FACTORS THAT AFFECT THE FOOD PRODUCTION IN MALAYSIA

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BY

LIM YANN TORNG

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

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APRIL 2022

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) The word count of this research report is 10,162.

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Date: 29/4/2022

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DEDICATION

This research project is dedicated to all of the individuals who have meant so much to me, they provide superior support and encouragement to me. I would like to dedicate this research paper to my supervisor and my coursemates. They are willing to share their opinions and knowledge and give some reliable information and suggestions to me during this period. In short, I have learned quite a lot of knowledge, information, and skills through this final year project (FYP).

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LIST OF ABBREVIATIONS

FAO	Food and Agriculture Organization
FPI	Food production index (2014-2016 = 100)
EA	Employment in agriculture (% of total employment)
AL	Agricultural land (% of land area)
PG	Population growth (annual %)
CPI	Consumer price index (2010 = 100)
FC	Fertilizer consumption (kilograms per hectare of arable land)
SGDs	Sustainable development goals
SWCorp	Solid Waste and Public Cleansing Management Corporation
GFS	Global Food Security
R&D	Research and development
U.S.	United States
OLS	Ordinary least squares
Ho	Null hypothesis
Ha	Alternative hypothesis
BLUE	Best linear unbiased estimator
VECM	Vector Error Correction Method
VAR	Vector autoregression
ADF	Augmented Dickey-Fuller
PP	Phillips-Perron
VIF	Variance inflation factor
IR 4.0	The Fourth Industrial Revolution

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Preface

It is a great opportunity for me to conduct a final year project (FYP) on " Factors that affect the food production in Malaysia". This research is focused on the factors that give an impact on food production in Malaysia. In fact, food production actually plays a key role in a nation, but it can be easily ignored by people. A country that has a good and reliable food production system can reduce a lot of potential issues in the future. It can aid in easing the problems of food security, inflation in food prices, maintaining the stability of politics, and so on. Therefore, this paper will be discussed the food production system in Malaysia, and provide a recommendation to improve it for a better future.

The whole project is divided into different chapters:

CHAPTER 1 – Research Overview

CHAPTER 2 – Literature Review

CHAPTER 3 – Methodology

CHAPTER 4 – Data analysis

CHAPTER 5 – Discussion, Conclusion, and Implications.

Abstract

This paper is investigating the relationship between employment in agriculture, agricultural land, population growth, consumer price index, fertilizer consumption, and food production index. Food and Agriculture Organization (FAO) has estimated the amount of food will need to raise at least 60 percent more in order to feed the future growing population. In the recent world, many factors will affect the food production of a country. Countries that have an issue with the food production system will lead to different issues and problems in society, economy, and politics. Relying on food imports will reduce the ability of self-sufficiency of a country. Besides, the price of food imports might have fluctuated due to the appreciation and depreciation of the currency. In 2019, food imports for Malaysia are about 60% of its food needs, which shows food security is a major issue in Malaysia. In this paper food production index act as the representative of food security, and the VECM model is used to determine the relationship between the variables. The findings of this study show that there are only 2 variables that have a significant relationship with the food production which are employment in agriculture (EA) and consumer price index (CPI), other variables like agricultural land (AL), population growth (PG), and fertilizer consumption (FC) do not have a significant relationship with food production index (FPI).

Chapter 1: Research Overview

1.1 Introduction

Food production is important for people as people always demand food to continue their daily activities. Food production began the process by collecting the raw materials, purifying the raw materials from impurities, preparing for the production process and lastly, packaging. Besides providing food to the people, food production is also able to provide more job opportunities to the people in a country. Also, food production does bring us other benefits like solving the malnutrition issues and the movement of the communities and country as an entire (*Food Production*, n.d.). According to the sustainable development goal (SGDs), zero hunger is intended to end hunger, achieve the purpose of food security and improved nutrition, and also promote sustainable agriculture for the people. Zero hunger could be reduced by increasing food security across the country. Food security is achieved when people are able to obtain safe, nutritious and adequate foods. It is important because food security is able to affect one's health, especially for children (Leanna Parekh, n.d.). Food insecurity is built up by 3 major components which are food accessibility, food availability, and food utilization. Food accessibility defines as the ability of people that have the capable amount of earnings to have food. Food availability means that there is a sufficient amount of food available to serve the population. Food utilization refers to the nutrition and diet that are consumed and absorbed by the people (FANTA, n.d.). According to United Nations (2017), the current year's estimated number of people worldwide that are suffering from hunger is about 690 million which is 8.9 per cent of the world population. The number of people who are undernourished in Asia countries is around 381 million. Food insecurity can cause problems to the community. People who are under food insecurity situation may lead to some negative outcomes like development of obesity, diabetes, hypertension, heart disease and so on to one's health. Also, low income is one of the factors that contribute to food insecurity,

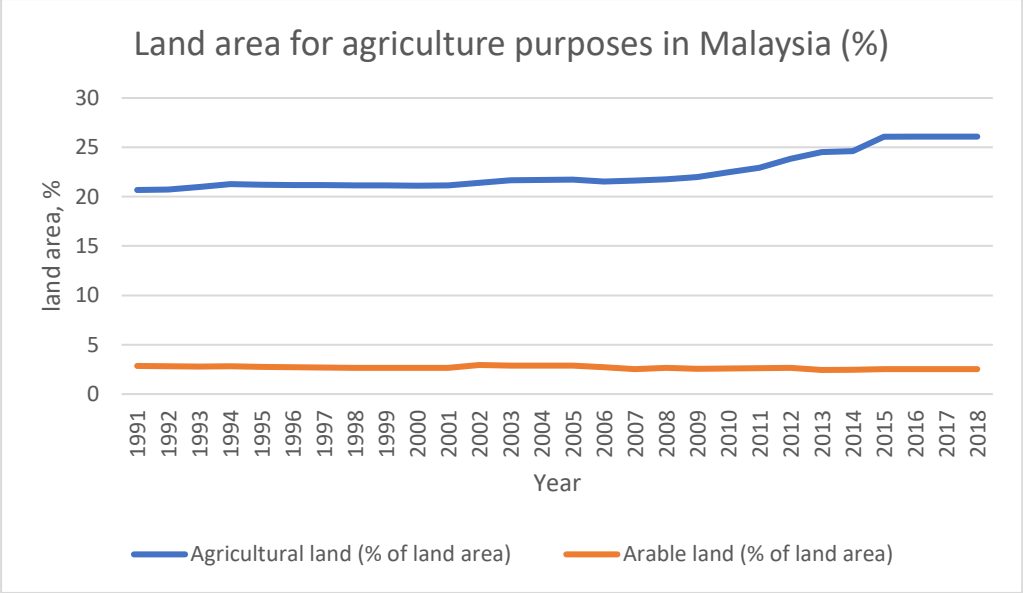
people who came from low-income households that have food insecurity problems will not be able to take care of their lifelong diseases which are related to their diet (Gordon, 2021). People that do not consume enough food will face malnutrition. Malnutrition in one will affect their productivity in the labour market. For women who are malnutrition, it will decrease their birth weight (Austin et al., 2011). Therefore, food insecurity is an issue that should not be ignored by all.

Food production is about transforming raw materials into ready-made food products or edible products in the food processing industries or the home. There are many types of the production process like packaging, sorting, preparing, adding and so on. All of the foods are produced through a huge amount of animals and plants like milk, honey, cereals, egg, vegetables, fruits, and so on. Crop production, harvesting, cultivation, preserving, and others are the types of food production (Reference, 2019). Utilizing the modern way to produce foods from limited resources is important because it not only fulfils the needs of humans by producing sufficient foods and products but also aids in food preservation to prevent the damage and rejection of foods (*Food Production*, n.d.). Additionally, an increase in food prices will lead to food insecurity. The food price can be increased due to the rapid growth of biofuels. There are some owners of farms who transfer the existing croplands into biofuels which not only cause a higher price for crops but will also increase the emissions of greenhouse gasses too (Shrestha et al., 2019). Having reliable food production is able to solve most of the food insecurity problems, therefore, in this research, the food production index will be present as the dependent variable in the whole study as the increase in food production is one of the methods to ensure the food security (Thomsett, 2008). The independent variables that are going to be investigated in this study are employment in agriculture, agricultural land, population growth, consumer price index, and fertiliser consumption.

1.2 Research Background

In Malaysia, the predominance of household food uncertainty in Malaysia was out of the blue detailed as tall. The affected groups are the elderly, students, low-income households, and Orang Asli. Besides, in west Malaysia, the food security problems do not only occur among the poor groups, more than one-third of the households that come from lower-income families are facing the same issues too (M. Alam et al., n.d.). The results of food insecurity had caused some negative effects on them such as health issues, dietary issues, and psychological issues. The defenceless population has high exposure to food insecurity issues which is not only happening in rural areas but also in the urban area too. Those who face these issues are found to have negative impacts on their nutritional status. Besides, lack of arable lands will lead to food insecurity issues as food production will be reduced in this situation. Despite all of the above poverty is one of the reasons that place the household under food insecurity because the price of food is keep on rising and the low-income household are not able to afford the burden (Sulaiman et al., 2021). If the food production is not able to fulfil the demand of people, food insecurity occurred. The study shows that the women who are facing food insecurity issues in the rural area were overweight and obese compared with those women who do not face this issue (Ahmad et al., 2020). The worldwide food production and local nourishment security are connected by the former's effect on rural item costs, and agricultural item costs themselves influence the changes in food costs and farmers' pay (Meyfroidt, 2018). Moreover, food insecurity will cause the risk of depression to increase too as it is also the factor that contributes to this problem among the older (Mesbah et al., 2020). According to the data collected from the World Bank database, the percentage of land area for agriculture purposes in Malaysia is shown. Figure 1 shows that the percentage of arable land is lesser than the agricultural land. The highest percentage for agricultural land is 26.09% during the 2015-2018 period, while the highest percentage for arable land is 2.92% in the year 2002.

Figure 1.2 Land area for agriculture purposes in Malaysia (%)



Adapted from: World Bank (World Development Indicators)

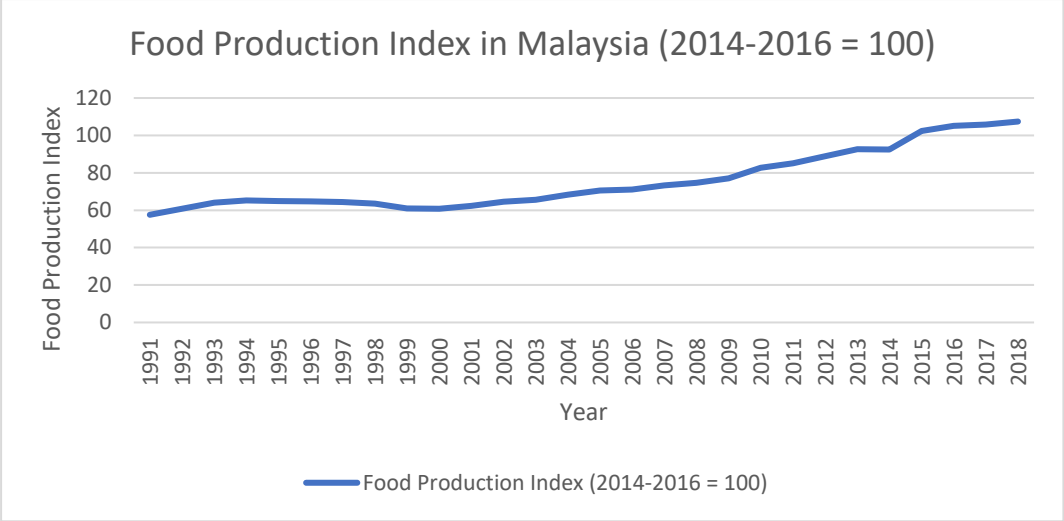
1.3 Problem Statement

According to the SWCorp Malaysia (Solid Waste and Public Cleansing Management Corporation), there are around 16.667.5 tonnes of food waste are produced in Malaysia and 24% of the food waste is still classified as edible, which shows that food is abundant by people in Malaysia (Angela, 2006). Abundant food does not mean the country is free from food security, based on the definition of food security which requires the people to have the ability to get adequate, nutritious, and safe food that meets their dietary needs (Angela, 2006). Besides, the ranking of Malaysia in the 2019 Global Food Security (GFS) Index is 28th (Esther Lee & Supriya Surendan, 2020) out of 133 countries, and according to Hunter (2022), the food imports for Malaysia in 2019 is about 60% of its need, the most production of food is rice which is around 70%, meaning that Malaysia still needs to improve in the food production system to better solve the food insecurity problem. However, the data collected from the World Bank in Figure 1.3.1 shows a gradual increase in Malaysia's food production index. Thus, the relationship between the independent variables and food production need to be studied and verified. Additionally, there

is an increment of RM38.8 billion to RM51.3 billion in food imports from other countries from 2013 to 2017 and there is an increment of 7.2% annually during these few years, which means that Malaysia is lack self-sufficiency due to population growth. It also mentioned that is time to invest in food production as a social duty because it will create returns in terms of society's prosperity (*Focus on Local Food Production, Reduce Imports*, n.d.). Moreover, Figure 1.3.2 shows the trend of employment in the agriculture industry from 1991 to 2018. This can be said that Malaysia is facing the issue of a lesser number of employees in the agriculture industry which give an impact on food production.

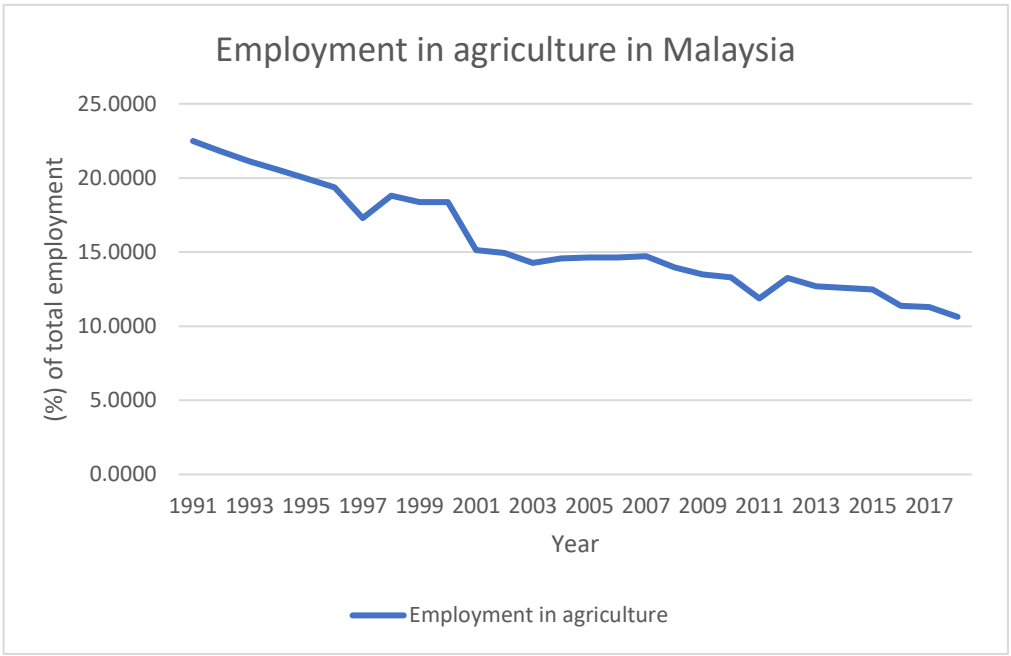
Furthermore, the Russia-Ukraine conflict that happened on 24 February 2022, had raised awareness of the increase in global natural and fertilizer prices as natural gas is the important ingredient to produce fertilizer which affects the cost of animal feed and crops. Even though Malaysia would not be affected by this incident in the short term as Malaysia does not rely on either Ukraine or Russia for the supplies like corn and wheat, it is better to be prepared for something we could not expect in the future (Azman, 2022). It pointed out the importance of how a country should have the ability to be self-sufficient. In order to investigate the research gap, this research will be discussing the relationship between the determinants (employment in agriculture, agricultural land, population growth, consumer price index and fertilizer consumption) and food production index and how far would the determinants bring impact food production in Malaysia.

Figure 1.3.1. Food Production Index in Malaysia (2014-2016 = 100)



Adapted from: World Bank (World Development Indicators)

Figure 1.3.2. Employment in agriculture in Malaysia



Adapted from: World Bank (World Development Indicators)

1.4 Research Objectives

1.4.1 General Objective

The general objective of this study is to develop the models of the food production of food in Malaysia. This is due to the reason that the ranking of Malaysia in the GFS index is 28th, thus, this study will determine which areas should the nation improve in order to have a better food production system to ensure food security.

1.4.2 Specific Objectives

1. To estimate the relationship between the independent variables and the food production index in Malaysia. Understand the significant relationship between the dependent and independent variables.

2. To investigate the factors affecting of food production index in Malaysia. Understand how far the dependent variables can affect food production in Malaysia.

3. To examine the methods to improve the food production system in Malaysia. Government or any relevant authority may implement any methods or innovation to improve the food production system.

1.5 Research Questions

1. What is the relationship between the independent variables and the food production index in Malaysia?

2. What are the factors affecting of food production index in Malaysia?

3. What are the methods to improve the food production system in Malaysia?

1.6 Significance of Study

In this research, the relationship and impacts between the independent variables and dependent variables will be investigated through different tests. Also, problems in the food production system in Malaysia will be pointed out throughout the study. The results of this study may provide some useful information to the related authority to improve the food production system in Malaysia. By doing so, the issues of food insecurity are expected to reduce and raise the awareness of food insecurity and hunger issues to the public. People may be united together to face up to these existing problems by working hand in hand as there are many solutions to these issues.

1.7 Chapter Layout

Chapter 2 will be the review of literature from previous research, hypotheses between the variables will be shown in this section. Chapter 3 will be the methodology part, it will show the collection of data, sample size, methods measurement scale, research design, and methods of data analysis. Chapter 4 is the data analysis part, the results of the test and the interpretation will be shown in this section. Chapter 5 is the discussion and conclusion part, major findings will be discussed in this section.

Chapter 2: Literature Review

2.1 Review of Literature

Stable food production is vital for a country, as it will affect the steadiness of a country's economy. It is everyone's commitment whether the family, agriculturist, private institutions or even the government. Food insecurity consists of 3 components which are food accessibility, food availability, and food utilization. In this study, food production act as the representative for food security to investigate the relationship with the independent variables. Since the population of Malaysians is anticipated to rise in the future, the food demand will be increased too. Thus, prompt and preparatory activities are required to deal with the food crisis. Besides, food security in the agriculture industry is fundamental to ensure the country is able to provide sufficient food for any unforeseen situation like a natural disaster, import and export issues and so on. For example, when the 1997 Asian Financial crisis occurred, the currency of Malaysia to the US dollar is 1: RM3.80 and this situation lead to the rise in the price of imported products which included foods, poultry, pesticides and so on (Razak et al., 2014). Additionally, Somasundram et al. (2016) had a review on organic food production in Malaysia. The local industry that is focused on organic food is still less as more than 60% of the items are imported from other countries. However, people nowadays are more concerned about their health, and the quality of food consumed, thus, there is a rise in the demand for organic food where people are more prefer chemical-free products. The fast development of the demand for organic food has produced much interest among the purchaser and businesses, as well as analysts even though there is only just a small portion of organic food in the food market. Organic food is able to consider one of the components that contribute to the nation's economic growth and tools to sustain its competitive advantage.

People who are facing the food insecurity problem have mostly come from low-income households and most of their earnings were spent on food. Food production is predicted to increase at least 60% in the future to ensure the production of food can catch up to the rising population and demand. Nonetheless, the number of people who is malnourished still keeps increasing. Therefore, different strategies should be utilized by the low-income household to deal with the insufficient food. For example, the methods of cooking at home and buying food at a cheaper price are preferable for the low-income households in Russia. Also, the percentage of people who are facing food insecurity is different between the rural and urban areas where the rural area have a higher figure (Alam et al., 2018). Moreover, Teh et al. (2020) indicate that poverty is one of the risk factors that will lead to food insecurity as it lowers the amount and quality of the consumption of food. This will raise the probability of getting problems in terms of mental, social, and development of psycho-emotional. There is almost 80 per cent of the Orang Asli in Malaysia is suffered from food insecurity.

2.1.1 Food Production Index

The food production index refers to the comprises of nourishment crops that are considered fit for human utilization and are nutritive. Still, coffee and tea are comprehensive since they have no dietary worth despite being eatable (Omodero, 2021). Based on the research from Asumadu-Sarkodie & Owusu (2016), there is a relationship between the food production index and the child fatality rate in the long run in Ghana. Besides that, the increase in the usage of fertilizer due to the expansion of food demand in Ghana had caused food production to increase

2.1.2 Employment in agriculture

According to Devereux (2016), the issue of food insecurity is amplified when there is a variance in food supplies or changes in price among destitute households. Numerous components had been formulated to deal with the issue such as imaginative approaches to rural protections, offering transitory work openings on public works programs, giving food help or transferring cash to targeted people or family units, and managing food supplies through key grain reserves. Besides the advancement of medium-scale, cultivate that give the high labour productivity employment can contribute to the food security. This gathered of agriculturists may be able to cultivate labour efficiency development by managing the vital capital inputs, supplying wage labour salary, and realizing integration in retail value chains towards household and trade markets (Meyfroidt, 2018). The study of Kang (2014) demonstrated that the unemployment of agriculture labourers in China is due to the low education level and the abuse of labour rights within agricultural production activities. At the same time, the work issue of modern era labourer workers is one of the foremost agricultural production issues in China. They account for a huge extent of the migrant workers among the entire 150 million migrant workers and their work circumstance isn't good. Entering the modern century, in any case, within the course of the modern era of migrant workers, the employment issue is getting to be more and more conspicuous. This situation caused the problem of labour shortage to show up from time to time.

2.1.3 Agriculture land

Furthermore, the land is one of the important factors that contribute to food production. As stated above, an increase in population growth will increase the urban coverage area, due to this reason, the coverage area for agricultural land will decrease in this situation. Many countries focus on the issue of how the food production and land-related as the population keep increasing. They found that natural resources like land and water do not distribute evenly among a growing number of societies of countries. This raised the

awareness of the scarcity of land (Branco et al., 2021). According to Narducci et al. (2019), the is a huge loss of agricultural land area due to the exploitation of urban land. Based on the study from Meyfroidt (2018), massive and concerted efforts are required to achieve the increment of agricultural production, indeed with the optimized allotment of land uses. In China, urban sprawl has expanded, whereas the utilization of agricultural land has ended up more seriously, driving wide impacts on the environment, such as air and water contamination. The land use function moreover will influence by the decrease in labour availability. Also, in order to ensure and increase food production, the expansion of agricultural land area is inescapable (Reidsma et al., 2012).

2.1.4 Population growth (annual %)

According to Schneider et al. (2011), the reduction in food consumption per capita is caused by the expansion of the population growth. The increase and development of population had caused the destruction or collapse of some ancient societies due to the overexploitation of the natural resources, and this will become a global threat issue for all as the resources are getting lesser and lesser year by year. Moreover, the increase in population growth will lead to higher demand for food. Based on the data from World Bank collected by Fauziyyah & Duasa (2021), 116.2 million people had increased from 2001 to 2017. Therefore, the food production in Malaysia will be affected as there they will need to ensure the availability of food by producing more food in the future, and this will be a challenge for the food production system in Malaysia unless they had invested in more advanced technology and research and development (R&D) to overcome this issue. Based on the research from Marshall (2007), indicated that the development of the population and densities of the population will cause the urban coverage land area to increase.

2.1.5 Consumer price index (2010 = 100)

According to Fauziyyah & Duasa (2021), the relationship between food production and consumer price index had pointed out. When the food price increase, the producers are likely to produce more food and increase food production. At the same time, the demand for food is sensitive to the food price in the food market, when the price decreases, people are willing to purchase especially the low-income households. However, when the food price is expected to rise in the future, people will tend to purchase foods from other countries that have lower prices compared to domestic food prices. Thus, the local food production will be affected due to the reduction in food demand. Besides, the higher oil prices are a motivation to utilize the food crops for creating biofuel but it will raise the costs of food production and lead to the food price rise around the world, and increase the consumer price index as it shows inflation on food price. Nevertheless, the study of Esmaeili & Shokoohi (2011) shows a coordinated impact between oil cost and food production index; a roundabout impact between oil cost, food price index and world GDP.

2.1.6 Fertilizer consumption

Fertilizer is one of the important factors in food production. The number of nitrogen fertilizers consumed had increased year by year as the population in increase too. The usage of fertilizer has increased during modern agriculture in order to increase the yield of crops, and produce excess food for people. For the one-third of individuals from the countries that have a large population, the utilization of nitrogen fertilizer is able to decide the distinction in health between sufficient diet and malnutrition. China is the country that consumes and produced the biggest amount of nitrogen fertilizer. The utilization of fertilizers has supplied approximately 80% of the supplement coming to the fields in China's most expected developed

coastal areas (Smil, 2002). Based on the study, the usage of fertilizer is crucial in order to produce sufficient food supply to meet the increasing demand because fertilizer is not only able to expand the lifespan of the food produced, it is also necessary for the cleared land to continue some cropping cycle in the future. For example, corn production in the United States (U.S.) is expected to decline by 40 per cent without the usage of fertilizer (Stewart et al., 2005). In the country like Myanmar, Laos, and Cambodia, the production of agriculture depends generally on normal fixation, and nitrogen take-up by crops is as much as the nitrogen input in numerous of these nations where nitrogen in farmland soils is being used by cropping (Shindo et al., 2003). However, if there is overuse of fertilizer, it will lead to negative impacts as indicated by Asumadu-Sarkodie & Owusu (2016), even though fertilizer is able to aid in increasing food production, too much consumption of fertilizer will cause the fertility rate to decrease, land degradation, and other critical issues in the country.

2.2 Hypotheses Development

Hypothesis 1

H_O: There is no relationship between employment in agriculture (EA) and food production index (FPI).

H_A: There is a relationship between employment in agriculture (EA) and the food production index (FPI).

Hypothesis 2

H_O: There is no relationship between agriculture land (AL) and food production index (FPI).

H_A: There is a relationship between agriculture land (AL) and food production index (FPI).

Hypothesis 3

H_O: There is no relationship between population growth (PG) and food production index (FPI).

H_A: There is a relationship between population growth (PG) and food production index (FPI).

Hypothesis 4

H_O: There is no relationship between consumer price index (CPI) and food production index (FPI).

H_A: There is a relationship between the consumer price index (CPI) and the food production index (FPI).

Hypothesis 5

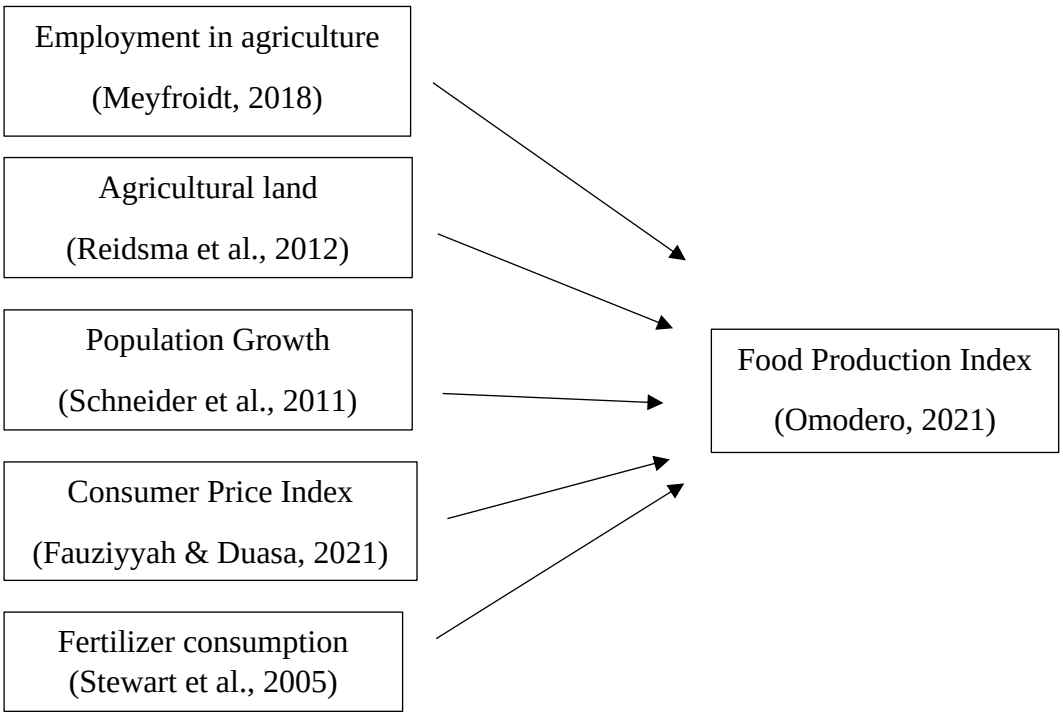
H_O: There is no relationship between fertilizer consumption (FC) and food production index (FPI).

H_A: There is a relationship between fertilizer consumption (FC) and food production index (FPI).

Chapter 3: Methodology

3.1 Conceptual framework

Figure 3.1 Conceptual framework of the factors that affect food production in Malaysia.



3.2 Model Specification

$$FPI_t = \beta_0 + \beta_1 EA_{t-1} + \beta_2 AL_{t-1} + \beta_3 PG_{t-1} + \beta_4 CPI_{t-1} + \beta_5 FC_{t-1} + \varepsilon_t$$

FPI_t = Food production index (2014-2016 = 100)

β_0 = Intercept term

β_1 = coefficient of Employment in agriculture

EA_{t-1} = Employment in agriculture (% of total employment)

β_2 = coefficient of Agriculture land

AL_{t-1} = Agricultural land (% of land area)

β_3 = coefficient of Population growth

PG_{t-1} = Population growth (annual %)

β_4 = coefficient of Consumer price index

CPI_{t-1} = Consumer price index (2010 = 100)

β_5 = coefficient of Fertilizer consumption

FC_{t-1} = Fertilizer consumption (kilograms per hectare of arable land)

t = time trend (1991 to 2018)

$\boldsymbol{\varepsilon}_t$ = error term

3.3 Data collection methods

In this research, time-series data are used and collected from the World Bank database. There are 7 variables in this research, the dependent variable in this study is the food production index (FPI) with a base year of 2014-2016=100 while the independent variables are employment in agriculture (EA), agricultural land (AL), population growth (PG), consumer price index (CPI) and fertilizer consumption (FC), the data are collected from the year 1991 to 2018.

3.3.1 Secondary Data

1. Food production index (2014-2016 = 100)

The food production index is the dependent variable in this research that acts as the intermediary for food insecurity. The data was collected in the Food production index (2014-2016 = 100). The base year of this data is 2014-2016=100, edible food crops except for coffee and tea are included in the measurement.

2. Employment in agriculture (% of total employment)

This is one of the independent variables in this research, the data collected is in the percentage of total employment. This variable is chosen as it gives impacts to the agricultural productivity where the sum of agricultural value-added is divided by the number of people employed in the agricultural industry to obtain the agriculture value added per worker. Also, agriculture value added per worker is higher in the high-income countries as they have advanced technology, affordability of the agricultural inputs, and other execution approaches to increase productivity (Roser, 2018).

3. Agricultural land (% of land area)

Agriculture land is referred to the land area that's arable by the permanent crops and beneath the lasting pastures. The land area defined by FAO as land under the temporary crops where double-cropped areas are counted once, temporary grassland used for mowing or grazing, land under markets or vegetable gardens, and land that is temporary fallow are included in the arable land, land areas that are abundant due to shifting cultivation are excluded from it. The land area that is under permanent crops grows crops that do not need to be replanted for a long time such as cocoa, rubber, and coffee. Land that is used for fodder for more than 5 years refers to the permanent pasture which includes the natural and cultivated crops ("Malaysia - Agricultural Land Area," n.d.).

4. Population growth (annual %)

The population growth rate is an aggregate parameter of population density or abundance trends. It shows whether the density or the abundance of the population is increasing, decreasing or remaining stable, and how fast the population growth rate is changing. The population growth rate is vital for future population size projections (Sibly & Hone, 2002). It usually defines the ratio of the annual growth rate of population size to the total population of the year and is multiplied by 100 (*Annual Population Growth Rate 1990-2025*, 2021).

5. Consumer price index (2010 = 100)

The consumer price index is a measure of inflation that is commonly used to reflect the changes in the prices of goods and services purchased by the households in a country. The cost of purchasing a basket of goods and services for the average consumer may vary or be fixed over a specific period, like annually (*Malaysia Consumer Price Index (2010=100)*, n.d.). 2010 is the base year where the CPI reading was set to 100 in this study, so if the CPI reading equals 100 in the following year means the inflation is back to the level same in the year 2010.

6. Fertilizer consumption (kilograms per hectare of arable land)

The fertilization consumption is calculated as the production add the imports and deduct the exports. The number of plant nutrients consumed per unit of arable land is measured by fertilizer consumption. Fertilizers with Nitrogenous, Potash, and Phosphate (including the ground rock phosphate) are under the coverage of fertilizer products, but traditional fertilizers or nutrients like animal and plant manures are excluded from it ("Fertilizer Consumption (Kilograms per Hectare of Arable Land)," 2019).

3.4 Assumptions

This research used the ordinary least squares (OLS) estimation method, which is a simple regression analysis that use to describe the relationship between the dependent and independent variables. In order to let the OLS estimators be best available, some classical assumptions must be met.

First of all, the regression model should be linear, correctly specified, and has an additive error term. Secondly, the error term needs to have a zero population mean. Thirdly, all of the independent variables should be uncorrelated with the error term. Next, there should be no serial correlation in which the observations of the error term are not correlated. Besides, assume there is no heteroskedasticity, no perfect multicollinearity and the error term is normally distributed.

3.5 Data Analysis

There are different tests run for the data analysis. First of all, descriptive statistics. It provides the tools for simplifying and summarizing the basic information of the data set. Descriptive statistics measure the central tendency, dispersion, and association of the data set. Mode, median, and mean are the appropriate measures of the central tendency, while range, variance, and standard deviation are the appropriate measures of dispersion. Chi-square and correlation are the appropriate measures for association (*Descriptive Statistics*, n.d.). Mode refers to the highest frequency, median refers to the middle value, and mean refers to the average value of a data set. Range refers to the gap between the lowest and the highest value, variance refers to the sum of square divided by n-1, and standard deviation refers to the positive square root of the variance in the data set.

Besides, the normality test is the simplest statistical measurement and is carried out as it is the significant continuous probability distribution which has a bell-shaped density curve described by mean and standard deviation. The extremum will not bring a significant effect on the mean value in the data set. A test statistic, Jarque-Bera is used to determine whether the residuals are normally distributed. The statistic is computed as:

$$JB = n[\frac{S^2}{6} + \frac{(K-3)^2}{24}]$$

S represent the skewness, K represents the kurtosis, and n represents the sample size of the data. This statistic is distributed as with the 2 degrees of freedom. The hypothesis statement is Ho: Residuals are normally distributed, Ha: Residuals are not normally distributed. Ho is accepted when the probability value is greater than the critical α 0.05 value. If the sample size of the data is large enough (more than 30 or 40), the violation of the normality assumption will not lead to major issues, however, the normality test does not have much power to reject the null hypothesis when the sample size is small, so it is often for the small sample to pass the normality tests compare to the large sample size (Ghasemi & Zahediasl, 2012).

Furthermore, the heteroscedasticity test is carried out to ensure the stability of the variance of the errors as data that shows heteroscedasticity will ruin the results and lead to biased coefficients. Data with severe heteroscedasticity will lead to few consequences which the significance tests will be too high or too low, biased in the standard errors, and the estimator provided by OLS will not have the smallest variance (Glen, 2015). If the variance of the error term changed for each observation then heteroscedasticity is present in the error term. 4 reasons could explain why heteroscedasticity happened, which are the estimators are linear but not the best linear unbiased estimator (BLUE), no minimum in coefficients (β), biased in variance, and unreliable t and F statistics. There is 2 test to detect the occurrence of heteroscedasticity which are the graphical examination of residuals and the white test. Graphical examination of residuals is suitable and useful for those models that have many independent variables, in this study, a white test (with no cross term) is carried out to test heteroscedasticity. The hypothesis statement for

heteroscedasticity is, Ho: Residuals are no heteroscedasticity, Ha: Residuals are heteroscedasticity. Ho will be accepted, residuals are no heteroscedasticity if the probability value is greater than α 0.05 value. In addition, there are a few ways to correct the heteroscedasticity issue which are using weighted least square (WLS), model respecification, and white's heteroscedasticity corrected standard error.

Next, serial correlation is carried out to ensure the systematic correlation does not exist between one observation of the error term and another, if a systematic correlation exists, then the accurate estimates of standard errors of the coefficient will be affected. Besides, this assumption often happened in time-series models. When all the observation from sample ε_{t+1} is correlated with ε_t, which means there is a serial correlation between the error term. Durbin-Watson test is used to determine the existence of autocorrelation in the least square regression. The null hypothesis stated the residuals are no autocorrelation, while the alternative hypothesis stated the residuals are autocorrelation. First-order serial correlation is the most common form of autocorrelation which can be either positive or negative. The positive serial correlation referred to the positive error that happened in one period that will carry over to the positive error in the next period. Same to negative serial correlation where the negative error that occurred in one period will bring to the negative error in the next period (Glen, 2016b). Besides, there is a test statistics that the Durbin-Watson test reported with the value within the range from 0 to 4, if the value obtained is 2, there is no autocorrelation; when the value obtained is smaller than 2 then it is a positive autocorrelation; when the value obtained is greater than 2 then it is a negative autocorrelation. Positive correlation usually occurred in the time series data while negative autocorrelation is not commonly happened in time series data (Glen, 2016a). Durbin-Watson test statistic formula is:

$$DW = \frac{\sum_{t=2}^{T}(e_t - e_{t-1})^2}{\sum_{t=1}^{T} e_t^2}$$

Unit root test is carried out to investigate the stationary of data sets. If the mean and variance are not constant and variables are not stationary then there is a unit root as unit root is one of the causes of non-stationary. If there is a unit root

among the variables, it may lead to a spurious regression result. There are different tests to determine the unit root of the data and these tests are known for having a low statistical power which are the Dickey-Fuller test, the Elliot-Rothenberg-Stock test, Schmidt-Phillips test, and Phillips-Perron (PP) test (Glen, 2016c). In this study, the Augmented Dickey-Fuller test and Phillip-Perron test are used to test the unit root tests.

A Vector Error Correction Method (VECM) model is a restricted vector autoregression (VAR) design which is used together with the non-stationary series that are known to be cointegrated, it contains the cointegration and VECM equation in this model. According to Kilian & Lütkepohl (2017), the VECM model is just a special case for the Vector Autoregressive (VAR) model where the variables are stationary in their differences. The cointegration equation is built into the specification to limit the long-term behaviour of the endogenous variables to connect to their cointegrating connection. In the cointegration equation, if the residuals are stationary and have a pattern, then the variables are cointegrated and have a long-term relationship between the variables. All endogenous variables were included in the VECM equation at the same time allowing for short-term adjustment dynamics. Besides, the Johansen Cointegration rank test is used to determine the number of co-integrating relationships and the fitness of a VECM model. Also, the Granger Causality test will be run in this study to investigate whether the time series model is useful to forecast and predict another (Maitra, 2019).

Chapter 4: Data Analysis

4.1 Descriptive statistics

Table 4.1 Descriptive statistics

	FPI	EA	AL	PG	CPI	FC
Mean	75.61286	15.64036	22.42533	1.995892	89.24373	1655.350
Median	69.38000	14.63500	21.64578	1.971275	86.50468	1601.721
Maximum	107.4200	22.49000	26.08735	2.682077	120.6632	2491.688
Minimum	57.57000	10.63000	20.68026	1.340475	59.28988	1004.805
Std. Dev.	15.66615	3.488944	1.829568	0.469941	18.08917	459.0940
Skewness	0.870403	0.508601	1.146925	-0.115699	0.113953	0.109827
Kurtosis	2.379094	2.010357	2.778871	1.598511	1.928474	1.526932
Jarque-Bera	3.985254	2.349777	6.195757	2.354003	1.400128	2.587874
Probability	0.136337	0.308853	0.045145	0.308201	0.496553	0.274189
Sum	2117.160	437.9300	627.9094	55.88498	2498.825	46349.80
Sum Sq. Dev.	6626.559	328.6637	90.37764	5.962799	8834.885	5690716.
Observations	28	28	28	28	28	28

Source: Developed for the research

For the food production index (FPI) the value of mean is 75.6129, and the value of median is 69.38. The maximum and minimum values for FPI are 107.42 and 57.57 respectively. The value of standard deviation of FPI is 15.6662, 0.8704 for the value of skewness, and 2.3791 for the value of kurtosis. For employment in agriculture (EA), the mean value is 15.6404, and the median value is 14.635. The maximum and minimum values for EA are 22.49 and 10.63 respectively. The standard deviation, skewness, and kurtosis value of EA are 3.4889, 0.5086, and 2.0104 respectively. For agricultural land (AL), the mean value is 22.4253, and the median value is 21.6458. The maximum and minimum values for AL are 26.0874 and 20.6803 respectively. The standard deviation, skewness, and kurtosis value of AL are 1.8296, 1.1469, and 2.7789 respectively. For population growth (PG), the mean value is 1.9959, and the median value is 1.9713. The maximum and minimum values for PG are 2.6821 and 1.3405 respectively. The standard deviation, skewness,

and kurtosis value of PG are 0.4699, -0.1157, and 1.5985 respectively. For the consumer price index (CPI), the mean value is 89.2437, and the median value is 86.5047. The maximum and minimum values for CPI are 120.6632 and 59.2899 respectively. The standard deviation, skewness, and kurtosis value of CPI are 18.0892, 0.1140, and 1.9285 respectively. For fertilizer consumption (FC), the mean value is 1655.350, and the median value is 1601.721. The maximum and minimum values for FC are 2491.688 and 1004.805 respectively. The standard deviation, skewness, and kurtosis value of FC are 459.0940, 0.1098, and 1.5269 respectively.

4.2 Correlation analysis

Table 4..2 Correlation analysis

	FPI	EA	AL	PG	CPI	FC
FPI	1.000000	-0.808023	0.981441	-0.917779	0.928465	0.791345
EA	-0.808023	1.000000	-0.761750	0.933970	-0.946694	-0.766038
AL	0.981441	-0.761750	1.000000	-0.883941	0.892544	0.735891
PG	-0.917779	0.933970	-0.883941	1.000000	-0.969500	-0.818223
CPI	0.928465	-0.946694	0.892544	-0.969500	1.000000	0.845317
FC	0.791345	-0.766038	0.735891	-0.818223	0.845317	1.000000

Source: Developed for the research

This analysis is used to measure the strength and direction of the linear relationship between 2 variables. The range of the r value is $-1 < 0 < 1$. If the r value is positive then the variables are perfect positive correlated, if the r value is negative, then the variables are perfect negatively correlated. If the r value is equal to 0, means the variables are not correlated. From the result generated, EA is highly and negatively correlated with FPI while PG is very high negatively correlated with FPI, other variables AL, CPI, FC, is positively correlated with FPI, however, AL and CPI are very high and positively correlated with while FC is highly positively correlated with FPI.

4.3 Unit root test

Table 4.3 Unit Root Test

Variables	ADF Statistics			PP Statistics		
	Level	**1st Diff**	**2nd Diff**	**Level**	**1st Diff**	**2nd Diff**
FPI	1.6518*	-3.9723**	-6.0065***	1.5860*	-3.9478**	-11.5167***
EA	-1.4918	-6.8633***	-10.9460***	-1.4717	-6.8524***	-31.8788***
AL	1.2265	-4.0270**	-5.9598***	1.0068	-4.0727**	-10.8697***
PG	-0.7635	-11.8166***	-6.2444***	-0.6124	-2.3937**	-2.2862**
CPI	0.3297	-5.6975***	-7.2271***	0.4227	-5.6975***	-26.0791***
FC	-2.1317**	-6.4133***	-8.4283***	-2.0396**	-16.0652***	-20.3683***

Source: Developed for the research

According to the results shown, the majority of the variables are stationary at the 2nd difference level, which is the Δ2 data series. Thus, the model should be run by using the VECM model suggested by both Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests.

4.4 Vector Error Correction Method (VECM) model

Cointegration equation model for FPI:

$0.2555\ \Delta 2FPI_{t-1} + 0.0570\ \Delta 2EA_{t-1} + 0.0473\ \Delta 2AL_{t-1} + 0.0009\ \Delta 2PG_{t-1} - 0.0482\ \Delta 2CPI_{t-1} - 22.7997\ \Delta 2FC_{t-1} = 0$

t-stat= [2.7345**] [1.3899^{ns}] [4.5804**] [2.5329**] [-0.9858^{ns}] [-1.6136*]

In the food price index (FPI) cointegration equation, the variables of food production index (FPI), agriculture land (AL), population growth (PG), and fertilizer consumption (FC) are cointegrated between the variables. There is also shows the long-term relationship between the variables, FPI, AL, PG, FC, statistically significant at α 0.05 level. There is no cointegration between variables of employment in agriculture (EA) and consumer price index (CPI) means there is no long-term relationship between these 2 variables.

VECM Equation:

$\Delta 2FPI_t = 0.3950 + 0.7698\ \Delta 2EA_{t-1} + 2.4402\ \Delta 2AL_{t-1} + 58.6255\ \Delta 2PG_{t-1} - 1.9093\ \Delta 2CPI_{t-1} - 0.0011\ \Delta 2FC_{t-1} - 0.7255\ \Delta 2FPI_{t-1} + 0.7638\ e_t$

t-stat: [2.3339**] [0.9200 ns] [1.3921 ns] [-2.9972**] [-1.1325 ns] [-1.6796*]

R2=0.6827 ; Adj R2=0.5439

According to the result of the FPI VECM model, the independent variables are accounted for 68.3 percent of the variation in the food production index (FPI) equation. Estimations reveal that the independent variables, employment in agriculture (EA), consumer price index (CPI) are the important variables which statistically significance at α 0.05 level. Thus, a 1 unit increase in employment in agriculture (EA), on average will have a positive effect on increasing the food production index (FPI) by 0.7698 units statistically significance at α 0.05 level, holding other variables constant. Also, 1 unit increase in consumer price index (CPI), on average, has a negative effect on decreasing in the FPI by 1.9096 units statistically significance at α 0.05 level, holding other variables are constant.

$\Delta 2EA_t = 0.0633 - 0.1210\ \Delta 2FPI_{t-1} + 0.5164\ \Delta 2AL_{t-1} + 13.6710\ \Delta 2PG_{t-1} - 0.3600\ \Delta 2CPI_{t-1} - 0.00016\ \Delta 2FC_{t-1} - 0.6651\ \Delta 2EA_{t-1} + 0.3354\ e_t$

t-stat: [-0.6378 ns] [0.4434 ns] [0.7394 ns] [-1.2871 ns] [-1.4994 ns] [-4.5929**]

R2=0.7785 ; Adj R2=0.6816

Based on the EA model's result, the independent variables are accounted for about 77.9 percent of the variation in the employment in agriculture (EA) equation. Estimations reveal that there are no important independent variables statistically significance at α 0.05 level in this model.

$\Delta 2AL_t = 0.0367 - 0.0321\ \Delta 2FPI_{t-1} + 0.1517\ \Delta 2EA_{t-1} + 7.6809\ \Delta 2PG_{t-1} - 0.2871\ \Delta 2CPI_{t-1} - 0.0002\ \Delta 2FC_{t-1} - 0.1788\ \Delta 2AL_{t-1} + 0.0844\ e_t$

t-stat: [-0.6731 ns] [4.1635**] [1.6509*] [-4.0793**] [-1.7822*] [-0.6102 ns]

R2=0.8362 ; Adj R2=0.7645

According to the results of the AL model, the independent variables are accounted for about 83.6 percent of the variation in the agricultural land (AL) equation. Estimations revealed that employment in agriculture (EA), population growth (PG), consumer price index (CPI), and fertilizer consumption (FC) were the important independent variables with statistically significance at α 0.05 level respectively; however, EA and CPI are the most vital variables in the model. Therefore, 1 unit increase in the employment in agriculture (EA), on average will have a positive effect on increasing the agricultural land (AL) by 0.1517 units statistically significance at α 0.05 level, holding other variables constant. A 1 unit increase in the population growth (PG), on average will have a positive effect on increasing the agricultural land (AL) by 7.6809 units statistically significance at α 0.05 level, holding other variables constant. A 1 unit increase in the consumer price index (CPI), on average will have a negative effect on decreasing in the agricultural land (AL) by 0.2871 units statistically significance at α 0.05 level, holding other variables constant. A 1 unit increase in the fertilizer consumption (FC), on average

will have a negative effect on decreasing in the agricultural land (AL) by 0.0002 units with statistically significance at α 0.05 level, holding other variables constant.

$\Delta 2PG_t = 0.000003 - 0.0001\ \Delta 2FPI_{t-1} - 0.00002\ \Delta 2EA_{t-1} + 0.0092\ \Delta 2AL_{t-1} - 0.0069\ \Delta 2CPI_{t-1} - 0.000003\ \Delta 2FC_{t-1} + 0.8923\ \Delta 2PG_{t-1} + 0.0030\ e_t$

t-stat: [-0.0745 ns] [-0.0124 ns] [0.8998 ns] [-2.8059**] [-0.7017 ns] [5.4757***]

R2=0.6635 ; Adj R2=0.5163

Based on the result of the PG model, the independent variables are accounted for about 66.35 percent of the variation in the population growth (PG) equation. Estimations reveal that the consumer price index (CPI) is the important variable with statistically significance at the α 0.05 level in the equation. Therefore, a 1 unit increase in the consumer price index (CPI), on average, will have a negative effect on decreasing in population growth (PG) by 0.0069 units with statistically significance at α 0.05 level, holding other variables constant.

$\Delta 2CPI_t = -0.0882 + 0.0.2421\ \Delta 2FPI_{t-1} - 0.2038\ \Delta 2EA_{t-1} - 2.2978\ \Delta 2AL_{t-1} - 0.4136\ \Delta 2PG_{t-1} + 0.0010\ \Delta 2FC_{t-1} - 0.4872\ \Delta 2CPI_{t-1} + 0.3996\ e_t$

t-stat: [1.0714 ns] [-1.1810 ns] [-1.6558*] [-0.0188 ns] [1.9735*] [-1.4620 ns]

R2=0.6924 ; Adj R2=0.5578

According to the CPI model's result, the explanatory variables are accounted for about 69.24 percent of variation in the consumer price index (CPI) equation. Estimation revealed that the independent variables that are important in this equation, namely the agricultural land (AL), and fertilizer consumption (FC) with statistically significance at the α 0.05 level. Therefore 1 unit increase in agricultural land (AL), on average, will have a negative effect on decreasing the

consumer price index (CPI) by 2.2978 units with statistically significance at α 0.05 level, holding other variables constant. Also, 1 unit increase in fertilizer consumption (FC), on average, has a positive effect on increasing the consumer price index (CPI) by 0.0010 unit statistically significance at α 0.05 level, holding other variables constant.

$\Delta 2FC_t = -7.4826 - 33.8073\ \Delta 2FPI_{t-1} - 16.3022\ \Delta 2EA_{t-1} - 9.0146\ \Delta 2AL_{t-1} - 5506.197\ \Delta 2PG_{t-1} - 110.2761\ \Delta 2CPI_{t-1} - 0.3555\ \Delta 2FC_{t-1} + 115.515\ e_t$

t-stat: [-0.5176 ^{ns}] [-0.3268 ^{ns}] [-0.0225 ^{ns}] [-0.8646 ^{ns}] [-1.1447 ^{ns}] [-2.4149**]

R2=0.7873 ; Adj R2=0.6943

Based on the FC model's results, the explanatory variables accounted for 78.73 percent of the variation in the fertilizer consumption (FC) equation. Estimations reveal that there are no important variables in the equation with statistically significance at the 0.05 level, holding constant with other variables.

4.5 Johansen Cointegration rank test

Table 4.5 Johansen Cointegration Rank Test

Date: 04/05/22 Time: 23:20
Sample (adjusted): 5 28
Included observations: 24 after adjustments
Trend assumption: Linear deterministic trend
Series: 2 FPI 2 EA 2 AL 2 PG 2 CPI 2 FC
Lags interval (in first differences): 1 to 1

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.935033	222.0479	95.75366	0.0000
At most 1 *	0.913971	156.4349	69.81889	0.0000
At most 2 *	0.814183	97.56132	47.85613	0.0000
At most 3 *	0.631203	57.16949	29.79707	0.0000
At most 4 *	0.576047	33.22927	15.49471	0.0000
At most 5 *	0.409285	12.63411	3.841465	0.0004

Trace test indicates 6 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.935033	65.61302	40.07757	0.0000
At most 1 *	0.913971	58.87357	33.87687	0.0000
At most 2 *	0.814183	40.39184	27.58434	0.0007
At most 3 *	0.631203	23.94022	21.13162	0.0196
At most 4 *	0.576047	20.59516	14.26460	0.0044
At most 5 *	0.409285	12.63411	3.841465	0.0004

Max-eigenvalue test indicates 6 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Source: Developed for the research

The result of the Johansen cointegration rank test is to determine the number of cointegrating relations and rank. Based on the results generated, there are 2 types of test statistics are reported which are trace statistics (first block) and maximum eigenvalue statistics (second block). There is more than 1 cointegrating relationship between the variables is explained by the results of both statistics. The results of both tests stated that 6 cointegrating equations were significant at α 0.05 level, which means, the variables met the long-term equilibrium.

4.6 Granger Causality test

Table 4.6 Granger Causality test

EA Granger Cause FPI	EA → FPI	0.8189 ^{ns}
FPI does not Granger Cause EA	FPI → EA	0.1031 ^{ns}
AL Granger Cause FPI	AL → FPI	0.7816 ^{ns}
FPI does not Granger Cause AL	FPI → AL	0.1281 ^{ns}
PG Granger Cause FPI	PG → FPI	0.4334 ^{ns}
FPI does not Granger Cause PG	FPI → PG	0.7735 ^{ns}
CPI Granger Cause FPI	CPI → FPI	0.3468 ^{ns}
FPI does not Granger Cause CPI	FPI → CPI	0.9829 ^{ns}
FC Granger Cause FPI	FC → FPI	0.3711 ^{ns}
FPI does not Granger Cause FC	FPI → FC	0.4602 ^{ns}

Source: Developed for the research

The Granger causality test shows that there is no cointegrated and no long-term equilibrium relationship between the independent variables and FPI, which is statistically significance at α 0.05 level. This may be due to the food price index (FPI) being influenced by other factors, so it cannot show the causality relationship between dependent and independent variables.

4.7 Residual tests

Table 4.7 Summary of Residual test

Diagnostic tests	Results	Hypothesis	Decision
Normality test (Jarque-Bera)	Jarque-Bera: 1.3132 P-value: 0.5186	Ho: Residuals are normally distributed Ha: Residuals are not normally distributed.	P value > α 0.05 Do not reject Ho. The residuals are normally distributed.
Heteroscedasticity test (White test)	P-value: 0.6610	Ho: Residuals are no heteroscedasticity Ha: Residuals are heteroscedasticity.	P-value > α 0.05. Do not reject Ho. There is no heteroscedasticity.
Serial correlation test (LM test)	Prob. Value: 0.0000 Durbin-Watson stat: 1.2343	Ho: Residuals are no autocorrelation. Ha: Residuals are autocorrelation.	P-value < α 0.05. Rejected Ho. There is autocorrelation among residuals.
Multicollinearity test (Variance Inflation Factor)	VIF =1/(1-R^2) =1/(1-0.1296) = 1.1489	Ho: Residuals are no multicollinearity. Ha: Residuals are multicollinearity.	VIF <5 Do not reject Ho. There is no multicollinearity.

Source: Developed for the research

For the normality test, the value of Jarque-Bera is 1.3132, and the p-value is 0.5186 which is greater than the α 0.05 level. Thus, do not reject the null hypothesis, there is evidence that the residuals are normally distributed. For the heteroscedasticity test, the p-value for the White test is 0.6610, which is greater than the α 0.05 level. Therefore, do not reject the null hypothesis, there is evidence that there is no heteroscedasticity. For the serial correlation test, the value of the p-value for the LM test is 0.0000, and the value for Durbin-Watson statistics is 1.2343 which is between the range 0 to 1.44, there is evidence of a

positive auto-correlation, thus, reject Ho. There is autocorrelation among the residuals. For the multicollinearity test, the variance inflation factor (VIF) is used to determine the existence of multicollinearity. The value of VIF obtained is 1.1489, which is lesser than 5, thus, do not reject the null hypothesis, there is no multicollinearity.

4.8 Hypothesis testing

Table 4.8 Summary of Hypothesis testing

Hypothesis	Decision (t-stat)	Supported / Rejected
H_O: There is no relationship between employment in agriculture (EA) and food production index (FPI). H_A: There is a relationship between employment in agriculture (EA) and the food production index (FPI).	T-stat value: 2.3339** Reject Ho.	Supported
H_O: There is no relationship between agriculture land (AL) and food production index (FPI). H_A: There is a relationship between agriculture land (AL) and food production index (FPI).	T-stat value: 0.9200^{ns} Reject Ha.	Rejected
H_O: There is no relationship between population growth (PG) and food production index (FPI).	T-stat value: 1.3921^{ns} Reject Ha.	Rejected

H_A: There is a relationship between population growth (PG) and food production index (FPI).		
H_O: There is no relationship between consumer price index (CPI) and food production index (FPI). H_A: There is a relationship between the consumer price index (CPI) and the food production index (FPI).	T-stat value: -2.9972** Reject Ho.	Supported
H_O: There is no relationship between fertilizer consumption (FC) and food production index (FPI). H_A: There is a relationship between fertilizer consumption (FC) and food production index (FPI).	T-stat value: -1.1325 ^{ns} Reject Ha.	Rejected

Source: Developed for the research

Chapter 5: Discussion, Conclusion, Implications

5.1 Summary

This study is aimed to investigate the relationship between the independent between independent variables (employment in agriculture (EA), agricultural land (AL), population growth (PG), consumer price index (CPI) and fertilizer consumption (FC)) and dependent variables (Food production index (FPI)) through the outcomes generated through different tests like VECM model, Cointegration rank test, and Granger causality test. The results of the tests show there are only two variables that are significant with the food production index (FPI) in this study which is employment in agriculture (EA) and consumer price index (CPI). Other independent variables, agricultural land (AL), population growth (PG, and fertilizer consumption (FC) do not have a significant relationship with the food production index (FPI) with statistical significance at α 0.05 level. According to the results obtained from the VECM model, the significant variables for food production index (FPI), employment in agriculture (EA), and the consumer price index (CPI) have different impacts on FPI. There is a positive relationship between EA and FPI, while there is a negative relationship between CPI and FPI.

5.2 Discussion of Major Findings

According to the VECM model, it shows employment in agriculture (EA) and consumer price index (CPI) are the most important variables which are statistically significance at α 0.05 level in the $\Delta 2FPI_t$ model. This outcome is consistent with the previous research done by (Meyfroidt, 2018; Fauziyyah & Duasa, 2021) where the advancement of medium-scale, cultivation that gives the

high labour productivity employment can contribute to the food security, and food price affect the consumption pattern of people and cultivate that give the high labour productivity employment can contribute to the food production. The lower the consumer price index will give a negative impact on food production. However, Nathan et al. (2021) indicated that food innovation technology is more important to increasing the agricultural output. Unlike most the Asia countries that still rely on the labour intense production to produce agricultural output through human labour, European countries like Hungary are more emphasis on the advanced technology as they have a greater awareness of food innovation compared to Malaysian. By emphasising food innovation technology, the performance in the ecological innovations is better in European countries compared to Asian countries. Also, a rise in consumer prices will bring impact to food production too. Volatility in price will affect the ways farmers allocate their inputs, their choice of crop, and the taste and preferences of consumers. All of this will bring an impact to food production (Wossen et al., 2018). Other than that, the consequences of inflation on production differ depending on the type of inflation. If there is cost-push inflation, then the inflation will cause the production to decline as the production costs are increased such as the wages and raw materials. This happened due to the confidence of the producer to meet the budget constraints is impeded. In contrast, if the inflation is a demand-pull inflation, it will encourage and rise the production. This type of inflation happened when there is rise in income and low unemployment rate. It will show a positive impact in he short run on the stakeholders of production, where the labour is able to received higher wages (McCaffrey, 2021).

On the other hand, the variables, agricultural land (AL), population growth (PG), and fertilizer consumption (FC) shows there is no significant relationship with FPI in the VECM model. These outcomes are against the previous research (Reidsma et al., 2012; Fauziyyah & Duasa, 2021; Smil, 2002). Moreover, the Johansen integration rank test result shows the long-term equilibrium of the variables is met at the α 0.05 level. However, the granger causality test shows that there is no cointegration and long-term equilibrium relationship between the independent variables, EA, AL, PG, CPI, FC, and the dependent variable, FPI. This

situation happened may be due to the reason that the FPI index could be affected by other factors, so it cannot show the causality relationship.

5.3 Limitations

There is limitation during this study. The data collected is insufficient, the total observation was only collected from the year 1991 to 2018, and the amount of sample size is 28 only, not more than 30, which is considered a small sample size. This might be difficult for this study to demonstrate the significant relationship between the variables and the generalization of the data collected. Larger sample size is able to ensure the representative allocation of the population.

5.4 Recommendations

Based on the findings, we can conclude that the major factors that affect Malaysia's food production are employment in agriculture (EA) and the consumer price index (CPI). In order to improve the food production system in Malaysia, the nation needs to tackle the problem of insufficient labour in the agriculture industry and the inflation in food prices which affect the food production. If food production is affected, people in a nation may face food insecurity problems which will threaten the political stability of a country.

Based on the results obtained, more employment in the agriculture industry will increase the food production index. Thus, in order to increase food production, the problem of employment issue in agriculture should be tackled. First of all, the government should come out with policies that could attract more youth to participate in the agriculture industry. However, there is a most important reason that the youth do not want to opt agriculture industry as their career option because of the cultural stereotype of the agricultural industry like it is a hard work job, with

not well paid. In order to solve this main issue, the government should improve the image of the agriculture industry by removing the stereotype of the agriculture industry as attracting youth employment in this industry not only will ease the unemployment among the youth, it also can address the issues of food security and the ageing population employed in the industry. Besides, the opportunity space provided to the youth should not be limited to the on-farm sector, it should involve the whole agriculture sector. This will provide the youth to exploit different opportunities. Also, the industry should aware of the off-farms dynamics that changed for young people which included the additional value that could be added to the food chain, the industry will also need to understand the future trends of employment, employment opportunities, and the requirement of labour skills and gaps (Fatimahwati & Dato, 2020).

In addition, the consumer price index (CPI) is used to measure the inflation over time in the prices that are paid by the consumers for a basket of goods and services. As shown in the findings, there is an inverse relationship between CPI and FPI, the lower the CPI, the higher the FPI. When the reading of CPI is lower, means there is not much inflation, all the operation costs in the agriculture industry for food production like transportation costs, wages and salary will not be increased. When the input prices for the food production increase, it would affect the farmers in terms of their cash flow, developing the need for a high level of operating management and traditionalist money-related procedures. Moreover, when the consumer price index (CPI) is high which refer to an increase in inflation, the food prices will be rise as well and this circumstance will cause high demand for the wage and salary which in turn will be passed to the costs of manufactured goods, and purchased and utilized by the agriculture industry as inputs (Van ZYL, 1986). According to *INFLATION - EFFECTS ON PRODUCTION* (n.d.), inflation will lead to the reduction in production as the price increase with the rising cost, this brings uncertainty to the production and thus reduce it. Inflation will also hinder production as the saving are reduced in this situation which affects the investment and capital formation of the agriculture business. Therefore, in my opinion, government can ease the additional cost price cause by inflation to the farmers by providing subsidies to the agriculture industry. When subsidies are provided, the

production costs face by the industry will not increase too much as the additional cost create by inflation is able to reduce. Therefore, when inflation is low, food prices decrease, people are affordable and tend to purchase more, demand for wages and salary will reduce, thus, reducing food production costs and increase in the demand and productivity for food production. By doing so, farmers are provided with support in terms of inputs such as power, water, and fertilizer to carry out and maintain the food production efficiency with lesser costs (Ahmed, 2008).

5.5 Conclusion

In conclusion, people should not ignore the issue of food production, it is one of the important factors to combat the food security issues. Improvement in local food production will not only reduce the possible issues happening due to food security like malnutrition, criminal cases, poverty, and so on, it can also aid in stimulating and boosting the nation's economy, and make a more prominent sense of community (Dunning, 2013). Improvement in the food production system in Malaysia will able to decrease the reliance on food imports from other nations which the costs might be increased due to fluctuation of currencies, minor the increased deficit of food trade between Malaysia and other countries, and become more self-sufficient to feed the people in the country. Anyway, the ministry is taking proactive measures to guarantee the agricultural segment keeps side by side with technological advancements and the IR4.0. Its accentuation on advanced cultivating will too be in line with the government's Shared Prosperity Vision 2030, with initiatives so far including innovation for improved paddy cultivating, the improvement of urban cultivating, and cultivating in a controlled environment (BERNAMA, 2020).

However, there is also another viewpoint that claimed that food production would bring some negative environmental impacts to a country like the usage of chemicals, greenhouse gas emissions, and issues after food production. Ritchie &

Roser (2020) claimed that the usage of the fertilizer on the land area where trees are cut to form farmland will lead to harmful air pollutants released into the atmosphere and harm individuals' health via bio-accumulation. This is due to the reason that, even though fertilizer is able to provide nutrients to the production of the crops, fertilizers are made up of chemicals, which can be toxic if a high concentration of it are exposed to individuals. Furthermore, artificial fertilizers are too energy-intensive to be produced where fossil fuels heavily rely on. This situation rise the emissions of greenhouse gases to the atmosphere which creates a negative impact on the sustainability of food production in the long run. Another issue is food waste. Another factor is food waste, the wasted food that is produced during the food production process to final consumption by households will also emit carbon dioxide into the atmosphere and give an impact on climate change.

In short, hopefully, this study is able to provide useful information to the government, relevant authorities, and the public to raise awareness about the food production issue in Malaysia, and work hand in hand for a better future. For researchers that wish to have further studies in the relevant field, they are recommended to do further research on the negative impact of food production on the environment, and on the advanced technologies for the food production, as the world is becoming more digitalized with a lot of advance technologies and machines, they may find better ways to improve the food production system in Malaysia and make it more efficient.

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Appendices

Appendix 4.4.1: Cointegration equation model for FPI

Vector Error Correction Estimates
Date: 04/03/22 Time: 03:10
Sample (adjusted): 5 28
Included observations: 24 after adjustments
Standard errors in ( ) & t-statistics in [ ]

Cointegrating Eq:	CointEq1
_2_FPI(-1)	1.000000
2_EA(-1)	-4.551520 (1.01914) [-4.46605]
_2_AL(-1)	-22.29348 (3.22408) [-6.91467]
_2_PG(-1)	-213.0124 (18.9680) [-11.2301]
_2_CPI(-1)	8.861991 (1.45098) [6.10759]
2_FC(-1)	0.013990 (0.00283) [4.94846]
C	-0.212143

Error Correction:	D(2 FPI)	D(2 EA)	D(2 AL)	D(2 PG)	D(2 CPI)	D(2 FC)
CointEq1	0.255479 (0.09343) [2.73445]	0.057015 (0.04102) [1.38987]	0.047278 (0.01032) [4.58037]	0.000916 (0.00036) [2.53294]	-0.048184 (0.04888) [-0.98576]	-22.79971 (14.1295) [-1.61362]

Appendix 4.4.2: VECM equation

Vector Error Correction Estimates
Date: 04/03/22 Time: 03:10
Sample (adjusted): 5 28
Included observations: 24 after adjustments
Standard errors in ( ) & t-statistics in [ ]

Cointegrating Eq:	CointEq1
2 FPI(-1)	1.000000
2 EA(-1)	-4.551520 (1.01914) [-4.46605]
_2_AL(-1)	-22.29348 (3.22408) [-6.91467]
2 PG(-1)	-213.0124 (18.9680) [-11.2301]
2 CPI(-1)	8.861991 (1.45098) [6.10759]
2 FC(-1)	0.013990 (0.00283) [4.94846]
C	-0.212143

Error Correction:	D(2 FPI)	D(2 EA)	D(2 AL)	D(2 PG)	D(2 CPI)	D(2 FC)
CointEq1	0.255479 (0.09343) [2.73445]	0.057015 (0.04102) [1.38987]	0.047278 (0.01032) [4.58037]	0.000916 (0.00036) [2.53294]	-0.048184 (0.04888) [-0.98576]	-22.79971 (14.1295) [-1.61362]
D(2 FPI(-1))	-0.725465 (0.43192) [-1.67964]	-0.120955 (0.18964) [-0.63782]	-0.032118 (0.04772) [-0.67309]	-0.000125 (0.00167) [-0.07450]	0.242104 (0.22597) [1.07142]	-33.80728 (65.3195) [-0.51757]
D(2 EA(-1))	0.769794 (0.32984) [2.33387]	-0.665136 (0.14482) [-4.59287]	0.151717 (0.03644) [4.16352]	-1.59E-05 (0.00128) [-0.01243]	-0.203786 (0.17256) [-1.18095]	-16.30215 (49.8817) [-0.32682]
D(2 AL(-1))	2.440235 (2.65251) [0.91997]	0.516443 (1.16462) [0.44344]	-0.178817 (0.29304) [-0.61020]	0.009236 (0.01026) [0.89984]	-2.297841 (1.38772) [-1.65584]	-9.014619 (401.144) [-0.02247]
D(2 PG(-1))	58.62549 (42.1122) [1.39213]	13.67099 (18.4899) [0.73938]	7.680922 (4.65247) [1.65093]	0.892272 (0.16295) [5.47565]	-0.413592 (22.0319) [-0.01877]	-5506.197 (6368.70) [-0.86457]
D(2 CPI(-1))	-1.909277 (0.63702) [-2.99722]	-0.359990 (0.27969) [-1.28710]	-0.287087 (0.07038) [-4.07932]	-0.006916 (0.00246) [-2.80585]	-0.487249 (0.33327) [-1.46204]	-110.2761 (96.3369) [-1.14469]
D(2 FC(-1))	-0.001103 (0.00097) [-1.13251]	-0.000641 (0.00043) [-1.49940]	-0.000192 (0.00011) [-1.78220]	-2.64E-06 (3.8E-06) [-0.70169]	0.001005 (0.00051) [1.97348]	-0.355529 (0.14723) [-2.41487]
C	0.395009 (0.76383) [0.51714]	0.063300 (0.33537) [0.18875]	0.036739 (0.08439) [0.43537]	2.71E-06 (0.00296) [0.00092]	-0.088217 (0.39961) [-0.22076]	-7.482552 (115.515) [-0.06478]
R-squared	0.682743	0.778501	0.836161	0.663488	0.692375	0.787318
Adj. R-squared	0.543943	0.681596	0.764481	0.516264	0.557790	0.694269
Sum sq. resids	216.2982	41.69722	2.639999	0.003239	59.20242	4946955.
S.E. equation	3.676770	1.614335	0.406202	0.014227	1.923578	556.0438
F-statistic	4.918904	8.033601	11.66523	4.506658	5.144493	8.461370
Log likelihood	-60.43778	-40.68309	-7.567221	72.87343	-44.88943	-180.8893
Akaike AIC	5.703148	4.056924	1.297268	-5.406119	4.407452	15.74077
Schwarz SC	6.095833	4.449609	1.689953	-5.013434	4.800137	16.13346
Mean dependent	0.115000	-0.029583	-0.001852	-0.002804	-0.149928	-5.229809
S.D. dependent	5.444488	2.860909	0.837006	0.020456	2.892646	1005.633

Determinant resid covariance (dof adj.)	34.44891
Determinant resid covariance	3.024321
Log likelihood	-217.6074
Akaike information criterion	22.63395
Schwarz criterion	25.28457
Number of coefficients	54

Appendix 4.6: Granger Causality test

Pairwise Granger Causality Tests
Date: 04/05/22 Time: 23:21
Sample: 1 28
Lags: 1

Null Hypothesis:	Obs	F-Statistic	Prob.
_2_EA does not Granger Cause _2_FPI	25	0.05367	0.8189
_2_FPI does not Granger Cause _2_EA		2.89186	0.1031
2_AL does not Granger Cause 2_FPI	25	0.07877	0.7816
2_FPI does not Granger Cause 2_AL		2.50058	0.1281
_2_PG does not Granger Cause _2_FPI	25	0.63687	0.4334
2_FPI does not Granger Cause 2_PG		0.08492	0.7735
_2_CPI does not Granger Cause _2_FPI	25	0.92434	0.3468
_2_FPI does not Granger Cause _2_CPI		0.00047	0.9829
2_FC does not Granger Cause 2_FPI	25	0.83361	0.3711
2_FPI does not Granger Cause 2_FC		0.56494	0.4602

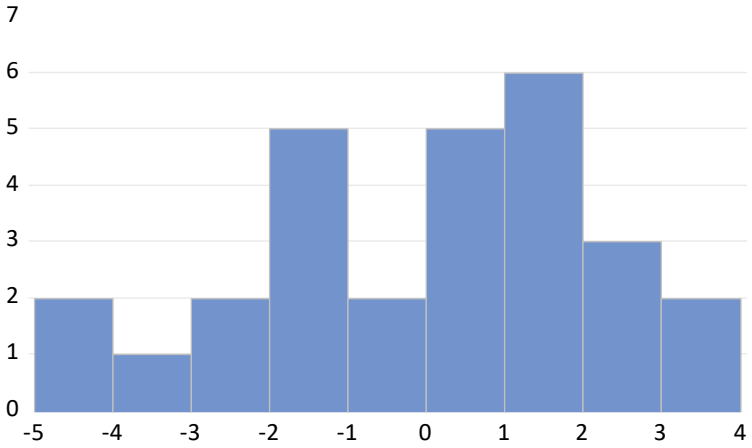
Appendix 4.7: Residual tests

Dependent Variable: FPI
Method: Least Squares
Date: 04/03/22 Time: 03:12
Sample: 1 28
Included observations: 28

Variable	Coefficient	Std. Error	t-Statistic	Prob.
EA	0.576322	0.592817	0.972175	0.3415
AL	5.933478	0.787869	7.531045	0.0000
PG	-3.813910	4.592691	-0.830430	0.4152
CPI	0.238808	0.174652	1.367335	0.1853
FC	0.001810	0.002072	0.873301	0.3919
C	-83.15717	21.60411	-3.849136	0.0009

R-squared	0.979359	Mean dependent var	75.61286
Adjusted R-squared	0.974668	S.D. dependent var	15.66615
S.E. of regression	2.493419	Akaike info criterion	4.852596
Sum squared resid	136.7770	Schwarz criterion	5.138068
Log likelihood	-61.93635	Hannan-Quinn criter.	4.939868
F-statistic	208.7707	Durbin-Watson stat	0.523444
Prob(F-statistic)	0.000000		

Appendix 4.7.1: Normality test



Series: Residuals	
Sample 1 28	
Observations 28	
Mean	-2.94e-14
Median	0.389359
Maximum	3.464267
Minimum	-4.792611
Std. Dev.	2.250737
Skewness	-0.401119
Kurtosis	2.305741
Jarque-Bera	1.313180
Probability	0.518617

Appendix 4.7.2: Heteroskedasticity test

Heteroskedasticity Test: White
Null hypothesis: Homoskedasticity

F-statistic	0.654953	Prob. F(5,22)	0.6610
Obs*R-squared	3.627866	Prob. Chi-Square(5)	0.6041
Scaled explained SS	1.462202	Prob. Chi-Square(5)	0.9174

Test Equation:
Dependent Variable: RESID^2
Method: Least Squares
Date: 04/03/22 Time: 03:15
Sample: 1 28
Included observations: 28

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	11.30620	18.58886	0.608224	0.5493
EA^2	0.037548	0.034553	1.086681	0.2889
AL^2	-0.080144	0.045569	-1.758741	0.0925
PG^2	-0.095935	2.548258	-0.037647	0.9703
CPI^2	0.003380	0.002180	1.550427	0.1353
FC^2	-1.04E-06	1.41E-06	-0.739754	0.4673

R-squared	0.129567	Mean dependent var	4.884894
Adjusted R-squared	-0.068259	S.D. dependent var	5.684349
S.E. of regression	5.875151	Akaike info criterion	6.566750
Sum squared resid	759.3829	Schwarz criterion	6.852223
Log likelihood	-85.93450	Hannan-Quinn criter.	6.654022
F-statistic	0.654953	Durbin-Watson stat	1.293761
Prob(F-statistic)	0.660987		

Appendix 4.7.3: Serial correlation test

Breusch-Godfrey Serial Correlation LM Test:
Null hypothesis: No serial correlation at up to 1 lag

F-statistic	33.38938	Prob. F(1,21)	0.0000
Obs*R-squared	17.18907	Prob. Chi-Square(1)	0.0000

Test Equation:
Dependent Variable: RESID
Method: Least Squares
Date: 04/03/22 Time: 03:16
Sample: 1 28
Included observations: 28
Presample missing value lagged residuals set to zero.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
EA	-0.421925	0.384035	-1.098663	0.2844
AL	0.407418	0.506018	0.805145	0.4298
PG	0.438051	2.921916	0.149919	0.8823
CPI	-0.059076	0.111548	-0.529602	0.6019
FC	-0.001788	0.001354	-1.320344	0.2009
C	4.886256	13.76612	0.354948	0.7262
RESID(-1)	0.853815	0.147761	5.778354	0.0000

R-squared	0.613895	Mean dependent var	-2.94E-14
Adjusted R-squared	0.503580	S.D. dependent var	2.250737
S.E. of regression	1.585804	Akaike info criterion	3.972378
Sum squared resid	52.81027	Schwarz criterion	4.305429
Log likelihood	-48.61330	Hannan-Quinn criter.	4.074195
F-statistic	5.564896	Durbin-Watson stat	1.234317
Prob(F-statistic)	0.001382		

Appendix 4.7.4: Multicollinearity test

$VIF=1/(1-R^2)$

$=1/(1-0.1296)$

$= 1.1489$