013 in Malaysia annually.

Therefore, those hypotheses that formed in the earlier chapters will be able to identify by using this research method. Meanwhile, long run and short run relationship between variables also can be detected.

3.1 Data Description

Time series analysis is used to examine the relationship between Climate Change, Population and Corruption on Food Security in Malaysia during 1984 to 2013. Below are the table that shows the variable used and source of data:

Table 3.1: Summary of Variable and Source of Data

	Abbreviation	Variable	Source
Food Security	lnFOOD	Food production index (2004-2006 = 100)	-World Bank
Economic Growth	lnGDP	GDP per capita (constant 2010 US$)	-World Bank
Climate change	lnCO2	CO2 emissions (metric tons per capita)	-World Bank
Population	lnPOP	Population, total	-World Bank
Corruption	lnCOR	Corruption Index	-Political Risk Services (PRS) Group

Adapted from: World Bank Indicator (2016)

3.1.1 Dependent Variables Description

3.1.1.1 Food Production Index

Food Production Index included food crops that are consumable and nutritious and those non-nutrients such as coffee and tea are excluded (World Bank, 2016). Food security is combined of four components, which are food availability, accessibility, utilization and stability. Meanwhile, food production is consists of stocks levels, net food export and food aid transfers and is known as food availability. According to FAO (1996), local food production is the most crucial quantitative component in national food security for most of the countries. Furthermore, food security often emphasized food availability to measure developed for use at the country level (Jones, Ngure, Pelto and Young, 2013). Therefore, lack of food supply will threat to people's life and safety. Thus, this is reason food production proxy as food security in this research.

3.1.2 Independent Variables Description

3.1.2.1 GDP per Capita

GDP per capita is gross domestic product divided by total population. GDP is the sum of consumer spending, government expenditure, investment and net export by all the citizen producers in the economy. All product and services were value added in GDP. Data are using 2010 U.S. dollars constantly (World Bank, 2016). GDP is used in per capita to see how each person in the population in Malaysia produced in a year. Sometimes, relatively high GDP in a country doesn't indicates a country have a high GDP per capita due too large population in the country. Therefore, GDP per capita is a more reliable measurement to determine the economics of a country based on individual perspective.

3.1.2.2 CO2 Emissions

Burning of fossil fuels and the manufacture of cement are the main contributors to carbon dioxide emissions. For instance, consumption of solid, liquid, and gas fuels and gas flaring were turned to carbon dioxide (World Bank, 2016). In this study, CO2 emissions (metric tons per capita) are applied as proxy of climate change due to Carbon dioxide is the main contributor of greenhouse gas to recent climate change. Same reason as GDP per capita, using metric tons per capita allow to find out the amount of CO2 emitted by each person in

the world. This will helped to determine the amount of CO2 emitted by per individual.

3.1.2.3 Population

Total population is a sum up of the legal status or citizenship for all residents' counts while the numbers is calculated by semi-annually (World Bank, 2016). Population matter to food security because increasing people in this world often increase the demand of the food. Thus, population become an essential factor to for food security.

3.1.2.4 Corruption Perception Index

Corruption also called as bribery and is the abuse of private gain by using entrusted power (Transparency International, 2016). While, Corruption Perception Index used in this research is International Country Risk Guide (ICRG) published by Political Risk Services (PRS) Group which consist of three risks such as political risk, financial risk and economic risk. This corruption index in ICRG ranges from 0 to 6 and lower score indicated highly corruption while higher score indicated low corruption.

3.2 Econometric Model

3.2.1 Base Model

This research proposes an econometric model that Malaysia's Food Production Index as a function of Gross Domestic Product, Co2 emission and Population. Meanwhile, Malaysia's Food Production Index as a proxy for Food Security. The econometric model for the Food Production index that is derived from literature review of the pervious chapter was constructed as below:

Food Production Index = f (GDP per capita, CO2 emissions per capita, Population)

$$\ln FOOD = \beta_0 + \alpha_1 \ln GDP_t + \alpha_2 \ln CO2_t + \alpha_3 \ln POP_t + \varepsilon_t$$

Where,

lnFOOD = Food production index (2004-2006 = 100)

β_0 = intercept of equation 3.1 at time t

$\alpha_1 \ln GDP_t$ = GDP per capita (constant 2010 US$) at time t

$\alpha_2 \ln CO2_t$ = CO2 emissions (metric tons per capita) at time t

$\alpha_3 \ln POP_t$ = Population, total at time t

ε_t= error term at time t

[Eq 3.1]

Above is the base model applied in this research and the data set was retrieved from 1984 to 2013.

3.2.2 Model with Corruption Perception Index

The model used to make comparison for this research was proposed an additional econometric model that Corruption added as independent variable into equation 3.1. The purpose of added extra variable is to examine if Corruption have short and long run relationship with Food Security. According to Uchendu and Abolarin (2015), a positive relationship between corruption and food security implied that as corruption decreased food security increased. The additional econometric model was constructed as below:

Food Production Index = f (GDP per capita, CO2 emissions per capita, Population, Corruption Index)

$$\ln FOOD = \beta_0 + \alpha_1 \ln GDP_t + \alpha_2 \ln CO2_t + \alpha_3 \ln POP_t + \alpha_4 \ln COR_t + \varepsilon_t$$

Where,

lnFOOD = Food production index (2004-2006 = 100)

β_0 = intercept of equation 3.1 at time t

$\alpha_1 \ln GDP_t$ = GDP per capita (constant 2010 US$) at time t

$\alpha_2 \ln CO2_t$ = CO2 emissions (metric tons per capita) at time t

$\alpha_3 \ln POP_t$ = Population, total at time t

$\alpha_4 \ln COR_t$ = Corruption Index

ε_t= error term at time t

[Eq 3.2]

In the event with corruption index, corruption will having a critical role to test whether it will affected food security in short run or long run in Malaysia.

3.3 Empirical Testing Procedures

3.3.1 ARDL Approach

ARDL modelling is selected in this research. ARDL modelling selected because it enable to identify the long run relationship between the dependent variable and independent variables. While, the advantages of using ARDL modelling is because it can be applied with a mixture of integrated of order zero, I(0) and integrated of order one, I(1) data. Compare to VECM and VAR modelling, VECM modelling can be use for non-stationary series (all variables must be integrated of order one) while VAR modelling must be stationary series (all variables must be integrated of order zero). Besides that, VECM and VAR model required to use a standardized lag lengths for all variables but ARDL modelling was allowed different lag lengths for different variables once they enter into the model. Furthermore, Belloumi (2014) states that ARDL approach is an approach that is more efficient especially in small sample sizes.

Model with an unrestricted intercept but no trend, which is case III in Pesaran, Shin and Smith (2001) terminology is employed in this study. While the lag length, Schwarz (Bayes) Information Criterion (SIC) is selected because it is a consistent model-selector and the sample size needed are not necessary large to provide accuracy (Kass and Wasserman, 1995).

In order to study the long run relationship between food security and independent variables, the equation of "unrestricted" error correction model (UECM) or conditional ECM called by Pesaran et al. (2001) without and with corruption is constructed as follow:

Base Model:

$$\Delta \ln FOOD_t = \alpha_0 + \sum_{i=1}^{k} \alpha_1 \Delta \ln FOOD_{t-i} + \sum_{i=1}^{k} \alpha_2 \Delta \ln(M)_{t-i} + \gamma_1 \ln Food_{t-1} + \gamma_2 \ln(M)_{t-1} + \varepsilon_{1t}$$

[Eq 3.3]

Model with Corruption Perception Index:

$$\Delta \ln FOOD_t = \beta_0 + \sum_{i=1}^{j} \beta_1 \Delta \ln FOOD_{t-i} + \sum_{i=1}^{j} \beta_2 \Delta \ln(N)_{t-i} + \eta_1 \ln Food_{t-1} + \eta_2 \ln(N)_{t-1} + \varepsilon_{2t}$$

[Eq 3.4]

Where Δ represents the lag operator in this model, α and β denoted as short run parameter while γ and η denoted as long run parameter. M= (GDP, CO2, POP) and N= (GDP, CO2, POP, COR). k and j are the optimal lag of the variables. ε_1 and ε_2 is the error terms for each models.

3.3.2 Unit Root Test

In line with the common practice in literature of time series analysis unit roots is conducted before the ARDL modelling. The purpose of unit root test is to determine the integrated order of each time series variable and identify their stationarity. As one of the requirement of ARDL model estimation is that no variable used are integrated at the second order, I(2), and above, therefore all the variables being fitted to this model should be stationary in either at level, I(0), or at first order I(1). Meanwhile, stationary indicate that the mean and variance are constant over time. If non-stationary variables used, it certainly acquired a misleading conclusion and spurious regression. There are few unit root test can be applied to examine a time series such as Dickey-Fuller Test, Augmented Dickey-Fuller (ADF) Test, Phillips–Perron Test and KPSS Test. Among so many tests, Augmented Dickey-Fuller Test and Phillips–Perron Test are selected to examine this research model.

3.3.2.1 Augmented Dickey-Fuller (ADF) Test

The reason Augmented Dickey-Fuller (ADF) Test selected is because Dickey–Fuller procedures have a wide range of application in order to obtain good result (Greene, 2002). The appropriated lag length of Augmented Dickey-Fuller Test is being considered by using Schwarz (Bayesian) Criterion (SC) in this study. The null hypothesis is variable has unit root while the alternative hypothesis is variable has no unit root. In fact, if the variable cannot be rejected in constant level but can be rejected in first differences indicates that variable is I(1) while if the variable rejected on constant level indicates that variable is I(0). However, any of the variable need to avoid to reach until I(2) because

the ARDL coinegration method will no longer applicable due to the F-statistic produced by Pesaran, Shin and Smith (2001) will be invalid.

3.3.2.2 Phillips–Perron (PP) Test

Phillips-Perron (PP) Test is second unit root test in this research. Although PP test cannot adding lagged difference term in the variables due to it is a nonparametric test, it offered to deal with the serial correlation problem in error term. The requirement for PP test is no structural break which our model is fulfill. Furthermore, PP test is appropriate to this research compare to DF/ADF/KPSS test because PP test specializing for small sample size. Well, the null hypothesis is similar to ADF test and the variable should be at I(0) or I(1), no I(2) are allowed.

After unit root test for all variables determined as either I(0) or I(1), the next step is co-integration analysis for ARDL model by using Bound Test.

3.3.3 Cointegration

Cointegration analysis will be the second step in ARDL modelling. The purpose cointegration techniques implemented is for examining the existence of long run relationship among dependent variable and independent variables. It shows a very critical and necessary role in this research because in order to avoid spurious regression problem in this time series model. According to these studies used cointegration based on either Engle and Granger (1987) or

the maximum likelihood test based on Johansen (1988) and Johansen and Juselius (1990), their cointegration techniques may not be appropriate when the sample size is too small (Odhiambo, 2009). Hence, Cointegration Test applied in this research is Bound Test.

3.3.3.1 Bound Test

ARDL bound testing cointegration approach which is provides better results for small sample size was developed by Pesaran and Shin (1997) to examine the existence of the long run relationship and short run dynamic interactions among dependent variable and independent variables. But, critical value developed by Pesaran and Shin (1997) was not suitable for small sample size and only suitable for large sample size such as 500 observations or above and this was argued by Narayan (2005). Therefore, critical value of ARDL bound test in this research was used critical value reproduced by Narayan (2005) that specific for small sample size. The bound test is based on the F-statistic which the null hypothesis is no cointegration while alternative hypothesis is have cointegration. If F-statistic larger than critical value indicates that the model is cointegrated, vice versa. Whereas, if F-statistic falls between lower bound critical value and upper critical value indicates that this model contains inconclusive result. Cointegration and long run form is the following step of the two stages procedures after ARDL bound tested.

3.3.3.2 Cointegration and Long Run Form

After Bound test was examined, the next cointegration analysis will be cointegration and long run form. This stage is to estimate the short run and long run coefficients in ARDL model. There have divided into two parts in cointegration and long run form, cointegrating form and long run coefficients. For cointegrating form, the error-correction coefficient in cointegration and long run form is required to be negative, less than one and must be statistically significant. This is because error-correction coefficient is represents the speed of adjustment from short run to long run and captures the long run residual(Ahmed, Muzib and Roy, 2013). For long run coefficients part, the null hypothesis is no long run relationship while alternative hypothesis is has long run relationship. If probability value is less than critical value, it indicates that the independent variable and dependent variable have long run relationship, vice versa.

The equations of "restricted" error correction model (ECM) for model with corruption and without corruption are constructed below:

Base Model:

$$\Delta \ln FOOD_t = \alpha_0 + \sum_{i=1}^{k} \alpha_1 \Delta \ln FOOD_{t-i} + \sum_{i=1}^{k} \alpha_2 \Delta \ln(M)_{t-i} + \phi_1 Z_{t-1} + \varepsilon_{1t}$$

[Eq 3.5]

Model with Corruption Perception Index:

$$\Delta \ln FOOD_t = \beta_0 + \sum_{i=1}^{j} \beta_1 \Delta \ln FOOD_{t-i} + \sum_{i=1}^{j} \beta_2 \Delta \ln(N)_{t-i} + \phi_2 W_{t-1} + \varepsilon_{2t}$$

[Eq 3.6]

Where speed of adjustment are ϕ_1 and ϕ_2 for each model respectively while $Z_{t-1} = (\ln Food_{t-1} - \varphi_0 - \varphi_1 \ln GDP_{t-1} - \varphi_2 \ln CO2_{t-1} - \varphi_3 \ln POP_{t-1})$ and $W_{t-1} = (\ln Food_{t-1} - \psi_0 - \psi_1 \ln GDP_{t-1} - \psi_2 \ln CO2_{t-1} - \psi_3 \ln POP_{t-1})$. Remaining represented symbol has been described at UECM model.

Once found out the cointegration relationship is existed, long run model constructed below:

Base Model:

$$\ln Food_t = \varphi_0 + \varphi_1 \ln GDP_t + \varphi_2 \ln CO2_t + \varphi_3 \ln POP_t + \nu_t$$

[Eq 3.7]

Model with Corruption Perception Index:

$$\mathrm{InFood}_t = \psi_0 + \psi_1 \mathrm{lnGDP}_t + \psi_2 \mathrm{lnCO2}_t + \psi_3 \mathrm{lnPOP}_t + \psi_4 \mathrm{lnCOR}_t + \nu_t$$

[Eq 3.8]

3.4 Diagnostic Checking

There are few Diagnostic Checking conducted in this research such as Autoregressive Conditional Heteroscedasticity (ARCH) Test, Breusch-Godfrey Serial Correlation LM Test, CUSUM and CUSUMSQ Test. These checking are to avoid that the result become biased, inconsistent and inefficient. In Econometric, few econometric problem need to be avoid such as heteroscedasticity and autocorrelation. All tests were performed by E-view 9.

3.4.1 Autoregressive Conditional Heteroscedasticity (ARCH) Test

H_0: There is Homoscedasticity

H_1: There is Heteroscedasticity

The null hypothesis for ARCH test is set as above. Heteroscedasticity is one of the problems in Econometric. It was a situation when the variability of the error term is not constant and varies across the value of independent variable. The purpose of using ARCH test is to detect

heteroscedasticity for time series data. The null hypothesis will be rejected if p-value of X^2 is smaller than at 1%, 5% or 10% significance level.

3.4.2 Breusch-Godfrey Serial Correlation LM Test

H_0: There is no serial correlation problem

H_1: There is serial correlation problem

The null hypothesis for Breusch-Godfrey Serial Correlation LM Test is set as above. Serial correlation occurs when the error terns are correlated. Time series data often happens of serial correlation. Breusch-Godfrey Serial Correlation LM Test applied because it can able to detect presence of serial correlation at higher order of autocorrelation while other test such as Durbin-Watson and Durbin's h Test is unable. The null hypothesis will be rejected if p-value of X^2 is smaller than at 1%, 5% or 10% significance level.

3.4.3 CUSUM and CUSUMSQ Test

The purpose of using Cumulative sum of recursive residuals (CUSUM) and cumulative sum of recursive residuals of squares (CUSUMSQ) is to examine the stability of the coefficients. The plot must fall within the range of the straight line to indicate that the stability of parameters at 5% significant level.

Chapter 4: Empirical Results

4.0 Introduction

This chapter will interpret results of methodology discussed in chapter 3. It will explain the result of the long run relationship between climate change, population, corruption and Malaysia's food security.

Table 4.1 and table 4.2 represent the result of ADF Unit Root Test and PP Unit Root Test while the outcome of ARDL bound test is presented in table 4.3 and table 4.4. Once the cointegration existed in the models, long run and short run estimation displayed in table 4.5 and table 4.6 respectively. Besides, table 4.7 illustrates the outcome of diagnostic checking. In addition, Figure 4.1 and Figure 4.2 have shown the structural stability of the models by using CUSUM and CUSUMSQ stability test.

4.1 Unit Root Test

Although unit root test on variables does not required in ARDL, but these tests could shows whether the model is suitable to be used (Duasa, 2007). The null hypothesis for unit root test had been mentioned in previous chapter. Augmented Dickey Fuller (ADF) Test and Phillips-Perron (PP) Test selected to check whether the variables have unit root or not. Table 4.1 illustrates the result of ADF Test at level form and first difference form while Table 4.2 illustrates the result of PP Test at level form and first difference form.

Table 4.1: ADF Unit Root Test Result

Augmented Dickey Fuller Test				
Variables	**Constant Level (p-value)**	**First Difference (p-value)**	**Constant Level (p-value)**	**First Difference (p-value)**
	Intercept without trend		**Intercept with trend**	
lnFOOD	-2.465 (0.1343)	-6.892*** (0.000)	-2.842 (0.1973)	-7.651*** (0.000)
lnGDP	-0.445 (0.8882)	-4.617*** (0.001)	-1.596 (0.7697)	-4.597*** (0.0053)
lnCO2	-1.538 (0.5008)	-5.175*** (0.0002)	-1.457 (0.8212)	-5.393*** (0.0008)
lnPOP	-4.359*** (0.0031)	-0.9466 (0.7512)	-1.515 (0.7911)	-3.188 (0.1161)
lnCOR	-1.38 (0.5763)	-5.43*** (0.0001)	-1.708 (0.7216)	-5.504*** (0.0006)

Remarks: All variables had been changed to natural logs while (***), (**) and (*) indicates that variables are statistically significant at 1%, 5% and 10% respectively.

Based on the ADF test result, only population achieved stationary at level form (intercept without trend) while other variables such as Food Production Index, Gross Domestic Product per capita and CO2 achieved stationary at first difference form. Meanwhile, for Corruption Index from model with Corruption Perception Index, it achieved stationary at first difference form. On the other hand, population was not achieved stationary at level form (intercept with trend) and thereby the result without trend selected.

Table 4.2: PP Unit Root Test Result

Phillips-Perron Test				
Variables	**Constant Level (p-value)**	**First Difference (p-value)**	**Constant Level (p-value)**	**First Difference (p-value)**
	Intercept without trend		**Intercept with trend**	
lnFOOD	-3.28 (0.0253)	-6.875*** (0.000)	-2.756 (0.2236)	-7.826*** (0.000)
lnGDP	-0.463 (0.8847)	-4.611*** (0.001)	-1.827 (0.6655)	-4.591*** (0.0054)
lnCO2	-1.555 (0.4923)	-5.175*** (0.0002)	-1.457 (0.8212)	-5.391*** (0.0008)
lnPOP	-12.688*** (0.000)	-0.261 (0.9717)	-0.648 (0.9992)	-3.086 (0.1288)
lnCOR	-1.385 (0.5766)	-5.428 (0.0001)	-1.930 (0.6133)	-5.497*** (0.0006)

Remarks: All variables had been changed to natural logs while (***), (**) and (*) indicates that variables are statistically significant at 1%, 5% and 10% respectively.

Whereas PP Test, the result is quite similar to ADF Test and all variables are interpreted in the same way. Gross Domestic Product per capita and CO2 also achieved stationary at first difference form while Population achieved stationary at level form (intercept without trend), same for Corruption Index from model with Corruption Perception Index. ADF test and PP test only has slightly difference in their τ statistic and p-value and the variation between ADF test and PP test would not lead to a different result.

Thence, both tests provided a same result which suitable for ARDL modeling {consist of I(0) and I(1) variable}. Variables of Population are significant at level form which rejected the null hypothesis at 1% significance level. Whereas variables of Food Production Index, GDP per capita, CO2 and

Corruption Index are significance at first difference form which rejected the null hypothesis at 1% significance level.

4.2 ARDL Bound Testing for Cointegration

ARDL Bound Test used to examine the long run relationship among those variables in this research. For Bounds test, F-statistic are comparing with I(0) and I(1) critical values from Narayan (2005). The null hypothesis for bound test had been mentioned in previous chapter.

4.2.1 Base Model

Table 4.3: Bound Test Result (Base Model)

Bound Test			
Model	**Optimal Lag Length**	**F-statistic**	**Conclusion**
Base Model	(1,0,2,0)	4.41*	Cointegration
Critical Value	**I(0)**	**I(1)**	
1%	5.333	7.063	
5%	3.71	5.018	
10%	3.008	4.15	

Remarks: (*) indicates that model is cointegrated at 10%.

For Base Model, the F-statistic is higher than the upper critical value at 10% significance level. In addition, fall between lower and upper critical value indicates that the base model contains inconclusive result at 5% while

fall below lower critical value means that the base model has no cointegration relationship because was rejected at 1% significance level. Thus, the base model was significance at 10% can conclude that this model is cointegration. Based on the lowest SIC, optimal lag length (1,0,2,0) was chosen for Food Production Index, GDP per capita, CO2 and Population respectively.

4.2.2 Model with Corruption Perception Index

Table 4.4: Bound Test Result (Model with Corruption Perception Index)

Bound Test			
Model	**Optimal Lag Length**	**F-statistic**	**Conclusion**
Model with Corruption	(1,0,1,0,0)	3.9937	No Cointegration
Critical Value	**I(0)**	**I(1)**	
1%	4.768	6.67	
5%	3.354	4.774	
10%	2.752	3.994	

Remarks: (*) indicates that model is cointegrated at 10%.

For Model with Corruption Perception Index, fall between lower and upper critical value indicates that the model with Corruption Perception Index contains inconclusive result at 10% and 5% significance level while fall below lower critical value means that the model with Corruption Perception Index has no cointegration relationship because was rejected at 1% significance level. Thus, model with Corruption Perception Index can be concluded that have no cointegration relationship at any significant level. Hence, the result of model with Corruption Perception Index was not acceptable and treated as long run relationships not existed among dependent variable and independent variables.

4.3 Long Run and Short Run Relationship

Table 4.5 demonstrated long run relationship among variables of base model in this research. Based on the table 4.5, base model illustrates that CO2 will affects food production negatively in long run while GDP along with population will have positive impact on food production. On the other hand, model with Corruption Perception Index suspended and long run and short run estimation result was invalid because it didn't cointegrated at 10%, 5% or 1% critical value. Therefore, model with corruption treated as not cointegrated in this study and long run and short run estimation outcome are not displayed in this chapter (result refer to Appendix 9).

4.3.1 Base Model

Table 4.5: Estimated Long Run Coefficients of ARDL approach

Variables	Optimal Lag Length	Coefficients	Standard Error	T-Statistics (P-value)
Base Model				
lnCO2	2	-0.27	0.1	-2.77(0.0114)**
lnGDP	0	0.653	0.192	-3.4(0.0027)***
lnPOP	0	1.43	0.174	8.2(0.0000)***

Remarks: (***),(**) and(*) indicates that null hypothesis was rejected at significance level 1%, 5% and 10% respectively.

Table 4.6: Estimated Short Run Coefficients of ARDL approach

Variables	Coefficients	Standard Error	T-Statistics (P-value)
Base Model			
lnCO2	0.06492	0.08998	0.7215(0.479)
lnGDP	0.5201	0.1744	2.981(0.0071)***
lnPOP	1.1388	0.2531	4.499(0.0002)***
ECT_{t-1}	-0.7958	0.134	-5.939(0.000)***

Remarks: (***),(**) and(*) indicates that null hypothesis was rejected at significance level 1%, 5% and 10% respectively.

Based on result shown, CO2 is showing no significant short run effect to food production but have an inverse relationship in long run at 5% significance level. It indicates that a 1% raise in the CO2 emission will decrease food production by 0.27% in the long run. This inverse relationship between CO2 emission and food production is supported by several studies such as Gregory et al. (2005); Schmidhuber and Tubiella (2007); Mittal (2009). Besides that, Siwar et al. (2009); Wahab et al. (2015) also stated a consistent result with this research and it also tested using Malaysia as case study. While, (Lewis, n.d) result of other developing country such as China also has a common result with this study. Eventually, increasing of Co2 emission will lead to a decline of food security.

Meanwhile, GDP per capita is responding positively in both short run and long run to food production at 1% significance level. This can be explained that 1% increase in GDP per capita will stimulates food production by 0.65% in the long run. This findings is consistent with Ruel et al. (1998); Timmer (2004); Tey et al. (2008); Wahid et al. (2008); Siwar et al. (2009); Godfray, et al. (2010); Van Dijk and Meijerink (2014);Burchi and Muro (2015); Poulsen et al. (2015) which all of those journals stated that the declined or increased of income of citizen will affected food security in identical way. Moreover, Alila and Atieno (2006) points out that the positive effect of public investment in GDP per capita also will raise the food

production. Public investments will affect allocation of resources, agricultural production and costs and revenues of production. Thus, affect the food production. Furthermore, Van Dijk and Meijerink (2014) also proved that investment will affect the food production efficiency through the advance technology available in the agricultural sector. As summary, the positive in food production is mainly due to the increase of income of citizen and investment and thus show the result in the long run.

In addition, the result above shown consistent effect from population to food production in short run and long run, which means population has significant and have positive impact on food production at 1% significant level. 1% increase in Population will accelerates food production by 1.43% in the long run. The result was evidenced by Delgado (1999); Trostle (2008); Siwar et al. (2009); Simon (2012); Van Dijk and Meijerink (2014); Wahab et al. (2015); Istikoma et al. (2015); Godfray, et al. (2010) which the growth population will lead to the increase of food production due to the demand will be increase and food production therefore must increase at the same time. While, Siwar et al. (2009) which selected same country as this study also shows that Malaysian grains production has been in risk due to population density will direct affect the food security. Apart from that, rural population getting lower will increase the food production and firm sizes Staal et al. (2010). Besides that, Wahab et al. (2015) revealed it results shows that only foreign workers would affect food security in both long run. In the nutshell, the expansion of population will increase food production directly in long term.

Based on ECT coefficient in Table 4.6, it demonstrated negative sign, less than one and is statistically significance at any significant level. The ECT indicated that the speed of adjustment from short run to long run while short run will adjust 79.58% per year to achieve long run relationship in this study. Hence, it will takes around 1.3years to fully achieved long run equilibrium.

4.4 Diagnostic Checking

Table 4.7: Diagnostic Checking Result

Diagnostic Testing	Chi-Square/P-value	Conclusion
Base Model		
Serial Correlation LM Test	0.4326	No Serial Correlation
ARCH Test	0.9636	No Heteroskedasticity

Remarks: (***),(**) and(*) indicates that null hypothesis was rejected at significance level 1%, 5% and 10% respectively.

(Base Model)

Figure 4.1

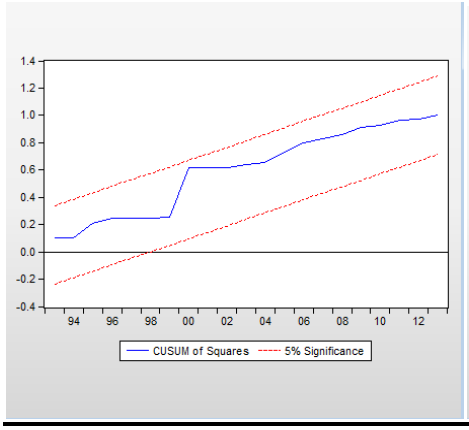
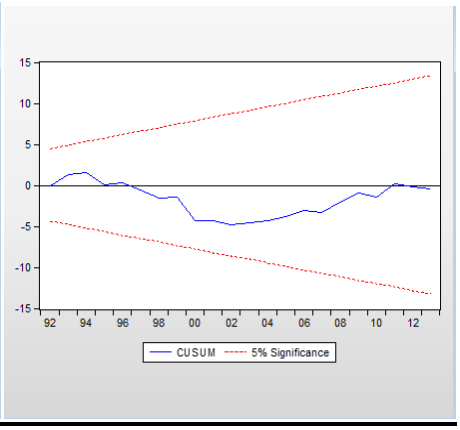


Figure 4.2



After ARDL bound testing performed, several diagnostic checking required to be passed such as autocorrelation, heteroscedasticity and structural stability test. Normality test is not applies in this research because normality is unnecessary and is excessive for regression model (Greene, 2002). Meanwhile, according to Pesaran et al. (2001), functional form misspecification may exist in ARDL model due to the presence of some non-linear effects or asymmetries in the adjustment

process. Thus, form misspecification test is not used in this research. The purpose of diagnostic test is to ensure that model is free from econometric problems. The null hypothesis had been discussed at pervious chapter.

Based on the result from Table 4.7, base model is free from any econometric problem at all significant level. For Base Model, the P-value of serial correlation LM test is 0.4326 and ARCH test is 0.9636 where both are larger than significance level at 10%. Conclusion, the null hypothesis does not rejected and there are no autocorrelation and heteroscedasticity problem in both models.

Whereas, Figure 4.1 and Figure 4.2 shows no evidence that model consist of structural instability in this research because the plot of CUSUM and CUSUMSQ are fall within the range at 5% significance level of critical bounds. Thus, base model have passed all the diagnostic tests.

4.5 Chapter Summary

This research is to determine the relationship between Carbon Dioxide Emissions, Gross Domestic Product (GDP), Population and Food Production Index in Malaysia from the year 1984 until 2013.

Firstly, unit root test on each of variables (lnCO2, lnGDP and lnPOP) had done in order to make sure that all of them are stationary. Meanwhile, all of the variables are stationary at first difference except for Population which is stationary at constant level.

For the testing of overall model's long run relationship, ARDL Bounds Test and result showed that the model does have long run relationship. Next step is to examine their short run and long run relationship of each variable. Co-integration and Long Run Form has conducted and the results demonstrated that all of the study variables have long run relationship toward the study however the variable CO2 only passed at 5% level and did not make it at 1% level. CO2 also found to not has short run relationship toward the study despite that, the other variables has been proved to have short run relationship as well. These tests have concluded model have long run relationship and safe to proceed to next step.

After all of the variables have been proved stationary and model have cointegration relationship, thus proceeded to the usual diagnostic checking to make sure that this model is free from heteroskedasticity and autocorrelation problem and model structure stability. ARCH Test has been conducted at optimal lag to detect the presence of heteroskedasticity, the test concluded that the model is free from this problem. The model is also free from autocorrelation problem as demonstrated by LM Test Lag 2 as in this chapter. Structural stability is observed through CUSUM Test and CUSUMSQ Test. The model has stable at 5% critical bounds level because the plot fell within the 5% critical bound all the way until the end as shown in previous chapter this showed that all coefficients in the error-correction model are stable. Empirical Result has shown and will proceeding to final chapter.

Chapter 5: Discussion, Conclusion and Implications

5.0 Conclusion

This chapter will covers the implications, findings, limitations and recommendation of this study, the conclusion will then be drawn. Findings as prove of that this study is consistent with the objectives and hypotheses made. An implication will also be presented in this chapter which will look into the ways to overcome the problem as well as how to make improvements on major findings to bring positive externality to this study's objective through the feasible policies. This study does have few short-comings when conducting this research and it will be discussed later in this chapter. Lastly, recommendations for future researchers who will be conduct the similar research.

5.1 Summary of Major Findings

The main objective of this study is to discover the kind of relationships that Carbon Dioxide Emissions, GDP and Population have on Food security index, this study has also observe whether or not the results obtained have consistency compared to the hypothesis. Firstly, CO2 is having inverse relationship to the Food Production Index in the long-run; this result has showed consistency to the hypothesis. There are research claimed that the increase of Carbon Dioxide brings benefits to crop growth, however it has been overestimated. The earlier model has been doubted, the recent research shows that there are decrease in rice production from hotter nights (McMichael, Powles, Butler and Uauy, 2007).

There are also research done by Solomon (2008), global temperature increases when carbon dioxide emissions increases and will remain constant from -0.5 degree to 0.5 degree Celsius toward the end of the millennium. This is followed by Goudriaan and Unsworth (1990) research claimed that for determinate crops, higher temperature reduces the radiation interception and leads to decrease in potential yield. The increase in average temperature (Climate change) will affect crop yield differently from each region, it brings negative impact toward the crop yield in developing countries (except China) like Malaysia. It is likely to be caused by shortening crop growing period, reducing water availability because of faster evaporation rate (Parry, Rosenzweig, Iglesias, Fischer and Livermore, 1999).

Secondly, the study found that the GDP is having positive relationship toward this study, Food Production Index in short run and long run. The increase in the GDP will also improve the food production which showed consistency to the hypothesis in Chapter 1. Bruinsma (2003) has claimed that an increase in GDP growth will be taken as a basis for assuming that there are increase in growth rates in livestock productivity and overall. The demand of livestock products would be driven by a third factor which is income growth, when income increases the expenditure on livestock product does increase too Steinfeld, Gerber, Wassenaar, Castel, Rosales and Haan, (2006); There are positive relationship between income equality and GDP growth Perotti (1995); Demand increases also lead to an increase in Supply (increase in food production) and of course it is using Adam Smith's invisible hand theory.

Livestock is one of the driving forces for food security as well as sustainable development in economy Sansoucy (n.d.). Additionally, according to the research of Rae and Hertel (2000), income growth will boost the livestock products' demand. When household income exceeds US$2 per day, it leads to an increase in livestock products especially for those living in urban areas, the reason being if there is further increase in household income, the consumer preference would switch for a higher quality products, however as long as it is under US$5,

consumer will still prefer quantity rather than the quality (McDermott, Staal, Freeman, Herrero and Steeg, 2010). Despite that, Delgado (1999) also stated that income increase will become factor that increases global demand livestock products in the future (in coming decades). Subsidy (government spending) is also part of the calculation in GDP, in 2008 Kenya suffered major food insecurity, the local government uses subsidy on farm inputs such as fertilizer which has solved the food security problem and greatly improved their food production during next 5 years (Kenya Agricultural Research Institute, n.d.), it implies that GDP has positive relationship toward Food Production in a country.

Lastly, the study found that Population is having positive relationship toward Food Production Index in short run and long run. This relationship is consistent to the hypothesis as mentioned in Chapter 1. According to Delgado (1999), population is one of the driver that lead to an increase in demand for livestock products. There are large numbers of poor producers in Africa and South Asia and the research showed that the farm sizes has increased which is increase in food production when rural population getting lower (Staal, Steeg and Herrero, 2010). The continuation of increasing in population also implies that the global demand for food will be increased as well (Charles and Godfray, 2010). Nonetheless, Trostle (2008) also claimed that in developing countries, the demand for agricultural commodities have strong relationship with income and rising population. In China and India, which they dominated almost 40% of world's population has provided a strong base to the agricultural products demand.

In USDA Agricultural Projections to 2017, they showed that has increased to 180 in 2015 (Base =100 in 1975) has resulted to an increase in production to 240 in 2015 (Base = 100 in 1975). The global population is expected to grow about 2.3 billion people at the year 2050, following the trend implies that demand for food will continue to grow especially cereals, the food production would grow by 70% by the year of 2050 (FAO, 2016).

5.2 Implications of Study

Based on the findings found out that the carbon dioxide have positive relationship in short run but found out inverse relationship in long run. On the other hand, this study also found out the emission of carbon dioxide will bring benefits to developed country but will bring negative impact to developing country. Since Malaysia still in developing country status which means the emission of carbon dioxide will reduce crop production in Malaysia. Thus, the implication is suggested that Malaysia government should engage new policies that restrict the maximum level of emission carbon dioxide from factory and also the vehicle emission such as Kram and Hill (1996) states that a lot of advanced country like Netherland, Switzerland, Japan, and other 7 countries were implemented a policy to control the level of carbon dioxide emission from factory by changing the new filter and also change new source of energy usage to make as non-regret energy. Besides that, they also request to change the fossil fuel to new formula because reduce in the carbon dioxide release as well as choosing coal to natural gas. From another study by Peters and Hertwich (2008), it also supported the statement of Kram and Hill (1996) which request countries by changing energy usage to non-regret energy. For instance, Norway almost having 100% usage of natural energy like hydro energy while Netherland using wind energy to generate electricity for their countries.

Secondly, Gross Domestic Product (GDP) has positive relationship with the food production index. This policy can obtain solutions through neighbour country, Indonesia where their application of liberalization policy due to promotion of domestic good via import tariff increase. FAO (2008b) also stated that increase of import taxes are able to help in promoting domestic food production. Besides that, Nijhoff, Jayne, Mwinga, Billy, Shaffer and Jim (2002) stated the involvement of the government will solve the food security problem because government can decide whether to subsidize or tax reduction from imported food. Dorosh, Dradri and Haggblade (2009) stated that Zambia policies

have started to restrict external trade flows of the country. The governments started take up some portion of food import which can are able to benefit from subsidy and also the incentive that are provided by government. Thus, consumers will be able to import food with lower price.

By additional support of the viewpoint, Alila and Atieno (2006), also proved that government decision that will direct influence the level and bounding of the input and output prices. Beside that the public investment also will affects the production of agricultural, cost, revenue and resources allocated. The farmers diversifying their non-traditional agricultural commodities because it adds value and reduce vulnerability. Based on Dorosh, Dradri and Haggblade (2009), the private sector and food aid agencies should access as soon as possible to the impact of the food production. For example, controlling the domestic maize prices, finding incentives for import and making sure of the food availability of the country, also observes the consumption of vulnerable groups. Moreover, Republic of Kenya (2004) showed up the importance of investment in agricultural sector which the marketing promotion of agricultural production must be enhanced because it attracts the private sector to invest in slaughter houses and cold storage. Mittal (2009) recommended the fund of loan for supporting small farmers should be well prepared because the supports toward them for running operation and also to improve the productivity of the crop production.

Thirdly is the population showed also the positive relationship with the food security which the population increase and the food production index also will increase. For examples, the research from the Njuguna, Katumanga and Gareth (2004) stated that when the agricultural production increase in production which mean the income of farmers also increase, because income increase more and more people will enter the sector by referring the general economic welfare enhanced. Besides that Mittal (2009) also supported that when small farmers have opportunity to get loan or fund to run the operation, it requires more workers and it will creates job opportunities which lead to increase in food production.

Even in the result, this study found out the corruption don't have direct relationship with food security, and also found out some research about it which the researchers Joseph (2008) brought up very important recommendation which is the transparency and policy consistency of the incentives and subsidy that provide for private sector from government. So those private sectors have confident to enter the market and improve the food production level of one country thanks to the reach of food accessibility to all citizens.

5.3 Limitations

The first limitation found in the study is the one country limitation. The journals and expectation sign mostly observed the case in the foreign country. All these cases may be suitable for foreign countries. However, it might not be suitable to apply it in Malaysia's context as Malaysia might not follow the results tested in the previous chapter.

This study only focus on how GDP, CO2 and Population bringing impact toward Food Production Index whilst ignoring the reversal way of relationship where Food Production might also influence the GDP and CO2 emissions as well as Population. This kind of two-way causality would open up new outcomes which require a wider analysis to be done (Dzhumashev, 2014). If this study is proved to be reversal, it would affect the government's policymakers and different policies would be used instead of the suggested one in the previous part. Additionally during this study, due to lack of availability were forced to omit one of the study variables, Corruption which has proved to be significance at 10% level.

This study may be also suffering for a statistical or data limitations as it is a rather small sample size conducted in this research. This study only used 30 years of annually data (30 sample size) to interpret the findings because the variable CO2 was unable to obtain a quarterly data, that is why all of the other variables have to go with the annually basis. This problem under-powers the results and causes the results interpreted to be slightly lack of accuracy/preciseness.

5.4 Recommendations

In this study, suggestion given to the future researchers is to look for more data regarding Malaysia's context. Future researchers can use Panel Data method to include more countries in their study so that the results obtained can be more significant.

Additionally, future researchers can conduct the analysis on two-directional way between Population, GDP, CO2 emissions on Food Production. Conducting the analysis would give information to the researchers on which way is actually affect more of the study. It could be Food Production that affect the GDP and Population, this become another way of interpreting the relationship between dependent and independent variable of this study so that policymakers can come up with more suitable policies to improve food security problem in Malaysia.

Besides that, this study recommend future researchers to include more observe data toward the Corruption as it may bring it to the 5% significant level. According to Bross (1971), 5% significance level is standard level, thus if there were no 5%, then some person would use higher (10%) significance level and 10% significance level is too large and meaningless. Fisher (1956) also points out that a

value greater than 0.05 but less than 0.10 regarded as insignificance because once the value larger than 0.05 is treated as relatively large.

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Appendices

Appendix 1: Augmented Dickey-Fuller Test

Level form: Intercept without trend

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

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.465305	0.1343
Test critical values:	1% level	-3.689194	
	5% level	-2.971853	
	10% level	-2.625121	

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

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-0.445118	0.8882
Test critical values:	1% level	-3.679322	
	5% level	-2.967767	
	10% level	-2.622989	

Null Hypothesis: INCO2 has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-1.537576	0.5008
Test critical values:	1% level	-3.679322	
	5% level	-2.967767	
	10% level	-2.622989	

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

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-4.359148	0.0031
Test critical values:	1% level	-3.808546	
	5% level	-3.020686	
	10% level	-2.650413	

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

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-1.383602	0.5763
Test critical values:	1% level	-3.679322	
	5% level	-2.967767	
	10% level	-2.622989	

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

First Difference: Intercept without trend

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

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-6.892079	0.0000
Test critical values:	1% level	-3.689194	
	5% level	-2.971853	
	10% level	-2.625121	

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

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-4.616654	0.0010
Test critical values:	1% level	-3.689194	
	5% level	-2.971853	
	10% level	-2.625121	

Null Hypothesis: D(INCO2) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-5.174872	0.0002
Test critical values:	1% level	-3.689194	
	5% level	-2.971853	
	10% level	-2.625121	

Null Hypothesis: D(INPOP) has a unit root
Exogenous: Constant
Lag Length: 8 (Automatic - based on SIC, maxlag=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-0.946572	0.7512
Test critical values:	1% level	-3.808546	
	5% level	-3.020686	
	10% level	-2.650413	

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

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-5.429296	0.0001
Test critical values:	1% level	-3.689194	
	5% level	-2.971853	
	10% level	-2.625121	

Level Form: Intercept with trend

Null Hypothesis: lNFOOD has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 5 (Automatic - based on SIC, maxlag=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.841659	0.1973
Test critical values:	1% level	-4.394309	
	5% level	-3.612199	
	10% level	-3.243079	

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

Null Hypothesis: lNCO2 has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic - based on SIC, maxlag=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-1.456828	0.8212
Test critical values:	1% level	-4.309824	
	5% level	-3.574244	
	10% level	-3.221728	

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

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

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-1.596172	0.7697
Test critical values:	1% level	-4.309824	
	5% level	-3.574244	
	10% level	-3.221728	

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

Null Hypothesis: lNPOP has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 8 (Automatic - based on SIC, maxlag=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-1.515273	0.7911
Test critical values:	1% level	-4.467895	
	5% level	-3.644963	
	10% level	-3.261452	

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

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

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-1.708270	0.7216
Test critical values:	1% level	-4.309824	
	5% level	-3.574244	
	10% level	-3.221728	

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

First Difference: Intercept with trend

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

	t-Statistic	Prob.*

Augmented Dickey-Fuller test statistic		-7.651196	0.0000
Test critical values:	1% level	-4.323979	
	5% level	-3.580623	
	10% level	-3.225334	

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

Null Hypothesis: D(lNCO2) has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic - based on SIC, maxlag=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-5.392792	0.0008
Test critical values:	1% level	-4.323979	
	5% level	-3.580623	
	10% level	-3.225334	

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

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

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-4.596690	0.0053
Test critical values:	1% level	-4.323979	
	5% level	-3.580623	
	10% level	-3.225334	

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

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

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-3.188320	0.1161
Test critical values:	1% level	-4.532598	
	5% level	-3.673616	
	10% level	-3.277364	

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

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

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-5.504133	0.0006
Test critical values:	1% level	-4.323979	
	5% level	-3.580623	
	10% level	-3.225334	

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

Appendix 2: Phillips-Perron Test

Level form: Intercept without trend

Null Hypothesis: INFOOD has a unit root
Exogenous: Constant
Bandwidth: 8 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-3.280327	0.0253
Test critical values:	1% level	-3.679322	
	5% level	-2.967767	
	10% level	-2.622989	

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

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-0.463417	0.8847
Test critical values:	1% level	-3.679322	
	5% level	-2.967767	
	10% level	-2.622989	

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

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-12.68806	0.0000
Test critical values:	1% level	-3.679322	
	5% level	-2.967767	
	10% level	-2.622989	

Null Hypothesis: INCO2 has a unit root
Exogenous: Constant
Bandwidth: 1 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-1.554588	0.4923
Test critical values:	1% level	-3.679322	
	5% level	-2.967767	

	10% level	-2.622989

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

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-1.385075	0.5756
Test critical values:	1% level	-3.679322	
	5% level	-2.967767	
	10% level	-2.622989	

First Difference: Intercept without trend

Null Hypothesis: D(INFOOD) has a unit root
Exogenous: Constant
Bandwidth: 3 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-6.875362	0.0000
Test critical values:	1% level	-3.689194	
	5% level	-2.971853	
	10% level	-2.625121	

Null Hypothesis: D(INGDP) has a unit root
Exogenous: Constant
Bandwidth: 1 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-4.611026	0.0010
Test critical values:	1% level	-3.689194	
	5% level	-2.971853	
	10% level	-2.625121	

Null Hypothesis: D(INCO2) has a unit root
Exogenous: Constant
Bandwidth: 1 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-5.175220	0.0002
Test critical values:	1% level	-3.689194	
	5% level	-2.971853	
	10% level	-2.625121	

Null Hypothesis: D(INPOP) has a unit root
Exogenous: Constant
Bandwidth: 2 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		0.261141	0.9717
Test critical values:	1% level	-3.689194	
	5% level	-2.971853	
	10% level	-2.625121	

Null Hypothesis: D(INCOR) has a unit root
Exogenous: Constant
Bandwidth: 2 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-5.427918	0.0001
Test critical values:	1% level	-3.689194	
	5% level	-2.971853	
	10% level	-2.625121	

Level Form: Intercept with trend

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

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-2.755906	0.2236
Test critical values:	1% level	-4.309824	
	5% level	-3.574244	
	10% level	-3.221728	

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

Null Hypothesis: lNCO2 has a unit root
Exogenous: Constant, Linear Trend
Bandwidth: 0 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-1.456828	0.8212
Test critical values:	1% level	-4.309824	
	5% level	-3.574244	
	10% level	-3.221728	

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

Null Hypothesis: lNGDP has a unit root
Exogenous: Constant, Linear Trend
Bandwidth: 2 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-1.826696	0.6655
Test critical values:	1% level	-4.309824	
	5% level	-3.574244	
	10% level	-3.221728	

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

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

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		0.648315	0.9992
Test critical values:	1% level	-4.309824	
	5% level	-3.574244	
	10% level	-3.221728	

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

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

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-1.929980	0.6133
Test critical values:	1% level	-4.309824	
	5% level	-3.574244	
	10% level	-3.221728	

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

First Difference: Intercept with trend

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

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-7.825959	0.0000
Test critical values:	1% level	-4.323979	
	5% level	-3.580623	
	10% level	-3.225334	

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

Residual variance (no correction)	0.001283

HAC corrected variance (Bartlett kernel)	0.001145

Null Hypothesis: D(lNCO2) has a unit root
Exogenous: Constant, Linear Trend
Bandwidth: 2 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-5.391212	0.0008
Test critical values:	1% level	-4.323979	
	5% level	-3.580623	
	10% level	-3.225334	

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

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

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-4.591375	0.0054
Test critical values:	1% level	-4.323979	
	5% level	-3.580623	
	10% level	-3.225334	

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

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

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-3.086349	0.1288
Test critical values:	1% level	-4.323979	
	5% level	-3.580623	
	10% level	-3.225334	

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

Null Hypothesis: D(lNCORRUP) has a unit root
Exogenous: Constant, Linear Trend
Bandwidth: 2 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-5.497443	0.0006
Test critical values:	1% level	-4.323979	
	5% level	-3.580623	
	10% level	-3.225334	

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

Appendix 3: Diagnostic Checking Test

Serial Correlation LM Test (Base Model)

Breusch-Godfrey Serial Correlation LM Test:

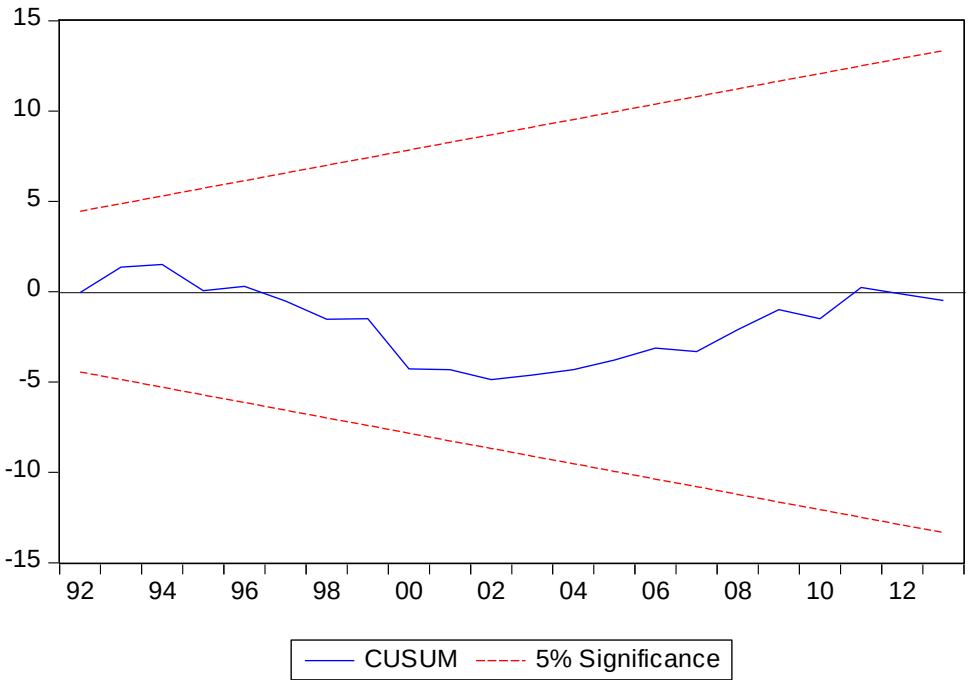
F-statistic	0.604777	Prob. F(2,19)	0.5564
Obs*R-squared	1.675817	Prob. Chi-Square(2)	0.4326

ARCH Test (Base Model)

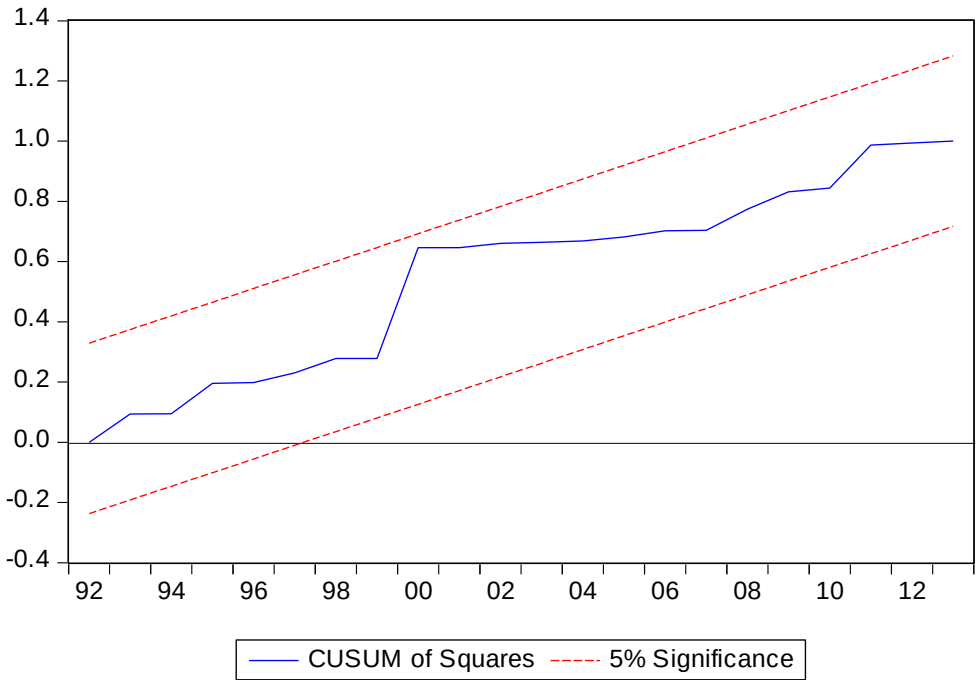
Heteroskedasticity Test: ARCH

F-statistic	0.032904	Prob. F(2,23)	0.9677
Obs*R-squared	0.074179	Prob. Chi-Square(2)	0.9636

CUSUM Test (Base Model)



CUSUMSQ Test (Base Model)



Appendix 4: Bound Test

Base Model

ARDL Bounds Test
Date: 01/09/17 Time: 19:37
Sample: 1986 2013
Included observations: 28
Null Hypothesis: No long-run relationships exist

Test Statistic	Value	k
F-statistic	4.413011	3

Model with Corruption Perception Index

ARDL Bounds Test
Date: 01/09/17 Time: 19:36
Sample: 1985 2013
Included observations: 29
Null Hypothesis: No long-run relationships exist

Test Statistic	Value	k
F-statistic	3.993753	4

Appendix 5: Cointegration and Long Run Form

Base Model

ARDL Cointegrating And Long Run Form
Dependent Variable: INFOOD
Selected Model: ARDL(1, 0, 2, 0)
Date: 01/09/17 Time: 19:39
Sample: 1984 2013
Included observations: 28

Cointegrating Form

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(INGDP)	0.520140	0.174473	2.981206	0.0071
D(INCO2)	0.064925	0.089984	0.721513	0.4786
D(INCO2(-1))	0.199446	0.069093	2.886623	0.0088
D(INPOP)	1.138759	0.253117	4.498945	0.0002
CointEq(-1)	-0.795873	0.134009	-5.938954	0.0000

Cointeq = INFOOD - (0.6535*INGDP -0.2799*INCO2 + 1.4308*INPOP -25.1806)

Long Run Coefficients

Variable	Coefficient	Std. Error	t-Statistic	Prob.
INGDP	0.653547	0.192220	3.399990	0.0027
INCO2	-0.279940	0.100928	-2.773655	0.0114
INPOP	1.430830	0.174539	8.197757	0.0000
C	-25.180570	1.923031	-13.094210	0.0000