DETERMINANTS OF FOOD SECURITY IN MALAYSIA

By

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ABSTRACT

Food security issue is getting more attention by world today. Although, Malaysia is a middle income country able to produce her own food, but there is still lack of food supply for domestic needs. She still has to import some food commodities including rice (staple food) to fulfill the demand of food. The increasing deficit between domestic demand and local production is expected to continue and this cause threat to food security to the country. With these trends lurking, understanding the determinants of food security is important because it will help the policy makers keep abreast of the main variables for food security in Malaysia. This paper thus analyse the factors that affect the food security model in Malaysia during the period of 1982-2011. Based on theoretical principles and research experience, the analysis in this paper include food production index as food security proxy while the other variables include food prices, Malaysian population, CO2 emission and foreign workers as important determinants of food security. The assessment of the impact of these factors is achieved using the Johansen Juselius Cointegration Test for long run model and Vector Error Correction Model approach (VECM) to check the adjustments of the cointegrated variables towards their equilibrium values. These series are defined in logarithm. Preliminary investigation revealed that the series were found to be I (1) process at initial level while the series become I (0) after first differences. The trace statistics test shows that the series on the food prices, Malaysian population, CO2 emissions and foreign workers are co-integrated each other. The results from Johansen test shows that all the variables are cointegrated each other and important determinants of food security in the long run. While, results from VECM shows only foreign worker is important determinant of food security in the short run. This model is a useful tool that

can guide the policy makers to develop more effective policies and strategies to improve food security level in the country. It could also provide a more quantitative means of assessing food security, and in particular to pinpoint specific variables that explain the highest effect to food security at the national level.

Keywords: Determinants, Econometric analysis, Food security, VECM

ABSTRAK

Isu keselamatan makanan semakin menjadi perhatian oleh dunia pada masa kini. Walaupun Malaysia merupakan sebuah negara berpendapatan pertengahan yang mampu menghasilkan makanannya sendiri, tetapi ia masih mengalami kekurangan bekalan makanan untuk keperluan tempatan. Malaysia masih perlu mengimport beberapa jenis makanan termasuklah beras (makanan ruji) untuk memenuhi permintaan terhadap makanan. Defisit yang semakin meningkat diantara permintaan dan pengeluaran tempatan dijangka akan berterusan dan ini menyebabkan ancaman kepada keselamatan makanan negara. Dengan menularnya trend ini, memahami penentu keselamatan makanan adalah penting kerana ia akan membantu pembuat dasar agar seiring dengan penyebab utama bagi keselamatan makanan di Malaysia. Dengan itu, kajian ini menganalisis faktor-faktor yang mempengaruhi model keselamatan makanan di Malaysia bagi tahun 1982 sehingga 2011. Berdasarkan kepada prinsip teoritikal dan kajian-kajian lepas, analisis di dalam kajian ini menggunakan indeks pengeluaran makanan sebagai proksi kepada keselamatan makanan, sementara pembolehubah lain yang digunakan ialah harga makanan, penduduk Malaysia, pembebasan karbon dioksida dan pekerja asing sebagai penentu penting kepada keselamatan makanan. Penilaian kepada kesan faktor-faktor ini dicapai dengan menggunakan ujian cointegrasi Johansen Juselius untuk model jangka panjang dan pendekatan 'Vector Error Correction Model' (VECM) untuk jangka pendek. Siri ini ditentukan dalam bentuk logaritma. Kajian awal menunjukkan bahawa siri ini mengalami proses I(1) pada tahap awal manakala menjadi I(0) selepas pembezaan pertama. Ujian statistik menunjukkan bahawa kesan siri pada harga makanan, penduduk Malaysia, pembebasan CO2 dan pekerja asing adalah berkointegrasi antara satu sama

lain. Keputusan daripada ujian Johansen menunjukkan semua pembolehubah adalah penentu penting kepada keselamatan makanan dalam jangka panjang. Manakala keputusan daripada pendekatan VECM menunjukkan hanya pekerja asing merupakan penentu penting kepada keselamatan makanan dalam jangka pendek. Model ini merupakan satu alat yang berguna yang boleh memberi panduan kepada pembuat polisi untuk mengembangkan lebih banyak polisi dan strategi yang berkesan untuk meningkatkan tahap keselamatan makanan di dalam Negara. Ia juga boleh menyediakan satu cara yang lebih kuantitatif dalam menilai keselamatan makanan, khususnya untuk menentukan pembolehubah-pembolehubah tertentu yang mdemberikan kesan yang paling tinggi kepada model keselamatan makanan di peringkat nasional.

Keywords: Penentu-penentu, Analisis Ekonometrik, Keselamatan makanan, VECM

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List of Abbreviation/Notation/Glossary Of Term

FAO – Food and Agriculture Organization

MOA – Ministry of Agriculture and Agro-Based Industry

DJBM – Dasar Jaminan Bekalan Makanan

NPK – Nitrogen, Phosphorus and Potassium

DOS – Department of Statistics

BERNAS – Padiberas National Berhad

SSL – Self-Sufficiency Level

USDA – United State Department of Agriculture

UNDP – United Nation Development Programme

GHG – Green House Gases

CO2 – Carbon Dioxide

IPCC – Intergovernmental Panel on Climate Change

WTP – Willingness-to-Pay

CVM – Contingent Valuation Method

OLS – Ordinary Least Square

ECCR – Ecumenical Council for Corporate Responsibility

VECM – Vector Error Correction Model

ARCH – Auto-Regressive Conditional Heteroscedasticity

LM – Lagrange Multiplier

ADF – Augmented Dickey-Fuller

PP – Phillips-Perron

KPSS – Kwiatkowski-Phillips-Schmidt-Shin

AIC – Akaike Criteria

VAR – Vector Autoregressive

FPE – Final Prediction Error

SC – Schwarz Information Criterion

HQ – Hannan-Quinn Information Criterion

CHAPTER 1

INTRODUCTION

1.1 Introduction

Food is important in human being's life. It is essential for a nation to have sufficient food in terms of quality and quantity for all people to continue its development. Lack of food in the long term with rapidly growing population will cause hunger and starvation that may cause death.

Since the World Food Conference in 1974, food security concept was introduced due to food crises and major famines in the world. This concept was evolved, developed, and diversified by the academic community and politics. There are several developed definitions of food security considering the original view point of food security problems. The international organizations and researchers defined it in different ways without much change in the basic concept.

According to the Food and Agriculture Organization (FAO) 2002, food security exist when all people, at all time, have physical and economic access to sufficient, safe and nutritious food that meet their dietary needs and food preferences for an active and healthy lifestyle. Thus food insecurity defined as exists when people do not have adequate physical, social or economic access to food. They also state that there are four components of food security such as food availability, accessibility, utilization and stability. Food availability addresses the supply side of food security and is determined by the level of food production, stocks levels, net food trade (exports minus imports) and

food aid transfers. Food access is defined as the individual's accessibility to adequate resources (entitlement) for acquiring appropriate food for a nutritious diet. The entitlements refer to the set of all commodity bundles over which a person can establish command given the legal, political, economic and social arrangements of the community in which they live (including traditional rights such as access to common resources). Utilization is usage of food through adequate diet, clean water, sanitation and health care to reach a state of nutritional well-being where all physiological needs are met. This carry out the importance of non-food inputs in food security concept. The concept of stability refers to both the dimension of availability and accessibility in food security. A population, household or individual must continuously access to adequate food at all times in order to be food secure. They should not risk losing access to food cause by sudden shocks such as an economic or climatic crisis or cyclical events like seasonal food insecurity. To realize food security objectives, all four dimensions of food security must be fulfilled simultaneously. To determine a country's or household's state of food security the components of availability, accessibility, utilization and stability are all interact.

1.2 Background of the Study

In year 2008, consumers worldwide face the high food price due to Global Food Price Crisis. The increase in food prices and the shortage of food supply at international level has led to a food shortage crisis in several countries. Nonetheless, the country's internal food supplies including supplies of food that are imported are still sufficient to fulfill the demand of Malaysians. However, as the world food price kept rising since early 2008, the

Malaysian Government has taken speedy action to ensure food supply remains sufficient at all time and at a reasonable price for consumers by approved new Food Security Plan which aimed at increasing food production and productivity to achieve self-sufficiency, to provide adequate incentive and income to produce more food and to ensure adequate safe and quality food for consumers.

The Ministry of Agriculture and Agro-Based Industry (MOA) had implemented *Dasar Jaminan Bekalan Makanan* (DJBM) to increase the production and productivity of the agro-food sector to satisfy the level of self-sustenance, and ensure adequate quality of food supply which is safe for consumption. Concurrently, DJBM also ensures that agricultural entrepreneurs receive reasonable income so that the production of food can be seen to be an attractive proposition. Some of the strategies of DJBM include increasing the production of rice which involves the maintenance of irrigation and sewerage infrastructure, leveling of paddy fields, providing additional Nitrogen, Phosphorus and Potassium (NPK) fertilizer, farm mechanization, improving mechanization output, subsidizing of paddy price, and giving incentives for increase in crop yield. Another notable measure to counter the food crisis was the Program *Bumi Hijau* which aims to create awareness and encouragement within the community to produce and enhance food supply, and also to cultivate interest in agriculture via the concept of edible landscape or kitchen garden. At the same time, MOA also tries to increase the production of food via *Program Taman Kekal Pengeluaran Makanan*, aquaculture and livestock breeding. Local farmers are offered Agriculture Produce Incentive to lessen their financial burden which indirectly helps to increase food production.

Even the total rate of population growth is decrease, it is still the key driver in increasing food demand. The world estimated to feed more than nine billion people by 2050 (Edwards, Simons, Marsden, Lee, Lang, Kiff, Bailey & Tibbs, 2009). While the government taking actions in increasing the food production, the Malaysian population also shows an increasing trend yearly (see Figure 1.1).

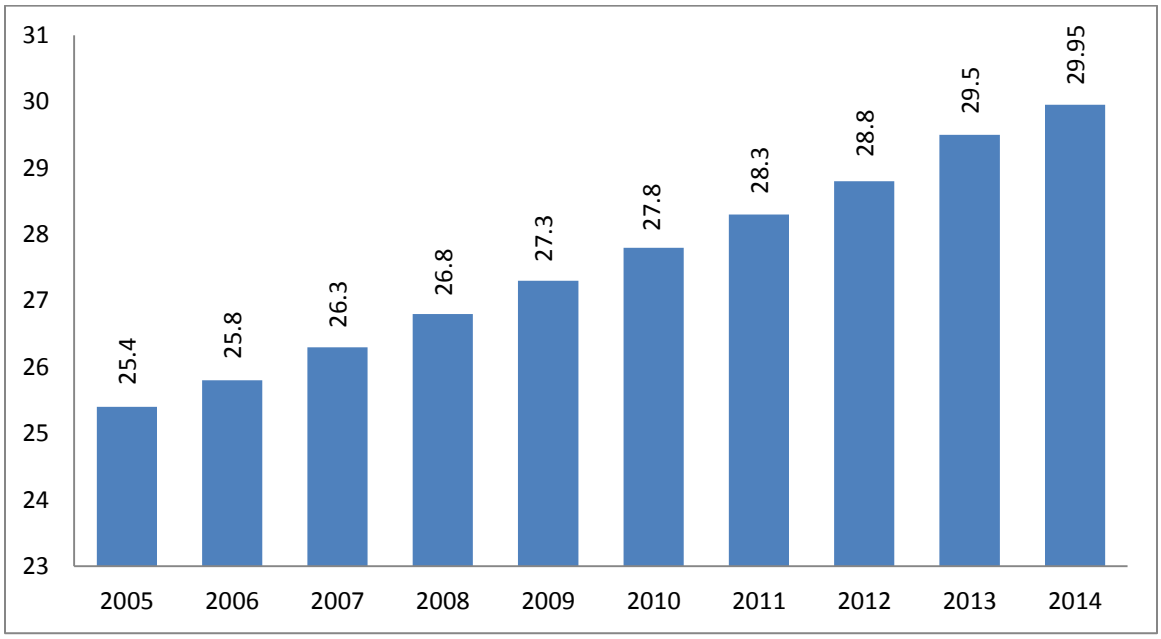

Figure 1.1
Malaysian Population from January 2004 until January 2014
Sources: Department of Statistic Malaysia, 2014.

According to DOS (2013), every 242 people on the planet are a resident of Malaysia (represents 0.42 percent of the world´s total population). During the last 50 years, Malaysian population increased 265% from 8.2 million in 1960 to 30.0 million in 2013 (DOS, 2013). An increase in population causes an increase in demand for food in the country. If the population continued to increase with constraint of sources, the production of food cannot fulfill the demand of food and will lead the country to food insecurity situation.

In addition, during the last few decades, certain sectors in Malaysia such as construction, plantation, agriculture, forestry and certain services experiencing labor shortage problem. Especially in agriculture sector where young Malaysians prefer to find job in other sectors and the labor gap is being increasingly filled by foreign workers. According to the Department of Statistics Malaysia (DOS), total workforce in agriculture sector was decreased dramatically from1.61 million workers in 2010 to 1.41 million in 2011 due to the decrease in total labor forces from 12.0 million in 2010 to 11.91 million in 2011 (see Figure 1.2).

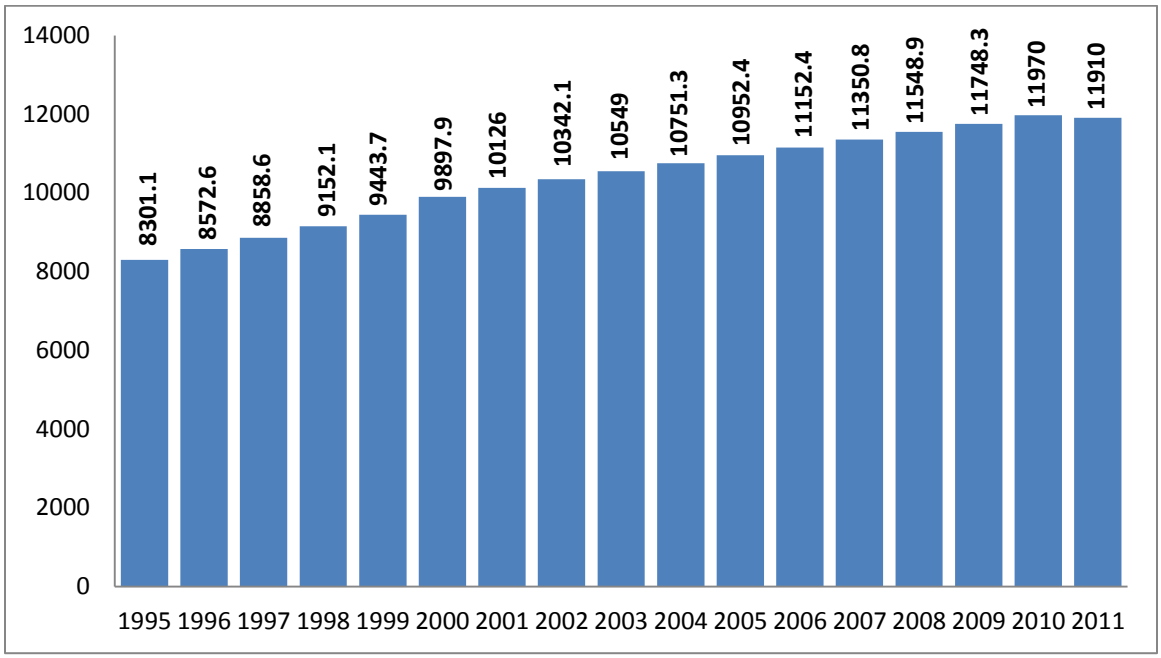

Figure 1.2
Malaysia Total Labor Forces for Year 1995 until 2013 ('000)
Sources: World Bank, CIA World Factbook and Department of Statistic

Immigration Department of Malaysia reported that the foreign workers in Malaysia continued to increase more than 2 million from 2001 to 2007. However, Malaysia Factbook (2013) reported the decrease of foreign workers in Malaysia started from 2008 to 2012 (see Table 1.1).

Table 1.1
Number of Foreign Worker by sector, Malaysia, 2008-2012

Sector	2008	2009	2010	2011	2012
Total	2,062,596	1,918,146	1,817,871	1,573,061	1,571,589
Agriculture	186,967	181,660	231,515	152,325	143,021
Plantation	333,900	318,250	266,196	299,217	314,329
Manufacturing	728,867	663,667	672,823	580,820	605,926
Construction	306,873	299,575	235,010	223,688	226,554
Services	212,630	203,639	165,258	132,919	138,823
Domestic help	293,359	251,355	247,069	184,092	142,936

Sources: Malaysia Factbook, 2013

The presence of foreign workers has both good and bad impact for Malaysia economy. In some of medium and large firms of economic sectors such as manufacturing and construction, foreign labor leads to increases in productivity levels. However, they are directly a part of Malaysian population. So, an increase in the foreign workers will give a big impact on Malaysia economy social and especially on food demand.

With respect to the increase in population adding with foreign workers, Malaysia has to import more food commodities such as dairy products, wheat, beef, mutton and rice from foreign country to meet the increase in food demand. Some of the foods exporting countries to Malaysia are Indonesia, Australia, China and Thailand. The dependence of Malaysia on food imported caused food trade balance deficit. As shown in figure 1.3, when the value of food imports exceeds the value of food exports means the country's food production was consistently below the level of domestic demand. Therefore, food import dependency is a threat to food security.

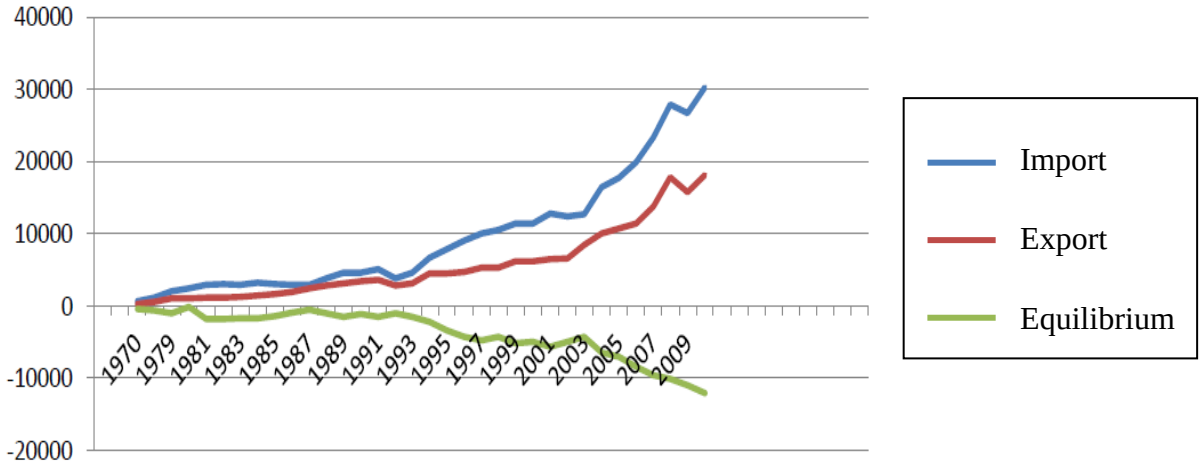

Figure 1.3
Imports, Exports and Balance of Malaysia Food for the Year 1970 to 2010 (RM Million)
Source: Department of Statistic Malaysia, 1984 to 2011

Malaysia still imports rice, the staple food to meet its self-sufficiency level (SSL). According to BERNAS, Malaysia imports about 30-40 percent of domestic rice demand annually to meet the rice requirement of the country. USDA (2013) stated that rice import is expected to increase up to 5 percent in 2013-2014 to 1.1 billion compared to 1.05 billion in 2012-2013. Although Malaysia was self-sufficient in several commodities of food such as fruits, vegetables, fisheries, poultry, eggs and pork, but we are still not self-sufficient in some commodities such as rice, beef, mutton and milk (see Table 1.2). Among all the commodities, as it is the staple food of the most population and provide employment especially for the rural poor, rice is considered the most strategic crop in Malaysia.

Table 1.2
Self-sufficiency Levels in Food Commodities, 2000-2010 (%)

Commodity	2000	2005	2010
Rice	70	72	90
Beef	15	23	28
Vegetables	95	74	108
Fruits	94	117	138
Fisheries	86	91	104
Eggs	116	113	115
Poultry	113	121	122
Mutton	6	8	10
Pork	100	107	132
Milk	3	5	5

Sources: Ninth Malaysia Plan (2010)

Agriculture sector is an anchor of country economy. Like the other developing countries, Malaysia also relies on agriculture sector including fisheries for basic food production and supply (Akhir, Omar and Hamid, 2009). Decreasing in agriculture land will decrease the production of food in a country and will be the threat for food security. Figure 1.4 shows the diminishing of agriculture land use in Malaysia. It reached maximum value of 78900 sq. km in years 1997-2000 but decrease by 200 sq. km to 78700 in year 2001 and it is the same till year 2012.

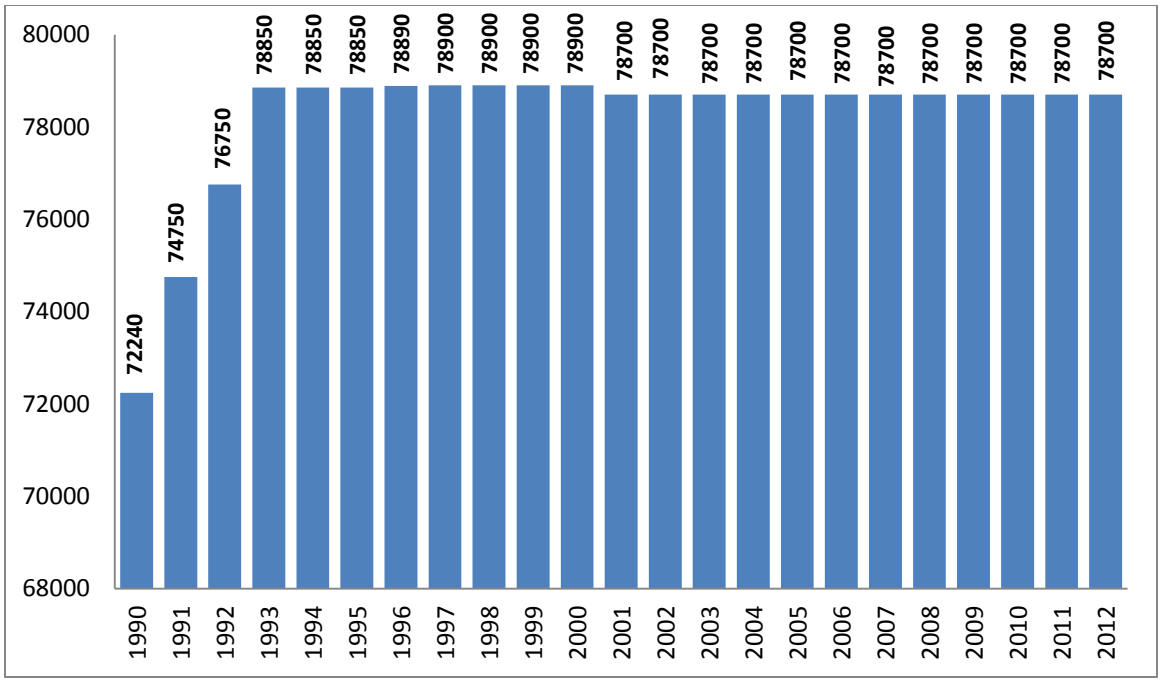

Figure 1.4
Land Use for Agriculture for the Year 1981-2012 (sq. km)
Source: World Bank, 2013

Climate change is another global issue that needs to be addressed by every individual, groups, organization and nations. Climate change is caused by the accumulation of greenhouse gases (GHG) in the atmosphere develop from the fossil fuels burning such as nitrous oxide carbon dioxide (CO2) and Climate change methane that will cause arises in earth temperature.

CO2 is the most important anthropogenic greenhouses gases (IPCC, 2007). Malaysia's CO2 generation has increased from 55.3 Metric/CO2 in 1990 to 177.5 Metric/CO2 in 2004 which is above global average.

The Intergovernmental Panel on Climate Change (IPCC) reported that current CO2 level is around 380 parts per million and will increased to 450 parts per million under business as usual scenario. Stabilization at this point will increase temperature by 2^0C. Thus the

global climate becomes warmer, the world and Malaysia agriculture productivity will decline, hence cause the decrease in food production. The developing countries will be worst by this issue than the developed countries as their nations are located in a part of the world with lower temperature.

Centre for Global Development (2007) reported that numerous of developing countries have hit the average temperature level which is near or above crops tolerance level. Besides, the agriculture productivity in the developing countries will decrease by 10 to 25 per cent in 2080 if the reduction of the greenhouse gases emissions and the implementation of climate change adaptation projects are unsuccessful. Unlikely, for the developed countries, the decline of the productivity is far lower as much as 6 per cent but it may also increase to around 8 per cent.

IPCC (2007) also stated that the average global temperature is estimated to increase about 1.1°C up to 6.4°C for the last decades of the 21st century. Climate change will threaten the basic elements of human life such as food, health, water and environment (Stern, 2006). The impact of this issued on food security will be a great concern by the government of developing countries especially which are dependent on agriculture since it is effected not only the food production alone but also the entire state of economy.

Malaysia is also included even it is more advanced developing nation according to its geographical location which is very near to the equator with high temperature around 27°C to 34°C.

1.3 Problem Statement

Food security issue is getting more attention by world today. Malaysia is still lack of food supply for domestic needs even it is able to produce their own food. It's still has to depend on the import of some food commodities including rice (Malaysian staple food) to fulfill the demand of food. Even worst, the rising deficit between domestic demand and local production is expected to continue. It will cause threat to food security to the country.

There are many factors that affect food security in Malaysia. The rising in food price due to the global food price crisis in year 2008 has been the main factor. Soaring food prices will cause food insecurity which is will threatens individual's survival, especially the poor rural populations. It will give an impact to their purchasing power and expenses. To ensure sufficient levels of food, many poor families option to either spend less on other essentials, such as healthcare and education, or resort to stinting, which is the act of buying cheaper (and likely less nutritious) food products. High food price also raise the likelihood of increased rural-urban migration, as many gather to the cities in hope of better livelihood opportunities.

Malaysian population is increasing yearly by of 265% from 8.2 million in 1960 to 30.0 million in 2013. The increase of population caused the rise in food demand. Therefore, the Malaysian food supply deals with the capacity of the production to meet the population demand. Lack of the production of food will cause a threat to human life. Adding with the increase in Malaysia population an increase in foreign worker is another factor influencing Malaysia's food security. The gap of unemployment in Malaysia is

filled by foreign worker resulted in an increase in foreign workers in Malaysia. Their existence will cause an increase in food demanded in Malaysia.

Another factor is CO2 emission that cause by the accumulation of GHG that will cause the increase of earth temperature. The warmer global climate will decline the agriculture production as well as food production. This factor should be a great concern since it threatens the basic elements of human life.

Since food security is increasingly become a critical issue in Malaysia and the ASEAN countries, all these problems that arise will influence food security should be noted in order to develop more effective strategies and policies to improve food security level in the country. Although food security defined to be a quite simple concept, it is far more difficult to determine it real determinants. So, it is important to examine the issues, the factors affect food security and develop an econometric model as useful tool to in order to explain food security determinants in Malaysia.

1.4 Objectives of the Study

The general objective of this study is to examine the factors which influence food security in Malaysia.

The specific objectives are:

1. to identify the factors effecting food security in Malaysia;
2. to examine the long run determinants of food security in Malaysia; and
3. to examine short run determinants of food security in Malaysia.

1.5 Significance of the Study

Food security for a country is important to make sure that the country is in stable condition for the economy and also for their citizen. To make sure a country to have a stable food security, a good plan to secure the condition is required.

Therefore, in order to achieve food secure situation, it is important to understand its determinants. By determining these factors, we can identify the significant factors that play an important role in Malaysia's food security. Moreover, we can determine the relationship and the effect of the interested variables on Malaysia's food security. It also can guide the policy maker to develop more effective policies and strategies to improve food security level in the country. So, there are very much needed of research for understanding about the status, issues and challenges of food security. In this study, four factors that determine food security such as food price, Malaysia population, carbon dioxide emissions and foreign worker will be used in the analysis.

1.6 Scope and Limitation of the Study.

The focus of this study is on the determination of the food security in Malaysia based on time series data for 30 years from 1982 to 2011. This study used yearly data on food production index, food price index, Malaysia population, carbon dioxide emissions and foreign worker. The limitation of this study is the problem in data regression for land used for agriculture in Malaysia. Even this variable is important determinant of food security as discussed, but a problem occur in the data regression. So, this variable has to remove from the model.

1.7 Organization of the Study.

This study comprises of five chapters which are organized as follows: The following chapter (Chapter 2) reviews literature on food security particularly theoretical framework and some empirical studies on factors determining food security. The methodology employed in the study and the data utilized in the analysis are described in Chapter 3. Chapter 4 presents the findings of the study. The last chapter (Chapter 5) concludes and gives some policy implications from this study.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

In term of definition by international organizations and researchers without much change in basic concept, food security has a flexible concept. During the global food crisis in the mid of 1970s, the food security concept was derived in the international food problems discussion. The original focus of attention was primarily on the problem of food supply to ensure the availability of food and to some level in terms of the stability of basic foodstuff prices at the national and international level.

In this chapter, the theoretical and empirical literature on determinants of food security will be reviewed. This basic idea can be built on a ground for the discussion on the factors that determine food security in Malaysia. Those literature reviews will determine and give the choice of variable to be included in the model specification.

2.2 Theoretical Framework

Food security has been defined as availability at all times of adequate world food supplies of basic foodstuffs to sustain a steady expansion of food consumption and to offset fluctuations in production and prices (World Food Summit, 1974). Food and Agriculture Organization (FAO) expanded the food security concept in 1983, by including the securing access to available supplies by vulnerable people and defined food security as ensuring that all people at all times have both physical and economic access to the basic

food that they need. The concept state that the demand and supply side should be balanced in the food security equation.

Reutlinger & Knapp (1980) in their study, defined food security as the assurance of a minimally adequate level of food consumption. Furthermore, Reultlinger (1987) denoted food security as access by all people at all times to enough food for an active, healthy life. Its essential elements are the availability of food and the ability to acquire it. On the other hand, food insecurity is the lack of access to sufficient food and can be either chronic or transitory. Chronic food insecurity is continuously inadequate diet resulting from the lack of resources to produce or acquire food. Transitory food insecurity, however, is a temporary decline in a household's access to enough food. It results from instability in food production and prices or in household incomes.

Likewise, Staatz & Carl (1990) stated that initially food security meant avoiding transitory shortfalls in the aggregate supply of food. The conceptual understanding of food security has evolved gradually over the past years to include not only transitory of inadequate supply at the national level but also chronic problems of inadequate access and unequal distribution at the household level.

Philips & Taylor (1990) denoted that food insecurity exists when members of household have an inadequate diet for part or all of the year or face the possibility of an inadequate diet in the future. States of food insecurity may be defined in terms of types of food insecurity (i.e. temporary, cyclical, chronic) levels of food of an acceptable standard), or a combination of both. Food insecurity results from an unfavorable balance between risk and insurance.

Green & Kirkpatrick (1981) mentioned that the food security problem has two principal aspects which are the long and short-term. Problem of long-term food security are reflected in the increasing gap between the consumption needs and production capacities of the developing countries. Irrespective of the long run trend in per capita food consumption, however, variability in per capita consumption is per se a significant cause of food security. While short run insecurity of food supplies has two main sources: domestic food production and foreign exchange availability.

Green & Kirkpatrick (1982) then extended the above issue by aming to expand the concept of food insecurity beyond the long term trend of increasing food imports by developing countries and short term insecurity caused by fluctuations in annual supply. Conventional estimates tend to infer that insecurity can be identified with actual short-term variation in food consumption. Food security may be concealed by a country's willingness to sacrifice other imports to maintain consumption levels.

According to Bigman (1982) food security is measured by the probability that the quantity available for consumption by 'poor' consumers does not fall under subsistence level and therefore is defined as food security represents the ability of a country or the world at large to supply the food needs of all its people at all times, now and in the future.

Mellor (1988) defined food insecurity as food insecurity is the inability of poor countries, poor families and poor individuals to purchase sufficient quantities of food from existing supplies. Improving food security requires both increasing the purchasing power of the poor and boosting overall food production. Developing countries can develop a two-pronged strategy to promote food security. In the long run, efforts must be made to

increase the purchasing power of the poor by raising the overall level of food production in the Third World. Increased food supplies and purchasing power must be inextricably linked to elements of any long term food security efforts. In the short run redistributing food supplies from the developed to the developing world is likely to be the best way to meet the more immediate food security needs of the poor.

Khadka (1990) in his study stated the regional food security important. In South Asia food security is strongly related with poverty and hunger. Therefore the eradication of poverty and hunger and the achievement of regional food security would enable the poorer section of the population to buy enough food through the generation of employment opportunities and the redistribution of income and assets. Also Khadka (1991) defined the regional food insecurity as lack of access by members of society and nations to enough food throughout the year to live healthy. This is a situation caused by inadequate food availability i.e. lack of adequate supply or by inadequate entitlements i.e. lack of effective demand, or both.

While, Hamilton, Cook, Thompson, Buron, Frongillo, Olson and Wehler (1997) defined food security as the ready availability of nutritionally adequate and safe foods and an assured ability to acquire acceptable food in a socially acceptable way.

The adopted of food security definition by the World Food Summit in 1996 is still more complex. Food security, at the individual, household, national, regional and global levels is achieved when all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life.

According to the FAO (2002), food security exists when all people, at all time, have physical and economic access to sufficient, safe and nutritious food that meet their dietary needs and food preferences for an active and healthy lifestyle. Thus food insecurity defined as exists when people do not have adequate physical, social or economic access to food. Food secure and food insecure can be examine at many levels such as national or country, household and individual level. In the national level, a country is food secure when on the continuous and stable basis, the food supply and effective demand are capable to cover the foods needs of its population (see Figure 2.1).

Food requirement can be met by the country through domestic food production, beyond domestic food production or through the both factors combination. In close economy, food requirements can be met just by the domestic food production alone(Aker & Lemtouni, 1999). But in open economy, the food requirements of the population depend on the world market to meet the caloric needs of the population. This indicates that the level of food security in the country is depend upon the domestic interaction and the global forces, so any valuation of food security in the national level have to take this in to account (Aker & Lemtouni, 1999).

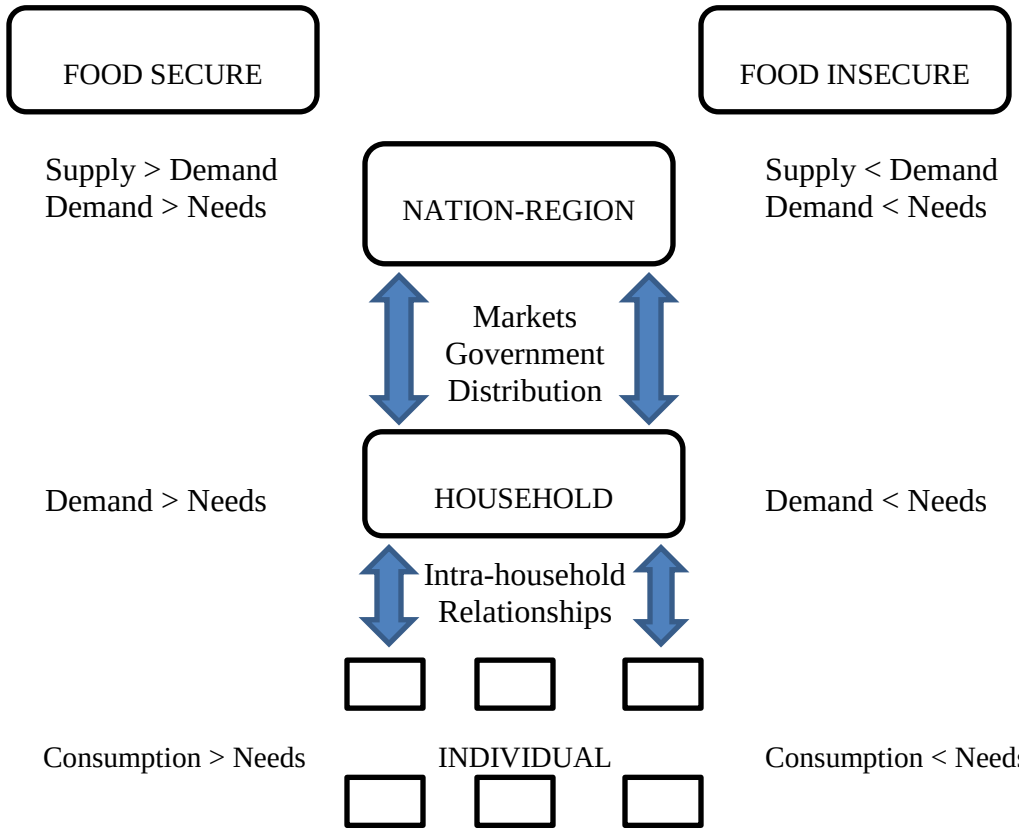

Figure 2.1
Level of Food Security
Sources: Thomson & Metz (1999)

Aker & Lemtouni (1999) built the conceptual model of food security according to the Anne Thompson and Manfred Metz framework that presented in the FAO's 1996 publication in order to provide a framework to examine the domestic food economy. The model has four components which are food supply curve, an effective demand curve, a food requirements line, and market prices. They stated that food security can be defined as a state in which supply and effective demand fulfill aggregate food requirements, whereas food insecurity is a situation whereby supply and/or demand fail to meet these needs. These researchers look the importance of food security at both demand and supply side.

2.3 Empirical Framework

There are many factors that determine food security and many research on food security has been done in different level such as country and household level.

2.3.1 Food Price

Aker & Lemtouni (1999) presented a framework for assessing food security at the national level in an effort to better understand how food security reacts to and is affected by the integration of domestic and global market in Morocco. They used the theory of demand and supply of food and Guttman Scale to provide more quantitative means for assessing food security also to determine the definite factors that influence food security. They stated that cereal price is ambiguous to food security where it is depends on country status as importer or exporter and the market regulation in the country economy. In the empirical result, they found that cereal prices have a negative impact to food availability as well as to food security.

Arshad & Hameed (2010) examine the factors that bring to the increase of price in food commodities and the implication to food security in Malaysia. The factors that cause the food price crisis are the fundamentals that include decline in growth of agricultural production, hence supply, decline in global cereal stocks and strengthening food demand from emerging economies. Second cause is the systemic factors that include underinvestment in agriculture and lopsided policy towards export crops at the expense of food. Third and fourth causes are increase in biofuel demand and technical factors respectively. As a net food importer, all these factors affected Malaysian in terms of first,

higher food import bill where in 2008, Malaysia food deficit increased to RM10.9 billion compared with RM4.9 billion in year 2000. Second, increase in consumer price index affected by the recent global price change. Third implication is short spell of social unrest in the midst of the crisis. The author recommended increasing public funding for agriculture and food and stability with growth with some liberalization and deregulation that may prove productive.

2.3.2 Population

Most of the previous studies focused on objective food security measures at the household level. Population is one of the factors that give impact on food security. At the household level, household size is the important determinants of food security. James, Robert & Thomas (2013); Mitiku, Fufa & Tadese (2012); Faridi & Wadood (2010); Omotesho, Adewumi, Muhammad-Lawal & Ayinde (2006); and Bashir, Schilizzi & Pandit (2012) in their study of the determinants of food security shows that household size are significant and have negative relationship to food security. This result or finding shows that an increase in household member will decrease the food security of the household. In the other hand, household size for food insecurity in household level gives significant result but positively related (Gebre, 2012). In the country level, we can imply that the increase in population will decrease the food security and vice versa. Different from the study did by Amaza, Adejobi & Fregrene (2008) which found that household size significant but have negative impact to food insecurity in rural household in Borno State of Nigeria.

2.3.3 Climate Change

Alam, Siwar, Murad & Toriman (2011) empirically investigated about the issue about the impact of the phenomena of climate change such as flood, natural disaster, pest attack, drought, plant disease and the time of crop cycle to the agriculture productivity changing, crop choice and food security in Malaysia. The chosen crops are paddy production (main staple food), vegetables fruits, beef, fish product, pork, muttons, chicken, egg, duck, and dairy product. They found that the climate change have negative impact on self-sufficiency and long term food security in Malaysia. Where, 64.1% of all the surveyed farmers report that yield of paddy production decrease due to climate change while 65.2% of them report the same impact for the other crop. They also give some suggestion to help the agriculture farmers to adapt with the climate change problems. First is controlling the pattern of rainfall, sunshine and moisture level to solve the problem. Second is protecting crops from excessive rainfall or sunshine and solving water login problems to improve shielding resources. Third is development of varieties of crops, development of rainfall and temperature tolerant plants and finding alternative crop and hybrids to develop defensive approach. Fourth is, find the alternative approach by changing the crop cycle and reducing the crop cycle timing. The last is, providing weather forecast and early warning system and ensuring delivery of proper information at the farm level to provide information.

Khee, Mee & Keong (2011) did the study to estimate the climate change economic impact on food security in Malaysia. This study reveals the demand side of Malaysians food security and use the willingness-to-pay (WTP) such basic necessity and use

Contingent Valuation Method (CVM) to elicits the respondent's WTP to dodge future damage on food security caused by the climate change by CVM questionnaire that included about the adaptation projects such as monitoring weather, dam construction, extremes, communal capacities buildings and developing disaster preparation strategies. To estimate the WTP function, Tobit Model are used and compared with the Ordinary Least Square (OLS) Model. The determinants of WTP that significant in this study are scale concern on the nation's food security is at risk, membership of environmental groups indicating the respondent being an environmentalist, gender and educational level. The result shows that the mitigation of climate change programs are important in assuring food security where for the mitigation programs, the public is willing to pay extra rice price in substitution of a rice subsidy reduction impact.

Arshad & Hameed (2010) also did the study to examine the patterns of policy response to the 2008 food security crisis in the producing countries due to the adverse weather situation and other technical and structural factors. Food security crisis found to affect the low income net-food countries include Bangladesh, Egypt, Indonesia, Nigeria and Philippines as they spent about 80% of their income on food. Weather is not directly impact the food security hence food security is indirectly related to the industrialization which contributed to the disruption of weather and global warming.

Edame, Ekpenyong, Fonta & EJC (2011) did the study to examine the impact of climate change on basic components of food security such as availability, accessibility, affordability, preference, utilization, and nutritional value and food system stability. Local beneficial effects where higher levels of atmospheric CO2 produced by the so-

called greenhouse fertilization affect stimulated plant growth. They found that the viability of current world agro ecosystem and future food availability have long term implication by altered hydrological cycles, increased intensity and frequency of storms and precipitation variance as much as 20% of decrease in agriculture activity in Africa, Asia and Latin America are expected. Most estimates also shows that climate change is likely to reduce agriculture productivity, production stability and income in some areas that already have high food security.

2.3.4 Foreign Worker

A foreign worker is a person who employed in a country on a temporary basis to which the person is not a citizen. Foreign workers are recruited by the company, recruitment agency or hired whilst they were job seeking in the country to supplement the workforce of the country for a limited term or to provide skills on a contractual basis that the country seeks (Mohamed, Ramendran SPR and Yacob, 2012). While, according to the Ecumenical Council for Corporate Responsibility (ECCR), the UN Migrant Workers Convention defines a migrant worker broadly as a person who is to be engaged, is engaged, or has been engaged in a remunerated activity in a State of which he or she is not a national.

Kanapathy (2006) state that migration has positive, negative or neutral effect and there is little empirical analysis on the impact of migrant workers on Malaysia economy due to the lack of accurate data on contract migrant workers. However, several casual observations have been made according to the irregular migrations high incidence and the

visible socio-political and security problems. Nonetheless these observations are tends to highlight the negative impact of migrant workers on the economy.

Different from cross-country experiences, show that the immigrants have been reasonably positive impact on economy but it is important to note that the impact of immigrants on the local economy is depend on the magnitude and type of immigrants (Kanapathy, 2006).

2.3.5 Agriculture Land Used

Farm size also one of the important determinant of food security at the household level. Omotesho et al. (2006); James et al. (2013); and Mitiku et al. (2012) in their study shows that farm size own by the household are significant and give positive impact on food security. These findings indicated that increase in farm size own by the household will increase food security and vice versa. For food insecurity, farm size have negative impact where increase in farm size own will decrease food insecurity of the household (Amaza et al., 2008) and vice versa. Those findings imply that agriculture land uses for food production are important to increase the food security in the country.

2.4 Conclusion

According to these reviews, the important determinants of food security are food prices, population, climate change, foreign workers and agriculture land used. However, there is no appropriate empirical study about the impact of foreign workers on food security in the country. Therefore, this study will review how this factor affects food security in Malaysia. Then the next chapter will discuss about the methodology used in this analysis.

CHAPTER 3

DATA AND METHODOLOGY

3.1 Introduction

This chapter will discuss about the econometric methods and procedure to analyze the determinants of food security in Malaysia that have been identified in the literature as potential determinants of food security. Section 3.2 discusses the conceptual framework for this study. Then section 3.3 presents the source of data in this study. The food security functions and the empirical specifications for the analysis are presented in section 3.4. The expected sign for each explanatory variable will also be discussed. Sections 3.5 discuss the measurement of variables based from the empirical specifications. The significance of chosen explanatory variables also will be discussed. Lastly, the techniques and procedure in conducting the econometric analysis discussed in section 3.6.

3.2 Conceptual Framework

Based on the issues, problem statements and research objective discussed in Chapter 1, three research objectives are developed to determine the impacts of four determinants such as food price (FP), population (POP), CO2 emission (CO2) and foreign worker (FW) on food security in Malaysia.

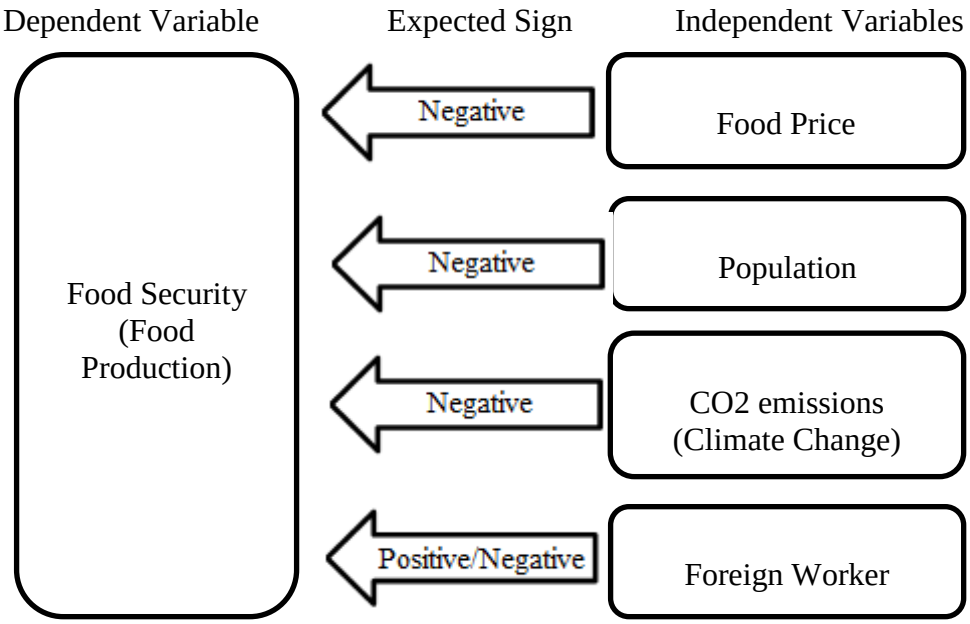

Figure 3.1
Conceptual Framework

Figure 3.1 illustrates the conceptual framework designed according to the study's objectives. Generally, this study is to demonstrate whether FP, POP, CO2 and FW are the determinants of food security as well as to examine the long run and short run relationship among those variables and finally to develop food security model in Malaysia. The aims are achieved by running the time series econometric techniques such as Johansen cointegration and VECM from 1982 to 2011. FP, POP and CO2 emissions are expected to give negative impact on food security in Malaysia. While FW is ambiguous and it means that it can be negative or positive impact on food security. The next section will explain the empirical models that will be used in the study in corresponding to the above mentioned conceptual framework.

3.3 Data

This study employs 30 years' time series data from year 1982 to 2011. There are five variables and all variables are expressed in log terms. Those data are obtained from Food and Agriculture Organization (FAO), World Bank, and Department of Statistic (DOS) websites. The five variables used in this study are:

i. Food production index (2004-2006=100) which is proxy of food security covers food crops that are considered edible and that contain nutrients. Coffee and tea are excluded because, although edible, they have no nutritive value.
ii. Food price index (FP) for based year 2002-2004=100.
iii. Malaysia population (POP) in million.
iv. Carbon dioxide emissions (CO2) in kilotonnes (kt) include carbon dioxide produced during consumption of solid, liquid, gas fuels and gas flaring.
v. Percent of total foreign worker (FW) in Malaysia.

The five interested variables were chosen based on the previous studies done by the researchers. However, there are not even any study discuss about the impact of foreign worker on food security in Malaysia. In this study, this variable will be included to examine the impact of this variable on food security in Malaysia.

3.4 Model Specification

Food security is defined in four components which are food availability, food access, food utilizations and food stability (FAO, 2006). Food availability is the total food available for human consumption, supplied either by production, stocks import or food aid. Food production indicates that food available for population which produced by a country through food domestic production alone or beyond food domestic production or both (Aker & Lemtouni, 1999). Domestic food production is the most important quantitative component in national food security for almost all countries (FAO, 1996). Lack of food supplies will cause hunger and starvation in a country. Therefore, food production will be used as proxy for food security.

Based on the discussion on the food security potential determinants, the model can be written as:

$$Q = fs\ (FP, POP, CO2, FW) \quad (3.1)$$

$$\log Q_t = \beta_0 + \beta_1 \log FP_t + \beta_2 \log POP_t + \beta_3 \log CO2_t + \beta_4 \log FW_t + \varepsilon_t \quad (3.2)$$

where,

Q = food production index (2004-2006 = 100)

FP = real food prices index (2002-2004=100)

POP = Malaysia population (million)

CO2 = Carbon dioxide emissions (kt)

FW = foreign worker (percentage)

ε = error term

t = time series period

β_0 = the intercept

$\beta_1, \beta_2, \beta_3, \beta_4$ = coefficients for the explanatory variables

In order to evaluate the impact of the variables in percentage terms, the model is modified by transforming the equation into a log form (see equation 3.2).

3.5 Measurement of Variables

This section will discuss the detailed description and measurement of all the various variables used in the econometric models. The dependent variable in this model is food security which is peroxided by food production index. Meanwhile, the explanatory variables are food price index, Malaysia population, carbon dioxide emissions and foreign worker. The detailed description and measurement are provided as below.

3.5.1 Food Production Index

The annual data available of this variable is in term of index (2004-2006=100), so this study will be using this variable in order to represent food production as a proxy of food security. According to Kiong (2012) index number of food production can be counted as:

$$Q_t = [(Q_1 / Q_0) \times 100] - 100 \qquad (3.3)$$

where,

Q_t = Food production index

Q_1 = Food production of specific year

Q_0 = Food production of base year (2004-2006=100)

Subtract 100 from the answer of index number is because of 100 is the full amount of the base period (or 100%). Base year are determined by data available from Department of Statistics (DOS).

3.5.2 Real Food Price Index

Just like food production index, the same calculation can be used to obtain food price index by replacing food production with food price. The data available for this variable are nominal and real (deflated) food price index (base year 2002-2004). In this study, real food price index is using to represent food price. The real food price is calculated using formula in equation (3.4).

$$R_t = P_t / D_t \tag{3.4}$$

where,

R_t = Real food price index

P_t = Nominal food price index

D_t = Deflator factor

Equation (3.5) is the equation 3.4 transformed into logarithm form:

$$\log R_t = \log\left(\frac{P_t}{D_t}\right) = \log P_t - \log D_t \tag{3.5}$$

According to the previous study, there is negative relationship between food price and food security (Aker & Lemtouni 1999). An increase in food price will lead to food insecure situation in a country. High price will decrease consumer's purchasing power especially for poor and low income group.

3.5.3 Malaysia Population

The growth of population should be positively correlated with production growth, but the growth of population is faster than growth of food production (Malthus, 1798). Thus, the coefficient of estimation according to Thomas Malthus theory on population should be inelastic. The theory suggests that this phenomenon will lead to hunger. However, this is not implying that the coefficient of the population effect on food production is always inelastic (less than one). If the population grows slower than food production that means there are always food surplus (food availability) and food secure in a country. However, population is rapidly increasing year by year and agriculture sector faces the challenges of shortfall in meeting increase demand of food (Ahmed & Siwar, 2013). So, according to the previous studies, the expected sign for this variable is negative.

3.5.4 Carbon Dioxide (CO2) Emissions

Climate change is one of the important issues related to food security at global level. Since the data available for climate change is only carbon dioxide (CO2) emissions, this variable will be used as a proxy for climate change in this study. The expected sign of this variable should be negative (Ahmed & Siwar, 2013; Lobell & Field, 2007).

3.5.5 Malaysia Foreign Workers

Foreign workers should be giving a positive impact on production of food since the gap of labor shortage in agriculture sector in Malaysia is fulfill by them (Ahmed & Siwar, 2013). However, migrations have positive and negative impacts on Malaysia economy (Kanapathy, 2006). Since agriculture sector demanded a lot of unskilled labor of foreign workers (World Bank, 2013), it is possibly leads to decrease in productivity. So, the impact of foreign workers on food production is ambiguous. It can be negative or positive impact on the food security.

3.6 Econometric Procedures

In order to examine the relationship between the potential explanatory variables with the food security, unit root test first employed before proceed with the other econometric estimation method. After that, the cointegration test will be conducted based on Johansen and Juselius test for cointegration to examine whether there exist the long run relationship of food security determinants. Vector Error Correction Model (VECM) approach is used to analyze the short run relationship. Finally, the diagnostic tests were performed by using Auto-Regressive Conditional Heteroskedasticity (ARCH), Normality and Lagrange Multiplier (LM) test to check the robustness of the model. Detailed procedure for the entire test is presented below.

3.6.1 Unit Root Test

Unit Root Test is firstly implied in this study to know wether time series are stationary or nonstationary before begin the regression analysis. It is important to avoid significant

analysis from unrelated data when nonstationary series are uses and the regression is said to be spurious. There are several test that can be use such as Augmented Dickey-Fuller (ADF) test, Philips Perrons (PP) and Kwiatkowski-Phillips-schmidt-shin (KPSS). Unit root test can be expressed as Autoregressive one (AR(1)) model as following:

$$y_t = \propto + \rho y_{t-1} + e_t \quad t = 1,2\ldots\ldots, \tag{3.6}$$

Where,

y_t= variable y at time t

y_{t-1}= variable y at lagged 1 t.

The value of ρ equal to one means that's the variable y has a unit root. For convenient unit root testing, the equation is substracted by y_{t-1} and come outs with equation:

$$\Delta y_t = \propto + \theta y_{t-1} + e_t \text{ and } \theta = \rho - 1. \tag{3.7}$$

The hypothesis for unit root test is as following:

H_0: $\theta = 0$ (y_t is non-stationary)

H_1: $\theta < 0$ (y_t is stationary)

In this test, the Akaike Information Criteria (AIC) is selected to execute Augmented Dickey Fuller (ADF) test. If the test shows the t statistic is greater than t critical, then H_0

is rejected which denote that y_t is stationary or do not has a unit root (Wooldridge, 2013) and vice versa. In this study, ADF and Philips Perrons (PP) test will be used.

3.6.2 Johansen Cointegration Test and Long Run Equilibrium

Johansen test is the procedure to test for cointegration in time series data. This test is based on the Vector Autoregressive (VAR) Model approach to test the variables of interest in the food security model. The purpose is to examine the long run relationship between the dependent variable and explanatory variables. In this study, the focus is to determine the long run relationship between food security and the determinants. Compared to the Engle-Granger test or Dickey-Fuller, this test is much more convenient (augmented) test in unit root because this test does not require all variables to have the same order of integration.

There are two types of Johansen test which consist of trace or eigenvalue. The difference between both is in the context of the null hypothesis involved. The null hypothesis for the eigenvalue test is r = equals the number of cointegration vectors in the model, while the null hypothesis for trace test is r ≤ the number of co integration vectors in the model. Similar to the unit root test, the number of co integration vectors could be constant or include a trend term or both.

This approach will later be used to examine the long run impact of the explanatory variables on food security.

3.6.3 Vector Error Correction Model (VECM)

When the variables in the Vector Autoregressive Models (VAR) are co integrated, the Vector Error Correction Model (VECM) technique is used. According to the Granger Representation theorem, when variables are cointegrated, there must also be an error correction model (ECM) that describes the short run dynamics or adjustments of the cointegrated variables towards their equilibrium values. ECM consists of one period lagged cointegrating equation and the lagged first differences of the endogenous variables. By using the restricted Vector Autorgession (VAR) method, we can estimate the ECM. In particular, the error correction model (ECM) can be constructed by expressing changes in the dependant variables as a function of the level of disequilibrium in the cointegrating relationship (captured by the error correction term) as well as changes in other explanatory variables. From the regression analysis, the coefficient for the explanatory variables are able to interpret and the signs are able to detect. This approach will show the speed of adjustment of the model in short run. The following error correction model is developed:

$$\Delta \log Q_t = \log\beta_0 + \beta_1 \Delta \log FP_t + \beta_2 \Delta \log POP_t + \beta_3 \Delta \log CO2_t + \beta_4 \Delta \log FW_t$$

$$+ \beta_5 ECM\text{-}1 + v_t \qquad (3.8)$$

Where ECM-1 is the error correction component and is the lagged estimated error series from Equation 3.2 while v are the random error terms.

3.6.4 Diagnostic Tests

To test the robustness of our model, the diagnostic tests were performed based on Auto-Regressive Conditional Heteroskedasticity (ARCH) test, Normality test and also Lagrange Multiplier (LM) test. The entire test is shown as below.

3.6.4.1 Auto-Regressive Conditional Heteroskedasticity (ARCH) test

Since heteroskedasticity is a common problem for time series data, ARCH test will be conducted to detect the presence of this problem. The regression model for ARCH test is shown as below:

$$Y_t = \beta_1 + \beta_2 X_{2t} + K + \beta_k X_{kt} + u_t \qquad (3.9)$$

$$\sigma_{2t} = \alpha_0 + \alpha_1 \sigma_{2t-1} + K + \alpha_p \sigma_{2t-p} + \varepsilon_t \qquad (3.10)$$

The null hypothesis is as follows:

$$H_0 = \alpha_1 = \alpha_2 = K = \alpha_p = 0 \text{ (No ARCH effect)}$$

By obtaining the value of the R^2 from the auxiliary regression, ARCH test statistic could be computed using the formula $(N-p)R^2$. The test statistic is distributed as chi-square with p degrees of freedom (χ^2_p).

3.6.4.2 Lagrange Multiplier (LM) test

The Breusch-Godfrey serial correlation LM test will be using in order to test for the presence of autocorrelation problem. Supposed that the disturbance term u_t is generated by the following ρth-order autoregressive model:

$$u_t = \rho_1 u_{t-1} + \rho_2 u_{t-2} + \varepsilon_t \qquad (3.11)$$

Where ε_t is a purely random disturbance term with mean zero and constant variance. The null hypothesis for the testing is as follows:

H_0: $\rho_1 = \rho_2 = 0$

H_1: At least one of the ρ is not equal to zero

The null hypothesis indicates that there is no autocorrelation of any order. The variable ρ=2 indicates that we introduce two lagged values of the residuals is introduce as additional repressor in the model. The formula for this analysis is:

$$(n- \rho)\, R^2 \sim \chi^2_p$$

Where n is the sample size, ρ is the number of lag and R^2 is the goodness of fit. If the value $(n- \rho)R^2$ exceeds the critical chi-square value at the chosen significance level, the null hypothesis can be rejected and conclude that at least one ρ is significantly difference from zero.

3.6.4.3 Normality Test

Normality is commonly assumed in many statistical and economic methods, although often conveniently assumed in reality without any empirical test. Violation of this assumption will result in unreliable inferences and misleading interpretations. With multivariate statistics, the assumption is that, the combination of variables follows a multivariate normal distribution. There are both graphical and statistical methods for evaluating normality. Graphical methods visualize the distributions of random variables or differences between an empirical distribution and a theoretical distribution. This method is using since it is intuitive and easy to interpret. Then, the histogram of the residuals will be compared to a normal probability curve. The actual distribution of the residuals should be bell-shaped and resemble the normal distribution. The Jarque-Bera test statistic will be used to empirically detect the normality. If the errors are not normally distributed, the estimator is biased.

CHAPTER 4

DATA ANALYSIS AND RESULTS

4.1 Introduction

This chapter presents and explains the empirical results of the data analysis. Unit root test is first conducted based on Augmented Dickey Fuller (ADF) and Phillips-Perron (PP) approach. Then, it is proceed with the co-integration test based on Johansen and Juselius (1990) co-integration approach to derive the long run relationship between food security and the explanatory variables. The Vector Error Correction Model (VECM) approach was conducted to see the short run adjustment. This chapter also presents the results of Diagnostic Test to check for residual which consist three test such as ARCH test for heteroscedasticity, LM test for serial correlation and normality test.

4.2 Unit Root Test

Unit root test is employed to determine the stationary of the variables. This test should be executed first to avoid spurious regression problem during the estimation. This test consists of two parts which are constant and constant with trend. The length of lag is automatically depending on Akaike Information Criteria (AIC). Table 4.1 and 4.2 show the unit root test results based on ADF and PP approach respectively. The analysis is categorized into two parts, which are, at level and first difference.

Table 4.1
Unit Root Tests for Augmented-Dickey Fuller (ADF)

Variable	Level		First Difference		Results
	Intercept	Intercept & Trend	Intercept	Intercept & Trend	
logQ	-2.5534 [1]	-3.0052 [4]	-7.4367 [0]	-8.2107 [0]	I(1)
	(0.1144)	(0.1504)	(0.0000)***	(0.0000)***	
logFP	0.5746 [0]	-3.2704 [7]	-4.1870 [0]	-4.4255 [0]	I(1)
	(0.9864)	(0.1973)	(0.0030)***	(0.0079)***	
logPOP	-0.6239 [7]	-2.9595 [7]	-3.7565 [6]	-4.0668 [0]	I(1)
	(0.8459)	(0.1647)	(0.0103)**	(0.0178)**	
logCO2	-1.6782 [0]	-1.0307 [0]	-5.4325 [0]	-5.5666 [0]	I(1)
	(0.1413)	(0.9237)	(0.0001)***	(0.0005)***	
logFW	-1.2252 [0]	-1.7106 [0]	-4.9571 [0]	-4.8734 [0]	I(1)
	(0.6496)	(0.7206)	(0.0004)***	(0.0028)***	

Note: *** indicates the rejection of hypothesis null of non-stationary at 1 percent level of significant.
**indicates the rejection of hypothesis null of non-stationary at 5 percent level of significant.
[ ] indicates the lag specification
( ) indicates t –statistic value

Table 4.2
Unit Root Tests for Phillips-Perron (PP)

Variable	Level		First Difference		Results
	Intercept	Intercept & Trend	Intercept	Intercept & Trend	
logQ	-2.2674 [17]	-1.7699 [2]	-7.3928 [2]	-8.2107 [0]	I(1)
	(0.1886)	(0.6930)	(0.0000)***	(0.0000)***	
logFP	0.4190 [1]	-0.920 [2]	-4.2020 [1]	-4.4255 [0]	I(1)
	(0.9804)	(0.9355)	(0.0029)***	(0.0079)***	
logPOP	0.9476 [4]	-3.1850 [4]	-4.1232 [0]	-3.2956 [0]	I(1)
	(0.9948)	(0.1071)	(0.0035)***	(0.0876)*	
logCO2	-1.6782 [0]	-0.9885 [1]	-5.4580 [2]	-5.5629 [1]	I(1)
	(0.1413)	(0.9303)	(0.0001)***	(0.0005)***	
logFW	-1.2297 [2]	-1.8355 [2]	-4.9513 [2]	-4.8654 [2]	I(1)
	(0.6496)	(0.6612)	(0.0004)***	(0.0028)***	

Note: *** indicates the rejection of hypothesis null of non-stationary at 1 percent level of significant.
*indicates the rejection of hypothesis null of non-stationary at 10 percent level of significant.
[ ] indicates the lag specification
( ) indicates t –statistic value

The results of unit root test both in ADF and PP shows that at level, t-statistic values for all the variables used in this study such as food production index (logQ), real food price index (logP), population (logPOP), carbon dioxide (CO2) emissions (logCO2) and foreign labor (logFW) are not statistically significance. Then, null hypothesis of non-stationary cannot be rejected at any significant level indicates that all variables series are non-stationary at level and the series contain a unit root.

However, at first difference, t-statistic values are significant. So, the null hypothesis of non-stationary can be rejected indicates that all variables are stationary at first difference. Therefore, the results means that all the series are integrated of order one, I(1). Since the variables in the model are I(1), the spurious regression problem occur. The next step is to test the co-integrations between the variables.

The following sections discuss the results of cointegration analysis. The discussion starts with the determination of the optimal lag length. It, is then, followed by the Johansen cointegration analysis results, Vector Error Correction Model (VECM) and Diagnostic Test.

4.3 Lag Selection

Before proceed with other analysis, the optimal lag length should be determined first to know how many lags we should select to run the model. The optimal lag length is obtained based on the VAR lag order selection criteria. The results in the Table 4.3 clearly show that the optimal lag length for cointegration is 1.

Table 4.3
VAR Lag Order Selection Criteria

Lag	LogL	LR	FPE	AIC	SC	HQ
0	216.0849	NA	3.28e-13	-14.55758	-14.32184	-14.48375
1	426.1525	333.2107**	9.67e-19**	-27.32086**	-25.90642**	-26.87787**

Notes: ** indicates lag order selected by the criterion at five level of significant.
LR : Sequential modified LR test statistic.
FPE : Final prediction error.
AIC : Akaike information criterion.
SC : Schwarz information criterion.
HQ : Hannan-Quinn information criterion.

4.4 Co-integration Test and Long Run Equilibrium

Co-integration tests are conducted since unit root test showed that all the variables are I(1) and stationary at same order. This tests are important to test whether the variables are co-integrated each other or not. The variables are said to have long run relationship if they are co-integrated each other and otherwise. In this study, Johansen co-integration test is used. Johansen test is purposely used to see the long run relationship between two or more variables in the model. There are two co-integration tests conducted such as trace test and Max-eigenvalue test and both tests used linear deterministic trend with restriction. The results are presented in Table 4.4.

Table 4.4
Results for Cointegration Test

Hypothesized No. of CE(s)	Trace		Max-Eigen	
	Statistic	0.05 Critical Value	Statistic	0.05 Critical Value
None	142.0823**	69.81889	59.50393**	33.87687
At most 1	82.57842**	47.85613	36.02549**	27.58434
At most 2	46.55293**	29.79707	27.59047**	21.13162
At most 3	18.96246**	15.49471	17.34538**	14.26460
At most 4	1.617078	3.841466	1.617078	3.841466

Note: ** indicates the rejection of hypothesis null of non-stationary at 5 percent level of significant.

The co-integration test results both based on Trace statistic and Max-eigenvalue indicates 4 co-integrating equations at the 5% level. Both results indicates that the variables are co-integrated each other and there is a long run relationship between food security and explanatory variables.

To achieve the second research objective, the empirical results of the long run model obtained by normalizing cointegrating equation on food security (Q). The estimated are presented in Table 4.5.

Table 4.5
Results for Estimated Co-Integrating Equation

Variable	Normalized Cointegrating Coefficient	t-statistic
LOGQ	1.0000	
LOGFP	-0.3100***	2.2691
LOGPOP	4.2899***	7.2914
LOGCO2	-1.8256***	8.6033
LOGFW	0.4239***	3.2116

Note: *** indicates the rejection of hypothesis null of non-stationary at 1 percent level of significant.

When normalized for a unit coefficient on FP, POP, CO2 and FW, the cointegrating regression of food security model in Malaysia can be written as follows:

$$\mathbf{logQ_t = -0.3100\ log\ FP_t + 4.2899\ log\ POP_t - 1.8256\ logCO2_t + 0.4239\ logFW_t}$$

This normalized equation explained the signs of the variables whether they are consistent with a priori expectation. The results show that two variables namely FP and CO2 are negative and statistically significant at 1 per cent level. This indicated that food price and carbon dioxide emissions are statistically significant contributing to food security in the long run. For FP the results shows that 1 per cent increase in food price is seen to cause a 0.31 per cent decrease in Malaysia food security. This result is consistent with other findings such as by Aker and Lemtouni (1999). For CO2 the results indicated that 1 per cent increase in CO2 emissions will lead to 1.8256 per cent decrease in food security. They are in line with a priori expectations such as by Alam et al. (2011), Khee et al. (2011) and Edame et al. (2011).

However, results for POP have shown significantly positive relationship with food security in the long run which is contradict with a priori expectations such as by James et al. (2013) and Mitiku et al. (2012). The degree of impact shows that 1 percent change in POP will lead to 4.2899 per cent increase in food security. An explanation for positive sign may be due to the used of food production as a proxy for food security. Theoretically, an increase in population will increase production of food caused by the increase in demand for food. But, this result is consistent with a study from a rural area in Borneo State of Nigeria by Amaza et al. (2008) which found that an increase in population causes an increase in food security.

Results for foreign worker also show significantly positive impact on food security in the long run. It is indicated that an increase in foreign worker in Malaysia will increase food security as well. As stated by Kanapathy (2006), foreign worker could be positive, negative or neutral impact on Malaysia economy and there is a little study on the effect of foreign worker to food security. So, this result may be due to the used of food production as proxy of food security as well. Since foreign workers also contribute to agriculture productivity cause by the decrease in local labor forces in that sector, their presence can cause an increase in food production.

Overall, results from Table 4.5 show that all the variables are statistically significant at one percent level of significance indicate that all the interested explanatory variables are important determinants of Malaysia food security in the long run.

4.5 Short Run Dynamics – Vector Error Correction Model (VECM)

Meanwhile, Vector Error Correction Model (VECM) can lead to a better understanding of the nature of any non-stationarity among the different component series and can also improve longer term forecasting over an unconstrained model. Besides that, it would be inappropriate to estimate a VAR model when the variables are co-integrated and expressed in first differences (Baffoe-Bonnie & Gyapong, 2012) because first differencing would leads to the loss of a significant portion of information related to the co-movement in the data. Rather than a VAR model, an error correction model is the appropriate model if the variables are co-integrated in first differences (Eagle & Granger, 1987). According to Engle and Granger (1987), the cointegration relationship must have an ECM representation. The ECM essentially estimates the short run dynamics between the variables.

The equation is regressed with difference of Q as a dependent variable against the lagged differences of the independent variables such as FP, POP, CO2 and FW. Due to the limited sample size, a 1-lag structure is employed. To answer the third research objective, the results of short run Error Correction Model for food security is presented in Table 4.6.

Table 4.6
Results for Estimated Vector Error Correction Model (VECM)

Variables	Coefficient	t-statistic
C	-0.068389	-1.095511
$\Delta logQ_{t-1}$	-0.060015	-0.279115
$\Delta logFP_{t-1}$	0.097518	1.479993
$\Delta logPOP_{t-1}$	8.415742	1.450691
$\Delta logCO2_{t-1}$	-0.00727	-0.085955
$\Delta logFW_{t-1}$	0.147794	2.571362**
Ect_{t-1}	-0.722071	-2.337230**

Note: ** indicates the rejection of hypothesis null of non-stationary at 5 percent level of significant.

Table 4.6 relates lag difference of Q to lag differences of FP, POP, CO2 and FW. It shows that foreign worker is the only variable that significant in the short run. While the others variables such as food price, population and CO2 emissions are not significant and not important in explaining Malaysia food security in the short run.

Changes in FP, POP and FW effect positively the changes in Q indicating the independent variables are positively affecting food security. A 1 per cent increase in $\Delta logFP_{t-1}$, $\Delta logPOP_{t-1}$ and $\Delta logFW_{t-1}$ will lead to expansion of $\Delta logQ_{t-1}$ by 0.0975 per cent, 8.4157 per cent and 0.1478 per cent respectively. In terms of significant level, while $\Delta logFW_{t-1}$ is statistically significant at 5 per cent level of confident, $\Delta logFP_{t-1}$ and $\Delta logPOP_{t-1}$ are statistically insignificant and again this possibly due to the small sample size.

On other hand, changes in CO2 affect changes in Q negatively and the affect is statistically insignificant. 1 per cent increase in $\Delta \log CO2_{t-1}$ leads to the decline of $\Delta \log Q_{t-1}$ by 0.0073 per cent in the short run. This result supported by previous study by Alam et al. (2011), Khee et al. (2011) and Edame et al. (2011).

Based on the VECM result, there is an error correction term exist in this analysis. If the coefficient value of this error correction term more than one ($Ect_{t-1} > 1$), it indicates that the short run deviation goes on rapid paths to equilibrium in the long run. Otherwise, if the coefficient value in this error correction term less than one ($Ect_{t-1} < 1$), it indicates that the error correction term slowly adjust back to equilibrium in the long run. The results presented show that the Ect_{t-1} coefficient is negative and significant at 1 percent significant level implying that the series cannot drift too far apart and convergence is achieved in the long run. The estimated coefficient of the error correction term was 0.722071 indicates that the speed of adjustment is around 72 percent at 1 percent significant level. It is means that the adjustment process of the disequilibrium is about 72 percent in one year.

4.5 Diagnostic Test

The diagnostic test was performed to check the robustness of the model. First, ARCH test was conducted to detect heteroscedasticity problem. Then, LM test based on Breusch-Godfrey test conducted to detect the presence of autocorrelation and finally tested the normality to check the distribution of the error terms. All the tests are discussed below.

4.5.1 ARCH test

In order to test for heteroskedasticity problem, the ARCH test was performed. The result for the test is summarized in Table 4.7.

Table 4.7
ARCH Test for Heteroscedasticity

ARCH test:			
F-statistic	0.026976	Probability	0.8709
Obs. R-squared	0.029102	Probability	0.8645

Hypothesis testing for ARCH test is:

H_0: Homoskedasticity (the variance of residual is constant)

H_1: Heteroskedasticity (the variance of residual is unequal)

Based on the result, the p-value of the F-test (0.8709) is bigger than any significance level (1%, 5% and 10%). Therefore, H_0 is fail to reject and concluded that the model have constant variance of residuals and thereby fulfilled the homoskedasticity assumption indicates that the model does not have heteroscedasticity problem.

4.5.2 LM Test

The Lagrange Multiplier (LM) test based on Breusch-Godfrey test using 2 lags was performed to detect the presence of autocorrelation problems in the model. Result for the test is reported in Table 4.8

Table 4.8
LM Test for Serial Correlation

Breusch-Godfrey Serial Correlation LM test:			
F-statistic	1.096344	Probability	0.3963
Obs. R-squared	6.678707	Probability	0.1539

Hypothesis testing for Breusch-Godfrey Serial Correlation LM test is:

H_0: no autocorrelation (no correlation between error term)

H_1: autocorrelation (correlation between error term)

Based on the result in Table 4.8, the p-value for the F-statistic is 0.3963, which is bigger than the any significance level (1%, 5% and 10%). Therefore, failed to reject H_0 and conclude that there is no autocorrelation problem in the model.

4.5.3 Normality Test

A normality test was conducted to see whether the residual are normally distributed or not normally distributed. The result for the test is presented in Figure 4.1.

Hypothesis testing for normality test is:

H_0 : Residuals are normally distributed

H_1: Residual are not normally distributed

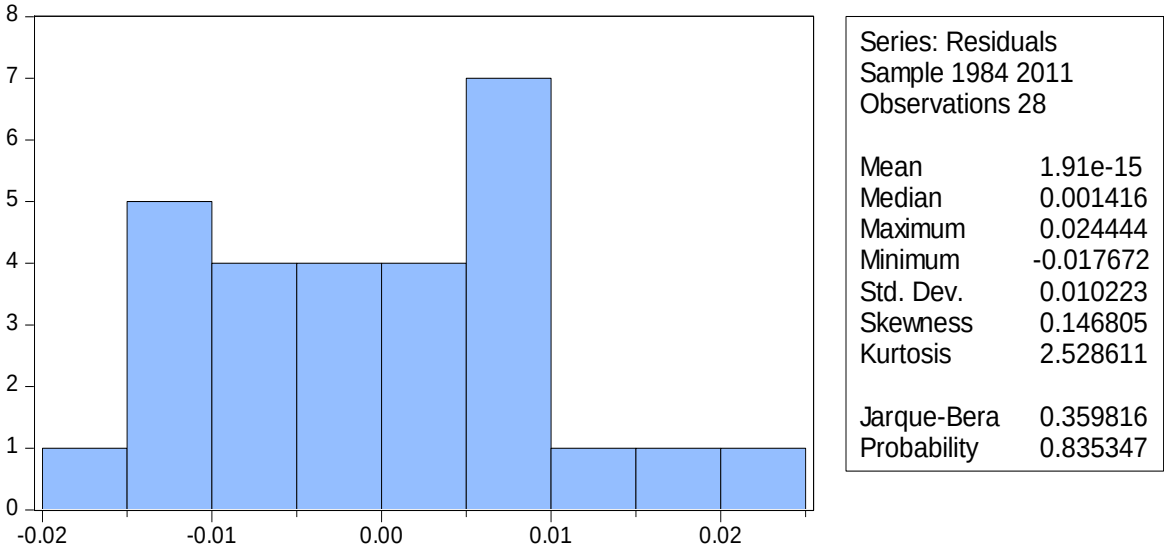

Figure 4.1
Normality Test

Based on the histogram, the bell shape indicates that the residuals are normally distributed although some parts show high residuals. This may be due to a shock in the economy. Furthermore, the p-value is bigger than any significance level (1%, 5% and 10%). So, failed to reject H_0 and conclude that the residuals are normally distributed.

CHAPTER 5

CONCLUSION AND POLICY RECOMMENDATIONS

5.1 Conclusion

The purpose of this study is to determine the influence of selected variables on Malaysia's food security model. There are many variables which can be used to determine food security in the country. The variables selected for the analyses were food price (FP), Malaysia population (POP), carbon dioxide emissions (CO2) and foreign workers (FW). These four independent variables have been tested to determine their effect on Malaysia food security model. This study employs time series data from 1982 to 2011.

In analyzing the time series data, the unit root test, cointegration test, and error correction model (ECM) techniques have been used. The unit root test is called the Augmented Dickey-Fuller (ADF) test and Philip-Perron (PP) test. The results show that food security and all the explanatory variables are stationary in the first difference value. The results indicates that all the variable are integrated of order one, I(1).

Next, Johansen test is conducted to examine the long run relationship between the dependent variable and the explanatory variables since the variables are integrated at the same order. Johansen test using the trace and Max-Eigen statistics test shows that there are four cointegrating equation which means that there is exists a long run relationship among the variables in this study. This result fulfill the second objective of the thesis which to examine the long run relationship between food security and its determinants.

The normalized cointegrating equation shows that all the explanatory variables are significant and important to determine food security in Malaysia in the long run.

Further, the data were analyzed using the Vector Error Correction Model (VECM) to determine how much the short run deviation from the long run. The coefficient in error correction term (Ect) is the speed of adjustment factor. There exists one error correction term in this analysis. The result shows the value of Ect is negative and significant indicated that there are a long run relationship between food security and its determinants. The speed of adjustment value is 0.72 (less than one) means that the Ect slowly adjust back to equilibrium in the long run.

Lastly, the diagnostic tests were conducted. These tests consist of the Lagrange Multiplier test. In the Breusch-Godfrey Serial Correlation LM Test, we conclude that there is no evidence of autocorrelation problem in the model. While, in the Autoregressive Conditional Heteroscedasticity (ARCH) test shows that we failed to reject H_0: Homoscedasticity (variance u is constant) and we conclude that there is no evidence of heteroscedasticity problem in the model. Lastly, normality test show that the residual are normally distributed.

5.2 Policy Recommendations

Based on the results of this study, several recommendations can be taken and performed to increase food security in Malaysia. These suggestions also allow the food security level to be better through improvements on the determinants that have significant effect on food security. Policymakers have a choice of long run and short run policies or a

combination of both in promoting food security in Malaysia. The results shows that only foreign workers would affect food security in both long run and short run while the other determinants such as food price, population and carbon dioxide emissions affects food security in the long run. Therefore the policymakers should manipulate the significant variables to achieve the long run and short run goals.

Food price shows significant and negative impact on food security in the long run. According to the Ministry of Finance (2013) low income group spent about 40% of their income on food. So, the government may control and have more restriction on the food price. This is to ensure that the supplier do not take advantage to increase the food prices. This action would protect the poor and the lower income group to consume food with appropriate prices.

Population shows a positive relationship on food security both in long run and short run although the result is only significant in long run. This result is contradicted with previous study in Malaysia. It is may be caused by the used of food production as proxy of food security.

A carbon dioxide emission shows a negative impact on food security both in long run and short run but only significant in long run. Even though the government had initiated more programs to create more awareness on environmental issues, but more effort should be done to educate related parties such as farmers, children, transport users and others to reduce climate change. Since, one of the factor that cause climate change is the use of inappropriate fertilizer by the farmers, so the government may organize more campaigns to introduce about the right fertilizer such as organic fertilizer. For transport users, they

may organize more programs to increase the awareness about the use of public transport. Indirectly, the climate change will reduce by the reduction in the use of private transport. Besides that, the government may educate children about the environmental awareness by adding some topics in their syllabus and provide several activities at schools.

Foreign workers is important factors in both long run and short run since the result shows that it is positively significant in both long run and short run. Lately, the government is trying to restrict the entry of foreign worker in the country. Since the finding of this study suggests that foreign worker is important on contributing the production of food and food security in Malaysia, the government should reconsidered the policy for foreign worker. However, to increase foreign worker in Malaysia is not good since they will increase social problems in Malaysia. To avoid this problem, the government may create more programs to encourage the local labor to work in the agriculture sector.

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