Global food price and monetary policy: Evidence from oil-importing and oil-exporting countries

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ABSTRACT

This study examines food price vulnerability in the case of oil-importing countries of Singapore and Vietnam and oil-exporting countries of Kuwait and Indonesia. The study is further extended to address the response of domestic food inflation to a sudden shock of a change in global food price, global oil price and monetary policy.

Applying the Autoregressive Distributed Lag method to cointegration and Vector Error Correction Model, the relationship between domestic food inflation and macroeconomic variables is analysed using monthly data over the period 2004-2019. Two following key methodologies to measure the volatility of domestic food inflation are applied GARCH and GARCH-ARMA models. The impulse response of domestic food inflation to the monetary shocks is based on the Vector Autoregression. The findings indicate that there exist long-run relationships between domestic food price of four countries and a set of macroeconomic variables. However, there is different impacts of macroeconomic factors, i.e., GDP per capita, the real money supply, the real effective exchange rate, industrial production, global food price and global oil price on food inflation in each case of four countries. The findings also indicate the potential impacts of short-run deviations between domestic food inflation and macroeconomic variables, as well as the behaviour of food price vulnerability in the four sample countries. Given the vital role of macroeconomic factors and global food price in controlling domestic food price volatility, the estimated findings provide various appropriate implications for monetary policies to deal with the issues of stabilising food inflation.

The related issue of global financial crisis impacts on economic growth and domestic food inflation is considered of 2007-2008 using the structural break analysis based on monthly data for the period 2004 to 2019. The results show that food price volatility happens during the period of global financial crisis. This study also indicates the important role of monetary policy on reducing food price vulnerability, especially in the case of emerging economies. The findings of the study provide a number of policy implications for policy- makers as well as for the behaviour of the producers and consumers. There are a series of comparisons in the investigating the sources of variations in domestic food price in four sample countries. Thus, the findings are highly important for the future course of food price because it relies on different structural economies and macroeconomic environment.

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This thesis is dedicated to the economic growth and the development of Vietnam's agriculture sector.

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LIST OF ABBREVIATIONS

ADF	Augmented Dickey-Fuller
ARDL	Autoregressive Distributed Lag
ARIMA	Autoregressive Integrated Moving Average
AIC	Akaike Information Criterion
BIC	Bayesian Information Criterion
CPI	Consumer Price Index
EC	Error Correction
FEVD	Forecast Error Variance Decomposition
FPE	Final Prediction Error
G7	Group of Seven
GNP	Gross National Product
GFC	Global Financial Crisis
GDP per capita	Gross Domestic Product (GDP) per capita
KPSS	Kwiatkowski–Phillips–Schmidt–Shin
LM	Lagrange Multiplier
OECD	Organisation for Economic Co-operation and Development
PPP	Purchasing Power Parity
SVAR	Structural Vector Autoregression
US	The United States
VAR	Vector Autoregression
VECM	Vector Error Correction Model
WTO	World Trade Organisation

Chapter 1 INTRODUCTION

1.1 Background of the study

The global food prices experienced a serious volatility as the consequences of two substantial price shocks, which are 2007-2008 Global Financial Crisis (GFC) and 2010-2011 post-crisis period. The steady increase in global agricultural commodity prices influences the entire worldwide population, especially the destitute people around the world (Żmija, Fortes, Tia, Šūmane, Ayambila, Żmija, & Sutherland, 2020). There are numerous reasons for a rise in the global food price over time. The first cause is higher oil prices which raise the shipping costs. The oil prices have a remarkable impact on farming as the oil by-products are a major component of fertilizers (Su, Wang, Tao, & Oana-Ramona, 2019). In the period 2001 and 2007, higher oil prices added more than 40 percent to the total trading cost of growing wheat, corn, and soybeans (Shrestha, Staab, & Duffield, 2019).

Besides, oil is the major source of energy for transporting food products over long distances globally. Oil price around the world has been fluctuating, causing a fluctuated price in global agricultural outputs' prices. Another reason noted is due to climate change and more extreme weather. Climate change results in greenhouse gas emissions, which consequently trap heat and cause air temperature to increase (Ballegeer, Fuertes, Andrés, Corrochano, Delgado, Herrero-Teijón, & Barbosa, 2019). As a result, floods and droughts unexpectedly occur, which directly impact on the food production and food processing. Moreover, the World Trade Organisation (WTO) notes that the influence of climate change places some limitations on the amount of subsidise given to the agricultural commodities (Akshalova, Solntsev, Abdraiym, Tlepina, & Iskakova, 2020). Consequently, the lower stockpiles reduce the amount of food available causing a shortage, which increases the food price volatility.

The situation of dramatic rise in global food price and oil price uncertainty exhibit threats to food security and domestic food price, especially in the case of emerging markets where a high fraction of the poor citizens spends most of their budget and income on food (Saguin, 2018). In addition, global food price fluctuations severely pose additional costs to consumers, producers and even governments. There is also an underlying relationship between high food price and high instability, due to the tightness of supply and demand (Katrakilidis, Kourti, & Athanasenas, 2018). In the period of economic shocks and volatile agricultural commodity markets, higher and more vulnerable food prices are detrimental to both the countries and households.

Moreover, there is a series of factors contributing to local food inflation, including global financial turmoil, financial speculation in food markets, ineffective logistics systems and food distribution, a rise in energy prices, demand for commodity stocks, export bans, political factors and weather conditions (Mueller, Anderson, & Wallington, 2011). Food price vulnerabilities lead governments to devote their attention to establishing and adjusting food policies with an aim to stabilizing food securities and remaining a stated objective of authorities in both emerging markets and advanced nations (Brzezina, Kopainsky, & Mathijs, 2016).

In this study, an empirical examination is undertaken to estimate the influence of global food price, global oil price and macroeconomic factors on domestic food inflation in the case of two oil-importing countries and two oil-exporting nations. The two country representatives of oil-importing countries are Singapore as a high-income country and Vietnam as an emerging market and the two cases of oil-exporting nations are Kuwait as a high-income economy and Indonesia as a developing country. We analyse the transmission of global agricultural commodity price to domestic food price for the case of Singapore as it is heavily dependent on agricultural commodity imports. The few local existing food manufacturers in Singapore fail to meet the overall demand, hence, it imports nearly 90 percent of the agricultural commodities (Tortajada, & Zhang, 2016). Therefore, the fluctuation in global food price and global oil price has a substantial influence on domestic food inflation of Singapore.

In contrast to the case of Singapore, Vietnam is a food self-sufficient economy with a high population growth. The welfare and well-being of approximately 100 million citizens in Vietnam can be hit by an increase in food price index (Kyeyune, & Turner, 2016). In the same scenario as Singapore, Kuwait imports more than 80 percent of food requirements from overseas countries (Jallow, Awadh, Albaho, Devi, & Ahmad, 2017). Thus, a sudden change in global food price can directly affect food inflation of Kuwait. Whereas Kuwait is a high-income country which depends on food imports, Indonesia is relatively a food self-sufficient nation and is a developing country. Therefore, this research illustrates and compares the food volatility, the influence of global food price, global oil price and macroeconomic factors on domestic food inflation of oil-importing and oil-exporting economies, and food self-sufficient and food imported-dependent countries. Additionally, the study indicates the response of domestic food inflation to a sudden change in addressing monetary policy in the case of four countries.

This study also presents a series of appropriate policy implications for different types of market economies to stabilise their food securities and response appropriately to global food price shocks. In the past, there were different measures performed by individual government in the reaction to the global financial crisis and global economic turbulence (Collingro, & Frenkel,

2019). However, a wide range of different policies of countries show distinctive degrees of effectiveness. For more details, exchange rate changes and global oil price shocks can have a considerable influence on domestic inflation in the oil exporting and oil importing nations. However, over the last few years, the vulnerability of food prices has caused a complicated issue for central banks to forecast and achieve the price stability (Álvarez & Sánchez, 2019). Therefore, the study illustrates numerous monetary policies for the Central Banks to adopt during the period of global economic turbulence. As a result, the monetary authority in Singapore, Vietnam, Kuwait and Indonesia could adopt multiple indicators and strategic approaches to signal the Central Banks' assessment of their economies. This research contributes to new comprehensive ways to clarify and explain distinct but complementary monetary policy tools and inflationary dynamics of oil-importing and oil-exporting economies.

1.2 Aims and objectives

The main purpose of the study is to clarify and examine the issues of food volatility and the response of domestic food inflation to a sudden shock in global food price, global oil price and monetary policy. These are essential issues in the policy environment, especially in the context of oil-importing and oil-exporting economies. The two net oil importers analysed in this study are Singapore and Vietnam, and the net oil exporters are Kuwait and Indonesia. Besides analysing the role of global food price and global oil price to the fluctuation of domestic food inflation, the study evaluates the relationship between macroeconomic variables and domestic food inflation, then clarifies and compares the impulse response of domestic food inflation to a shock of monetary policy of the four countries. Several monetary policy implications will be suggested.

The existing literature on food volatility and the connection between domestic food inflation and macroeconomic variables follows the neoclassical and ecological theories of the agricultural economic growth that imply the link between global agricultural commodity price and domestic food price. This study attempts to estimate the roles of global food price, global oil price, macroeconomic factors and monetary shocks on domestic food inflation in the case of the net oil importer and net oil exporter countries. The first question this study addresses is whether there exists domestic food price volatility in the oil-importing nations of Singapore and Vietnam and of the oil-exporting countries of Kuwait and Indonesia. To examine the hypotheses of food volatility, the models are estimated on time series monthly data for the period 2004-2019, employing the Autogressive Distributed Lag (ARDL) approach to cointegration. The results from these models present policy recommendations for

macroeconomic and energy policies related to the economic growths of oil-importing and oil-exporting nations.

A second crucial issue concerns whether a change in global food price, global oil price and monetary policy influences domestic food inflation of the four countries. The impulse response function is the main methodology applied to test the hypothesis. Research on oil prices and food prices are appropriate, as trading activities around the world face a challenge with the outbreak of the new type of virus, causing the price of food and crude oil fluctuated. The oil price rise will trigger the recession of several economies, as in the case of the two oil shocks in the 1970s. However, in accordance with net oil importing nations, the alleviation of higher food prices can be an opportunity and a vehicle for improving economic and trading situations based on the implementation of appropriate monetary policies. First, in the presence of various shocks on global food prices the relative effects of food commodities change for local food, thus inflation is positive in the oil importing economies such as Kuwait and Indonesia, and it is negative in the oil exporting nations like Singapore and Vietnam. There is a series of factor that contribute to the volatile local commodity price. Thus, food price vulnerabilities lead local governments to devote their attention by establishing and adjusting food policies and monetary policies to stabilise food securities. Therefore, in response to the global price shocks a variety of monetary policies are discussed and compared, in the case of different structural market economies.

Given the different economic status of the four countries, this study addresses the reaction of domestic food inflation to global price shock and monetary shock utilising impulse response function. This system of monetary policy variables is analysed to clarify the direct impacts of global food price, global oil price and monetary shocks, then we compare the performance of the reaction of domestic food inflation to a monetary shock of oil-importing countries and oil-exporting economies. An analysis of the link between global food price, global oil price and macroeconomic variables and domestic food inflation is valuable for various reasons. First, it is crucial to justify the relationship between food volatility and macroeconomic and monetary factors so that policies can be formulated. As a result, the joint achievement of agriculture sector and monetary objectives can be obtained. This research relates to a rapidly growing literature on monetary policies in the open markets This study extends the literature of previous studies related to global food prices and monetary policy in several ways. We model food and oil as key imports, traded in the flexible price competitive economies. The study emphasizes whether the shocks to global food price, global oil price and domestic food inflation

can move in opposite directions. As such where there are negative consequences, appropriate and effective monetary policies ruled out by the governments should be a priority.

This study has a wide range of objectives. The initial objective is to illustrate an overview of the theorical and empirical literature concerning the problems of food and oil volatility and global price and monetary shocks and their relationships with domestic food inflation in the oil-importing and oil-exporting nations. The second objective is to evaluate and to determine the relationship and dynamic interactions between price changes in global energy and food products and domestic food inflation in oil-importing economies of Singapore and Vietnam and oil-exporting countries of Kuwait and Indonesia. The models are extended to compare the extent of price changes of standard agricultural outputs that are transmitted to domestic food inflation in this sample groups of oil importing and exporting economies. After that, the study highlights the future direction of the domestic food inflation of the four countries.

The last objective is to empirically clarify the main causes of domestic food inflation shocks and the response of different structural economies to global price shocks and macro-economic imbalances. The further analysis makes a comparation among these effects of global food prices on different structural market economies. Based on the levels of impacts the analysis provide policy implications of adjustment policies for the food price situation and food security, especially of the vulnerable groups. It is anticipated that the outputs from this study will inform the policy-makers with simultaneously obtaining monetary policy objectives and food security. The strategic approaches to stabilisation and structural adjustment policies are also analysed.

1.3 Data and methodology

The study utilizes a series of models to analyse the food volatility and the reactions of domestic food inflation to the global price shock and monetary shocks in the case of four countries. The empirical analysis uses monthly data from 2004M9 to 2012M12 for four sample countries of Singapore, Vietnam, Kuwait and Indonesia. The primary data used in chapter three which discusses about food volatility and the relationship between domestic food inflation and global food price, global oil price and macroeconomic factors are retrieved from the websites tradingeconomics.com and globaleconomy.com. These variables in chapter three are the global food price, global oil price, GDP per capita, industrial production, the real exchange rate, real money supply and domestic food inflation of Singapore, Vietnam, Kuwait and Indonesia.

The variables used for chapter four which investigates the reaction of domestic food inflation to a global price shock and the monetary shock are global food price, global oil price, the real money supply, the real exchange rate, the interest rate, and domestic food inflation of

the four countries. The monthly data in chapter four is retrieved from the websites tradingeconomics.com and globaleconomy.com, covering the time span between 2004M9 and 2019M12. The original series are not removed of seasonal patterns. However, a wide range of studies argue that using seasonally unadjusted data is such an effective way in estimating financial and economic variables. They recommend statistical techniques to remove seasonal pattern and to account for seasonality in the data (for instance, seasonal unit roots or seasonal dummies) (Osborn, 1990; Lee & Siklos, 1991). The Stata program is utilised in computing the estimates for two oil exporting and two oil importing countries. The variables of global food price, global oil price, GDP per capita, industrial production, the real exchange rate, and the real money supply are expressed in log forms in the models.

The methodologies applied to evaluate the numerous models consist of the most-current economic procedures of the time series literature. In terms of the relationship models (chapter 3) for the period 2004-2019, the ARDL approach to cointegration is utilised. To examine the long-run and short-run connection between domestic food inflation and macroeconomic variables, the cointegration test and Vector Error Correction Models are constructed. Besides, the ARCH-GARCH framework allows the estimation of total impacts of macroeconomic variables and global indicators on domestic food price vulnerability. The GARCH model is a statistic model for time series data. As such, the model measures and illustrates relative agricultural commodity price volatility. GARCH model was pioneered by Bollerslev (1986), which is commonly applied in modelling the financial time series which exhibit volatility clustering and time- varying vulnerability. Chou (1988) notes that using GARCH models is a positive method to capture a wide range of dynamics structures of both incorporating heteroscedasticity and conditional variance into the estimation system. As a result, simultaneous estimation of various parameters of the procedure has been intensely examined. Besides, the methodology of the GARCH-ARMA models, first introduced by Lee & Hansen (1994), is applied for testing the relationship of short-run deviations from a long-term cointegrated link and vulnerability.

On the other side, for chapter four, the impulse response function from VAR model approach allows the estimation of the reaction of food price index when a random shock of global agricultural commodity price happens and whether it adjust instantaneously to changes in economic situations. In the chapter 4, where we will examine the impulse response to a random shock, we also follow the methodology of FEVD based on Cholesky decomposition to compare and clarify the influence of macroeconomic factors on domestic food price. Also, VAR-ARIMA models offer a stronger solution to provide more reliable and more precise

forecasting results. As such, a great variety of literatures illustrate a wide range of models which can be employed to forecast agricultural commodity prices and food price vulnerability. Febrian & Herwany (2009) suggest that some techniques such as Autoregressive integrated moving average (ARIMA) modelling, exponential smoothing, the Vector Autoregression (VAR), and Vector Error-Correction Models (VECM) can be followed together in forecasting the prices. This study, with the aim of forecasting agricultural commodity prices using the adequate frameworks and considering the essence of food policy reforms addressed by an emerging country. As these models are complete measurement equations of relating the observed measure to latent vulnerability, the expected results of the analysis can be accurate and precise (Ullman & Bentler, 2003). These equations also facilitate a simple structure of the dependence between future price inflation.

1.4 Chapter outline

The empirical investigation on the influences of global commodity prices on domestic food prices of net oil importing countries (Singapore and Vietnam) and oil exporting countries of Kuwait and Indonesia are structured as follows. Chapter 2 notes the relevant literature review on the linkages between global food prices and local inflationary performance based on the oil exporting and importing nations. It outlines the global food price, trading activities and production literature that sets the scene for the contribution of this study. The estimations of various models in Chapter 3 for each sample oil exporting and oil importing nations evaluate the food volatility and the relationship between domestic food inflation and global food price, global oil price, and macroeconomic variables. Chapter 4 examines the impacts of global price including global food price and global oil price, and monetary policy on domestic food inflation in the case of Singapore and Vietnam, and Kuwait and Indonesia. The analysis is further extended to compare the influence of the changes in monetary policies on domestic food price of the four countries.

Finally, chapter 5 concludes the study by summarizing the influence of macroeconomic elements on domestic food inflation and the response of domestic food inflation of different structural economies to global price shocks and macro-economic imbalances. Based on the comparative evaluations amongst the different structural market economies, chapter 5 presents the welfare ranking of monetary policy rules and a wide range of the implications of monetary policies. Chapter 5 also highlights the further research for the agricultural economics sector.

Chapter 2 LITERATURE REVIEW

2.1 Introduction

This chapter illustrates a series of the relevant theoretical and empirical literature on the connection between global food price shocks and inflationary pressures, focusing on the role and the importance of oil and food price changes in the process of food security and food price stability. The chapter addresses also covers the related economic overviews of the four sample countries, i.e., Singapore, Vietnam, Kuwait, Indonesia as well as other advanced and advancing countries. The extensive literature considers the overviews of these economies and relevant studies related to the influence of macroeconomic factors on local inflationary pressures. Therefore, a clear explanation of the relationship between global food prices and the country's consumer price index is essential for designing and adjusting monetary policies which must directly manage the global price shocks. To identify the important theoretical relationship, considerations has been given to relevant literature; econometric models, developed and developing countries, net oil importing and exporting countries in Asia, global food price shocks, global energy price shocks, domestic food inflation and various time periods.

A wide range of questions have been addressed in several studies that present the tightness between macroeconomic variables like global commodity prices and food inflation. A latest study by Bala and Chin (2018) investigate the asymmetric effects of oil price changes on local inflation in Algeria, Libya, Angola, and Nigeria. In addition, several studies reiterated that global energy price and food price are the principal elements of inflationary pressures, such as Chang & Catao (2015), Holtemoller & Mallick (2016), Choi, Furceri, Loungani, Mishra, & Poplawski-Ribeiro (2017), and Nookhwun & Worasak (2018). These studies demonstrate a wide range of theoretical perspectives on the global food price shock hypothesis, and statistical evidence on the calculated magnitude of the spikes influencing on local consumer price index through various direct and indirect channels.

The rest of the chapter is structured as follows: Section 2.2 illustrates the nexus of global commodity price and local inflationary spiral. Section 2.3 notes an overview of global food prices, global oil prices and their tightness with economic and trading outputs of various nations in the world. Section 2.4 addresses the contractionary monetary policies in dealing with the global food price shocks performed by monetary authorities. Section 2.5 illustrates the asymmetric effect and spot prices volatility. The last sections note the significance of this study and its contribution to the literature followed by concluding remarks for the oil importer and exporter countries.

2.2 Impacts of food price shocks: Theoretical Aspects

According to economic theory, the food price changes influence the economic and trading activities by the channels of supplying and demanding. As such, increases in agricultural commodity prices over the last few years have raised concerns among policymakers about worldwide food shortage (Ihle, Rubin, Bar-Nahum, & Jongeneel, 2020). In theory, soring global commodity prices poses issues for three groups, first, the poor whose capability to purchase foodstuff is undermined. Second, governments of low-income nations that face increasing import bills, higher costs for safety net plans and political unrest. Lastly, the aid agencies juggle between the needs of increasing demands for food, technical advice and cash financial assistance. Above all, high food price spikes highlight the long-term need for investment and compelling management of global food supply (D'Odorico, Davis, Rosa, Carr, Chiarelli, Dell'Angelo, & Rulli, 2018). In terms of global oil price changes, a soar of crude oil price causes an increase in costs, which theoretically exacerbate entrepreneurial firms to reduce outputs (Su, Wang, Tao, & Oana-Ramona, 2019). There are also numerous demand-side responses to consumption and investment which can be testified and predicted by economic theories. Therefore, this study implies that a sudden change in the oil price shock can cause constraints of outputs.

The theoretical foundation notes the relationship between higher food price and the persistent increase of crude oil. This is due to oil products that are notably utilized for agricultural equipment. Therefore, higher oil prices raise the costs of processing, storing, transporting and distributing agricultural commodities of the retail customers. It is also noted that there is an increasing reliance on biofuels in industrialised market economies – especially in the United States (US) (Johnson, 2017). Moreover, the situation of dramatic rise in food price and commodity price fluctuations exhibit threats to food security in various ways, especially in the case of developing country where a high fraction of poor people spends total or most of their budget and income on food (Tacoli, 2017). Moreover, food price fluctuation severely poses costs to consumers, producers and even governments, especially the case of developing countries (Baker & Wojcik, 2019). There is also an underlying relationship between high food price and high instability, due to the tightness of supplying and demanding sides. In a period of economic shocks and vulnerable food commodity markets, increasing and volatile food prices are particularly detrimental to both countries and households (Laborde, et al., 2019).

Various studies have assessed the influence of food price changes and energy price shocks on inflation employing international data. Several studies that analyse structural factors explain the magnitude of impacts of spot price shocks on inflationary pressures. However, some results are diverse and mixed. LeBlanc & Chinn (2004) state that a 10 percent rise in global

agricultural commodity price leads to immediate inflationary increases of approximate 0.1-0.8 percentage points in the case of five developed countries. They employed the augmented Philips curves on quarterly data in the context of five advanced nations including the US, United Kingdom, France, Germany and Japan, for the period time from 1980Q1 to 2001Q4. Their results reflect that there is no remarkable difference in the pass-through between the US and European Union. Chen (2009) illustrates the influence of oil price changes in the framework of 19 advanced markets. He found that a 10 percent rise in oil price led to an increase of the overall price degree by more than 0.05 percent after one-quarter. He suggests that the impact has gradually declined and attributed it to enhancements in the performance of monetary policies and higher trade openness.

De Gregorio, Landerretche, Neilson, Broda, & Rigobon, (2007) present evidence on a decreased pass- through from global energy price to domestic consumer prices. They also found that the decrease in the pass-through is notably pronounced in the case of advanced nations. They attributed the decrease to a sharp decline in oil intensity and the percentage of the exchange rate pass-through. They applied the augmented Philips curves and used monthly data for both the advanced and developing countries. Ötker, Vávra, Vázquez, Jácome, Habermeier, Ishi, & Kisinbay (2009) applied the panel data of 50 nations during the period time of 2007-2008 and note the important role of monetary policy in addressing the size of pass-through of agricultural commodity and oil price changes. They also find that an economy with higher inflation targeting regime and central bank independence tends to alleviate pass-through effect.

On the other side, Álvarez, Hurtado, Sánchez, & Thomas (2011) summarise that the direct impacts of oil price raise inflation recorded as a gradual enlargement in the Euro region due to increasing expenditure share of the households on refined crude oil products, while their indirect and second-round impacts have been minimised. Zoli (2009) and Caceres, Poplawski-Ribeiro, & Tartari (2013) clarify the influence of agricultural commodity price shocks on consumer price index of emerging Europe and Central Africa, respectively. They applied Vector Autoregressions model (VAR model) methodology and find that relative prices to European Union region is a vital element in explaining the responses of inflation dynamics to food price changes in emerging Europe, and price controls have an essential role in Central Africa. They conclude that region-specific factors can influence the reactions of local inflation to spot price collapses in the emerging markets.

A recent study by Gelos & Ustyugova (2017) evaluate country-by-country augmented Philips curves, applying quarterly data from the developed and developing countries during the time between 2000 and 2010. Their study is specifically different from several studies as

they recommend the testing of pre-existing inflation degree and high fuel intensities that are reasonable elements in clarifying cross-country diversities in the impacts of agricultural commodity shocks. They also mentioned that the conduct of monetary policies and inflation targeting regimes are not the primary determinant of the level of pass-through.

Another strand of relevant literature clarifies the time-varying impacts of crude oil price that collapses the nation involving inflationary dynamics. The findings have emphasised the fundamental sources of oil price shocks that are the underlying determinants of macroeconomic impacts. In particular, Kilian (2009), Peersman & Van Robays (2012), Baumeister & Peersman (2013) argue that the impacts of oil price changes cause a diverse impact on real GDP and CPI. They also agreed that oil price changes are determined by a negative source from the supply collapse and a positive change of the demand shocks. Besides, because of their decomposition, the oil price spikes in the 1970s are mostly attributed to exogenous collapse and shortfalls in crude oil production (known as a negative change of the supply shocks), whereas the lengthened build-up in crude oil price which began in 1999 is primarily driven by shifts in the request for crude oil (known as a positive change of the demand shocks). In the study relating to the reason of Great Moderation, Gali & Gambetti (2009) find that a change in the size of the structural spikes gradually drove the reduced reaction of aggregate inflation to crude oil price.

2.3 Global food price and Economic activity: Empirical studies

This section discusses the transmission channels of global food price changes to the trading and economic activities. In theory, arguments about the tightness between oil price and agricultural commodity prices is currently diminishes. It is also thoroughly described that oil price spikes spread to trading activities by numerous channels. In a study by Brown & Yucel (2002), the channels of price shocks transmission are the supplying side impacts in which income transmits from oil importers to oil exporter economies, monetary policy and real balance effect. Together with the mentioned channels, Lardic & Mignon (2008) argued that a rise in oil price can cause inflation, disruption of investment, stock prices and consumption. These findings have been considered effectual in a series of empirical papers in the case of advanced and emerging markets.

In addition, agricultural commodity prices are becoming a fundamental problem around the world. Both crude oil and food products prices are responsible for the global economic slowdown and financial crises, for example, the two big price-rise in global food markets and turbulence in the international economy. As such, there existed substantial price shocks of the time 2007-2008 and 2010-2011, in the context of global economic slowdown, which highlight

the serious volatility of global food price and higher uncertainty of worldwide food trading operation (Gaetano, Emilia, Francesco, Gianluca, & Antonio, 2018). Few analytical studies focused on the links between food price and macroeconomic factors, for instance see Headey and Fan (2008), Galesi & Lombardi (2009), Hakro & Omezzine (2010), Abott, Ward, & Hu (2011). These studies note that food prices transfer to macroeconomic factors, such as output, inflation, terms of trade and exchange rate. Based on the theoretical structures, these concepts of transmission channel for investigating oil-food price and macroeconomic variables relationships are analysed for the four sample countries.

In the context of a negative change in the oil and food price, a soar in oil price means an increase in manufacturing cost, leading to a reduction in industrial production. From commodity importers' viewpoint, a soar in the import bills triggers a drop of the net exports, leading national output to decrease. From agricultural exporters' viewpoints, a rise of global food price triggers a reduction of demand for food exports, consequently reducing the net export of national output (Bouët, & Debucquet, 2012). Another explanation is that in case of an increase of food prices, the employees tend to seek higher wages (Cengiz, Dube, Lindner, & Zipperer, 2019). As a result, the demand for labours or physical workers falls and the production hampers, eventually leading a decrease in production.

Besides, it is currently well presented that in case of a sharp rise of global oil and food price, inflationary dynamics happen worldwide. When inflation increases, demand for money increase, causing a soaring rise in the rate of money market (Tabaković, & Dragašević, 2020). As a consequence, interest rate records an increase. Besides, due to global oil and agricultural commodity price shock, the soar of inflation and interest rate has adverse impacts on the exchange rates (Balcilar, & Bekun, 2020). Other macroeconomic indicators are plausibly influenced by global food and oil shocks. As such, global spikes hamper the profitability of a reduction in the demand for stock in global financial market (Hamilton, Henry, Rounsevell, Moran, Cossar, Allen, & Alexander, 2020). Consequently, the stock prices in the whole trading market records a decline.

The influence of oil prices on macroeconomic activities have been considerably conducted in numerous studies, starting with the initial pioneering study of Hamilton (1983). Employing Sims' VAR method (1980) to the US quarterly data for the time period of 1948-1980, he notes that oil price and gross national product (GNP) of the US exhibited a strong correlation. He also argued that the event of a sharp rise in oil prices happens before the recession after World War II. After Hamilton's work, a series of studies focus on the adverse influence of crude oil price shocks on GDP of the US, see for instance, Gisser & Goodwin

(1986), Mork (1989), Lee, Ni, & Ratti (1995), Hamilton (2003). There are also some work illustrating the impacts of oil prices beyond the structures of the market.

The impacts of soring energy price on outputs and wages were described in Rotemberg & Woodford's work (1996). Their study focuses in the scenario of an imperfectly competitive market. They found that 1 percent a rise in oil price contributes to 0.02 percent of production and 0.09 percent of real wage reduction. Following these studies, Finn (2000) finds similar results for the relationship between oil price and macroeconomic variables in a perfect competition structure. According to Finn, the negative influence of a soar in oil price on trading activities is in a perfect competition. The negative influence of oil price escalation on economic activities is identical to the framework of the market. He concludes that regardless of the market structure being perfect or imperfect, a rise in oil prices could adversely influence economic activities.

A series of studies mention the influence of oil price changes in the sectoral level applying individual sector wise data. Keane and Prasad (1996), test the micro level panel data, find that oil price changes substantially influence real wage. However, they argue that the result of oil price change is different in the case of skilled workers. As such, they separated labour and physical workers in terms of their level of skills and find that the influence of oil price changes on real wage varies for skills. Davis and Haltiwanger (2001) also demonstrated the same idea in their study applying VAR in a sector format show that oil price shocks play a dominant role to the short-term fluctuation of employing destruction. Their findings are asymmetric that oil price shock responded to employment destruction and not to employment creation. They point out that the influence of oil price changes is double than monetary shocks in the case of the US for the period 1972 to 1988.

Another study from Lee and No (2002) on the influence of crude oil price shocks on numerous industries, applying VAR method with the US cooperation level data find that oil price change has short term impacts on the industrial outputs. Their tests identified that oil shocks influence the demanding and supplying sides of industries. In terms of oil price spikes, the supply sources of oil intensive industries declined and simultaneously the demand for other industries diminished. Lippi and Nobili (2009) investigate that structural shocks (industrial production, oil producing costs and other macroeconomic factors), together with oil supply shock reduced national outputs. They find that a positive change in the oil demand shock recorded a positive and persistent effect on GDP. In addition, a recent study, Francesco (2019) clarifies that oil price changes have positive effects on the outputs of manufacturing and service sectors. They used linear data for the United Kingdom industries.

On the other hand, the analysis on the effects of agricultural commodity prices on domestic inflation has gained higher attention after the time of the global crisis of the late 2000s. A series of the studies estimate the impacts in the context of a multi-nation setting including a series of developing and developed countries. For example, Furceri, Loungani, & Zdzienicka (2018) examine the impacts of global food prices find that, in case of advanced economies, a 10-percent rise in worldwide food prices increase local inflation by 0.5 percent. Moreover, they state that the effect could be greater in the case of emerging economies as a results of higher level of the food share in the much less-anchored inflation anticipations and in CPI. Choi et al. (2017) show that domestic inflation increased by 0.4 percent following a rise of 1 percent in global oil prices. They also report that positive energy price shocks had a more large-scale impact on CPI than the negative ones. Besides, a wide range of studies examine the hypothesis that structural characteristics of each nation mattered for the magnitude of the influence. Gelos & Ustyugova (2012) explicitly investigate the elements affecting dispersions in inflation pressure responses to agricultural commodity price shocks. They find that the food shares, pre-existing inflation proportion, fuel intensities happened after such dispersion. Thus, a question about where the Asian countries stand in the scenario of food products' price pass- through was raised.

Blanchard & Gali (2007) report that the decrease in the pass-through is due to an effective conduct of monetary policies. Jongwanich & Park (2011) is the only work which exclusively illustrates the important role of global oil and agricultural commodity price shocks on domestic inflation in the scenario of emerging markets in Asia. However, they note that the magnitude of the pass-through is relatively small, citing the dominant role of price controls and subsidies in alleviating the effects. In the context of only oil importing nations, Manopimoke & Direkudomsak (2017) investigate on the impacts of globalisation process which assist to alter the oil importing countries' inflationary pressures since 1990s. They conclude that from 2001, inflation dynamics has become substantially dependent on global macroeconomic variables, especially global oil prices.

2.4 Monetary policy and its impacts

The influence of monetary policy on relative food prices was first introduced by Cantillon in 1959. His work entitled, "An essay on the nature of trade in general" illustrated a comprehensive idea that the degree of a change in the quantity of money caused price level changes. As noted, the way new money is injected into an economy influences the prices initially. There are also a wide range of studies providing empirical and theoretical explanations for the tendency of agricultural commodity prices which are more flexible relative to the

aggregate price in the economy. For instance, Bordo (1980), Chambers & Just (1981), Frankel (1986), and Orden (1986), illustrate that agricultural commodity prices react more rapidly to changes in the performances of monetary policies than do prices of other services and goods. Furthermore, two remarkable studies from Orden and Fackler (1989) and Dorfman & Lastrapes (1996) clarify that a rise in money supply leads to a rise in food products' prices relative to the aggregate price level. They also provide evidence of real short-term and long-term influence of monetary policies changes on agricultural commodity prices. Until the 2000s, Balke & Wynne (2007) and Nishina, Maghrebi, & Holmes (2012) note that monetary disturbances have significant relative price impacts, resulting in a rise in distribution of the cross-section dispersion of prices. These studies provide evidence of monetary non-neutrality and that agricultural commodity prices fail to respond uniformly to the changes of monetary policies. Besides, in terms of food price volatility, agricultural commodity prices are highly flexible and fluctuated more relative to aggregate price level in the turmoil.

In terms of the influence of relative food prices on the inequality and poverty in the case of low-income economies, Mello (1978), Ravellion (1998) and Rao (1998) were the pioneers investigating that a rise in relative food prices led to a soar in poverty and inequality situations in the urban and rural areas. Their focus in the case of India show that the reason was due to adverse distributional impacts on the real income of low-income households. Pons (2011) also agreed that the most vital distributional consequence of an increase in relative commodity prices on poverty is through a decline in real income. Furthermore, a series of scenarios for the Latin American nations, including Guatemala, Honduras, Nicaragua and Peru, by Robles & Torero (2010) find that a rise in relative commodity prices represented an adverse shock for destitute households due to their disproportionately excessive share of food expenditure.

The next fundamental distributional consequence of an increase in relative commodity prices is through its differential impacts on nets sellers and net purchasers of agricultural stuff. Soaring relative commodity prices harm all households who are the net buyers of agricultural commodity. There are a wide range of studies illustrating the negative influence of higher food prices. For example, Dev and Ranade (1998) show that the distributional results of an increase in relative food prices in the case of India, impact on the net consumers and net producers of food. They find that, by a conservative estimate, the whole urban population and approximately 50 percent of total rural citizens are negatively affected by a rise of food prices.

Alderman, Hoddinott & Kinsey (2006) in the case of Zimbabwe and Sub-Saharan African nations point out that there is strong links between high relative food prices and decreasing caloric intake, poverty, and a rise in child malnutrition. Angel-Urdi nola& Wodon

(2010) also reach similar conclusion as these previous studies. They all note that a soaring relative food price disproportionately harms the poor households in emerging economies, particularly due to two crucial reasons. The first reason is that the low-income households are the net purchasers of food and the second one is that they spend a remarkable proportion of total budget on food.

In terms of the effect of the monetary policies on addressing the issues of poverty and inequality, there are numerous channels illustrating the impacts of monetary policy shocks on inequality and poverty, especially in the case of advanced countries. Doepke & Schneider (2006) note that inflation through redistribution shock effects welfare of the households. Coibion, Gorodnichenko, & Wieland (2012) conclude the five channels whereby monetary policies can impact inequality are through income composition passage; the tendency of capital income to increase more relative to wage income; financial segmentation channel which means the capability of various financial agents to benefit more from policy spikes; portfolio passage which means wealthy households tend to be the biggest holders of securities will achieve more from asset booms generated by expansionary policy; and is through savings redistribution passage where an unanticipated decline in interest rates will harm the savers and benefit borrowers. They also point out that the fifth channel is through earnings heterogeneity passage where the trend of lower incomes tends to fluctuate business cycle more.

The monetary policies are transmitted through various direct and indirect channels. However, as the households in developing countries differ from each other and from the advanced nations there exist a wide range of aspects, for example, income levels, employment status, financial inclusion, wealth, political institutions, patterns of consuming expenditure and so on (Neumeyer, & Perri, 2005). Therefore, monetary policies influence all households in different ways. Yannick & Ekobena (2014) clarify that while a soar in interest rate causes a rise of poverty in the US through the savings redistribution channel, a rise in interest rate fails to influence poverty in the case of Central Africa due to its lower financial development. Based on the various views noted there it is important to present the evidence based on the asymmetric impacts and the influences of food price changes, volatility and monetary policy in advanced and emerging economies.

2.5 Asymmetric effects and the effects of global food price changes on volatility

A question about the causes of asymmetric impacts of oil price shocks were raised since there are opinions that asymmetric impacts of oil spikes affect monetary policy. The first study by Hamilton (1988), provides evidences on the causes of asymmetry as the adjustment cost of crude

oil price changes contribute to the asymmetry. Ferderer (1996) presents a different explanation by illustrating that sectoral shocks and insecurity contribute to asymmetry effects and note that the monetary way is irresponsible for asymmetric impact of oil spikes. Bernanke, Gertler, Watson, Sims, & Friedman (1997) show that the impact of oil spikes on the economy is not because of the change of global oil price. They argue that the contractionary monetary policies attributed to asymmetric impacts of oil price shocks and recommend that effective monetary policy should be applied to reduce the consequences of recessions. This has not been acceptable by Hamilton and Herrera (2004).

A number of studies also clarify the literature relating to oil data specification by applying a linear log real price of oil format. However, a question raised is whether oil data performs in a linear format. This argument drew high attention from various scholars. As such, Mork (1989) is the pioneer in putting forward an explanation by applying the data of crude oil price fluctuation to show the asymmetric impacts of oil prices on the US's GDP. In 1996, Hamilton proposed a methodology of nonlinear approach as a major flexible method of modelling oil data as the primary net oil price increase (NOPI), see Gounder & Bartlett (2007). Andreepoulos (2009) apply asymmetric impacts of oil price shocks on the trading markets. In a different passage of paper, Kilian & Vigfussion (2009) note that the types of asymmetric specifications of crude oil price soar and decline due to misspecifications in the models. Their study established the structural methods of asymmetric influence of energy price and note that the asymmetry of oil price was not estimated in the VAR model representation. Thus, they proposed an alternative regression tests of symmetry measure in the model impact through a predominant change required in the approaches to examine asymmetric impacts of oil price shocks. However, Hamilton (2010) notes that their findings were recognized more as complementary than challenging.

A series of papers focus on the strength and magnitude of oil price shocks. Burbidge and Harrison (1984) apply the VAR method as a primary approach and demonstrate that oil price has a negative impact on the macroeconomic factors in five Organisation for Economic Co-operation and Development (OECD) nations. They note that oil spikes of the period time 1973-1974 is totally distinguished from that of 1979-1980. In the years 1973-1974, the impact of price over macroeconomic elements were relatively strong, Blanchard and Gali (2007) agree with their findings and also clarify that oil price shocks of 1970s and 2000s are diverse due global economies lack concurrent negative shocks with recent oil spikes. This is because of a smaller-scale share of energy in production including crude oil, and that the causes of global oil shocks are more flexible labour markets and more effective monetary policies.

Similarly, Hooker (1996), employing multivariate Granger causality test, discusses that there exists no asymmetric or linear tightness between macroeconomic variables and energy price shock. Carruth, Hooker, & Oswald (1998) applying Granger causality test find that real oil price was responsible for unemployment in the US. Segal (2007), points out that monetary policy is the vital channel of transmitting oil price, and that when crude oil prices transmitted to core inflation, interest rates which were increased by the monetary authorities finally ceased economic growth. He also states that oil price has relatively little impact on the macroeconomy as most of the US based studies.

Lescaroux & Mignon (2016), by employing a Factor-Augmented Vector autoregressive method, report a positive link between crude oil price and CPI, and an adverse impact of oil price shock on national output, investment and consumption in China. Similarly, Kim, Hammoudeh, Hyun, & Gupta (2017) discuss that there are short run and long run impacts of oil price in China. They use structural vector autoregressive (SVAR) model to present that a rise in oil price adversely affect output and investment, however, state that oil price change positively influences inflation and interest rate. Zhang & Reed (2008), use a non-linear specification of oil method discuss that there is an existing link between energy price shocks and economic growth. Cologni & Manera (2018) show the macroeconomic impacts of oil price shocks, using various regime switching method for G-7 group of nations. They establish a different non-linear explanation of crude oil price contributing to a more comprehensible definitions of oil effects on output growth. Their findings are an important part of oil shocks on recessionary episodes.

Asymmetric influence of energy price on macroeconomic elements was also conducted by Lee, Yang, & Huang (2012). They employed multivariable threshold model to the case of three advanced economies, i.e., the US, Japan and Canada. They find that a sudden change in oil price substantially influences economic activities rather than energy price vulnerability. Besides, a wide range of studies clarify the link between crude oil price and the exchange rates. For example, Bénassy-Quéré, Mignon, & Penot (2007) and Lizardo and Mollick (2010) argue that there is an existing transmission from oil price to the exchange rates. However, some other researchers conclude that exchange rate affects the price of crude oil and energy product (see Zhang, Lai, & Wang, 2008). Others note that there is no link between energy price and the real effective exchange rates (see Breitenfeller and Cuaresma, 2008).

Furthermore, some scholars investigate the association between crude oil price and stock price. Jones and Kaul (1996) find the link between energy price and stock market in the

US and Canada. Sadorsky (2006) test on a group of emerging economies and Park & Ratti (2008) employ tests on the case of the US and 13 European economies. They all agreed that oil price adversely influenced stock markets. There are also some studies demonstrating that there exists no or little relationship between energy price and stock markets (Cong, Wei, Jiao, and Fan, 2008; Apergis and Miller, 2019). The study of Lascaroux (2019) on the issue of oil price shocks and the dispersion hypothesis notes that oil price shocks matter for economic activities.

In terms of the effects of food price on the macro economy, Birur, Hertel, & Tyner (2008) identify that the depreciation of the US dollar and the change in production of bio-fuel contribute to food price hike. Aksoy and Ng (2017) argue that food price shocks significantly deteriorate trade balances of low-income economies. They also found that in the case of middle-income markets, food price shocks improve their trade balance. Braun (2008) demonstrate that high food prices affect the net food importer economies. Besides, Galesi & Lombardi (2009) note that oil price and agricultural commodity prices caused different inflationary impacts using the data for the sample period 1999 to 2007 and found that the inflationary impacts of crude oil price mostly influenced the advanced regions. In addition, the agricultural commodity price shocks affect developing countries.

There is a series of factors that contributes to a volatile commodity market environment, including global financial turmoil, financial speculation in food markets, ineffective logistics systems and food distribution, a rise in energy prices, demand for commodity stocks, export bans, political factors and weather conditions. Food price vulnerabilities lead governments to devote their attention to establishing and adjusting food policies with an aim to stabilizing food securities and remaining a stated objective of authorities in emerging markets (Valdes, 2019). A wide range of empirical studies have identified the relationship between food price vulnerability and macroeconomic factors. Algieri & Leccadito (2019) argue that speculative activities have a considerable impact on food prices. Meanwhile, Johnson (2016) states that trade policy interventions including a great amount of import subsides or export tariff and the considerable flow of speculative capitals into food markets are the significant explanations for global agricultural commodities price impacts during the 2007-2008 global financial crisis.

A wide range of questions have been addressed in several papers on the connection between macroeconomic elements and food price index, a group of researchers including Mejia, Mrkaic, Novta, Pugacheva, & Topalova (2018) argue that significant uncertainty of the new extent of nominal prices constitutes for a remarkable crop price volatility. They also provide empirical evidence that changes in the agricultural commodity markets now is comparable to those happening in the period of 1970s. However, they only identify the

macroeconomic factor of nominal price which has an influence on food price volatility and conclude that food market participants can surprisingly adjust to some updated pricing environment.

Moreover, Paris (2018), based on the analysis using structural vector-autoregression model, state that in addition to higher costs of generating energy from agricultural products, higher consumption of oil-based input results in soaring food prices. In terms of speculative financial activities, Troster, Shahbaz, & Uddin (2018), using the Panel-VAR model conclude that speculation has a significant influence on food prices. A wide range of studies clarify that unexpected trading quantities in agricultural products lead to a greater price vulnerability (see Marsden, Moragues Faus, & Sonnino, 2019).

It has also been noted that other macroeconomic variables influence food price index. In terms of expected inflation, a several studies conclude that there is a strong connection between inflation and change in agricultural commodity products (Henderson, 2018; Reed & Saghaian, 2018; Nakamura, 2018; Bhattacharya & Sen Gupta, 2018; Bloom, Curhan & Hollis, 2018; Tule, Salisu & Chiemeke, 2019). A number of study including Bernanke, Laubach, Mishkin, & Posen (2018) interpret the relationship between inflation and food price index. Their study notes the implications of the reverse impact of food price on inflation, proving the powerful link between inflation rate and agricultural commodity price. As such, accelerating food prices also result in higher inflation, which means that real consumption, savings and investments can sharply decrease. As a result, aggregate demand falls and economic activities can be dampened.

In terms of interest rate, Tan, Sha, & Paudel (2017) employing A Factor- Augmented Vector Autoregressive approach show strong evidence that the relationship between food prices and macroeconomics is indirectly due to low interest rates. Basically, they argue that the global financial crisis, which was connected with excess liquidity in international economies was nourished by negative interest rate, particularly derived from the G7 central banks. The output of the global financial crisis was in line with excess liquidity and nurtured by low interest rates, particularly established by the Group of Seven (G7) central banks together with fast economic expansion of Chinese and Indian economies.

The macroeconomic variables may have potential impacts on food price volatility by means of institutional policies. For example, monetary policies could influence food price through the measurement of the external competitiveness of a financial state. In addition, any transformations in real exchange rates can transform the constitution of price between tradeable agricultural products and non-tradeable goods (Pérez-Cervantes, 2018). Moreover, the effect

of fiscal policies on food price volatility is taken into consideration where the fiscal management could substantially influence both domestic interest rate and exchange rate. The article by Kretschmer, Bowyer, & Buckwell (2012) suggests that the course of current account has a remarkable impact on the demand for agricultural products. In addition, in terms of investments, Gillespie & van den Bold, (2017) show that deficiency in investments results in an increase in food price. Bangara & Dunne (2018) argues in their study that apart from investments, inflation and exchange rate are two major macroeconomic variables which directly matter for food price vulnerability. Additionally, he exemplifies that the presence of accelerating food prices challenges policy responses. As such, a rise in food prices (in mean and in vulnerability) pushes policymakers and authorities to set trading registrations including restricting exports and attempting to controlling domestic prices in the context of price rises.

The most relevant article on the relationship between macroeconomics and food price volatility by Buffie, Airaudo, & Zanna (2018) apply monthly data and the short-run structure to examine the degree to which macroeconomic variables which systematically generate inflation rate alter relative food prices. They confirm the hypothesis that the level of money prices, inflation and exchange rate fail to alter the real aggregated food prices. They also argue that an economic and financial state that triggers changes of the components can lead to remarkable price swings. Swinnen (2018) apply the ARCH model finds that macroeconomic factors play a crucial role in altering inflation, which, in turn, variates food prices. He also claims that macroeconomic instability leads to higher food price vulnerability, resulting in adverse impacts on agricultural commodity production and income.

Roache (2010) well documented that there is the low frequency vulnerability in agricultural commodity prices and illustrated that foreign exchange and interest rated exert a remarkable impact on describing the low frequency vulnerability. Apergis and Rezitis (2011) conducted the link between food prices and numerous macroeconomic variables and explained that there exists a cointegration link between vulnerability in real GDP per capita, real exchange rates and budget deficit. Meanwhile, Hochman, Rajagopal, Timilsina, & Zilberman (2014) are much more successful on analysing the underlying reasons of crises relating to food prices. They took the impacts of inventory on price vulnerability into consideration and stated that if the level of inventory effects is not accounted for, the effects of numerous elements on food price inflation can be overestimated. Tadesse, Algieri, Kalkuhl, von Braun (2014) in a comprehensive study notes that the sharp interactions between foreign shock and agricultural commodity and energy price. Besides, their research illustrates which factors caused volatility

in commodity prices. They also noted that financial markets play an essential part in exhibiting the vulnerability of food prices.

In the case of emerging economies, Amaiquema & Amaiquema (2017) conducted a more detailed study about the relationship between energy and food price and economic growth in Ecuador using data for the period time of 1980-2015. He found that global food price significantly affected economic growth and domestic inflation. He used SVAR model and employed annual data, together with annual survey, which is a new point in his methodology. Following previous studies, Kavila & Roux (2017) investigate on the linkages between macroeconomic shocks and domestic inflation. They employ the VECM applying monthly data for the period time from 2009 to 2012. They find that a rise in global food price shocks exerted a positive influence on local inflation. Solaymani & Yusoff (2017) examine the influence of high agricultural commodity prices on Malaysia's trading activities and poverty. They conclude that the idea of generating a rise in the degree of farming productivity is a much more productive way of decreasing the adverse effects of shocks on global commodity prices than the agricultural supporting choice.

In the case of Asia, it has been debated that macroeconomic factors and policies including fiscal, monetary, exchange rate as well as agricultural policies contribute to food prices volatility. Basnet (2015); Lahirushan & Gunasekara, (2015); Lau & Lee (2016); Hajilee & Al Nasser (2017); and Ridzuan, Ismail, & Hamat (2018) illustrate that the rises of food prices in Asian economies during the 1970s are the significant consequences of macroeconomic variables. Alegwu, Aye, & Asogwa (2017), following the trend- cycle approach, exemplify the important role of exchange rates in forming agricultural prices. In particular, the exchange rates can influence agricultural commodity prices through the mechanism of worldwide purchasing power and the impact on margins for agricultural products' producers. Shah, Corrick & Saboor (2018) show that monetary policy can influence the agriculture sector in an indirect method by attributing to the lower level of interest rate, stable inflation expectations, and low inflation. By contrast, James (2016) using a VECM finds that monetary effects are not the dominant elements for agricultural commodity prices. He stresses that interest rate is a major factor which directly influence food prices, especially in case food market participants anticipate interest rate spikes to persist.

2.6 Significance of this study

The analysis in this research fills the gap on the issues of volatile food prices and domestic food inflation's reactions to a monetary shock from the perspective of the two Asian oil-importing

and oil-exporting economies. The political and economic events are also taken into consideration given the impact of various economic crises and oil shocks. The methodology applied here tests for breakpoints based on the crisis and situations faced in the global economy. The important role of monetary policies, the drivers and effects of food volatility and the influences of commodity price volatility contribute to the literature from the directional linkages based on these in-depth factors that identify the monetary policy responses to address food price volatility. The findings based on specific markets with different structural features of the economies, geographies and terms of trade note the role of the governments and appropriate monetary policies for the sample countries of Singapore, Vietnam, Kuwait and Indonesia to control the price volatility. Another contribution of the study is to clarify and compare how the households, traders and societies from different structural economies are influenced by the level of volatility and appropriate policies for each type of country to deal with price vulnerability and the global price shocks from microeconomic perspectives. The application of advanced quantitative methodologies and empirical models contribute to the policy implications.

2.7 Summary and conclusion

The chapter presents an overview of the influence of oil price and macroeconomic factors on economic developments, focusing on the period since 1955. It has also noted that the economic trading activities affect the domestic food price changes through both the supply and demand channels. The importance of these issues notes the concerns in the last few years amongst the policymakers due to food shortage. The market structures and the agricultural commodity market trends indicate oil and food as vital components. From the economic growth perspective, the adverse impact of higher global commodity prices leads to economic and social crises amongst the poor whose capability to purchase food is undermined, the governments of low-income nations that face increasing import bills, higher costs for safety net plans and the political unrest due to poor policy formations.

Several studies have explored the strong relationship between oil price and stock market returns, while the positive sensitivity of energy related stock prices to oil prices and the adverse sensitivity indicates the various factors that affect the economies. These effects of real oil prices and unemployment remains a cointegrated tension. The empirical studies on the global food price and economic activities have gathered momentum to address the transmission channels of global food price shocks to economic activities. In theory, arguments about the tightness between oil price and food prices note that oil price spikes spread to economic activities by

numerous channels from the supply side impacts while the agricultural commodity prices are fundamental issues from the oil and food prices, due to global economic slowdown and financial crises affecting the global food markets and turbulence in the international economy.

Based on the theoretical and few analytical studies with the focus on the relationship between food price and macroeconomic factors the food prices transfer to macroeconomic factors, such as output, inflation, terms of trade and exchange rate. Based on the theoretical structures, these concepts of transmission channel for investigating oil-food price, macroeconomic factors and domestic food inflation relationships are analysed for the four sample countries here. The asymmetric literature is given the importance based on the causes of asymmetric effects of oil price shocks and its impact on the monetary policy. The monetary policy attributes and the asymmetric impacts of oil price shocks are analysed based on this literature for effective monetary policy crucial to address the consequences of recessions. In order to properly adopt the policy decisions for global food prices and monetary policies in oil exporting countries and oil importing economies, it is thus vital to determine the causal relationship between various factors to enhance economic growth and socio-economic development over time.

Few studies have noted the effects of agricultural food prices and the monetary policy in Asian countries; hence the objective of this study is to assess the influences of both oil and food prices for two-oil importing and two-oil exporting group of emerging and newly advanced nations, that is Singapore, Vietnam, Kuwait and Indonesia. The choice of the counties is based on the lack of studies in the Asian region. The next chapter presents the empirical analysis of the link between domestic food inflation and global food price, global oil price and macroeconomic factors as well as food volatility for the oil importing countries of Singapore and Vietnam and oil-exporting countries of Kuwait and Indonesia. Chapter 4 will illustrate the impulse response of domestic food inflation to a monetary shock and a sudden shock of global food price and global oil price.

Chapter 3 FOOD PRICE VOLATILITY AND MACROECONOMIC FACTORS IN OIL-IMPORTING AND OIL-EXPORTING COUNTRIES: EMPIRICAL RESULTS

3.1 Introduction

After twenty years of relative stability in commodity price (between the mid-1980s and mid-2000), the global food security has been under threat as a result of two price spikes of the global food markets due to its impacts from the 2007-08 global financial crisis (GFC). The GFC resulted in a volatile market, coupled with global economic meltdown. The market has been characterised with severe volatility in global food prices and higher level of uncertainty in the global food trading operation (Gaetano, Emilia, Francesco, Gianluca & Antonio, 2018). Studies have shown the emergency of such a volatile market and its worsening effect on emerging countries, where a significant fraction of poor people spends most of their budget and income on food (Baker & Wojcik, 2019). This chapter examines the volatility of food prices and related macroeconomic factors in the two oil-importing countries of Singapore and Vietnam, and two oil-exporting countries of Kuwait and Indonesia applying monthly data over the period 2004 to 2019.

The theoretical and empirical studies have offered several insights into the effect of global price fluctuations and domestic prices. There is an underlying relationship between high food price and high instability due to the tightness of supply and demand. For one, the increasing and volatile food prices detrimentally affect the households' consumptions and purchasing power of the countries (Laborde, Lakatos & Martin, 2019). There is a series of factors contributing to such a volatile commodity market environment, including the global financial turmoil, financial speculation in food markets, ineffective logistics systems and food distribution, a rise in energy prices, demand for commodity stocks, export bans, political factors and weather conditions (Valdes, 2019). The mechanism is that food price vulnerabilities lead governments to devote their attention in establishing and adjusting food policies with an aim of stabilizing food securities and remaining a stated objective of authorities in emerging markets.

In examining the influence of global food price on domestic food inflation in the case of two oil importing countries of Singapore and Vietnam, and the two oil exporting countries of Kuwait and Indonesia, the GARCH process (Engle, 1982) and the Vector Error Correction Model (VECM) (Newbold & Granger, 1974) are applied in this study to analyse the sensitivity and consequences of the global oil and food price fluctuations on these four countries' food

prices. Secondly, the analysis is extended to investigate the heterogeneity of the impact, in particularly, we test whether the effect is asymmetric and whether the pass-through effect has gradually changed over time. The results contribute to the current debates on the interlink between globalisation and its displacement effects on domestic food market (see Laborde et al., 2019). First, we examine if the negative changes of global oil price and food price have a substantial impact on the inflationary dynamics within each of the sample countries. The results shed light on the role of government measures and the firms' price-setting behaviour in a high-competitive and globalised environment. The large-scale changes are found to have a dramatic consequence on inflationary pressure than small alternation, noting the existence of the adjustment costs. The findings are linked to previous studies that influence the agricultural commodity price changes and the monetary policy requirements towards food security and price stability. Stabilisation policies and support actions are recommended to assist the local and small business to shield away from the global volatility.

The next section presents a brief literature review followed by estimating the impact of food price volatility in the two oil-importing (Singapore and Vietnam), and oil-exporting sample countries (Kuwait and Indonesia). This study contributes to the literature in threefold ways. First, we show that there exists food price volatility in both the cases of oil-importing countries of Singapore and Vietnam, and oil-exporting countries of Kuwait and Indonesia in the sample. Second, the study indicates that in the case of these four Asian countries, an unexpected increase in the domestic food inflation leads to an increase in food price vulnerability more than in the cases of unexpected decrease in food prices. Finally, we demonstrate the heterogenous effect of globalisation on different countries' domestic prices. Section 3.3 explains the institutional contexts of the oil-importing and oil-exporting countries of Singapore, Vietnam, Kuwait and Indonesia, respectively. Section 3.4 explains the data and model specifications, followed by sections on the methodology and the empirical results. Section 3.5 demonstrates the conclusion of this analysis.

3.2 A Brief Literature Review

Several empirical studies have identified the relationship between food price volatility and macroeconomic factors. Algieri & Leccadito (2019) argue that the speculative activities have a considerable impact on food prices, referring to the global price shocks as the main factor that directly affected domestic prices. Johnson (2016) documents the trade policy interventions including a considerable amount of import subsidies or export tariff and the enormous flow of speculative capitals into the food markets. He notes that these interventions

have a strong explanatory power for the global agricultural commodities price crisis in 2007-2008. Holtemöller & Mallick (2016) examine the global food prices and monetary policy in the case of India that shows the inflationary supply shocks, for example, cost-push, crude oil price, relative food price and a sudden change in global food price, contribute to inflation. They document the monetary authority react to these supply shocks with a higher level of the interest rate that tends to delay economic growth. In a study on Thailand, Nookhwun & Worasak (2018) point out that various inflationary movements are demonstrated to be accompanied by the periods of vulnerability in food prices and in the in a recent decrease in global energy prices, the headline inflation decreased sharply by the end of the year 2014 and has been recorded a lower level from then.

The second strand of the related literature focuses on the influence of agricultural commodity prices on local inflation after the GFC during late 2000s. Most studies use cross-country data for developed and developing countries to draw conclusion. For example, Furceri, Loungani, Simon & Wachter (2016) examine the impacts of global food prices in advanced economies and show that a 10-percentage point rise in global food inflation increases local inflationary pressure by 0.5 percentage points. They argue that the influence could be more severe in the case of emerging markets, due to higher food share in the consumer price index basket and less-anchored inflationary dynamics. Choi, Furceri, Loungani, Mishra & Poplawski-Ribeiro (2018) note that the local inflation in developed markets rose by 0.4 percentage point following a 1 percentage point rise in the global energy prices. They also point out that positive oil price shocks had a crucial impact on inflation than the negative ones. The study by Manopimoke and Limjaroenrat (2018) illustrate that agricultural commodity prices could explain around 70 percent of relative price changes at the cycle frequencies in the business sector in the case of Thailand as a representative of an emerging economy. The empirical analyses for Singapore, Vietnam, Kuwait and Indonesia contribute to this strand of literature by illustrating the potential impacts of short-run deviations between agricultural commodity prices and specific macroeconomic variables in a combination of these four oil-trading countries in Asia. This is the first study that examines how these sample countries' relative food price volatility indicate over time.

3.3 Institutional contexts and macroeconomy

It is crucial to discuss about the structural framework of Singapore, Vietnam, Kuwait and Indonesia in terms of the national economy, trading fields and policies. In the case of Singapore, a highly advanced free-market economy is ranked as the most open global economy and the

third least corrupt nation (Rees, 2017; Rubasundram & Rasiah, 2019). Singapore is examined to analyse the impact of global oil and food price in an advanced Asian economy. Singapore is heavily dependent on purchasing natural resources and raw agricultural materials. Singapore also has limited arable land, as such it relies significantly on the agrotechnology park for the agricultural producing progress and consumption. Therefore, the change in global food price and energy price is likely to exert a strong impact on Singapore's economy. To preserve the international outstanding rankings and further its economic and financial prosperity, the effective measures and tools of monetary policies are taken into consideration to address the global price shocks.

Vietnam is a socialist-oriented market economy and is a large oil importing country being the 32nd nation in the global economies in terms of the purchasing power parity (PPP). From the mid-1980s, through the Doi Moi reform period, Vietnam moved from a highly-centralised command market to a mixed economy (Son, Chi, & Kingsbury, 2019). As such, the government uses both directive and indicative planning which supports the open market-based economy. Since the post-2011, Vietnam has recorded rapid economic growth rate besides becoming a leading agricultural exporter and a net oil importer of the Asian region (Alston, Arsov, Bunny, & Rickards, 2018). Vietnam is an attractive destination for foreign investment in the Southeast Asia region (Nguyen, 2020). Almost all enterprises in Vietnam are new-small and medium-size enterprises and is an economy dependent on the agricultural production for economic growth (Barker & Üngör, 2019). Thus, it is crucial to examine the impacts of global oil price and food price in the case of Vietnam. Despite economic and trading achievement following Doi Moi, there are various issues which lead researchers to examine the economic slowdown and to address the appropriate monetary policies to perform effectively in coping with the global turmoil.

The oil exporting economy of Kuwait is a relatively small but wealthy petroleum-based market economy and the official currency Kuwaiti dinar is the highest-value unit of the global currency (Twarowska, 2019). Kuwait has approximately 94 billion barrels of recoverable oil reserves, known as one of the biggest crude oil reserves in the world (Cordesman, 2018). The agriculture sector in Kuwait accounts for only 0.2 percent of the total gross domestic product (GDP) which does not require a large-scale source of employment (Mohammed, 2017). This sector produces fruit, vegetables and fishes for domestic consumption. Kuwait heavily depends on importing food from overseas (Hassen & El Bilali, 2019). Thus, Kuwait, as a global net oil exporter in the world, has experienced substantial impacts through global food price and oil price shocks.

The oil exporting economy of Indonesia is the biggest Southeast Asian nation and one of the bigger emerging global market (Jomo, 2019). Indonesia amongst the newly industrialised economies is dependent on oil exports (Palmer, 2018). Indonesia is also the only Asian member of the Organisation of Petroleum Exporting Countries (OPEC) since 2008 (Behera & Varma, 2019). The foreign enterprises and firms participate through the production-sharing and temporary contracts (Osterreich, 2020). As such, oil, gas and other energy contractors are entitled to finance the exploration, development and production fees in their contract terms and cover the cost of operating, exploration and development costs above the energy produced. While Indonesia had subsidised fuel price in order to maintain the low prices, however, there has been a reduction in government subsidy on fuel prices in various stages since 2005. The government has provided one-time program of subsidies for their qualified citizens to slow down and alleviate poverty (Olken, 2019). The analysis on the influence of global food price and oil price in a net oil importer of Indonesia is crucial to understand the appropriate monetary policies with structural politics and economic framework.

3.4 Empirical models, methodology and data

This section demonstrates the empirical models, methodology and the data employed to estimate the impact of macroeconomic variables on food inflation in the case of two oil importing economies and two oil exporting economies. The variables used in the specifications clarify the influence of macroeconomic elements on food price in the case of Singapore and Vietnam (oil importing countries) and Kuwait and Indonesia (oil exporting countries) in the sample case studies. The time period of the analysis includes monthly data 2004M9 to 2019M12.

3.4.1 Methodology

The first step of unit root tests is applied for the stationarity of all the time series variables used here, see Asteriou & Hall (2007) for details. The lag length of the GARCH model are selected and the numbers of cointegrating vectors apply the Johansen test procedure for testing cointegration range of the time series. The application of VECM are based on the autoregressive distributed lag model. The first step applies the test for structural break in order to indicate its influence on the trend of a data series. This is important as the GFC during the period 2007-2010 records a considerable effect on the global economic and trading activities. Thus, it is vital to detect the movement of each series (distorted/truncated) or the difference between the past and future movements of a time series. The Gregory-Hansen Cointegration test is applied for

the structural break of the global shocks for the period 2007-2010. Therefore, various specific tests have been utilised to address if the global oil price and food price changes exert statistically significant and economically essential, though short-lived, impacts on the domestic inflation. The food price changes appear to exert a more significant and long-lasting influence, probably as a result of a large-scale share of food in the CPI market (Ranyard, Del Missier, Bonini, Duxbury, & Summers, 2008). As the local inflation is affected in many ways, it suggests a limited second-round impacts on inflationary expectations and labour wages (De Gregorio, 2012).

3.4.2 Model specification

To estimate the influence of macroeconomic variables on the price level of agricultural commodity of four countries under study, this study utilises the ARCH-GARCH model in clarifying the relationship between food price volatility and macroeconomic factors (Apergis & Rezitis, 2011). This framework allows for the estimation of total impacts of macroeconomic variables and global indicators on domestic food price vulnerability. Besides, a vector autoregressive framework is also employed to examine the impulse response to a random shock, illustrated in the next section. The ARCH model, initially developed by Engle (1982), notes the estimating uncertainty that considers in case it is periodically correlated. The model specification for the conditional mean is as follow:

$$y_t = x_t b + \alpha_t$$

$$\text{and} \qquad \alpha_t | \Omega_{t-1} \sim N(0, h_t) \tag{1a}$$

It is assumed that α_t is a framework's prediction error and b is a vector of parameters. Let x_t be a vector of predetermined variables. h_t is assumed to be the variance of α_t. Besides, Ω is calculated at time $t-1$. The GARCH definition, which was developed by Bollerslev (1986), specifies h_t as:

$$h_t = a_0 + \sum_{i=1}^{p} u_i \, h_{t-1} + \sum_{j=1}^{q} v_j \, \alpha_{t-1}^2 \tag{1b}$$

a_0, v_j, u_i are non-negative parameters. In addition, the parameter a_0 shows that price vulnerability acts as floor, preventing the variance from falling below the floor level (Koutsomanoli-Fillipaki & Staikouras, 2006). In the second equation, the conditional variance h_t is described as a linear operation of the conditional variances (lagged p) and the squared residuals (lagged q). Engle and Bollerslev (1986) and Lamoureux and Lastrapes (1990) identify if the result of the equation equal to unity, the GARCH models are extended to an integrated GARCH (IGARCH) procedure:

$$\sum u_i + \sum v_j = 1 \quad (1c)$$

The above consequence also implies that current shocks unlimitedly persist in future conditional variance. The maximum likelihood methodologies are applied to consider the parameters of the GARCH framework (see Berndt, Hall, Hall, & Hausman, 1974). To consider the unaccounted variance in the GARCH, this study utilises the GARCH-ARMA model, which is an augmented GARCH framework. As such, the GARCH-ARMA framework takes into account the impacts of short-term deviations on the conditional variance. In this case, equation (2) is specified as follows:

$$h_t = a_0 + \sum_{i=1}^{p} u_i h_{t-1} + \sum_{j=1}^{q} v_j \alpha_{t-1}^2 + \beta_1 z_{t-1}^2 \quad (2a)$$

In the context of the GARCH model, in terms of persistence, estimated result is obtained based on the GARCH-ARMA model as follows:

$$\sum_i u_i + \sum_j v_j < 1 \quad (2b)$$

Thus, $a_0 > 0$ and $u_i, v_j > 0$ ($i = 1, 2, \ldots, p$ and $j = 1, 2, 3, \ldots, q$). The lagged error-correction term z_{t-1}^2 denotes the short-term deviations. The error-correction term (ECT) operates as a proxy for the residuals based on the cointegrating vector which links certain macroeconomic factors and food prices to have substantial predictive impacts on the food prices' conditional variance. The parameter β_1 identifies the powers of the short-term deviations on the conditional variance if the residuals of food prices and macroeconomic factors are from a long-term cointegrated links. If the estimated β_1 is positive, the deviations of food prices from certain macroeconomic variables become greater, leading to a more possible volatility and less accurate predictions. Similarly, with the aim to get more reliable and accurate confidence intervals for forecasting the agricultural commodity prices, this study exploits the presence of deviations in the conditional variance. As such, the GARCH-ARMA framework includes the crucial elements like the macroeconomic deviations of the country since they are examined by the deviations starting from the equilibrium pathway.

3.4.3 Data and descriptive statistics

The analysis of the models is based on the monthly data of the four countries, retrieved from the website tradingeconomics.com and globaleconomy.com, covering the time span between 2004M9 and 2019M12. The choice of the specific time period for these nations are based on the data availability. The sample nations include both Asian oil-importing countries, namely, Singapore and Vietnam and oil-exporting economies, namely, Kuwait and Indonesia. These

economies have also been affected by GFC of 2007-08, formulating a sufficiently representative selection.

The variables taken into account are global food price, global oil price, gross domestic product per capita, industrial production, exchange rate, real money supply and food inflation. Besides the global oil price and the global food price, the literature review suggests four other potential determinants of a domestic food price index. First, from the demand-side perspective, the personal income can increase the demand for food, potentially affecting the domestic price index. As such, we use a series of GDP per capita, which measures the average level of national income per person as a proxy for the demand side of the economy.

We use a series of exchange rate that affects domestics prices and is considered to have an impact on the domestic food price since Vietnam relies on rice and other processed food exports, and on the tourism sector, while Singapore relies on exports in machinery, electronics manufacturing as well as its substantial financial services. Real money supply is an important factor to be considered in terms of monetary policy. From the supply side, a popular measure used in the literature is the industrial production value as a proxy for economic growth (see Basnet & Upadhyaya, 2015; Lahirushan & Gunasekara, 2015). All time series estimations are undertaken using Stata. The seasonally adjusted time series remove the seasonal patterns of the time series data (see Figure 3.1 to Figure 3.6). Table 3.1 shows the descriptive statistics of seasonally adjusted series of countries for Singapore, Vietnam, Kuwait and Indonesia, respectively. As evident all of the series are normally distributed, as illustrated by the skewness and kurtosis statistics.

Figure 3.1 Global food price and Global oil price

Note. Grey shading denotes global financial crisis. The green line indicates Global food price, the orange line indicates Global oil price.

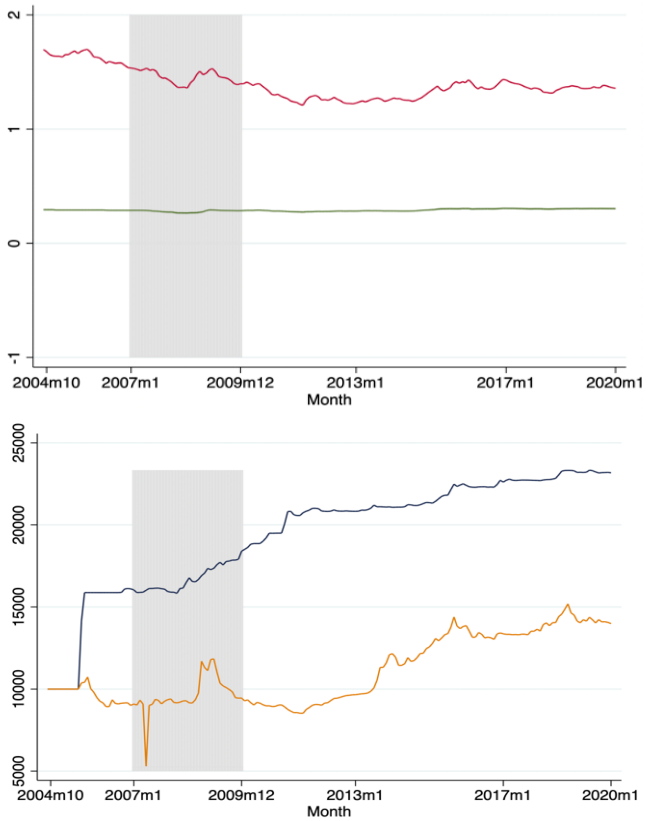

Figure 3.2 Seasonally adjusted series of the Real Exchange Rate of four countries

Note. Grey shading denotes global financial crisis. Note. Grey shading denotes global financial crisis. The red line indicates the Real Exchange Rate of Singapore, the dark blue line indicates the Real Exchange Rate of Vietnam, the green line indicates the Real Exchange Rate of Kuwait, and the orange line indicates the Real Exchange Rate of Indonesia.

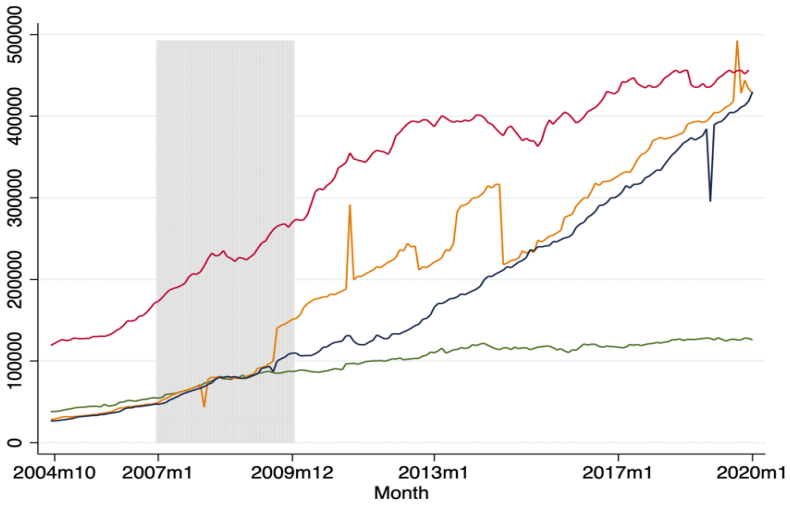

Figure 3.3 Seasonally adjusted series of Real Money Supply of four countries

Note. Grey shading denotes global financial crisis. The red line indicates the Real Money Supply of Singapore, the dark blue line indicates the Real Money Supply of Vietnam, the green line indicates the Real Money Supply of Kuwait, and the orange line indicates the Real Money Supply of Indonesia.

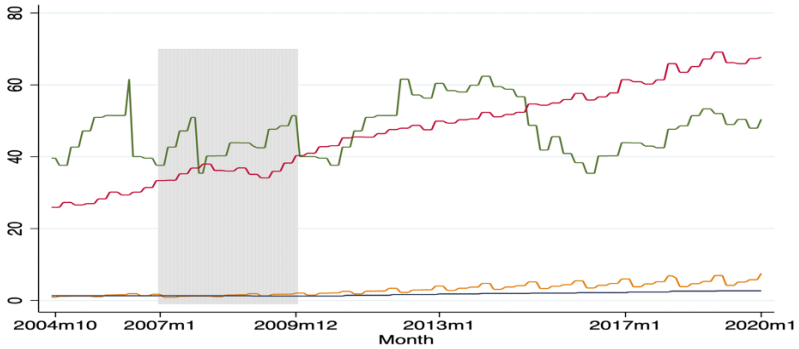

Figure 3.4 Seasonally adjusted series of GDP per capita of four countries

Note. Grey shading denotes global financial crisis. The red line indicates the GDP per capita of Singapore, the dark blue line indicates the GDP per capita of Vietnam, the green line indicates the GDP per capita of Kuwait, and the orange line indicates the GDP per capita of Indonesia.

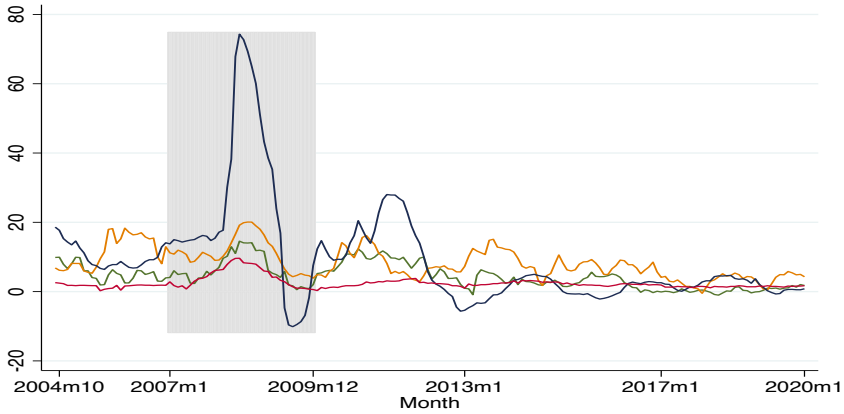

Figure 3.5 Seasonally adjusted series of Food Inflation of four countries

Note. Grey shading denotes global financial crisis. The red line indicates Food Inflation of Singapore, the dark blue line indicates Food Inflation of Vietnam, the green line indicates Food Inflation of Kuwait, and the orange line indicates Food Inflation of Indonesia.

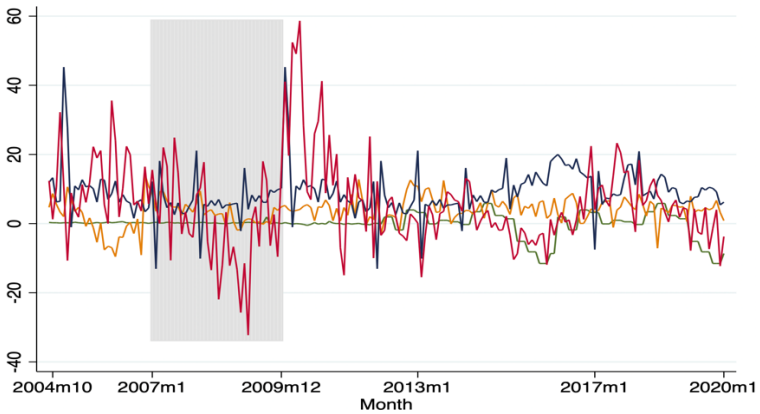

Figure 3.6 Seasonally adjusted series of Industrial Production of four countries

Note. Grey shading denotes global financial crisis. The red line indicates Industrial Production of Singapore, the dark blue line indicates Industrial Production of Vietnam, the green line indicates Industrial Production of Kuwait, and the orange line indicates Industrial Production of Indonesia.

Table 3.1 Descriptive statistics

	Singapore				Vietnam			
	Mean	SD	Skewness	Kurtosis	Mean	SD	Skewness	Kurtosis
$LGDP_{PC}$	3.81	0.28	-0.33	2.00	0.56	0.73	10.62	1.97
IP	5.67	12.90	0.9	5.61	8.98	7.01	1.23	10.85
LER	0.33	0.09	0.59	2.53	9.85	0.22	-1.63	1.07
LM_2	12.61	0.42	-0.9	2.43	11.80	0.79	-0.39	1.32
LGFPI	4.93	0.13	-0.38	2.40	5.14	0.19	-0.46	1.34
LGOPI	4.88	0.22	0.27	2.44	5.11	0.27	0.06	1.13
FI	2.43	1.71	2.42	9.01	9.33	14.71	2.38	9.79
Obs.	184	184	184	184	184	184	184	184
	Kuwait				Indonesia			
	Mean	SD	Skewness	Kurtosis	Mean	SD	Skewness	Kurtosis
$LGDP_{PC}$	3.85	0.15	0.16	2.02	0.95	0.59	-0.15	1.80
IP	-0.17	3.4	-1.68	6.42	3.74	3.96	-0.54	4.35
LER	-1.24	0.037	-0.32	2.29	9.23	0.19	0.02	2.48
LM_2	11.44	0.44	1.38	12.93	11.98	0.83	-0.7	2.11
LGFPI	4.93	0.13	-0.38	2.4	4.93	0.13	-0.38	2.40
LGOPI	4.88	0.22	0.27	2.44	4.88	0.22	0.27	2.44
FI	4.48	3.75	0.72	2.71	8.35	4.61	0.65	2.75
Obs.	184	184	184	184	184	184	184	184

Notes. $LGDP_{PC}$ is log of purchasing power parity Gross Domestic Product (GDP) per capita, IP is Industrial Production, LER is log of the real Exchange Rate, LM_2 is log of Real Money Supply, LGFPI is log of Global Food Price Index, LGOPI is log of Global Oil Price Index, FI is Food Inflation.

3.5 Empirical results

3.5.1 Trends and Stationarity test

This section demonstrates the findingss for the stationarity of the variables using the Augmented Dickey-Fuller (ADF) test, Kwiatkowski-Phillips Schmidt-Shin (KPSS), and the modified Dickey-Fuller t test (DF-GLS) followed by the error correction model. Figure 3.7 illustrates how domestic food prices of Singapore, Vietnam, Kuwait and Indonesia are impacted by the global factors. The global food price and global oil price fluctuate in the same manner. This is likely as the Vietnamese domestic food price also follows similar fluctuations, as such, the global oil and global food prices have an effect on Vietnamese domestic food price index, indicating a strong correlation. On the other hand, it is likely that Indonesian food price, food inflation of Kuwait and food inflation of Singapore slightly follows the trend of global price

fluctuation. It is seen that both global price indexes have strong impacts on their domestic food inflation.

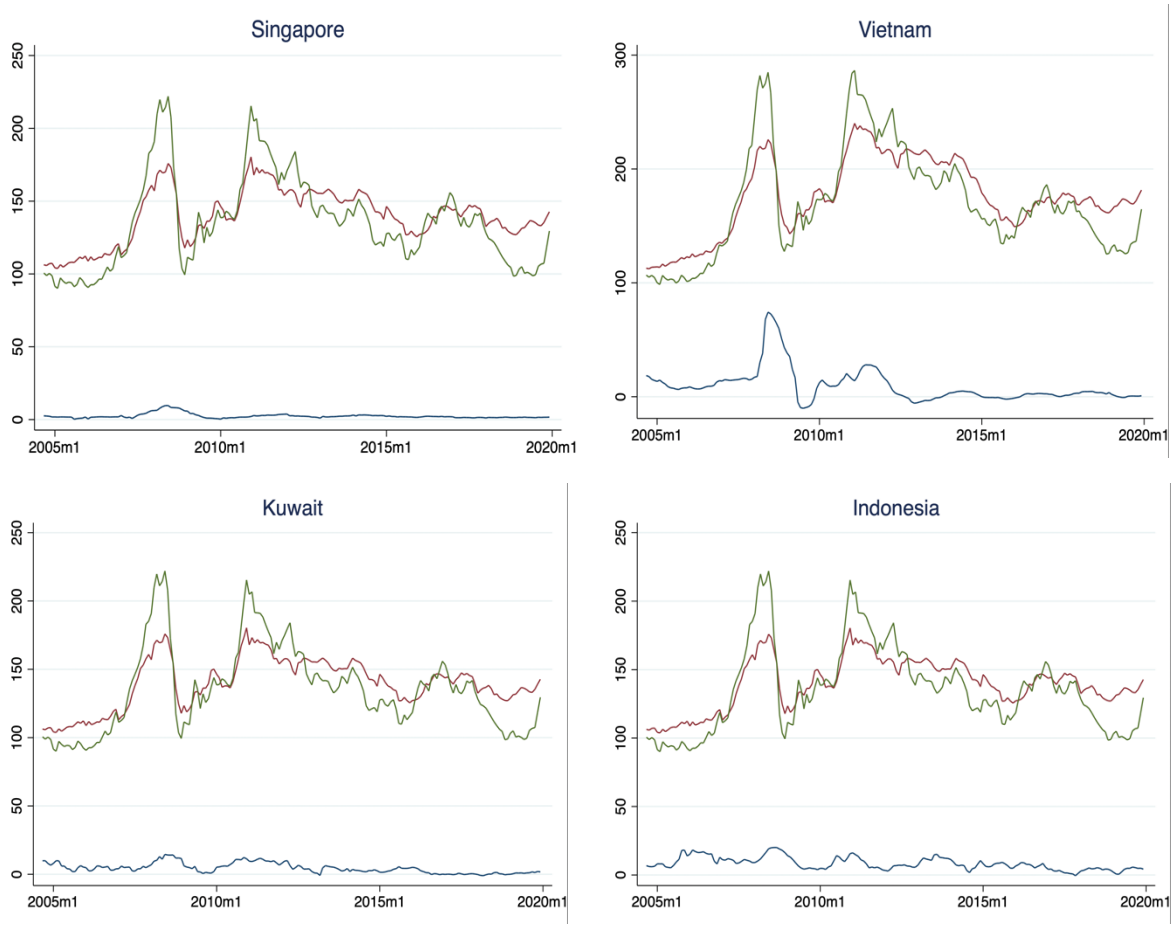

Figure 3.7 Domestic Food Price Index of four countries and Global indicators

Note. The blue line indicates domestic food inflation of Singapore, Vietnam, Kuwait and Indonesia, the red line indicates global food price, the green line indicates global oil price.

As the VECM and GARCH analysis below evolves around the short-run and long-run dynamics of the linkage between macroeconomic variables and food inflation. The three-unit root tests for variables' stationarity are ADF test based on Dickey and Fuller (1979), KPSS proposed by Kwiatkowski et al. (1992), and DF-GLS for Singapore, Vietnam, Kuwait and Indonesia. The following variables of food inflation, GDP per capita, exchange rate, global food price, global oil price, real money supply and industrial production are undertaken in the level forms and first differenced forms. The variables in level forms did not attain stationarity at 5% significance level and is stationarity in the first differenced form.

The choice of the three tests follows a series of criteria. Firstly, the ADF is regarded as a classical and most common unit root test in empirical analyses. Secondly, since the ADF test generates low power results, we use KPSS test as alternative test to raise the power of the unit

root test. Finally, to check for the robustness of the outputs, the adjusted unit root test by Elliot test is also employed. Using KPSS test and Elliot test are a positive way to avoid the issue of short-spanned data. The test results for the four economies are presented in table 3.2 for Singapore, Vietnam, Kuwait and Indonesia. In all sample countries and for all variables under investigation, the empirical results present that the variables in the first difference form are at the 5% significance level. Overall, the findings attain stationarity for all the variables used in the models for each country.

Table 3.2 Unit root test

	ADF		**KPSS**		**DF_GLS**	
	Levels	First Difference	Levels	Difference	Levels	Difference
			Panel A. Singapore			
$LGDP_{PC}$	-2.22	-7.3	-2.74	-25.87	-1.53	-11
IP	-3.07	-3.76	-7.49	-15.93	-3.8	-4.83
LER	-1.74	-5.28	-1.57	-9.22	-.9	-8.04
LM_2	-1.25	-5.49	-.84	-9.92	-.56	-5.6
LGFPI	-2.73	-5.48	-2.04	-8.76	-1.73	-6.62
LGOPI	-2.71	-2.71	-2.07	-2.07	-2.14	-2.14
FI	-4.15	-4.15	-1.92	-1.92	-2.52	-2.52
			Panel B. Vietnam			
$LGDP_{PC}$	-5.19	-9.09	-13.26	-36.57	-8.42	-8.42
IP	-4.53	-5.12	-11.74	-13.27	-2.33	-2.33
LER	-4.49	-5.82	-3.15	-9.44	-1.73	-5.9
LM_2	-2.05	-4.7	-2.06	-7.36	-0.4	-0.4
LGFPI	-2.55	-5.33	-1.72	-8.16	-1.76	-6.28
LGOPI	-2.66	-2.66	-1.84	-1.84	-1.81	-1.81
FI	-4.36	-4.36	-2.36	-2.36	-3.65	-3.65.
			Panel C. Kuwait			
$LGDP_{PC}$	-2.5	-5.02	-2.94	-13.49	-6.13	-6.13
IP	-2.9	-5.53	-2.97	-13.44	-3.29	-3.29
LER	-2.7	-4.32	-1.99	-7.57	-1.85	-4.34
LM_2	-3.39	-5.49	-9.75	-9.92	-2.06	-5.6
LGFPI	-2.73	-5.48	-2.04	-8.76	-1.73	-6.62
LGOPI	-2.71	-2.71	-2.07	-2.07	-2.14	-2.14
FI	-3.53	-3.53	-3.15	-3.15	-3.08	-3.08
			Panel D. Indonesia			
$LGDP_{PC}$	-3.98	-6.89	-5.72	-25.98	-6.07	-3.37
IP	-4.15	-5.33	-8.44	-10.29	-5.7	-7.5
LER	-2.42	-5.73	-3.58	-18.33	-1.35	-3.87
LM_2	-1.29	-5.49	-1.8	-9.92	-.74	-5.6
LGFPI	-2.73	-5.48	-2.04	-8.76	-1.73	-6.62
LGOPI	-2.71	-2.71	-2.07	-2.07	-2.14	-2.14
FI	-4.65	-4.65	-3.58	-3.58	-2.95	-2.95

Notes. ADF: augmented Dickey-Fuller, KPSS: Kwiatkowski-Phillips-Schmidt-Shin, DF-GLS.
$LGDP_{PC}$ is log of purchasing power parity Gross Domestic Product per capita, IP is Industrial Production, LER is log of the real Exchange Rate, LM_2 is log of the real Money Supply , LGFPI is log of Global Food Price Index, LGOPI is log of Global Oil Price Index, FI is Food Inflation.

3.5.2 Cointegration and Error Correction Analysis

The first set of results are based on the cointegration and the error correction analysis in the case of four countries, namely, Singapore, Vietnam, Kuwait, Indonesia. Cointegration test is applied to test for the long term link between food price index and the macroeconomic factors, i.e. GDP per capita, exchange rate, global food price, global oil price, industrial production and real money supply. The maximum Eigen value and trace statistics employed present the exact number of cointegrating vectors. Based on the Johansen cointegration test, we can also predict food price index's movement from other macroeconomic factors.

To estimate the long-run relationship between domestic food inflation and macroeconomic factors in the case of oil importing economies, the appropriate lags order for the cointegration test and VECM is selected using the Akaike Information Criterion (AIC) and Final Prediction Error (FPE) as developed by Sims (1980). Table 3.3 summarises the criteria and our decision. The results in Table 3.3 for the AIC and FPE both yield the optimal lag length of 2 for the case of Singapore and Kuwait, and for the case of Vietnam and Indonesia the optimal lag length is 3.

Table 3.3 Selection-order criteria for choosing optimal lag

Lag	**Singapore**		**Vietnam**		**Kuwait**		**Indonesia**	
	AIC	FPE	AIC	FPE	AIC	FPE	AIC	FPE
2	-19.35	9.3e-18	-9.75	1.4e-13	-12.69	7.2e-15	-11.413	2.6e-14
3	-19.42	8.8e-18	-9.53	1.7e-13	-12.87	6.1e-15	-11.318	2.9e-14

Notes: AIC is Akaike information criterion, FPE is final prediction error.

The cointegration test findings for the sample countries are reported in Table 3.4. Interestingly, in the case of Singapore, the null hypothesis of no cointegration is rejected at the 5% critical level and the results of the λ trace and the λ max statistics of Singapore demonstrate the presence of four cointegrating vectors, which is, $r = 5$. This implies that there is a presence of $n - r = 7 - 5 = 2$ common trends between food inflation and macroeconomic variables. In the case of Vietnam, there is a presence of $n - r = 7 - 4 = 3$ common trends between food inflation and macroeconomic factors. These outputs further highlight that these macroeconomic factors and food inflation of oil-importing economies cannot swing independently for a long time. In other words, food price index and macroeconomic factors financially move together in the long term period.

In the case of oil-exporting countries, namely, Kuwait and Indonesia, the findings from the eigenvalue test statistic and the trace test statistic present that there exists a long-run

relationship between domestic food prices and the macroeconomic factors under consideration. Besides, the cointegration test results present the existence of 2 and 4 cointegrating vectors for domestic food inflation and macroeconomic factors, respectively, implying 5 and 3 common trends between the food price index and macroeconomic elements in the case of Kuwait and Indonesia, respectively.

Table 3.4 Johansen-Juselius tests for cointegration

	Singapore					**Vietnam**				
r	eigenvalue	m.λ.	95%	Tr	95%	eigenvalue	m.λ.	95%	Tr	95%
$r = 0$		76.98	51.42	257.29	156.00		111.37	51.42	303.58	156.00
$r \leq 1$	0.35	55.23	45.28	180.31	124.24	0.46	76.12	45.28	192.21	124.24
$r \leq 2$	0.26	42.65	39.37	125.07	94.15	0.34	45.06	39.37	116.09	94.15
$r \leq 3$	0.21	32.24	33.46	82.42	68.52	0.22	26.61	33.46	71.04	68.52
$r \leq 4$	0.16	26.87	27.07	50.18	47.21	0.14	19.22	27.07	44.43	47.21
$r \leq 5$	0.14	13.36	20.97	23.32	29.68	0.10	15.58	20.97	25.21	29.68
$r \leq 6$	0.07	5.76	14.07	9.95	15.41	0.08	7.78	14.07	9.63	15.41
$r \leq 7$	0.03	4.19	3.76	4.19	3.76	0.04	1.85	3.76	1.85	3.76
$r \leq 8$	0.02					0.01				
	Kuwait					**Indonesia**				
r	eigenvalue	m.λ.	95%	Tr	95%	eigenvalue	m.λ.	95%	Tr	95%
$r = 0$		80.04	51.42	217.20	156.00		58.19	51.42	209.00	156.00
$r \leq 1$	0.36	52.45	45.28	137.16	124.24	0.28	50.55	45.28	150.81	124.24
$r \leq 2$	0.25	33.34	39.37	84.71	94.15	0.24	30.61	39.37	100.25	94.15
$r \leq 3$	0.17	15.28	33.46	51.37	68.52	0.15	25.30	33.46	69.64	68.52
$r \leq 4$	0.08	13.86	27.07	36.09	47.21	0.13	19.62	27.07	44.34	47.21
$r \leq 5$	0.07	12.03	20.97	22.23	29.68	0.10	13.07	20.97	24.72	29.68
$r \leq 6$	0.06	5.85	14.07	10.20	15.41	0.07	8.69	14.07	11.64	15.41
$r \leq 7$	0.03	4.35	3.76	4.35	3.76	0.05	2.95	3.76	2.95	3.76
$r \leq 8$	0.02					0.02				

The existence of cointegrating relationship and the difference of cointegrating ranks in the case of oil-importing countries and oil-exporting economies imply that the short-run deviation is corrected by internal dynamics. As such, this system highlights the misalignment and bring the economies of four nations back to the equilibrium path in the long term period. (see Darrat & AlShamsi, 2005). From Johansen Cointegration test results, we conclude that the value of future food inflation of four countries can be predicted using the value of macroeconomic factors. There is sufficient evidence to proceed the analysis in the Vector Error Correction model.

The VECM results in the case of oil – importing economies, Singapore and Vietnam, is based on two and three lags with five and four cointegration vectors, for these countries, respectively. In oil - exporting countries, two lags and the cointegrating rank of two for Kuwait and three lags and the cointegrating rank of four are seen in the case of Indonesia. The VECM illustrates the outputs of normalised cointegration coefficients from the VECM in the case of Singapore, Vietnam, Kuwait and Indonesia. We find that both the eigenvalue test statistic and

the trace statistics present that there is a long-run tightness between domestic food inflation and macroeconomic factors.

The cointegration and long-run models for four sample countries of Singapore, Vietnam, Kuwait and Indonesia, respectively, are as follows:

Singapore:

$$FI_t = \underset{(2.11)*}{0.032\mathrm{M}_{2_t}} - \underset{(-7.41)***}{0.67\mathrm{IP}_t} - \underset{(-2.26)*}{0.0032\mathrm{GDP}_{\mathrm{PC}_t}} + \underset{(2.7)*}{0.041\mathrm{ER}_t} - \underset{(-2.71)*}{0.187\mathrm{GOP}_t} + \underset{(2.16)*}{0.062\mathrm{GFP}_t} - \underset{(-3.68)***}{0.113Con}$$

Vietnam:

$$FI_t = -\underset{(-2.15)*}{0.04\mathrm{M}_{2_t}} - \underset{(-7.47)***}{1.044\mathrm{IP}_t} - \underset{(-1.76)*}{0.036\mathrm{GDP}_{\mathrm{PC}_t}} - \underset{(-0.59)}{0.0011\mathrm{ER}_t} - \underset{(-3.59)*}{0.094\mathrm{GOP}_t} - \underset{(-3.34)***}{0.001\mathrm{GFP}_t} - \underset{(-4.56)***}{0.097Con}$$

Kuwait:

$$FI_t = -\underset{(-3.21)***}{0.017\mathrm{M}_{2_t}} + \underset{(0.15)}{0.46\mathrm{IP}_t} + \underset{(0.13)}{0.001\mathrm{GDP}_{\mathrm{PC}_t}} - \underset{(-1.73)*}{0.001\mathrm{ER}_t} + \underset{(0.36)}{0.036\mathrm{GOP}_t} + \underset{(2.21)*}{0.001\mathrm{GFP}_t} - \underset{(-2.85)**}{0.074Con}$$

Indonesia:

$$FI_t = +\underset{(0.00)}{0.001\mathrm{M}_{2_t}} - \underset{(-4.91)***}{0.473\mathrm{IP}_t} - \underset{(-6.77)***}{0.442\mathrm{GDP}_{\mathrm{PC}_t}} + \underset{(1.64)*}{0.042\mathrm{ER}_t} - \underset{(-2.00)*}{0.216\mathrm{GOP}_t} - \underset{(-4.52)***}{0.246\mathrm{GFP}_t} - \underset{(-3.85)***}{0.13Con}$$

Note: ***, **, * indicates statistical significance at 1, 5, and 10 percent levels, respectively. Con is the constant term.

Based on the estimated coefficients for the long-run equations, the following outputs for the case of oil-importing countries are noted. First, the results show that relative food prices, in the case of Singapore and Vietnam, are cointegrated with the set of macroeconomic factors, i.e., Real Money Supply (M_2), Industrial Production (IP), GDP per capita ($\mathrm{GDP}_{\mathrm{PC}}$), and global indicators including global food price (GFP) and global oil price (GOP) is accepted. In the case of Singapore, money supply, exchange rate and global food price exert a positive impact on domestic food inflation, whereas industrial production, GDP per capita and global oil price have

a negative impact on relative food price. In the case of Vietnam, except for the real exchange rate, all macroeconomic variables have statistically negative influence on relative food prices. The real exchange rate fails to have an effect on Vietnam's domestic food price whereas it has a considerable effect on Singapore's food inflation in the long term.

Real money supply records a positive effect on domestic food price in the case of Singapore and a negative impact in Vietnam in the long run. The positive impact suggests that an appropriate amount of money supply from Singapore's authorities leads to a decrease in domestic food price (Saleh & Harvie, 2005). Meanwhile, the real money supply has a negative impact on Vietnam's domestic food inflation. The reason is that since Vietnam is a large agricultural exporting country, the decline in money supply leads to a sharp decrease in consumer spending, especially for the agricultural products. The elasticity of the aggregate demand decreases with respect to the monetary shocks (Kyer & Maggs, 1995). In the case of a food self-sufficient country like Vietnam, the trend output growth decreases with the agricultural output to monetary shocks. Thus, if there is a negative change in money supply, food price in Vietnam reacts in a negative way.

Additionally, other macroeconomic factor like industrial production exerts a negative impact on food inflation of both Singapore and Vietnam. A decrease in industrial production of Singapore's economy suggests that the country is experiencing a lower level of economic growth. As a result, food price is likely to increase due to the characteristics of Singapore's high imports of food. In particular, Singapore's biggest industry is the manufacturing sector and imports most of agricultural products, hence, a higher degree of industrial products fails to impact the farming and food producing activities in Singapore (Schneider, Havlík, Schmid, Valin, Mosnier, Obersteiner, & Fritz, 2011). In the case of Vietnam, a decrease in industrial production suggests a sharp decline of economy and in national output. As a result, the supply of agricultural products records a decline, which consequently leads to a rise in domestic food price. The variable GDP per capita records a negative effect on domestic food price in both the case of Singapore and Vietnam. In terms of GDP per capita, per capita income decreases which could lead to a significant drop in purchasing items including food and agricultural commodities. There is also a decline in the potential agricultural input, production at full employment and purchasing capacity. A decrease in GDP per capita consequently triggers the distorting impact of inflation on the price of agricultural commodity production (Baffes, Kose, Ohnsorge, & Stocker, 2015).

Similarly, the real exchange rate exerts a positive influence on domestic food inflation in the case of Singapore, whereas it tends to have no impact on Vietnam's food inflation. This

explanation is consistent with the fact that Singapore is highly dependent on importing agricultural commodities. Thus, a higher exchange rate in the case of Singapore leads to a significant decrease in food price index. Since Vietnam is known as a food self-sufficient country, the exchange rate appears not to influence its food inflation. Unlike the case of Singapore where the exchange rate influences the rate of food inflation in a wide range of direct and indirect way, the exchange rate fails to change the price of imported food products and services in the case of Vietnam (Mergenthaler, Weinberger, & Qaim, 2009). The reason is that the self-supply of food is functioning well in Vietnam. Thus, the change in the growth of exports and imports does not matter to the fluctuation of relative food price in Vietnam.

Next, global oil price exert a considerable negative impact on food inflation of both Singapore and Vietnam. These results of global oil price suggest that in oil-importing economies, a higher level of global oil price escalates food price, this is likely due to the increasing demand from the manufacturing sector, transportation and logistics services and a decline from the oil supply factor (De Amorim, Valduga, Ribeiro, Williamson, Krauser, Magtoto, & de Andrade, 2018). As Singapore depends on importing agricultural commodities, an increase in global oil price obviously triggers a sharp increase in its domestic food price as a higher oil price leads to a soar in the costs of transporting activities. In the case of Vietnam, a soar in global oil price leads to higher costs for agricultural production, cultivation, farming, processing and transport services. As a consequence, domestic price of agricultural commodities records an increase.

Global food price records a positive effect on Singapore's food inflation and a negative impact on Vietnam's food inflation. It can be explained that Singapore mainly imports its agricultural commodity from overseas, hence, if there is any negative change in global food price, the cost of food imports will be higher. Vietnam as an agricultural exporting country, an increase in global food price motivates Vietnamese food producers to export more. As a consequence, domestic food price will be higher due to the international competitive markets and a higher level of demand side factors. Thus, generally, global food price exerts a negative impact on Vietnam's food inflation.

In the case of oil-exporting countries in the sample for Kuwait and Indonesia, the analysis of the long-run structure and in terms of stationary cointegrating relations, indicates the following outputs. The hypothesis that domestic food prices are cointegrated with a series of macroeconomic factors is accepted. Also, only three macroeconomic variables that are the real money supply, the real exchange rate and global food price exert statistical and significant impact on the domestic food price index of Kuwait. The real money supply and the real effective

exchange rate have a negative impact on Kuwait's food inflation while global food price exerts a positive effect. In case of Indonesia, industrial production, GDP per capita, global oil price and global food price all have a negative effect on domestic food inflation.

The real money supply has a negative impact on food inflation of Kuwait, suggesting that general, an inappropriate monetary policy leads to a fluctuation and a collapse in domestic food price in the case of Kuwait. In Indonesia, the government has a consolidated policy about money supply creation. In particular, when foreign exchange earnings rise, there is a creation of domestic money supply, which consequently triggers the issue of inflation. Thus, the government decides to maintain budget surplus by some fiscal activities. By stabilising budget surplus, the government helps to control the inflation (Misra, & Ranjan, 2018). When there is an increase in the international oil price which directly raise the national revenues from taxation, the development expenditure of the Indonesian increases (Akhmad, Romadhoni, Karim, Tajibu, & Syukur, 2019). However, they maintain budget surplus as an effective way to control food inflationary issue and avoid the creation of money supply.

In terms of industrial production, interestingly, it has no effect on the change of food price of Kuwait, suggesting that when an economy records a higher level of the output of manufacturing, utilities and mining, the domestic food inflation has no contribution from industrial sector. It can be explained that Kuwait imports almost all of its agricultural products, hence, the industrial sector has no direct impact on the cost of food consumption. In the case of Indonesia, the industrial production has a negative impact on food inflation in the long run. The effect is consistent with the fact that the sudden decline of manufacturing sector leads to an increase in domestic food inflation. It is because Indonesia produces and supplies some of the specific agricultural commodities. Since manufacturing units and food industries also offer a considerable amount of employment, a decline in industrial output means a decrease in both domestic consumption and exports in Indonesia. As a result, the economy experiences a lower level of growth and domestic supply, which then increases the price of agricultural products (Neilson, Dwiartama, Fold, & Permadi, 2020).

GDP per capita exerts no effect on domestic food price of Kuwait. This is consistent with the fact that food and agricultural products carry a large weight in Kuwait's importing activity (Alajmi, & Somerset, 2015). Thus, the personal income of Kuwait fails to influence the general domestic price of agricultural commodities which are decided from international factors. Meanwhile, a decline in GDP per capita of Indonesia is expected to have a negative effect on economic growth, which is in line with a theory of decreasing return on national and foreign investment (Teixeira & Queirós, 2016). Besides, in the case of developing country like

Indonesia, consumers spend their budget more on food and agricultural commodities (Dartanto, 2013). Thus, in case of a decrease in GDP per capita, agricultural outputs and costs of farming and food producing tend to be higher which consequently triggers an increase in domestic food price of Indonesia. As a food importing country, a decline in GDP per capita leads to a difficult way to get agricultural products, for example, costs of logistics and services can increase (Jongwanich, 2009). As a result, the price of domestic food items increases.

While the exchange rate of Kuwait shows a negative impact on domestic food price, the real effective exchange rate of Indonesia records a positive sign on food inflation. This finding is consistent with the fact that Kuwait is heavily dependent on importing agricultural commodities. Thus, a lower exchange rate in the case of Kuwait shows a substantial increase in food price index. On contrast, the exchange rate has a positive impact on Indonesia's food inflation. It means that the higher level of exchange rate Indonesia leads to a lower degree of its domestic food inflation. Since Indonesia imports some particular agricultural products (for example, garlic from China) and exports some kinds of agricultural commodities like tree crops (wood) and higher valued vegetables, a higher exchange rate benefits the agricultural trading activity (Tayibnapis & Wuryaningsih, 2019). Consequently, there is a gradual decrease in domestic food inflation of Indonesia.

Next, the global oil price exerts a negative impact in the long run on relative food prices of Indonesia. The findings are consistent with the fact that Indonesia produces a number of agricultural commodities for domestic market. Thus, in case of an increase in oil price, farming and agricultural production activities record an increase of input costs, which consequently raising the costs of outputs. Meanwhile, global oil price has no significant effect on food inflation of Kuwait. Kuwait which is a main oil-exporting economy imports almost all of their agricultural products from overseas, the balance between oil trading activities and food imports (like transporting and storing processed food) helps to stabilise the domestic food price (Guesmi & Fattoum, 2014).

Besides, generally, global food price exerts a positive impact on domestic food inflation of Kuwait and a negative effect on Indonesia's food inflation. It can be explained that a decrease in global food price help to lower the domestic food inflation of Kuwait since Kuwait highly depends on importing agricultural products. Thus, a drop in global food price benefits Kuwait's domestic consumers. In case of Indonesia which can both supply for itself and import some specific food items, an unreasonable price from food supply factor leads to a fluctuation of its domestic food price.

3.5.3 Cointegration, GFC and Oil Price Shocks: Structural Break Analysis

A strutural break happens is tested given the effects of GFC in 2007-08 period affect the global economies and this impact was seen to extend beyond a year. In many countries the effects elongated to 2010-2011 period since 2007. In such cases the global financial crisis as a major economic event is examined for the structural break which is detected in the series using the Gregory-Hansen (1996) Cointegration test. This is examined for the seven macroeconomic variables used in the analysis that are integrated of different orders.

Table 3.5 Results of the cointegration test for multiple breaks

	Singapore		**Vietnam**	
Statistic recursive	Test Statistic	5% Critical Value	Test Statistic	5% Critical Value
	2.012	0.948	1.45	0.948
	Kuwait		**Indonesia**	
Statistic recursive	Test Statistic	5% Critical Value	Test Statistic	5% Critical Value
	2.13	0.948	1.814	0.948

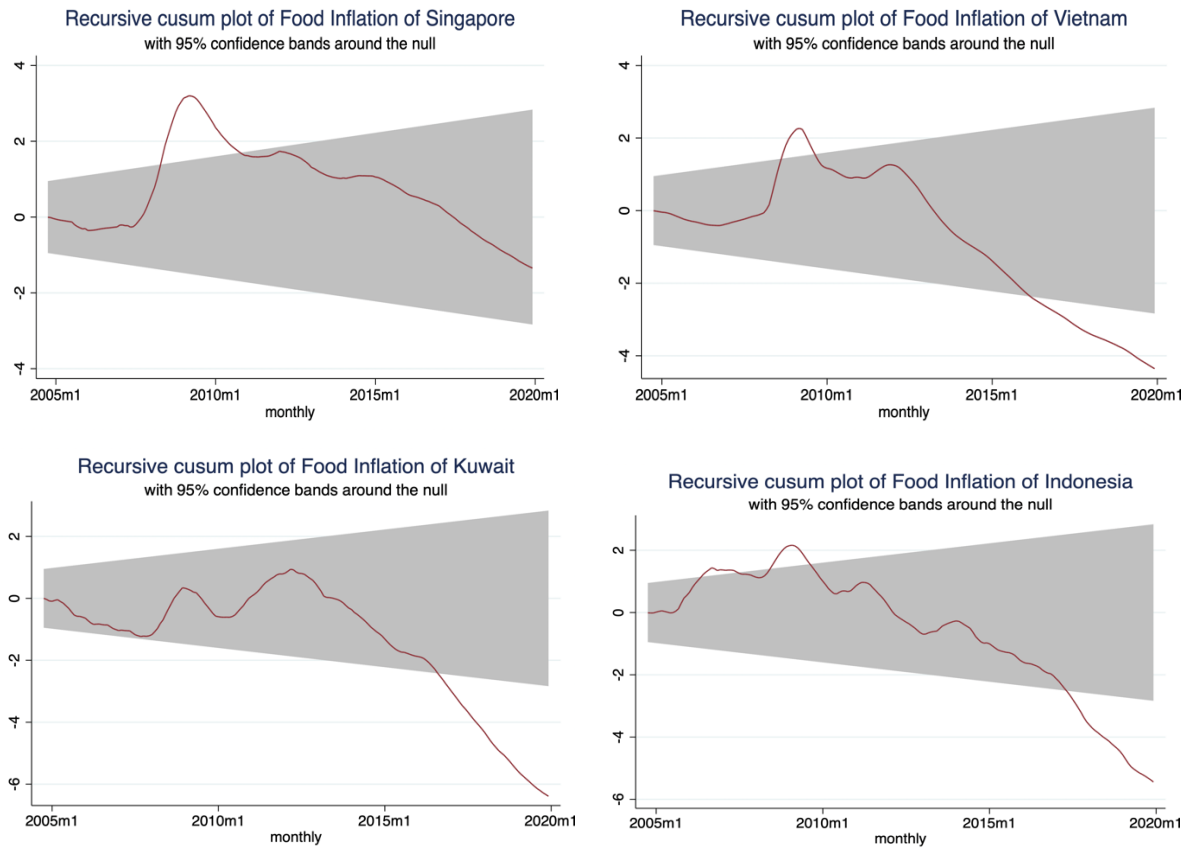

Figure 3.8 Trends of Food Inflation of Singapore, Vietnam, Kuwait and Indonesia

Consequently, the models are tested for the possibility of structural breaks in the cointegrating relationship. Figure 3.8 visualises the trend of food inflation in the cases of Vietnam, Indonesia, Singapore and Kuwait. As shown in the Figure 3.8, in the period of GFC between 2007-2009, shows a sharp break in the time series data, which means there is a truncation in the pattern of food inflation in the case of four countries. The cusum plot drops outside the confidence bands, suggesting there exists structural break in the series. Because of the presence of a break point, the bounds cointegration test for multiple breaks in the time series, the results of the cointegration test for multiple breaks for food inflation of four countries, namely, Singapore, Vietnam, Indonesia and Kuwait are presented in Table 3.5.

The findings in the case of the four countries show the estimated values of test statistics are higher than the critical value at 5% significance, rejecting the presence of no breaks and no co-integration at the break point. Figure 3.8 and Table 3.5 provide support for the existence of structural breaks when a time series abruptly changes in the period 2007-2010, due to the global financial crisis in the case of the sample oil exporting and oil importing countries. The findings (Table 3.4) show evidence of cointegration of food inflation and other macroeconomic variables of the four countries. Thus, in the case of oil-importing countries of Singapore and Vietnam and oil-exporting countries of Kuwait and Indonesia, the results of the cointegration and error correction analysis are valid without and with the presence of a structural break that occurred during the period 2007-2010.

3.5.4 Impacts of Macroeconomic factors and global oil price on domestic food inflation: The short-run linkage

As shown in the cointegration test and error correction analysis of the sample countries for Singapore, Vietnam, Kuwait and Indonesia, the results from the eigenvalue test statistic and the trace test statistic (Table 3.4) note that there is a long-term tightness between domestic food prices and the macroeconomic factors under consideration. Having established the presence of a cointegrating link between relative food prices, on the one hand, and macroeconomic variables and global indicators, on the other hand, a parsimonious error correction vector autoregressive mechanism, which then adds the residuals from the cointegrating vector is applied in the next step for the short-run impacts of global energy price on domestic inflation,

The following results of the short-run error correction estimations for Singapore, Vietnam, Kuwait and Indonesia are obtained, respectively, as follows:

Singapore:

$$\Delta FI_t = \underset{(3.05)\,**}{0.321\mathrm{FI}_{t-1}} + \underset{(2.37)\,*}{7.735\mathrm{M}_{2_{t-1}}} + \underset{(3.38)\,***}{0.038\mathrm{IP}_{t-1}} - \underset{(-0.22)}{0.718\mathrm{GDP}_{\mathrm{PC}_{t-1}}} + \underset{(1.21)}{2.059\mathrm{ER}_{t-1}} + \underset{(1.66)\,*}{2.166\mathrm{GOP}_{t-1}} - \underset{(-1.94)\,*}{5.101\mathrm{GFP}_{t-1}} - \underset{(-3.76)\,***}{0.032\mathrm{EC}_{t-1}}$$

Vietnam:

$$\Delta FI_t = \underset{(3.22)\,***}{0.341\mathrm{FI}_{t-1}} - \underset{(-0.73)}{5.097\mathrm{M}_{2_{t-1}}} - \underset{(-1.7)\,*}{0.328\mathrm{IP}_{t-1}} + \underset{(0.83)}{13.763\mathrm{GDP}_{\mathrm{PC}_{t-1}}} + \underset{(-1.11)}{6.849\mathrm{ER}_{t-1}} - \underset{(2.22)\,*}{21.809\mathrm{GOP}_{t-1}} + \underset{(1.71)\,*}{33.885\mathrm{GFP}_{t-1}} - \underset{(-1.71)\,*}{0.069\mathrm{EC}_{t-1}}$$

Kuwait:

$$\Delta FI_t = \underset{(2.39)\,*}{0.242\mathrm{FI}_{t-1}} + \underset{(2.35)\,*}{2.104\mathrm{M}_{2_{t-1}}} - \underset{(-0.33)}{0.029\mathrm{IP}_{t-1}} - \underset{(-0.68)}{1.142\mathrm{GDP}_{\mathrm{PC}_{t-1}}} + \underset{(1.83)\,*}{49.81\mathrm{ER}_{t-1}} + \underset{(1.88)\,*}{7.195\mathrm{GOP}_{t-1}} - \underset{(-1.73)\,*}{12.019\mathrm{GFP}_{t-1}} - \underset{(-2.86)\,**}{0.235\mathrm{EC}_{t-1}}$$

Indonesia:

$$\Delta FI_t = \underset{(6.91)\,***}{0.586\mathrm{FI}_{t-1}} - \underset{(1.86)\,*}{3.33\mathrm{M}_{2_{t-1}}} - \underset{(-2.74)\,*}{0.209\mathrm{IP}_{t-1}} - \underset{(-0.68)}{1.142\mathrm{GDP}_{\mathrm{PC}_{t-1}}} - \underset{(-1.94)\,*}{6.276\mathrm{ER}_{t-1}} + \underset{(2.40)\,*}{9.626\mathrm{GOP}_{t-1}} - \underset{(-1.70)\,*}{12.442\mathrm{GFP}_{t-1}} - \underset{(-6.03)\,***}{0.434\mathrm{EC}_{t-1}}$$

Note: ***, **, * indicates statistical significance at 1, 5, and 10 percent levels, respectively. EC is the error correction term, and t-1 suggests the previous year from long-run equilibrium.

Table 3.6 indicates the results of model diagnostic tests. The models are estimated on monthly data for four countries for the fifteen years from 2014 to 2019. The above equations provide support for the view that there is a strong short-run relationship between domestic food inflation and macroeconomic variables. The adjusted R^2 value ranges from 0.31 to 0.72 and the value of F-statistics of the four equations are significant at five per cent level. The LM serial correlation test is applied to examine whether there is any autocorrelation in the errors of the residuals in the regression model. In the four countries, since the value of the probability is significantly statistical, we accept the hypothesis, suggesting there is no autocorrelation in the residuals of the model in the case of both the oil-importing countries and oil-exporting countries. Thus, we accept the findings of the VECM and the results of LM test indicate the reasonability of the model estimation. The results of LM test indicate that the four equations

perform satisfactorily. The results of Jarque-Bera test as another diagnostics test confirms the reliability of the vector error correction model. The results look reasonable in terms of log likelihood of the equations which have significantly positive signs. Overall, a closer inspection on equations using diagnostic test on table 3.6 show that there is no evidence of multicollinearity in equations of four countries.

Table 3.6 Results of model diagnostic tests

	Singapore	**Vietnam**	**Kuwait**	**Indonesia**
Serial Correlation (Lagrange multiplier)	p=0.02 (Lag 2)	p=0.07 (Lag 1)	p=0.15 (Lag 1)	p=0.04 (Lag 1)
Functional Form (Ramsey Reset (2))	$F_{(3,176)}$ 0.55	$F_{(3,177)}$ 1.24	$F_{(3,179)}$ 0.006	$F_{(3,176)}$ 0.19
Normality (Jarque-Bera)	5.34χ2(2)	1.15χ2(2)	4.23χ2(2)	4.3χ2(2)
Heteroscedasticity (Breusch-Pagan-Godfrey)	1.63χ2(1)	2.9χ2(1)	1.06χ2(1)	2.6χ2(1)
Observations	184	184	184	184
Adjusted R^2	0.53	0.31	0.72	0.39
F statistics ($F_{(6,177)}$)	34.66***	14.87***	34.65***	20.31***
Log Likelihood	1557.814	620.15	1494.17	1005.33

Note. H_0: No autocorrelation at the lag order. Critical values for the various tests at five per cent level of significance are as follows. χ2(1) = 3.84, χ2(2) = 5.99, $F_{(3,176)}$= 2.66, $F_{(3,179)}$= 2.66, $F_{(3,177)}$= 2.66. $F_{(6,177)}$= 2.15. ***, **, * indicates statistical significance at 1, 5, and 10 percent levels.

We have the dominant features of the estimated model as follows. In the case of both oil-importing countries and oil-exporting countries for Singapore, Vietnam, Indonesia and Kuwait, the adjustment terms, respectively, are statistically significant at the 5% level, suggesting that previous year's error (or deviation from long-run equilibrium) are corrected for within the current year at a convergence speed.

The relative food price of Singapore and Vietnam's (known as oil-importing countries) adjustment to deviations from disequilibria is rather slow, i.e., the estimated speeds of adjustment parameter are 0.032 and 0.069. Meanwhile, the adjustments to deviations from disequilibria of oil-exporting countries, namely, Kuwait and Indonesia are much faster than the case of oil-importing countries. As such, the estimated speeds of adjustment parameter in the case of Kuwait and Indonesia are 0.235 and 0.434, respectively.

As for the case of oil-importing countries, the short-run impact of the real money supply on domestic food inflation records a high level in the case of Singapore and has no impact in Vietnam's food inflation in the short run. Industrial production a very low degree of short-run impact on food price of both Singapore and Vietnam. GDP per capita shows no short-run effect on domestic food inflation of both Singapore and Vietnam. The real exchange rate

also exerts no impact on food price in the case of oil-importing countries. Global oil price records an average impact in the case of Singapore and a much higher effect on Vietnam's domestic food price. Additionally, global food price exerts a stronger impact on Vietnam's food inflation than that of Singapore. This is consistent with the fact Vietnam's economy depends on exporting agricultural products, thus, a change in global agricultural commodities' price affect domestic supply and demand sides in Vietnam.

In the case of oil-exporting countries including Kuwait and Indonesia, the short-run effect of real money supply on food inflation records the relatively similar level. There is no short-run impact of industrial production of Kuwait on domestic food inflation. However, the impact of industrial production holds a very low level in the short term in the case of Indonesia. Besides, GDP per capita exerts no significant impact on food inflation in the case of oil-exporting countries. The short-run impact of the real exchange rate in Kuwait is very strong whereas its short-run impact in Indonesia is very slow. It can be explained by the fact that Kuwait imports almost all of the agricultural commodities from overseas. Therefore, the exchange rate has a high influence on food trading activities of Kuwait. Global oil price in the case of oil-exporting countries holds a same low level of short-run impacts, indicating that in the short term, global oil price plays a role in changing domestic food price of both countries. The coefficient of global food price in the case of Indonesia is also similar to that in the case of Kuwait, suggesting that global food price substantially affects domestic food price of both oil-exporting countries.

The findings on the long-run and short-run relationships in the case of oil-importing countries of Singapore and Vietnam and in the case of oil-exporting countries of Kuwait and Indonesia are different from Apergis & Rezitis's (2011) study in the case of Greece. They applied cointegration methodology and found that the macroeconomic variables of the real exchange rate, real public deficits, the real money supply and the per-capita income have a statistically significant impact on domestic food price of Greece, in both long-run and short-run periods. They concluded that in the case of Greece, the exchange rate, the GDP per capita income and the real public deficits have a positive effect on domestic food price in the long run, while the real money supply exerts a negative impact. Holtemöller & Mallick (2016)'s study in the case of India found that there is a long-term relationship between food price index of India and global food price, global oil price, Indian consumer prices and Indian real effective exchange rate. Holtemöller & Mallick applied VAR model to test for the cointegration. In the study for Singapore, Vietnam, Kuwait and Indonesia, not all macroeconomic factors exert a

statistically significant effect on food inflation in the case of four countries in terms of both long-run and short-run periods.

3.5.5 ARCH model results

The next step applies the modelling approach by employing ARCH-GARCH models to estimate the predicted volatility of food inflation caused by other macroeconomic factors are undertaken for the oil importing and oil exporting countries. The models consider the attributes of annual food price, which are influenced by not only the global indicators like global food price and global oil price but also the internal factors such as GDP per capita, consumer price index, real money supply and industrial production as well. The ARCH models deal with the vulnerability of the food price (i.e., the variance of the series) and the GARCH models show the markets in which the volatility can fluctuate and become more volatile during the periods of global financial crisis or any other world events.

While the volatility of food price can be less volatile and remain relatively calm in the periods of steady economic growth, the increased volatility can be predictive of the vulnerability going forward. As such, the vulnerability can return to the degrees resembling that of pre-crisis degrees or in another case the volatility can uniformly go forward. In most economic time series, it exhibits the periods of unusually high vulnerability followed by the more tranquil periods of low vulnerability. Figure 3.9 illustrates the certain periods which have high volatility of food price of Vietnam, Indonesia, Singapore and Kuwait. The food price index shows periods of higher volatility that results in higher risk than other periods. It is observed that large changes in the macroeconomic factors and global indicators cause vulnerability in the annual food price leading to volatility. There are subperiods of higher volatility during 2007-2010 period and this volatility is much higher than in the previous years.

Testing for the presence of ARCH effect the estimate of volatility in food inflation and in Table 3.7 indicates the results for vulnerability in the residual for the sample four countries. Based on the results it is seen that the time series data follows the ARCH effects. Thus, the conditional tests for ARCH-GARCH model on the time series data of food inflation of the four countries are accepted. The ARCH tests present the presence of vulnerability clustering in domestic food prices. It suggests that the application of the GARCH methodology as the appropriate technique to generate both the consistent examines of the mean equation and the evaluation of the variance of relative food price.

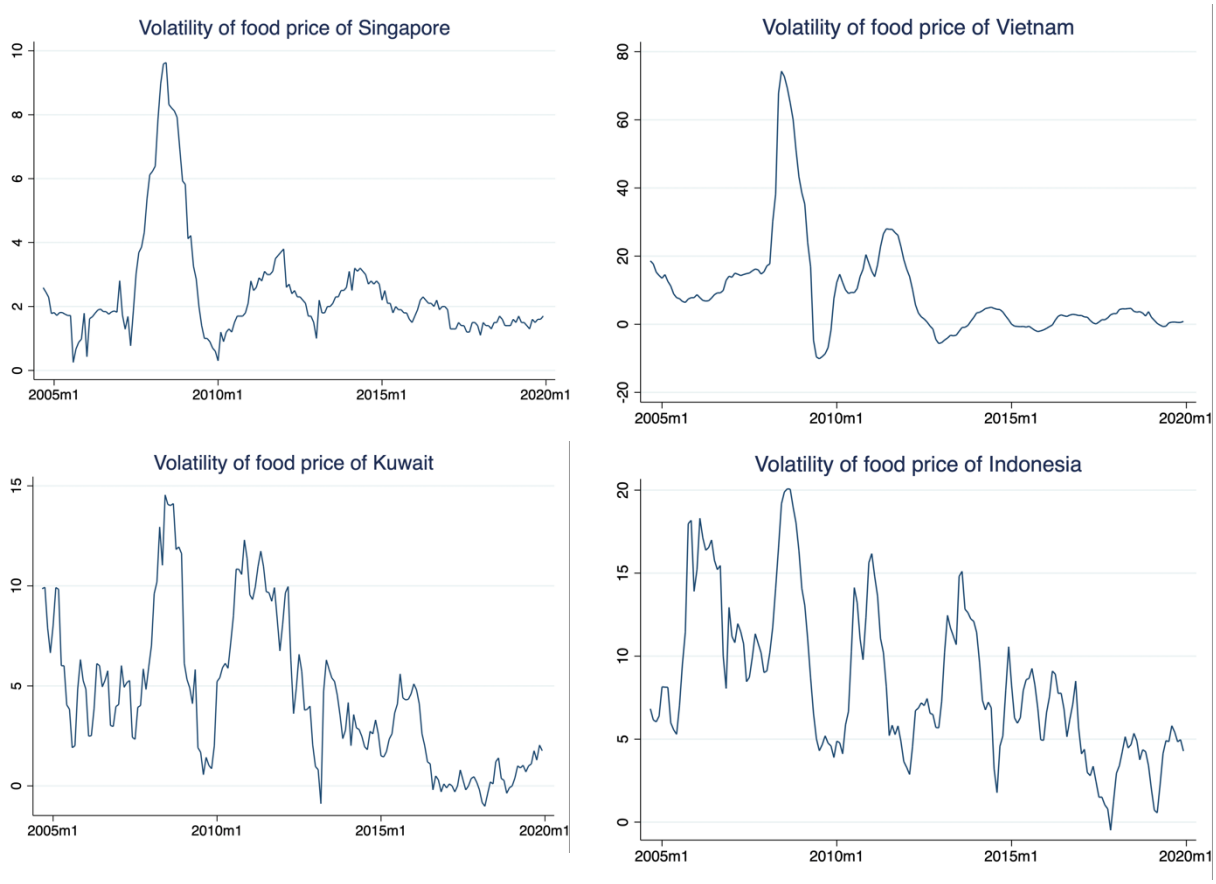

Figure 3.9 Volatility of annual food price of oil-exporting and oil-importing countries

Notes. Dark blue line indicates the food price volatility.

Table 3.7 Clustering volatility in the residual testing

LM test for autoregressive conditional heteroskedasticity (ARCH) χ^2	df	Prob > chi-squared
Singapore	166.640	1	0.000
Vietnam	159.513	1	0.000
Kuwait	133.100	1	0.000
Indonesia	135.302	1	0.000

Note: H_0. no ARCH effects vs H_1: ARCH(p) disturbance.

3.5.6 GARCH and GARCH with ARMA terms Estimates

In term of the root of parsimony criteria, the GARCH models are regarded as a particular example of an ARMA structure (Tsay, 1987). Thus, through the Box-Jenkins methodological procedure, a GARCH(1,1) exhibition presents the best fit. In particular, higher order GARCH formulations created no remarkable improvements in the goodness of fit criteria. The findings yield the following estimations for two oil-importing and two oil-exporting countries, respectively:

Singapore:

$$FI = -2.03\mathrm{M}_2 - 0.01IP + 1.43GDP_{\mathrm{PC}} - 8.15ER + 2.38GOP - 3.45GFP + 30.25EC \quad (3a)$$

$$h_t = 0.021 + 0.97h_{t-1} + 0.19\xi_{t-1}^2$$

Vietnam:

$$FI = -3.42\mathrm{M}_2 + 0.003IP - 2.58GDP_{\mathrm{PC}} - 13.87ER + 13.83GOP + 3.75GFP + 95.77EC \quad (3b)$$

$$h_t = 0.59 + 1.29h_{t-1} - 0.05\xi_{t-1}^2$$

Kuwait:

$$FI = -1.18\mathrm{M}_2 - 0.22IP - 6.97GDP_{\mathrm{PC}} - 89.28ER + 0.8GOP - 7.97GFP - 30.31EC \quad (3c)$$

$$h_t = 0.86 + 0.98h_{t-1} - 0.023\xi_{t-1}^2$$

Indonesia:

$$FI = -3.23\mathrm{M}_2 - 0.11IP + 0.05GDP_{\mathrm{PC}} - 2.28ER - 2.34GOP - 0.81GFP + 83.47EC \quad (3d)$$

$$h_t = 1.43 + 1.2h_{t-1} - 0.14\xi_{t-1}^2$$

h_t is the equation of conditional volatility. Function values (the log likelihood), in the case of Singapore, Vietnam, Kuwait and Indonesia, respectively, are as follows: -148.73, -505.04, -357.28.41and -446.85 with ξ_t being the residuals from the EC model. For these models, we focus on the second components of the estimations that contains the adjustment to past shocks h_t. To interpret these GARCH-type models, we focus on the generalised modelling with the following specification:

$$h_t = \gamma_0 + \delta_1 h_{t-1} + \gamma_1 \xi_{t-1}^2 \quad (3e)$$

Where γ_1 measures the level to which a vulnerability shock in the current period would fed through into the next period's volatility and $\gamma_1 + \delta_1$ measures the rate at which this effect will die out over time. We can also rewrite equation $(3e)$ as: $h_t - \delta_1 h_{t-1} = \gamma_0 + +\gamma_1 \xi_{t-1}^2$ as a measure of the volatility shock. Based on this, the GARCH-estimates systems indicate a long and persistent recovery of the countries after any global food price shocks.

First, for all the countries, a price shock today would have a positive and resilient effect onto future periods' domestic prices. This volatility magnitude is the largest for Singapore which is substantially dependent on importing agricultural commodities (at approximately 0.19 unit), while Kuwait with a strong and integrated importing market facing the least disruption to the future price (0.023). This result highlights the effective and flexible policies in an integrated

country such as Singapore in dealing with the global price shocks. For Vietnam and Indonesia, those with relatively less dependent on the global food supply fluctuations, the dependence path is relatively smooth (less than 0.15 units of price shocks).

Second, there is a clear evidence for persistent effects of the global price volatility on domestic prices for Vietnam and Indonesia (the sum of $\gamma_1 + \delta_1$ is both larger than 1). Whereas for Singapore and Kuwait, these sums are less than unity, suggesting that the rate of the effects is being faded sooner. These results are intuitive in the sense that the government policies and the global integration are key in smoothing out the effect of global prices shocks. While Singapore is highly integrated and a financial hub, Kuwait's economy depends on the global oil price and is largely affected by the oil prices instead of food prices. These countries are, therefore, less exposed to global food price fluctuations. Vietnam and Indonesia with the larger population sizes and, perhaps, with the less effective government regulations and response policies, are likely to be caught up with the severity of the global prices shocks.

To illustrate the persistence of the shocks, we further rewrite our GARCH(1,1) model in the form of ARMA(1,1) to incorporate the shock persistence into the parameters as suggested in Tsay (1987). By restricting the estimations into 6 parameters, GARCH-ARMA(1,1) models for the four countries identify the following estimates for Singapore, Vietnam, Kuwait and Indonesia, respectively:

Singapore:

$$FI = -0.13\begin{pmatrix}-0.87\mathrm{M}_2 - 0.01IP - 0.44GDP_{\mathrm{PC}} + 1.38ER \\ + 1.004GOP + 0.095GFP + 9.01\end{pmatrix} + 0.94EC \qquad (4a)$$

$$h_t = -0.0004 + 0.06h_{t-1} + 0.934\xi_{t-1}^2$$

Vietnam:

$$FI = 0.31\begin{pmatrix}-3.8\mathrm{M}_2 - 0.05IP - 0.12GDP_{\mathrm{PC}} - 3.39ER \\ - 0.63GOP + 10.08GFP + 36.23\end{pmatrix} + 0.89\mathrm{EC} \qquad (4b)$$

$$h_t = 0.018 + 1.76h_{t-1} + 0.32\xi_{t-1}^2$$

Kuwait:

$$FI = 0.06\begin{pmatrix}-0.98\mathrm{M}_2 - 0.07IP - 2.83GDP_{\mathrm{PC}} - 57.94ER \\ +2.79GOP - 6.77GFP - 25.55\end{pmatrix} + 0.82EC \qquad (4c)$$

$$h_t = -0.013 + 0.04h_{t-1} + 0.96\xi_{t-1}^2$$

Indonesia:

$$FI = 0.72\begin{pmatrix}0.99\mathrm{M}_2 - 0.044IP + 0.0043GDP_{\mathrm{PC}} - 1.63ER \\ + 0.03GOP - 6.21GFP + 41.09\end{pmatrix} + 0.89EC \qquad (4d)$$

$$h_t = 0.343 + 0.12h_{t-1} + 0.72\xi^2_{t-1}$$

The coefficient on the error correction term is positive and statistically significant, noting a direct link between vulnerability and short-run deviations. The coefficients of the EC terms in GARCH-ARMA measure the shock volatility in the next period. As such, Singapore records the highest volatile shock in its future food price at the speed of 0.94. Vietnam and Indonesia have the same speed of 0.89. The volatile shock also means more risks and uncertainties in the forecast of future price. Kuwait's food inflation can be predicted at the speed of 0.82 of the volatility's shock. In terms of effect of intervention, the coefficient of the GARCH-ARMA of Singapore is -0.13, which means that there exists a series of inventions decreasing the food inflation. In the case of Vietnam, Kuwait and Indonesia, the positive coefficients from the models indicate that the intervention in effect increases the domestic food price of these countries.

These results present that prediction of domestic food inflation can become a complex task due to the impact of macroeconomic factors that increase in the short run. In this case, productive policy formulation seems to be a complex task estimated in the short-term period. In terms of the Likelihood Function estimation, the GARCH-ARMA(1,1) formular outperforms the standard GARCH(1,1) model, meanwhile all coefficients in the process provide the nonnegativity condition. Lastly, another important finding is that even though the persistence measure remains less than one, it is greater with the inclusion of the error correction term, which denotes that the macroeconomic shocks cause a higher persistence impact on food price vulnerability.

3.5.7 A comparison between GARCH and GARCH-ARMA models.

An essential aspect of the GARCH models is the test of the superiority between models based on the Akaike's and Schwarz's Bayesian information criteria (AIC and BIC). These two information criteria are used to compare models, i.e., the smaller AIC fits the data and the smaller BIC value indicates a better-fitting model. Table 3.8 presents the results of AIC and BIC formulas for two models GARCH (1,1) and GARCH-ARMA (1,1) for Singapore, Vietnam, Indonesia, Kuwait. The estimated test results show that the adequacy of the GARCH model against the adequacy and productivity of the GARCH-ARMA model and vice versa, the value of AIC and BIC all supports the GARCH-ARMA model. Thus, the GARCH-ARMA model fits the process statistically better than the regular GARCH model. We focus our analysis on the GARCH-ARMA models.

Table 3.8 Comparisons the two models GARCH(1,1) and GARCH-ARMA(1,1)

	Singapore		**Vietnam**		**Kuwait**		**Indonesia**	
Models	AIC	BIC	AIC	BIC	AIC	BIC	AIC	BIC
GARCH(1,1)	317.46	349.55	1032.61	1064.76	734.56	766.71	913.69	945.84
GARCH-ARMA(1,1)	162.13	200.65	711.75	750.33	588.86	627.43	666.23	704.82

The next step quantifies the food price volatility robustness test for the GARCH model, i.e., with the Power GARCH model (PGARCH) or the asymmetric GARCH model, to measure the characteristics of food prices like an alternative methodology of persistence and asymmetric impacts. This model (see Nelson, 1990) allows for the asymmetry in responsiveness of food price vulnerability to the sign of a change to food prices and fail to impose the non-negativity constraints on the parameters. Although this model was extensively employed to quantify vulnerability in numerous money, financial, and exchange rate factors, it has not been noted yet to illustrate the food price vulnerability.

The PGARCH model is presented applying the robust technique of Bollerslev-Wooldridge's quasi-maximum likelihood estimator assuming the Gaussian standard normal distribution. Table 3.9 indicates the findings of asymmetric effects of macroeconomic factors on domestic food prices in the case of oil-importing countries and oil-exporting economies. The results of the four countries show the asymmetric effect of a positive and statistically significant coefficient value. The outputs suggest that the unexpected rises in food prices trigger the vulnerability of food price more than the case of unexpected declines in food prices.

Table 3.9 The asymmetric effects of macroeconomic factors on food prices

Singapore				**Vietnam**			
Log likelihood	p-value	Coef.	Std.err	Log likelihood	p-value	Coef.	Std.err
-67.99	0.504	5.96	8.91	-350.32	0.344	5.92	6.26
Kuwait				**Indonesia**			
Log likelihood	p-value	Coef. Of Power	Std.err of Power	Log likelihood	p-value	Coef. Of Power	Std.err of Power
-282.11	0.022	1.55	0.68	-338.41	0.881	16.83	112.6

The findings for the food volatility in this study in the case of oil-importing countries of Singapore and Vietnam and oil-exporting countries of Kuwait and Indonesia is similar to the case of Greece of Apergis & Rezitis's paper (2011). They applied GARCH(1,1), GARCH-

X(1,1) along with EGARCH to measure the volatility of food price of Greece. This study finds the same results as the case of Greece. The domestic food inflation is vulnerable and there exists a positive impacts between food price vulnerability and the deviations. This study extends to conclude that the adjustment speed of volatility shock of four countries is different. The results are vital for sellers and consumers since higher vulnerability augments the risk in the agricultural commodity markets. As the countries experience the level of volatile food market, this provides the need for the government to allocate resources for the overall welfare of the nation.

3.6 Conclusion

This chapter addresses the important issues of cointegration and causality between macroeconomic factors and domestic food inflation of Singapore, Vietnam, Kuwait and Indonesia. The results illustrate the behaviour of relative food price vulnerability and the potential impacts of short-run deviations between the relative food prices and specific macroeconomic elements on food price vulnerability in the case of oil-importing countries of Singapore and Vietnam, and oil-exporting countries, of Kuwait and Indonesia. The short-run tightness between relative food prices and the macroeconomic factors include GDP per capita, the real effective exchange rate, industrial production, real money supply, global oil price and global food price in the case of both oil-importing countries and oil-exporting economies. The results from GARCH(1,1) and GARCH-ARMA(1,1) suggest a significant and positive effect on the vulnerability of relative food prices in the case of Singapore, Vietnam, Kuwait and Indonesia. An increase in the price volatility indicates higher risk about the future prices, given the price range may be wider in the future. As a result, the producers and consumers are influenced by the increased price volatility leading to risk and uncertainty in the commercial trading. An increased price volatility affects producers' and customers' forecasts of the future agricultural commodity prices, thereby triggering welfare losses to both sellers and purchasers of the agricultural commodities.

The estimated results of the short-run and long-run impacts of macroeconomic variables on domestic food price of four countries indicate that the relationship in each country is different due to different economic policies structures. The GARCH(1,1) results show that the impacts of macroeconomic factors on food price volatility are crucial for policymakers in the oil-importing countries and oil-exporting countries to reduce the degree of food price vulnerability to adopt appropriate hedging strategies. These policy implications will be discussed in chapter 5 from the perspective of relevant macroeconomic and energy policies. The next chapter

empirically investigates the related issues of global oil price shocks and monetary shocks and domestic food inflation's impulse response, which is essential for the agricultural-economic growth nexus in the case of oil-importing countries and oil-exporting economies.

Chapter 4 THE IMPACT OF MONETARY POLICY ON DOMESTIC FOOD INFLATION: EMPIRICAL RESULTS

4.1 Introduction

The global indicators of global food and oil price and macroeconomic variables have been noted to have a considerable impact on domestic food price in both short run and long run periods. There are a wide range of studies that investigate the role of monetary and exchange rate policies to control domestic food inflation. Generally, various studies address the problem of core versus headline inflation employed by the central bank. For example, Ginn and Pourroy (2019) advocate for agricultural commodity price subsidy policy in stabilising domestic consumption and food price, thereby requiring less intense reaction of monetary policies. The theoretical literature notes the important role of optimal monetary policy for domestic food price (Anand and Prasad, 2010; Catao and Chang, 2015). The route for monetary policy to minimise food inflation is moderating not only the aggregate demand but also the interest rate and some macroeconomic factors. This study empirically examines the effectiveness of monetary policy which affects the inflation rate in the food sector. Gauging the relative productivities of monetary policy has an essential implications in understanding how a unexpected interest rate shock affects domestic food inflation (Bhattacharya & Jain, 2020). Thus, government authorities can assign appropriate monetary policy to stabilise food inflation.

In this chapter, the analysis is to examine the effects of global price including global food price and global oil price, and monetary policy on domestic food inflation in the case of two oil-importing countries, i.e. Singapore and Vietnam and two oil-exporting countries, i.e. Kuwait and Indonesia. The evaluation is further extended to compare the impact of the change in monetary policies on food price between the advanced nations and the emerging economies. We will follow the impulse response functions of Vector Autogressive (VAR) methodology to estimate the response of four Asian countries to worldwide price volatility. As a result, to extent that the movements of global commodity price influence inflation, this study indicates the crucial implications of the monetary policy. With regard to the impact on inflation, the analysis concludes whether the rise in global oil price is a driver of permanent and transient component of inflationary dynamics in the case of oil-importing countries and oil-exporting economies. We explore how a wide range of countries with different structural markets respond to the global price shocks. The changes describe the level of variation in inflationary pressures, compared to other standard macroeconomic factors.

The study explains whether a change in global price or monetary policy can induce a persistent effect on domestic food inflation. The growth of agricultural commodity prices is time-varying and is coinciding with domestic trend consumer price index in the sample countries of Singapore, Vietnam, Indonesia and Kuwait. As a result, these findings pose fundamental challenges to monetary policymakers. In particular, the authorities have to take into consideration not only the interest rate decisions but also with the establishing of the inflation targets. The structure of this chapter is presented as follows. The next section presents the brief literature review followed by the model specifications. Section 4.3 discusses the findings for the impulse response of food inflation of an economy due to a shock to macroeconomic factor. The results highlight the response of food inflation of oil-exporting countries and oil-importing nations to monetary policy shock and global indicator shocks. The final set of results on the direction of food inflation of the four countries is followed by the conclusion.

4.2 Brief literature review

This section presents a series of literature on the important role of monetary policies for controlling domestic food inflation**.** There are a wide range of studies presenting the response of an economy to global oil price and foodstuff price shocks. Roberts and Schlenker's (2013) study illustrates the analysis using a joint structural vector autoregression (VAR) method for the global food market in the case of United States' (US) economy. They constructed a novel quarterly composite worldwide production index for four essential staple food which are corn, wheat, rice and soybeans. Their finding identify that food market disturbances are related to macroeconomic conditions and assert that worldwide food market disruptions exert a significant impact on the U.S. economy. They found that an unfavourable shock to the worldwide food production index of 1 standard deviation increases the real food prices by approximately 1.7 percent. The study by Edelstein and Kilian (2009) illustrate that the reaction of personal and household consumption to a change of the energy price is around four times the level of the highest discretionary purchasing power loss.

The study by Romer and Romer (2010) applied the VAR analysis to identify the exogenous agricultural market shocks in case of India. They argued that the main changes in food prices were controlled by exogenous elements, disturbances and macroeconomic conditions that respond immediately to the global price shocks. Besides, Frankel (2006) applies the US data of the years 1950–2005, and indicates that an increase in the real interest rate results in a decline of aggregate real food price indices. He also compared the results between a few

selected advanced countries, namely United Kingdom, Canada, Switzerland, Australia and New Zealand, and with the middle-income countries, such as Brazil and Chile. In a reduced form Neo-Keynesian methodology, together with an estimated Baysian technique, Anand, Ding, & Tulin (2014) present that food inflation decreases due to a monetary tightening, employing various key macroeconomic elements for the period 1996Q1 to 2013Q4 in the case of India. Similarly, Holtemoller and Mallick (2016) found that in India, monetary policy plays a vital part in stabilising food inflation.

In a recent paper, in the context of developing countries where governments provide their subsidies to minimise the transmission of a change in global agricultural commodity price to domestic food inflation, Ginn and Pourroy (2018) find that there is a welfare gain when policymakers assign a coordinated subsidy policy for food products and subsidised monetary policies. The current study in the case of two oil-importing and oil-exporting econimes of Singapore, Vietnam, Kuwait and Indonesia contributes to the empirical literature on the success of monetary policy to control food inflation in three ways. The analysis highlights the role of global indicators monetary policy for food inflation in the case of oil-importing and oil-exporting economies. The findings fill the gaps for the lack of theoretical consensus on the behaviour of domestic food price in reaction to a change in monetary policies. Second, the focus of this study illustrates an insight on this problem from a comprehensive view not only of oil-importing and oil-exporting countries but also of advanced nations and emerging economies. The study also compares the findings from two sets of sample nations.

4.3 Model Specification

To examine the role of monetary policy and capture the influence of global food price and global oil price on food inflation, we estimate a reduced form VAR model for a set of sample oil-importing and oil-exporting. We follow the VAR structure in a process as a panel of equations employing the impulse response analysis methodology following Holtz-Eakin et al. (1988); and Abrigo and Love (2016) and employ the impulse repsonse function following the study by Holtemöller & Mallick (2016). The VAR model approach allows the estimation of the reaction of food price index when a random shock of global agricultural commodity price takes place and whether it adjust instantaneously to the changes in economic situations. However, this study extends the methodology by examining further the reaction of food inflation to global shocks in each case of a different structure of the advanced and emerging economies. the methodology of Forecast Error Variance Decomposition (FEVD) following

Cholesky decomposition based on the study by Bhattacharya, Jain, & Singh (2019) are applied to compare and clarify the influence of macroeconomic elements on domestic food price.

Second, the results specify the short run forecast of food inflation, employing Autoregressive Integrated Moving Average (ARIMA) model on the basis of Box-Jenkins method to model time series for the four sample countries. This is particularly essential to indicate the direction of food price index in the short run period. The impulse response analysis demonstrates the dynamic influence of a monetary factor on food inflation and other key macroeconomic elements. The FEVD analysis identifies the sources of the variations in food price index and other macroeconomic variables over the horizon using monthly data from 2004M9 to 2019M12. The next sections demonstrate the data and the detailed techniques applied in the analysis.

4.3.1 VAR Model: Impulse response function and Variance Decomposition

The VAR equation has been applied to examine the reaction of food price index due to the global energy price shock on the economy. Moreover, to pursue key issues of considerable impacts of energy price and foodstuff price changes, we clarify the magnitude of global price shock on various variables over time. The impulse response function is employed which is a productive method to trace the VAR system's response to the typical random price shocks. For more details, the impulse response function clarifies the positive residuals of a standard deviation unit in one model in each system (Sims, 1980). The models applied in this study have a 6-variable VAR(1) equation specified as follows.

$$\begin{bmatrix} Food\ Inflation_t \\ Interest\ Rate_t \\ Real\ Money\ Supply_t \\ Exchange\ Rate_t \\ Global\ Food\ Price_t \\ Global\ Oil\ Price_t \end{bmatrix} = \begin{bmatrix} \alpha_{11}\alpha_{12}\alpha_{13}\alpha_{14}\alpha_{15}\alpha_{16} \\ \alpha_{21}\alpha_{22}\alpha_{23}\alpha_{24}\alpha_{25}\alpha_{26} \\ \alpha_{31}\alpha_{32}\alpha_{33}\alpha_{34}\alpha_{35}\alpha_{36} \\ \alpha_{41}\alpha_{42}\alpha_{43}\alpha_{44}\alpha_{45}\alpha_{46} \\ \alpha_{51}\alpha_{52}\alpha_{53}\alpha_{54}\alpha_{55}\alpha_{56} \\ \alpha_{61}\alpha_{62}\alpha_{63}\alpha_{64}\alpha_{65}\alpha_{66} \end{bmatrix} \begin{bmatrix} FI_{t-1} \\ IR_{-1} \\ M2_{t-1} \\ ER_{t-1} \\ GFP_{t-1} \\ GOP_{t-1} \end{bmatrix} + \begin{bmatrix} \in_{FI} \\ \in_{IR} \\ \in_{M2} \\ \in_{ER} \\ \in_{GFP} \\ \in_{GOP} \end{bmatrix} \quad (1)$$

A perturbation in the global indicators including global oil price and global food price has a short run and long run effect on food inflation. In the period t+1, the perturbation in $Food\ Inflation_t$ affects $Food\ Inflation_{t+1}$. These influences continue to work through the period t+2 and so on. Therefore, random shocks in the global indicators in the equation of VAR model set up a chain reaction in other variables. The impulse response functions help to calculate these chain functions and the direct effects of macroeconomic factors on food inflation.

While the impulse response function specifies the impacts of a sudden shock to endogenous variables, in this study, macroeconomic variables on the food inflation in the VAR equation, the decomposition separates the variation of endogenous factors into the component shocks. As such, the variance decomposition records the importance of each macroeconomic factor in the variation process of the VAR system. In this process, the multi-period forecast error variance decomposition presents to which level a random shock influences the food price index of the four different Asian countries and predicts its subsequent fluctuation.

In the recursive ordering for y (dependent variable) and r (set of independent variables), all of the one period forecast-error variance of y is due to u_{yt}. At longer horizons, the explanatory share of shocks to u_{yt} will diminish. Additionally, the variance of the forecast error increase with the horizon. We use recursive ordering to see the impact of a long-term shock. The equation of structured SVAR identification is as follows for the shocks to r that only affect output gap y with a lag.

$$y_t = \beta_{10} + \beta_{11} y_{t-1} + \beta_{12} r_{t-1} + u_{yt} \qquad (2a)$$

Both shocks have a contemporaneous impacts on r.

$$r_t + a_{21} y_t = \beta_{20} + \beta_{21} y_{t-1} + \beta_{22} r_{t-1} + u_{rt} \qquad (2b)$$

If r is the monetary-policy interest rate, authorities observe y and react to it within the period. In other words, shocks to y affect r within the period. If movements of r are monetary policy decisions, the policy is reacting to output and inflation within the period. All shocks affect r within the period.

$$e_{yt} = u_{yt}$$

$$e_{\pi t} = -a_{21} u_{yt} + u_{\pi t}$$

$$e_{rt} = (-a_{31} + a_{21}) u_{yt} - a_{32} u_{\pi t} + u_{rt}$$

$$\begin{bmatrix} e_{yt} \\ e_{\pi t} \\ e_{rt} \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 \\ -a_{21} & 1 & 0 \\ -a_{31} + a_{21} a_{32} & -a_{32} & 1 \end{bmatrix} \begin{bmatrix} u_{yt} \\ u_{\pi t} \\ u_{rt} \end{bmatrix} \qquad (A^{-1}) \quad (3)$$

We have a three-variable recursive ordering with y, π and r. y is the dependent variable, in this study, y is domestic food inflation, π is the change of global indicators including global oil price and worldwide food price and r is the element of the monetary policy, which can be interest rate, the real money supply or the real exchange rate. The policy interest rate only affects the other variables (y, π) with a lag. With a recursive ordering, matrix $A^{-1}$and A, and with A^{-1} provides the impulse response results. In addition, the invertible matrix can be broken into two lower triangular factors (Cholesky factors). It is a numerical technique to = estimate a recursive ordering. The zero on the upper side in a recursive ordering, $A^{-1}$is the Cholesky factor

of $\sum_e()$, the variance-covariance matrix. If correlations between the errors are low, the order is irrelevant, but usually, correlations are strong and the order matters. the ordering (restrictions) is undertaken to show what order the variables are recursive and its responses that can be scaled and compared by the variance of the responding food inflation factors.

4.3.2 ARIMA forecasting model

The ARIMA model for time series forecasting in the short-run period is applied in order to clarify the direction of food inflation of the four countries, namely, Singapore, Vietnam, Kuwait and Indonesia in the future. This ARIMA method is a popular and widely applied statistical approach for time series forecasting, see Wadi, Almasarweh, Alsaraireh & Aqaba (2018) study that predicts banking stock market and Kumar & Anand (2014) study which predicts sugarcane production in India. The ARIMA model also employs the dependency between a residual error from a sample of the moving average method linked to lagged observations, each of these elements are explicitly illustrated in the model as a parameter. Generally, a standard notation for ARIMA model (i.e. ARIMA(p,d,q)) indicates the specific applied ARIMA methodology where p is specified as the number of lag observations (the lag order) and d is the level of differencing q is the size of the moving average window. In this study, the ARIMA model is used for forecasting food inflation in 24 months of the four nations including Singapore, Vietnam, Kuwait and Indonesia.

4.4 Data description

The analysis of the models is based on the monthly data of the four countries, retrieved from the website tradingeconomics.com and globaleconomy.com, covering the time span between 2004M9 and 2019M12. The choice of the specific time period for these nations are based on the data availability. The sample nations include both Asian oil-importing economies, namely, Singapore and Vietnam and oil-exporting nations, namely, Kuwait and Indonesia. These economies have also been affected by GFC of 2007-08, formulating a sufficiently representative selection.

The variables taken into account in this chapter are global food price, global oil price, the real effective exchange rate, the real money supply, the interest rate and domestic food inflation of Singapore, Vietnam, Kuwait and Indonesia. This study considers four vital factors of monetary policy which directly affects the domestic food inflation. Besides, the results of a shock in global food price and global oil price to food inflation are investigated. All time series estimations are undertaken using Stata. The seasonally adjusted time series remove the seasonal

patterns of the time series data (see Figure 4.1 to Figure 4.5). Table 4.1 shows the descriptive statistics of the seasonally adjusted data series of countries for Singapore, Vietnam, Kuwait, and Indonesia, respectively. As evident all of the series are normally distributed, as illustrated by the skewness and kurtosis statistics.

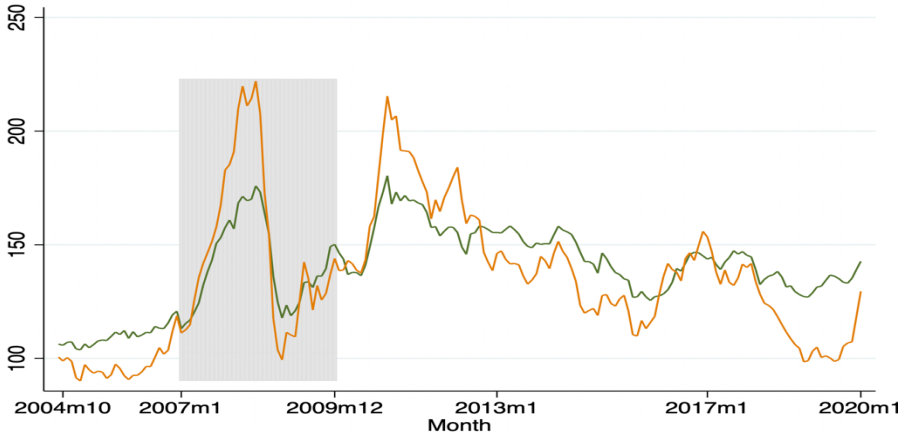

Figure 4.1 Global food price and Global oil price

Note. Grey shading denotes global financial crisis. The green line indicates Global food price, the orange line indicates Global oil price.

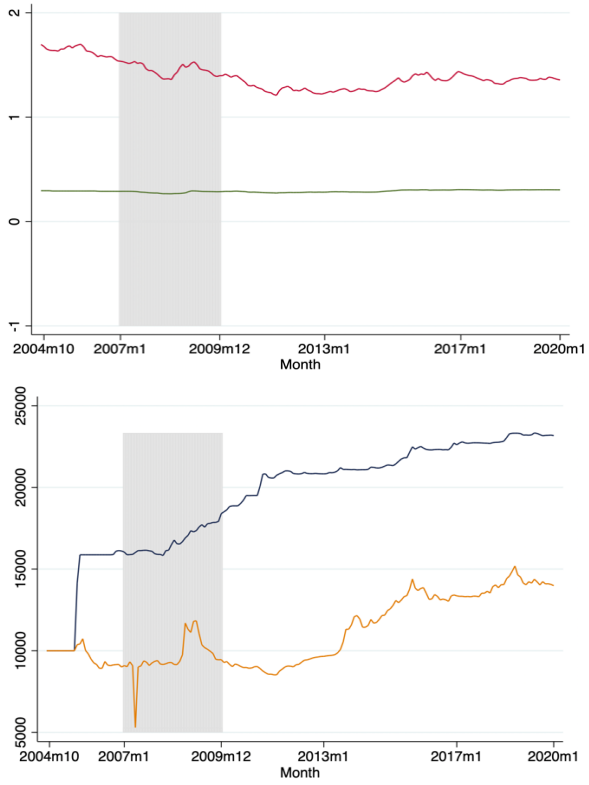

Figure 4.2 Seasonally adjusted series of Real Exchange Rate of four countries

Note. Grey shading denotes global financial crisis. Note. Grey shading denotes global financial crisis. The red line indicates the Real Exchange Rate of Singapore, the dark blue line indicates the Real Exchange Rate of Vietnam, the green line indicates the Real Exchange Rate of Kuwait, and the orange line indicates the Real Exchange Rate of Indonesia.

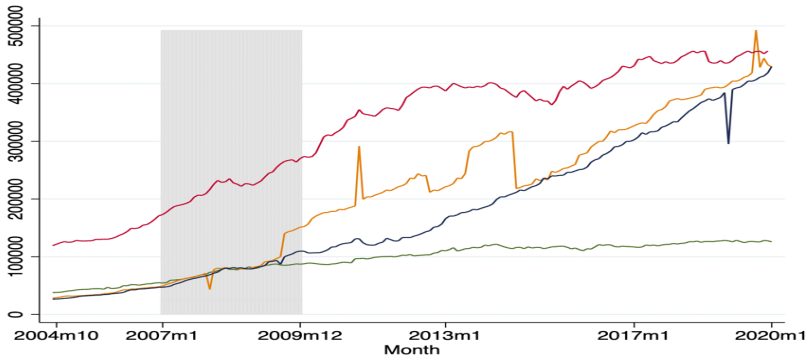

Figure 4.3 Seasonally adjusted series of Real Money Supply of four countries

Note. Grey shading denotes global financial crisis. Note. Grey shading denotes global financial crisis. The red line indicates the Real Money Supply of Singapore, the dark blue line indicates the Real Money Supply of Vietnam, the green line indicates the Real Money Supply of Kuwait, and the orange line indicates the Real Money Supply of Indonesia.

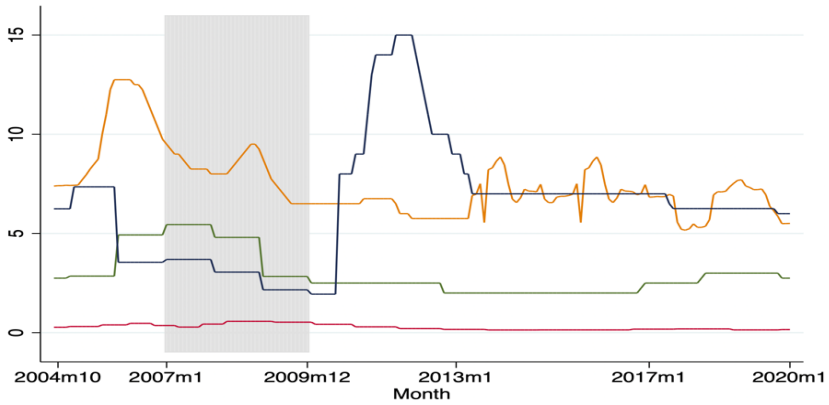

Figure 4.4 Seasonally adjusted series of the Interest Rate of four countries

Note. Grey shading denotes global financial crisis. Note. Grey shading denotes global financial crisis. The red line indicates the Interest Rate of Singapore, the dark blue line indicates the Interest Rate of Vietnam, the green line indicates the Interest Rate of Kuwait, and the orange line indicates the Interest Rate of Indonesia.

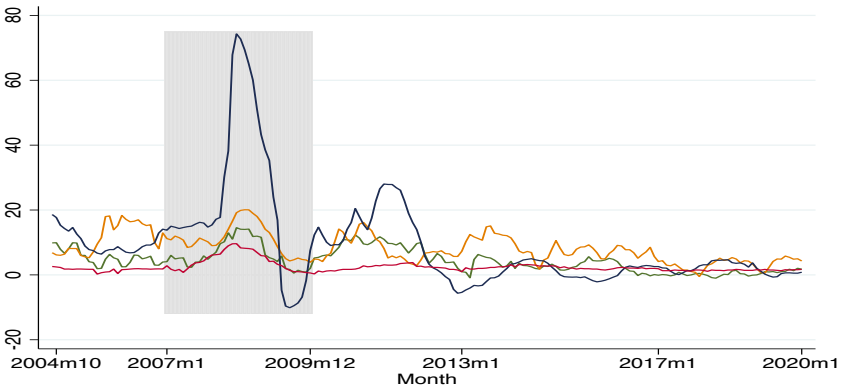

Figure 4.5 Seasonally adjusted series of Food Inflation of four countries

Note. Grey shading denotes global financial crisis. The red line indicates Food Inflation of Singapore, the dark blue line indicates Food Inflation of Vietnam, the green line indicates Food Inflation of Kuwait, and the orange line indicates Food Inflation of Indonesia.

Table 4.1 Descriptive statistics

	Singapore				Vietnam			
	Mean	SD	Skewness	Kurtosis	Mean	SD	Skewness	Kurtosis
IR	0.28	0.14	0.75	2.22	6.43	3.049	0.87	4.02
ER	1.39	0.12	0.75	2.73	19413.33	3498.56	-1.09	3.67
M_2	321470.2	109788	-0.53	1.84	175051.5	116572.1	0.55	2.08
GFP	139.49	18.27	-0.12	2.33	175.35	33.12	-0.1	2.22
GOP	135.22	31.19	0.75	3.10	170.30	46.99	0.6	2.76
FI	2.43	1.71	2.42	9.01	9.33	14.71	2.38	9.79
Obs.	184	184	184	184	184	184	184	184
	Kuwait				**Indonesia**			
	Mean	SD	Skewness	Kurtosis	Mean	SD	Skewness	Kurtosis
IR	2.97	1.09	1.24	3.13	7.48	1.68	1.48	5.23
ER	0.29	0.01	-0.26	2.19	11059.1	2068.18	0.31	1.78
M_2	95235.97	27683.69	-0.67	2.14	208593.4	125154.8	0.08	1.83
GFP	139.49	18.27	-0.12	2.33	139.4967	18.27	-0.12	2.33
GOP	135.23	31.19	0.75	3.10	135.23	31.19	0.75	3.10
FI	4.48	3.75	0.72	2.71	8.35	4.61	0.65	2.75
Obs.	184	184	184	184	184	184	184	184

Note. $LGDP_{PC}$ is log of purchasing power parity Gross Domestic Product per capita, IP is Industrial Production, LER is log of the real Exchange Rate, LM_2 is log of the real Money Supply , LGFPI is log of Global Food Price Index, LGOPI is log of Global Oil Price Index, FI is Food Inflation.

4.5 Empirical results

4.5.1 Stationarity test

The reason for choosing these three tests follows the following criteria. Firstly, the ADF is a classical and most common unit root test in theoretical analyses. Secondly, since the ADF test generates low power results, we use KPSS test as alternative test to raise the power of the unit root test. Finally, to check for the robustness of the results, we also employed the adjusted unit root test by Elliot test. Using KPSS test and Elliot test are a positive way to avoid the issue of short-spanned data. The test outputs for the four countries are presented in table 4.2 for Singapore, Vietnam, Kuwait and Indonesia.

In all countries and for all variables being investigated, the empirical results note that the variables in the first difference form are at the 5% significance level. Generally speaking, there is consistency in our unit root examining and the presence of cointegration is valid to be investigated.

Table 4.2 Unit root test

	ADF		KPSS		DF_GLS	
	Levels	First Difference	Levels	Difference	Levels	Difference
Panel A. Singapore						
IR	-2.11	-4.96	-2.22	-13.42	-1.41	-6.54
ER	-1.78	-5.28	-1.65	-9.22	-.85	-8.04
M_2	-1.18	-5.15	-.77	-9.75	-1.15	-8.7
GFP	-2.74	-5.49	-2.06	-9.92	-1.84	-5.6
GOP	-2.85	-5.48	-2.15	-8.76	-2.39	-6.62
FI	-4.15	-3.32	-1.92	-13.54	-2.52	-4.51
Panel B. Vietnam						
IR	-2.2	-4.52	-1.52	-11.83	-2.1	-4.73
ER	-3.96	-5.82	-2.86	-9.44	-1.39	-5.9
M_2	-.47	-7.65	-1.84	-30.57	-.54	-11.14
GFP	-2.58	-4.7	-1.67	-7.36	-1.92	-1.92
GOP	-2.8	-5.33	-1.93	-8.16	-2.13	-6.28
FI	-4.36	-5.37	-2.36	-7.15	-3.65	-5.9
Panel C. Kuwait						
IR	-1.93	-5.29	-1.89	-13.21	-1.46	-6.39
ER	-2.65	-4.32	-1.99	-7.57	-1.8	-4.34
M_2	-.87	-5.76	-1.03	-16.03	-.39	-6.24
GFP	-2.74	-5.49	-2.06	-9.92	-1.84	-5.6
GOP	-2.85	-5.48	-2.15	-8.76	-2.39	-6.62
FI	-3.53	-5.04	-3.15	-12.83	-3.08	-7.05
Panel D. Indonesia						
IR	-3.26	-4.87	-2.53	-13.92	-2.96	-8.49
ER	-2.4	-5.73	-2.77	-18.33	-1.32	-3.87
M_2	-2.9	-5.9	-3.86	-19.65	-2.06	-2.06
GFP	-2.74	-5.49	-2.06	-9.92	-1.84	-5.6
GOP	-2.85	-5.48	-2.15	-8.76	-2.39	-6.62
FI	-4.65	-5.33	-3.58	-9.55	-2.95	-6.94

Notes. ADF: augmented Dickey-Fuller, KPSS: Kwiatkowski-Phillips-Schmidt-Shin, DF-GLS.
$LGDP_{PC}$ is log of purchasing power parity Gross Domestic Product per capita, IP is Industrial Production, LER is log of the real Exchange Rate, LM_2 is log of the real Money Supply , LGFPI is log of Global Food Price Index, LGOPI is log of Global Oil Price Index, FI is Food Inflation.

4.5.2 Macroeconomic impact of global food price and global oil price shocks on food inflation

The generalised impulse response functions and the forecast error variance decomposition results are presented for the direct impacts of global food price and oil price shocks on the domestic food inflation of the oil importing countries, i.e. Singapore and Vietnam, and the oil -exporting countries, i.e. Kuwait and Indonesia. In the next step, the potential indirect effects on food inflation and the relative contribution of global oil price and food price fluctuations on the volatility of domestic food inflation variables are considered. The impulse response of the domestic food inflation of Singapore and Vietnam are based on the generalised one-standard-deviation global food price and oil price shock.

Figure 4.6 traces the influence of a shock to global price equation on domestic food inflation over the monthly period of 15 years. Interestingly, the global food price shock presents that over time, the global food price imposes a positive impact on food inflation of both Asian oil-importing countries. The largest impacts for both countries occur in the sixth quarter and remain a considerable amount over the two-year time period. The y-axis indicates the rate of change of the given variables, and the impulse responses can be interpreted as percentage change values multiplied by the factor of 100. Accordingly, the eighth period in the case of Singapore and Vietnam record a slight decrease in domestic inflation. Whereas the amount of a decrease in the case of Singapore is around 0.05 percent of food inflation, Vietnam records a much more considerable positive impact when the cumulative effect is approximately 0.5 percent of food inflation. Food inflation of Singapore stabilises slightly over the next 6 quarters. Meanwhile, in the case of Vietnam, the impact is followed by a gradual decrease over the next quarter. The impulse response functions imply that the effects on food inflation of both these Asian oil-importing countries are transitory.

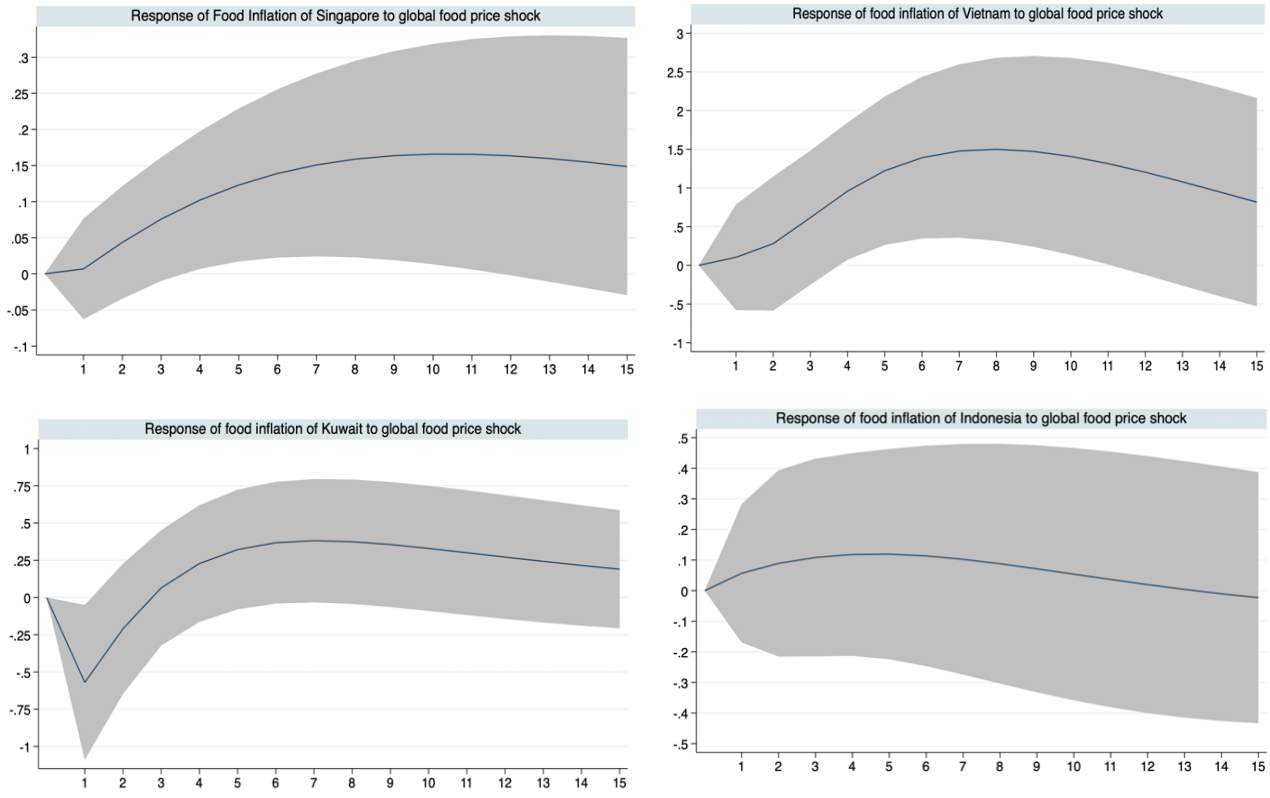

Figure 4.6 Generalised Impulse response results: Global food price

Note: The dark blue line denotes the orthogonalized impulse response function. The grey area denotes 95% confidence intervals for orthogonalized impulse response function.

The next step considers the implications of impulse response of global food price shock on domestic food inflation of the oil-exporting sample countries of Kuwait and Indonesia. Accordingly, a sharp, positive response of food inflation of Kuwait to the initial price shock suggests that domestic consumers face lower prices for agricultural commodity. The impulse response plotted for food inflation of Kuwait to a one-standard-deviation food price shock in Figure 4.6 is persistent through to fourth quarter (i.e. 11 years). The magnitude of the sharpest increase occurs in the second quarter reaching nearly 0.8 percent. After an unprecedented increase, food inflation of Kuwait stabilises starting from the fourth quarter. The impulse response of Indonesia as shown (Figure 4.6) indicates the impact on food price index due to global food price shock. It can be seen that there is no substantial volatility of food inflation as in the case of Kuwait. On the other hand, the time path of the impulse response illustrates an initial negative increase in the domestic food inflation, before it decreases from the fourth quarter, and finally asymptotes to 0 in the fifteenth quarter. Overall, the influence of global food price shock on food inflation of Indonesia is relatively short-lived.

Thus, overall, the impulse response of food inflation to global food price shock in the case of oil-importing countries records relatively in the same directions. Meanwhile, in the case of oil-exporting economies, at the initial stage, there exists a totally different response of domestic food inflation of Kuwait and Indonesia. In particular, Kuwait records a significantly declines in its food inflation, whereas Indonesia sees a slight rise in its food inflation. However, starting from the fourth quarter, food inflation of both these oil-exporting nations remains a gradual decrease and stabilise the impact of global food price shock around the last three years. To estimate the impact of global oil price shock on domestic food inflation in the case of oil-importing countries of Singapore and Vietnam and oil-exporting countries of Kuwait and Indonesia, Figure 4.7 illustrates the generalised impulse response function of global oil price shock to a one-standard-deviation global oil price shock. The findings for the impulse responses of domestic food inflation to a sudden change in global food price in the case of Singapore, Vietnam, Kuwait and Indonesia are similar to the case of India from Holtemöller & Mallick's (2016) study. They applied SVAR analysis with impulse response function and found that global food price are transmitted directly to India's food inflation.

The estimated results in Figure 4.7 show the impulse response function of food inflation due to global oil price shocks. In the case of Singapore, it initially records a sharp soar in its food inflation in the eight quarter which is followed by a gradual decrease over the next six quarters before the effect reaches to 2 percent of inflation rate. In contrast to Singapore, a sudden, positive response of food inflation of Vietnam to the initial oil price shock suggests

that domestic consumers in Vietnam face lower prices for food and agricultural products. However, there is a slight increase in Vietnam's food inflation in the next period and continues to increase significantly in the next six quarters. From the ninth quarter, similar to Singapore, Vietnam records a decrease in food inflation. The magnitude of the fall that occurs in the case of Vietnam, however, is much more considerable than the case of Singapore. Thus, the oil price shock has the fluctuating effect on Vietnam's food inflation while this impact tends to be gentle in the long run in the case of Singapore.

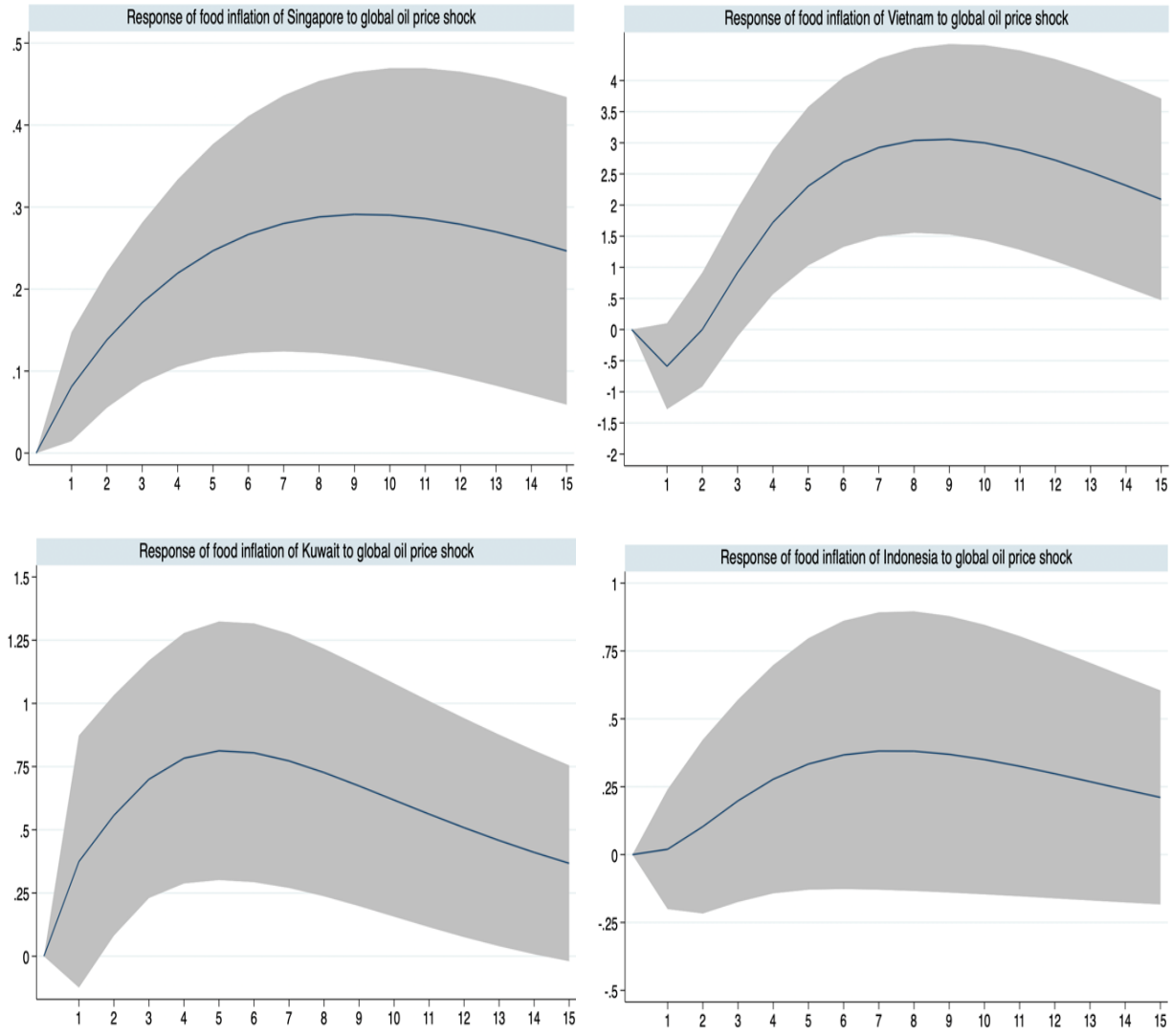

Figure 4.7 Generalised Impulse response results: Global oil price

Note: The dark blue line denotes the orthogonalized impulse response function. The grey area denotes 95% confidence intervals for orthogonalized impulse response function.

Figure 4.7 shows that a shock on global oil prices cause relatively similar changes in food inflation of oil-exporting countries, namely, Kuwait and Indonesia. It can be seen that there is more volatility in the food inflation caused by global oil shock in the case of Kuwait

than the case of Indonesia. There is a sharp increase in Kuwait's food inflation in the first quarter, followed by a significant rise in the next five quarters. From the sixth quarter, food inflation of Kuwait tends to decrease gradually. It is noted that the scale of effect of global oil price shock to Kuwait's inflation is of larger magnitude than this of Indonesia. The maximum increase in the first quarter in the case of Kuwait is 0.5 due to one percentage change. Meanwhile, the magnitude of the change in food inflation of Indonesia is approximately 0.01 percent in the first quarter. The impulse response of Indonesia's food inflation follows the same path as Kuwait. Essentially, the influence of global oil price shock on Kuwait's food inflation is significant in the short term and to Indonesia's food inflation, it has a gentle effect in the long term.

4.5.3 Responses to a monetary shock on food inflation

The next set of results of the dynamic effects of a change in monetary policy on domestic food inflation are presented for the sample of oil-exporting and oil-importing countries applying the estimated impulse response functions. The generalised cumulative impulse responses of domestic food inflation of four to one-standard deviation shock are shown in Figure 4.8 to Figure 4.10. The dashed lines represent a one-standard error. Figure 4.8 illustrates the response of domestic food inflation to a change in the real exchange rate in the case of Singapore and Vietnam (oil-importing countries), and Kuwait and Indonesia (oil-exporting countries).

In the case of Asian oil-importing economies, a positive shock to the real effective exchange rate is linked with an immediate decrease of domestic food inflation in Singapore. The immediate reaction to the exchange rate of Singapore's food inflation decreases by 1 percent, which means the impact of the exchange rate's shock is statistically remarkable. Compared to the case of Vietnam, the exchange rate shock is relatively more influential. Vietnam's food inflation records a fluctuation reacting to the real effective exchange shock. Starting from the second quarter, Vietnam's food inflation slightly increases. Following a small initial increase for around seven quarters, domestic food inflation of Vietnam declines and the estimated impact is approximately 2 percent of a decrease. Generally, food inflation of Singapore tends to decrease immediately at the initial stage. Meanwhile, Vietnam's food inflation increases slightly in the following the seven quarters beginning from the second quarter. Both food inflation of Asian oil-importing becomes negative as they record a significant decrease at the end of the horizon. As expected, the medium and long-run influence of a positive real exchange rate shock on food inflation of Asian oil-importing countries is positive.

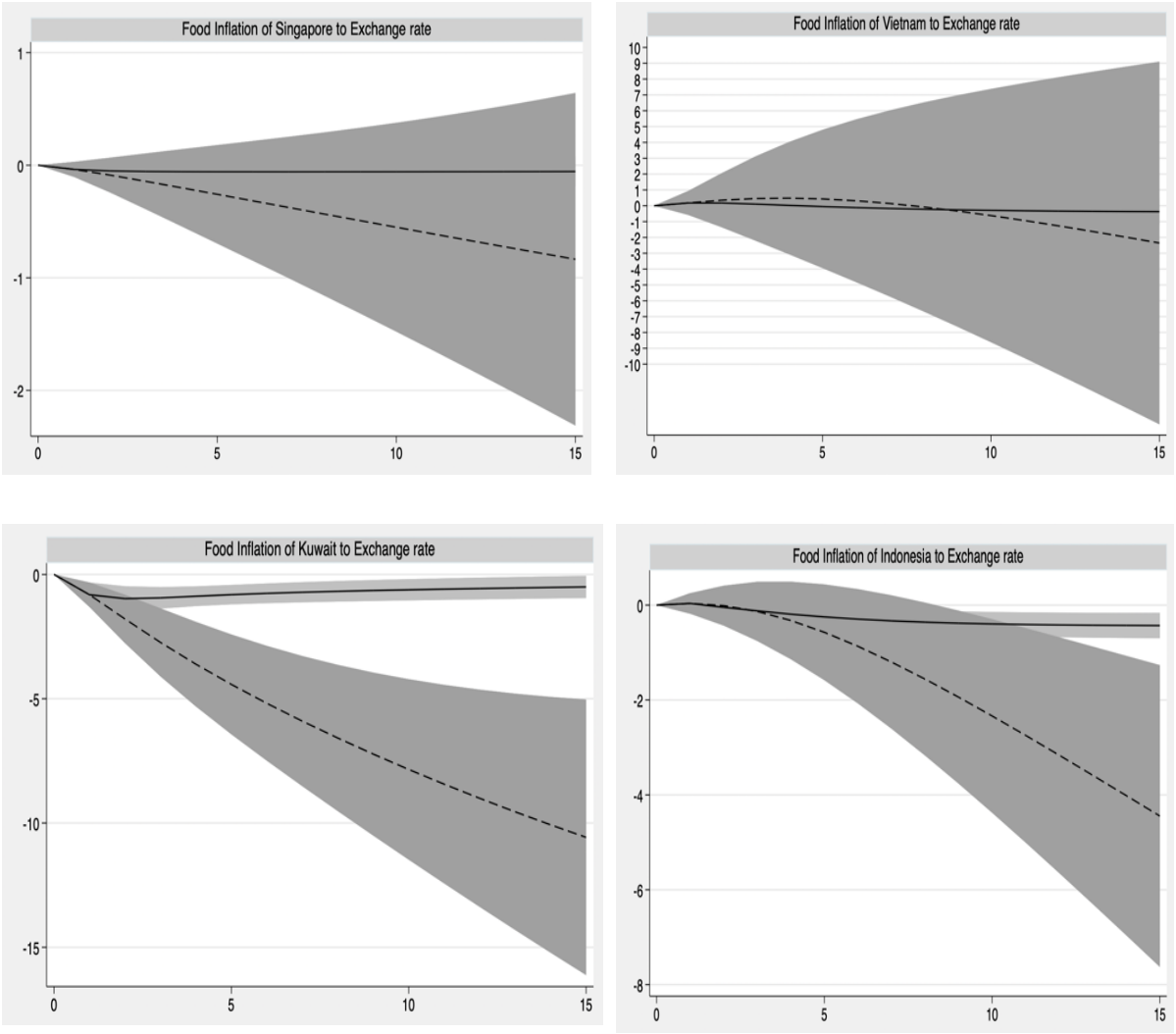

Figure 4.8 Cumulative impulse response function 2004:09 to 2019:12: The effective exchange rate

Note: The dark grey area indicates 95% confidence intervals for cumulative orthogonalized impulse response function. The light grey area indicates 95% confidence intervals for orthogonalized impulse response function. The dashed line denotes the cumulative orthogonalized impulse response function. The dark line denotes the orthogonalized impulse response function.

In the case of Asian oil-exporting countries, we find that the reaction of food inflation to the real effective exchange rate shock is highly sensitive to the assumption on the elasticity of higher currency value with respect to its GDP. Figure 4.8 shows that the responses of food inflation of Kuwait to a positive real exchange rate shock begins from the second quarter. In particular, Kuwait records a remarkable decrease of domestic food inflation, the effect is ten percent of the decrease in the final quarter. Meanwhile, in estimating the impact of the real effective exchange rate shock to Indonesia's food inflation, it can be seen that the exchange rate

is a considerable source of volatility reduction, i.e. it contributes substantially to around 5 percent of a decrease of the vulnerability in food inflation, following a slight 0.01 percent increase in the first three quarters of the exchange rate shock.

The next measure of the monetary policy variable taken into consideration is the interest rate. In the case of Asian oil-importing countries, a positive shock to interest rate leads to a statistic and persistent decrease in Singapore's food inflation. The maximum increase in the whole horizon of Singapore's food inflation is around three due to one percentage change. Meanwhile, it is noted that the scale of effect of an interest rate shock to Vietnam's food inflation is of much higher magnitude than that of Singapore. The sequence can be rationalised as follows: the interest rate of shock initially raises the food inflation of Vietnam. After eleven quarters, however, it contributes to a reduced food inflation (as seen in Figure 4.8). The magnitude of the sharpest fall occurs starting from the eleventh period reaching nearly 5 percent, whereas the cumulative impact of the interest rate shock causes an increase in food inflation of around 2 percent. Consequently, the impulse response function in the context of oil-importing country suggests that the food inflation of Singapore is not as volatile as in the case of Vietnam.

In the case of oil-exporting countries, there exists a different direction of impulse response of domestic food inflation to a positive interest rate shock. However, at the end of the horizon, both oil-exporting economies of Kuwait and Indonesia, records a sharp increase of their domestic food inflation. In the case of Kuwait, the dynamic profile of the impulse response suggests the shock to inflation is immediate, decreasing in the order of 0.1 percent in the second quarter due to a one-standard-deviation interest rate change innovation. This is followed by a gradual increase over the next 6 quarters. Along with the narrow band for food inflation, the cumulative impact is around 1 percent increase. Meanwhile, in the case of Indonesia, a sharp, negative response of food inflation to the initial interest rate shock suggests that domestic consumers would face higher prices for agricultural commodity. The plot of the impulse response for food inflation is persistent through to the fifteenth quarter. The magnitude of the sharpest rise occurs at the end of the horizon, reaching nearly 6 percent. According to the results presented so far, it appears that the cumulative impact is high in the case of Indonesia.

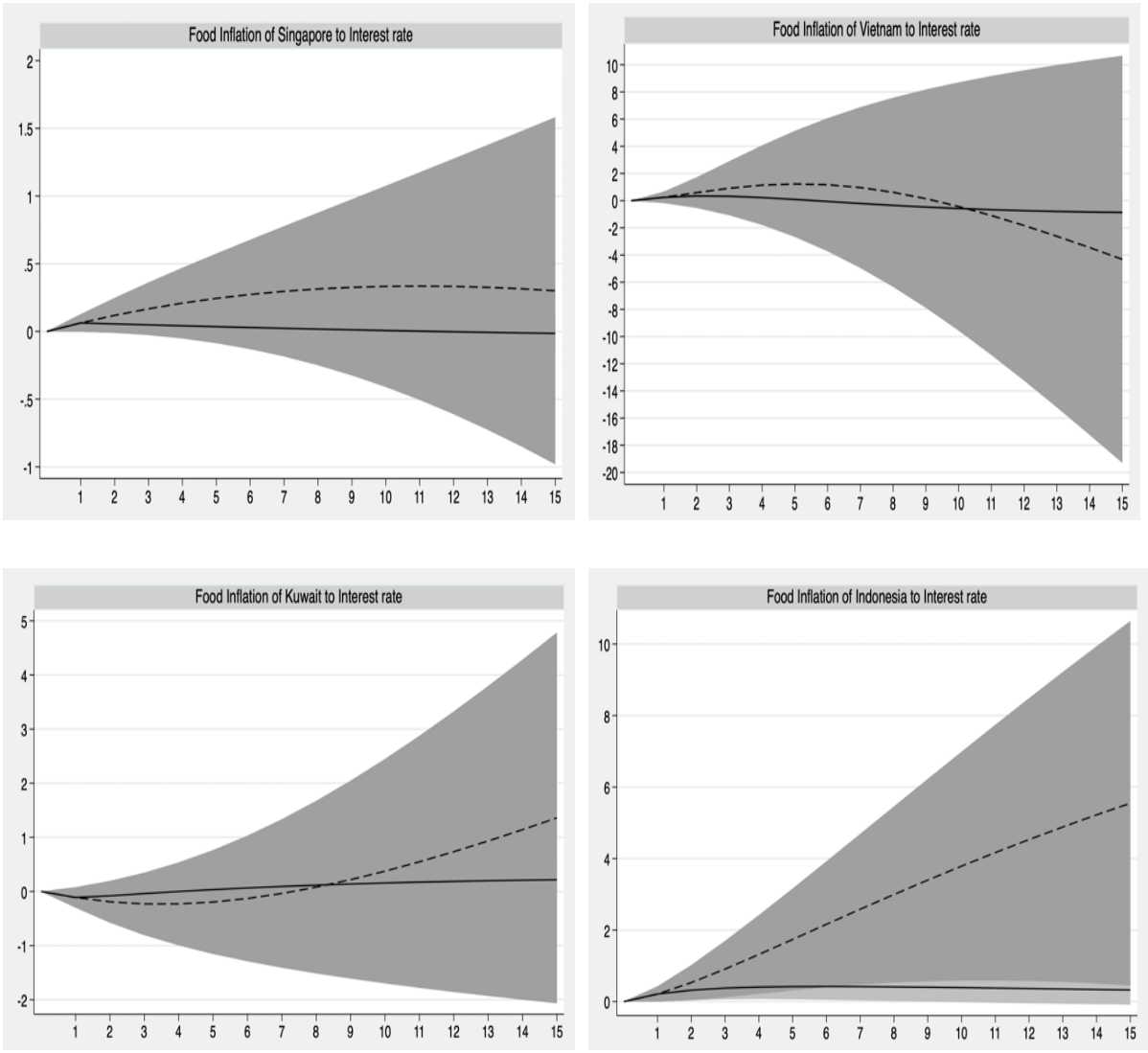

Figure 4.9 Cumulative impulse response function 2004:09 to 2019:12: The interest rate

Note: The dark grey area indicates 95% confidence intervals for cumulative orthogonalized impulse response function. The light grey area indicates 95% confidence intervals for orthogonalized impulse response function. The dashed line denotes the cumulative orthogonalized impulse response function. The dark line denotes the orthogonalized impulse response function.

Overall, a shock to the interest rate triggers an increase of food inflation in the high-income economies of Singapore and Kuwait. Meanwhile, there is a different of impulse response to a positive interest shock in emerging economies. It is noted that in the case of high-income economies, i.e., Singapore and Kuwait, monetary policy tightening appears to react slightly to domestic food price shocks whereas in the case of emerging markets of Vietnam and Indonesia, the monetary policy has a significant impact on domestic food price inflation. The reason is that food plays an important part in the consumption basket and the aggregate demand of developing countries. Thus, higher attention is needed for the central bank to food inflation

as it influences the wage inflation. Consequently, monetary policy is to be tightened through the channel of interest rate in response.

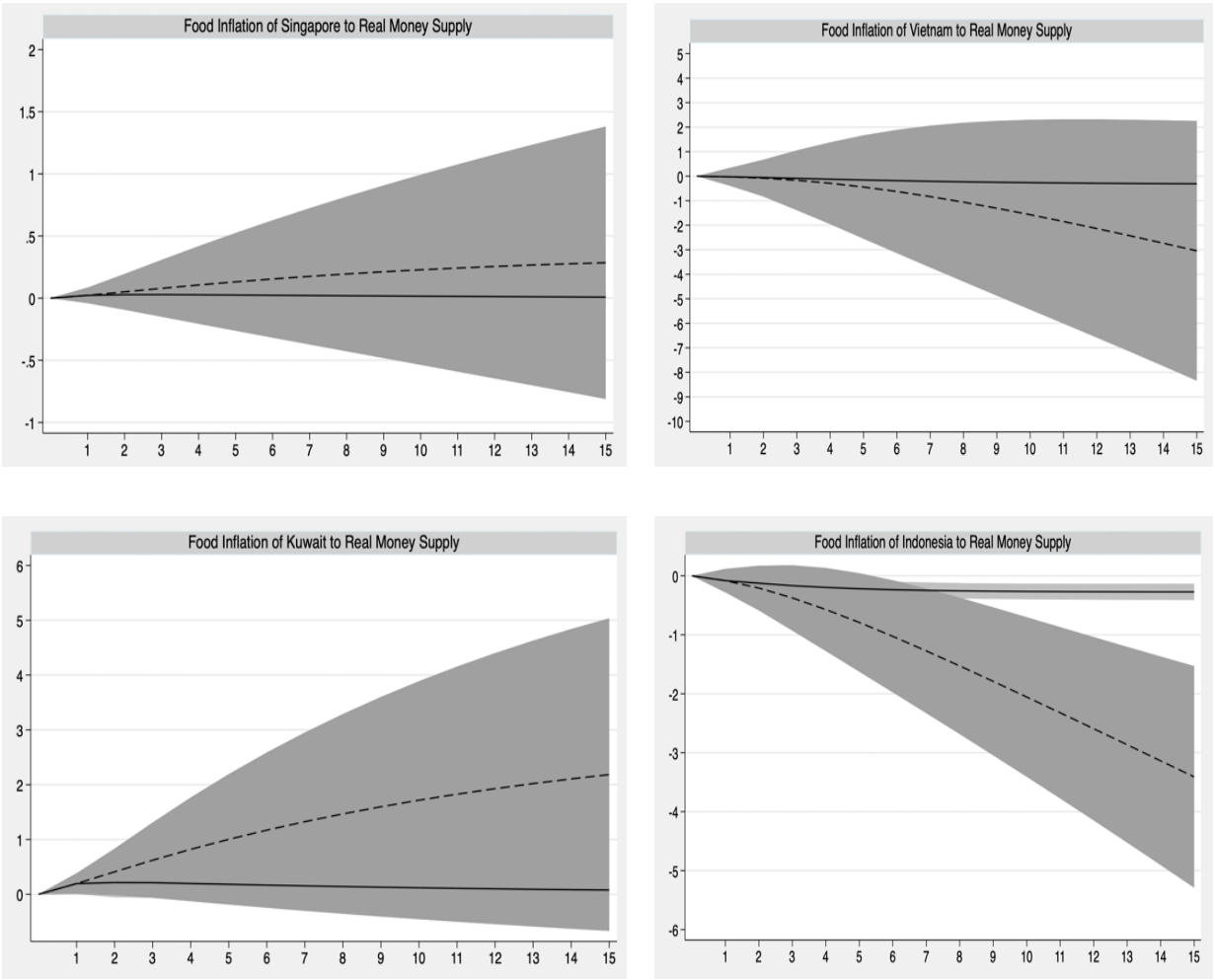

Figure 4.10 Cumulative impulse response function 2004:09 to 2019:12: The real money supply

Note: The dark grey area indicates 95% confidence intervals for cumulative orthogonalized impulse response function. The light grey area indicates 95% confidence intervals for orthogonalized impulse response function. The dashed line denotes the cumulative orthogonalized impulse response function. The dark line denotes the orthogonalized impulse response function.

The cumulative impulse response presented in Figure 4.10 illustrates that the short run response of food inflation due to money supply shocks in the case of high-income countries, i.e., Singapore and Kuwait is significantly similar, to that of the emerging economies of Vietnam and Indonesia, the impulse response function also records a similar direction. As in the graph, for Singapore, this oil-importing country's food inflation shows a negative response

to money supply shock. As such, Singapore's food inflation tends to increase immediately from the beginning. The maximum magnitude of an increase is around 2.5 percent which happens at the end of the horizon. On the contrast, in the case of Vietnam as another oil-importing country, one percent growth in money supply will push the levels of food inflation up by approximately a 3 percent.

The impulse response of Kuwait records a same direction as in the case of Singapore. The time path of the impulse response indicate a gradual increase in food inflation. The maximum rise during the whole period is around 2 percent due to one percentage change. On the other hand, in the case of Indonesia, this oil-exporting country shows the estimated elasticities which present that after one year a one percent rise in the money supply will push the level of the price down by 3.5 percent. In general, from our impulse response results, it is indicated that monetary policy shock does considerably respond to food inflation in both case of oil-importing nations and oil-exporting economies. The magnitude of money supply shocks to food inflation in the case of oil-exporting countries is more pronounced than the case of oil-importing economies.

We test for the stability test using the estimated autoregressive (AR) coefficient matrices and innovations covariance matrix. Figure 4.11 illustrates plots of stability test in the case of four series of four countries. The variables are all in the circle of Characteristic Roots indicate the linear stability as required and the results are clarified to be considerably reliable. We test if the variables have r roots in characteristic roots, or in another word, the variables are in the circle of characteristic roots or not. Figure 4.11 shows the findings of Inverse roots test in the case of Vietnam, Indonesia, Singapore and Kuwait, respectively. All variables in the cases of four countries are plotted in the circles of inverse roots. Thus, the precondition of stationarity of the time series data are noted. Hence, we analyse impulse response function for the four countries. We also confirm that the roots of time series in the case of Vietnam, Indonesia, Singapore and Kuwait are real and distinct. the presence of the integrated variables (and unit moduli) in the VECM representation indicates that a shock can be both permanent and transitory.

Figure 4.11 shows that all the eigenvalues lie within the unit circle so the estimated VAR models are stable. Therefore, our inferences from the IRF function can be noted. We conclude that the responses are consistent with the economic theory or a priori expectations. Besides, the impulse responses trace the influence of structural shocks on the endogenous variables in case of four countries. Each response includes the influence of a specific shock on one of the variables of the system at effect t, then on t+1, and so on. Based on the results from

variance decomposition specifies forecast errors and relationships among the variables, the proportion of the movements of a variable because of the shocks to itself and to shocks is noted to other variables.

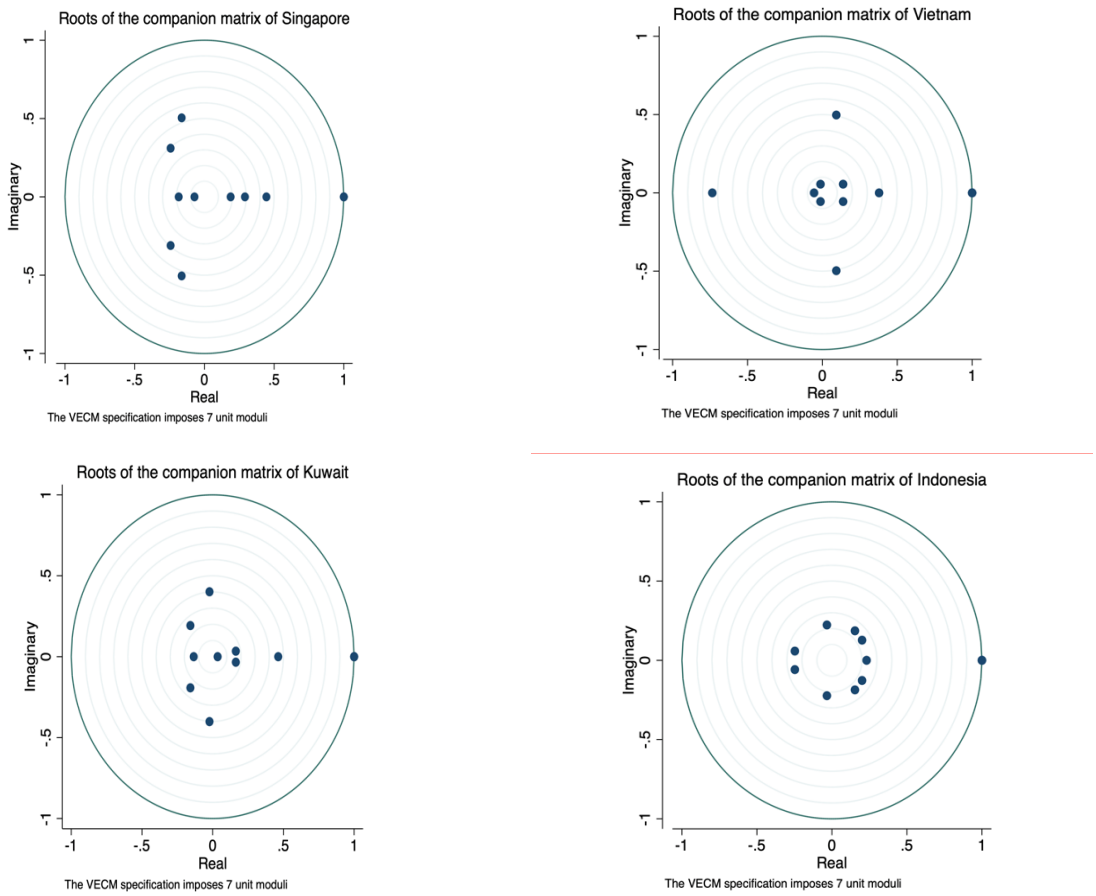

Figure 4.11 Results of plots of stability test of four Asian countries

The residual correlation LM test for autocorrelation is based on the monthly data, thus twelve lags are utilised in the serial correlation LM test. Table 4.3 illustrates the results of LM test for autocorrelation for the four countries. In the case of the oil-importing countries (Singapore and Vietnam) and oil-exporting countries (Kuwait and Indonesia), there is no correlation in the impulse response function. Together with the findings of stability test, all the eigenvalues lie within the unit circle, the estimated VAR equations satisfy the stability condition of the impulse response function.

Table 4.3 Results of Lagrange-multiplier test for autocorrelation

	Singapore		Vietnam		Kuwait		Indonesia	
Lags	df	Prob>χ_2	df	Prob>χ_2	df	Prob>χ_2	df	Prob>χ_2
12	104	0.34	104	0.07	104	0.48	104	0.006

4.5.4 A comparative analysis: Monetary policy response

The impulse response analysis is applied to capture the dynamic impact of a monetary policy response for global food price and global oil price on domestic food inflation in the case of the oil-exporting countries and oil-importing economies. The forecast error variance decomposition (FEVD) analysis is applied to identify and compare the sources of variations in domestic food inflations of four Asian countries over the horizon of fifteen quarters.

In the case of oil-importing economies, the results (Figure 4.12) show that an unexpected monetary tightening has a negative impact on Singapore's food inflation. A standard deviation unexpected positive interest rate shock leads food inflation of Singapore to increase by 0.01% initially, with the impact intensifying in the subsequent quarters. While the interest rate shock shows a negative response, the exchange rate shock indicates positive effects on Singapore's food inflation. As such, following the rise in exchange rate, quarter-on-quarter, the food inflation decreases by 0.05% immediately after the negative change and the impact is transitory. Meanwhile, the real money supply tends to show a negative impact, although none of the effects are significant. Interestingly, the variations of food inflation of Kuwait records similar effect to that Singapore. Moreover, a positive interest rate shock triggers food inflation of Kuwait to increase at around 0.002%. The exchange rate shock, as in the case of Singapore, shows a positive effect on Kuwait's food inflation. The global oil price and real money supply tends to have a relatively slight low negative impact on food inflation of Kuwait. However, in terms of a change in interest rate, food inflation of Indonesia increases significantly into 0.2% at the end of the horizon. Meanwhile, food inflation of Vietnam remains relatively stable.

As shown from the FEVD analysis, overall, there is a similarity about the influence of monetary policy on food inflation between the high-income countries of Singapore and Kuwait and between the emerging economies of Vietnam and Indonesia rather than between oil importing countries (Singapore and Vietnam) and between oil-exporting countries (Kuwait and Indonesia). In the case of Vietnam and Indonesia, real money supply appears to have a small impact on food inflation. When there is a positive change in real money supply of Vietnam, food inflation seems to remain stable whereas in the case of Indonesia, food inflation records a marginal increase of 0.001% initially and gradually declines afterwards. The exchange rate appears to have a small impact on Vietnam and Indonesia's food inflation. In particular, food inflations of Vietnam and Indonesia show a slight increase (reaching approximately 0.05% over the horizon) when there is a positive shock of the exchange rate.

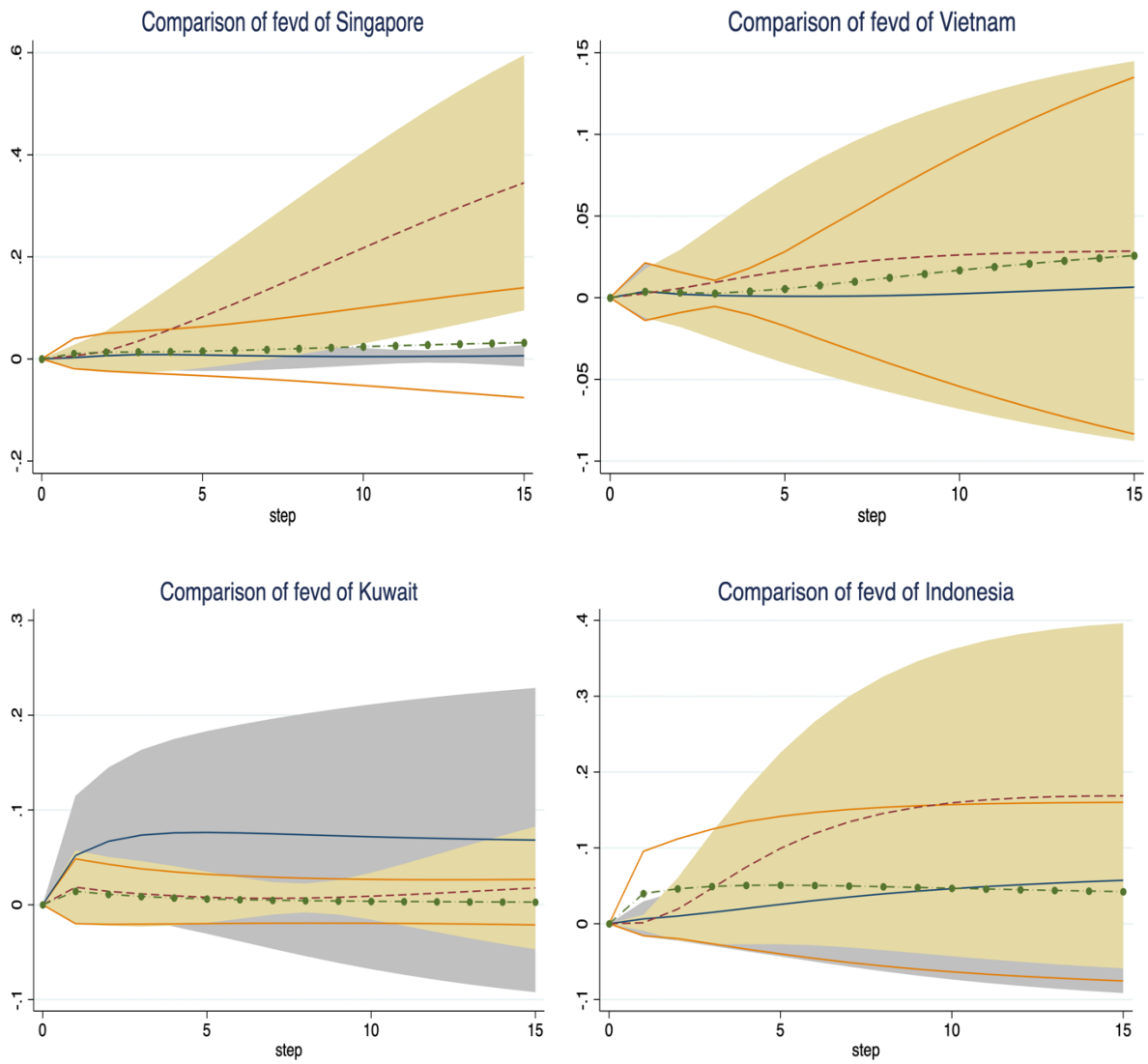

Figure 4.12 Comparison of FEVDs: Monetary policy and global indicators on domestic food inflation

Note. The grey area denotes the 95% confidence intervals of the response of Food Inflation to the real Exchange Rate, the yellow area denotes the 95% confidence intervals of the response of Food Inflation to the Interest Rate, the orange lines denote the bounds of the 95% confidence intervals of the response of Food Inflation to the real Money Supply. The dark blue line indicates the fevd of Food Inflation to the real Exchange Rate, the red dash line indicates the fevd of Food Inflation to the Interest Rate, the green dash-dosh line indicates the fevd of Food Inflation to the real Money Supply.

There is a similarity between the case of oil-importing countries (Singapore and Vietnam) and between the case of oil-exporting countries (Kuwait and Indonesia) is the effect of global oil price on domestic food inflation. In particular, while global oil price index has no impacts on food inflation of Kuwait and Indonesia, it changes food inflation's direction of Singapore and Vietnam in different ways. It is seen that Singapore's food inflation initially

increases then gradually declines around 0%, Vietnam's food inflation increases remarkably by 1% over the horizon when there is a positive shock to global oil price.

Comparing the dynamic macroeconomic effects of an unexpected monetary policy shock in high-income economies visà-vis emerging countries, there is a remarkable and long-lasting negative real impact in the case of emerging economies (Vietnam and Indonesia) more than in the case of high-income economies (Singapore and Kuwait). The findings are in line with the long-standing literature on monetary policy transmission presenting the lack of transmission impacts in developing countries because of the underdeveloped financial and institutional set up in these economies (Toader, Onofrei, Popescu, & Andrieș, 2018). In particular, an unanticipated monetary tightening raises all food prices through the production cost channel of monetary policy transmission.

The results from FEVD analysis also suggest that the drivers of food inflation vary across oil-importing and oil-exporting nations substantially. Besides, variation in domestic food inflation appears to be driven by the variations in global food price, global oil price and macroeconomic factors in both the oil-importing and oil-exporting economies. Thus, the monetary policy considerably impacts domestic food inflation of the emerging countries of Vietnam and Indonesia much rather than high-income economies of Singapore and Kuwait. Thus, the FEVD results of the monetary policies reveal a fantastic picture on the policy priority in the scenarios of four sample economies, especially in the case of developing nations. In the emerging economies, stabilisation of factors of monetary policies are the primary goals of exercising domestic food inflation.

Based on the FEVD results, the next step of estimation is undertaken to forecast the direction of food inflation. The autoregressive integrated moving average (ARIMA) model is employed to estimate the predicted future points of food price index. Figure 4.13 presents change in forecasting function of food inflation in case of four countries.

The inflation forecasting at the 24-month horizon is examined for the domestic food inflation based on an ARIMA framework, and based on macroeconomic variables, including interest rates, the real money supply, the exchange rate, GDP per capita and the global indicators, namely, global food price and global oil price. In the case of Singapore, there is statistical evidence that Singapore's food inflation will fluctuate at around 2% over this horizon. In addition, food inflation of Singapore appears to slightly increase in the near future.

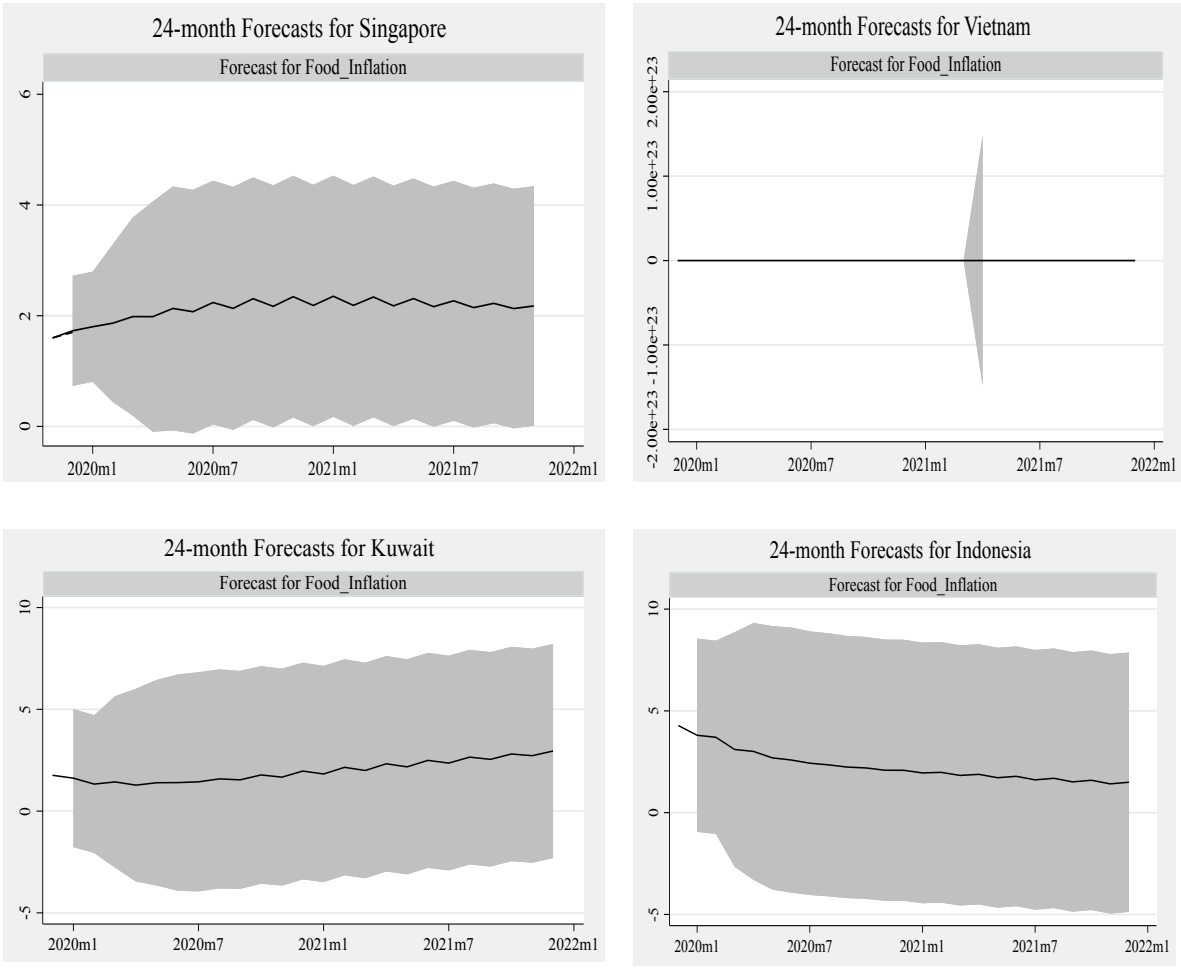

Figure 4.13 Results of forecasting function of domestic food inflation

Note. Grey area indicates 95% confidence intervals. Black line denotes the forecast direction of domestic food inflation.

However, for the case of Vietnam, the food inflation of Vietnam is much more difficult to forecast as Vietnam is self-sufficient in agricultural commodity. As the farm activities and crop growth of Vietnam largely depends on the weather and pest control (Yuen, Hanh, Quynh, Switzer, Teng, & Lee, 2020), the price of domestic agricultural products is difficult to forecast. The monetary policy of Vietnam's government also affects directly the complex matter of forecasting the food inflation. For example, the government attempts to maintain the fixed exchange rate system while facing with increasing foreign capital inflows. Their goal is to keep the food inflation under 4 percent per year (Pham, & Riedel, 2012). However, there is no plan for controlling electricity prices (Nguyen & Turksen, 2020) which impacts the agricultural production and consumption or manage the price of food during the national holidays. In the case of oil-exporting countries, it is seen that the food inflation of Kuwait tends to increase in the case future, reaching approximately 3 % by 2022, whereas food inflation of Indonesia

appears to significantly decline. The forecast of domestic food inflation is important for an appropriate money policy actions of the government authorities.

4.6 Conclusion

This chapter has empirically considered the response of domestic food inflation to a shock of global food price, global oil price and monetary shocks in the case of oil-importing countries of Singapore and Vietnam, and the case of oil-exporting countries of Kuwait and Indonesia, over the monthly period 2004M9 to 2019M12. Utilising the impulse response analysis of VAR model, the results indicate that global food price changes the direction of food inflation of two oil-importing countries in different ways, whereas the global food price shock decreases domestic food price of oil-exporting countries. The positive global oil price change leads to domestic food inflation of four countries to decline at the end of the horizon.

Following the impact of global indicators on domestic food inflation, the effect of monetary policy changes on food inflation in a set of oil-importing and oil-exporting countries is examined. The analysis shows that an unexpected monetary tightening has an impact on food inflation in both oil-importing and oil-exporting economies, especially in the case of Vietnam and Kuwait. The results recommend that in the backdrop of the inflationary pressure starting from the agricultural sector, a monetary tightening policy turns out to destabilise the food sector and overall inflation in the market, especially in the case of developing countries. Within the limited strand of existing literature on monetary policies, the findings from the study fill the gap in the literature pertaining to oil-importing countries and oil-exporting economies. The main results indicate that an unexpected monetary tightening have a significant effect on domestic food inflation in the oil-importing countries and oil-exporting nations. Also, monetary shock appears to remarkably affect domestic food price in the case of emerging economies. Overall, it is noted that there is a fundamental relationship between domestic food inflation and monetary policy and global indicators. An appropriate monetary policy is vital to stabilise and control food inflation, especially in the case of emerging economies. The results obtained there provide policy-makers the monetary policy instruments that can be targeted to domestic food prices and also the forecasting of domestic food prices.

Chapter 5 CONCLUSION AND POLICY IMPLICATIONS

5.1 Introduction

This study empirically examines a series of key impacts of global food price, global oil price and macroeconomic factors on domestic food price in oil-exporting and oil-importing economies. The study is further extended to investigate the response of domestic food inflation to a sudden monetary shock. The methodology used to estimate time series models applied the Vector Error Correction Model (VECM) approach to cointegration and short-run linkage. The GARCH model is also utilised to analyse food volatility in the case of Singapore, Vietnam, Kuwait and Indonesia. To clarify the impulse response of domestic food inflation to a change in monetary policy, Impulse Response function based on the Vector Autoregression (VAR) models is utilised. The study also employs Forecast Error Variance Decomposition to make a comparison between oil-importing countries and oil-exporting countries, so as to investigate the sources of variations in domestic food inflation of the four economies. Based on theorical and practical concerns, the impacts of global food price, global oil price and macroeconomic factors on food inflation are analysed applying monthly data over the period 2004-2019, which includes the period of the global financial crisis (GFC) of 2007-08.

A wide range of models are estimated for the relationships of domestic food price and macroeconomic factors. The VECM based on the autoregressive distributed lag models estimates the relationship between domestic food inflation and global food price, global oil price and various macroeconomic variables. In particular, these macroeconomic variables included are GDP per capita, the real money supply, the real effective exchange rate, and industrial production for the case of two oil-importing countries of Singapore and Vietnam; and the two oil-exporting nations of Kuwait and Indonesia. The structural break analysis for the GFC is taken into consideration.

The analysis for monetary policy and global oil price shocks take into consideration the variables of domestic food price, global oil price, global food price, the real money supply, the real effective exchange rate, and the interest rate. The impulse response functions in chapter four examine the response of domestic food price in the case of oil-importing countries and oil-exporting countries to a sudden change of global oil price shock and a monetary shock. The estimated models provided essential empirical evidence on the relationships of domestic food price of the four countries with global indicators, macroeconomic factors and monetary policy that are robust to model specification. The implications of the results are essential for the upcoming course of agricultural commodity prices as it relies on the course of the

macroeconomic environment, particularly currently with the problematic monetary position in the global economies and macroeconomic environment.

The structure of the chapter is arranged as follows: section 5.2 briefly summarises the contributions and key findings of each of the preceding chapters. Section 5.3 discusses the crucial energy and monetary policy implications and section 5.4 suggests some areas of further research pertaining to global agricultural commodity price and monetary shocks issues for oil importing and oil-exporting nations.

5.2 Chapter summary

The major focus of the study is on the issues of global food price shock, global oil price shock and monetary shocks as they relate to economic growth, agricultural economics and monetary policies in the case of oil-importing and oil-exporting economies. Chapter 1 presents the key issues surrounding the situation of dramatic rise in global food price and oil price uncertainty which exhibits threats to food security and local food inflation. This chapter also outlines the aims and objectives of the study, as well as general data and methodology, and the brief empirical evaluation in the subsequent chapters.

Chapter 2 presents a broad analysis and review of the theoretical and empirical literature on the tightness between global food price shocks and inflationary pressures, focusing on the role and the importance of oil and food price changes in the process of food security and food price stability. This chapter also illustrates the relevant overviews on economies of four sample countries undertaken in this country which includes Singapore, Vietnam, Kuwait and Indonesia. The extensive literature considers the overviews of these economies and relevant studies related to the impacts of macroeconomic factors on local inflationary pressures. Therefore, a clarification of the relationship between global foodstuff prices and domestic food inflation is essential for designing and adjusting monetary policies which could be applied with the global price and monetary policy shocks.

Chapter 3 addresses the issues of domestic food price vulnerability and the potential impacts of short-term deviations between relative food prices and specific macroeconomic vectors on food price vulnerability in the case of oil-importing countries of Singapore and Vietnam and oil-exporting countries of Kuwait and Indonesia. In particular, chapter 3 uses the methodology of VECM and GARCH-ARMA approaches as the major empirical analysis, in order to examine the performance of domestic food price vulnerability of the four countries. We identify the Error Correlation term from the cointegration link between domestic food inflation and specific macroeconomic factors including GDP per capita, the real exchange rate,

the real money supply, industrial production, the real money supply, global oil price and global food price proxies short-run deviations.

Generally, the findings from GARCH-ARMA model show that a positive and significant impact is imposed by the deviations on the vulnerability of domestic food price of both the oil-importing and oil-exporting nations. Furthermore, the presence of macroeconomics spikes brings them closer to permanency although persistence remains less than one. A rise in price vulnerability presents higher uncertainty about the future price index, since the magnitude in which the prices lie in the future becomes much wider. As a consequence, sellers and consumers can be impacted by higher price vulnerability as it augments the risk and uncertainty of the market. Thus, it is important for policymakers to concern about the degree of price vulnerability in order adopt appropriate hedging plans.

Chapter 4 empirically evaluates the impulse response of domestic food inflation of the four countries, i.e., Singapore, Vietnam, Kuwait and Indonesia, to a monetary shock and the global oil price and worldwide food price shocks employing monthly data for the period 2004-2019. The impulse response analysis is conducted in the context of VAR model where global food price, global oil price, the real money supply, the interest rate, the real exchange rate and domestic food inflation variables are included. The results suggest that a negative change in global food price triggers different directions in the case of Singapore and Vietnam as the oil-importing countries. In particular, the global food price shocks increase Singapore's food inflation and decrease Vietnam's food inflation. In the case of oil-exporting countries, global food price shocks decrease domestic food price of Kuwait and Indonesia. In terms of global oil price shocks, a global oil price shock triggers a decline in domestic food inflation of the four economies at the end of the horizon.

Besides the significant impact of global indicators on domestic food inflation, chapter 4 investigates and compares the influence of monetary changes on food inflation in a set of oil-importing and oil-exporting countries. The important finding is that an unexpected monetary tightening have a considerable impact on domestic food inflation in oil-importing countries of Singapore and Vietnam and oil-exporting economies of Kuwait and Indonesia. Monetary shocks also substantially affect domestic food price in the context of developing economies, namely, Vietnam and Indonesia.

Overall, it can be said that there is a strong link between domestic food price and monetary policy and the global indicators. The results obtained are of value to policy-makers in developing monetary policies which help to control domestic food inflation, especially in the case of emerging economies. Furthermore, the presence of macroeconomics spikes suggests an

avenue for future research to examine if there are similar findings across developing and developed countries. The implications of the results are relatively essential for the upcoming course of food price as it relies on the macroeconomic environment.

5.3 Policy implications

This study illustrates that a growth in price shocks implies higher uncertainty about future prices. Due to the range which becomes wider in the future, the producers or sellers and consumers or customers can be influenced by higher price vulnerability as it augments the risk and jeopardy in the food market. Increasing price vulnerability reduces the accuracy of seller's and consumers' forecasts of upcoming food price, thereby leads to high welfare losses to the sellers and customers of food products. It is also crucial for the authorities and policymakers to acknowledge the level of price vulnerability in order to adopt appropriate hedging plan and strategies. Estimated from a policy viewpoint, the findings are vital because the participants receive a notification that the agricultural commodity market can be vulnerable. As a result, it leads them to call for an increase of intervention of the government in reallocating resources. Nevertheless, the global financial crisis also justifies and complicates the resolution of the macroeconomic factors like public deficits and government debts. In particular, the tighter fiscal policies will cause a complexing financial situation of the substantial investments in the agriculture sector whose main purposes are to improve food security, especially for the poor and low-income groups. Besides, other actions can be implemented to slow down and alleviate the effect of macroeconomic policies on food insecurity, for example, the encouragement of trading and financial organisations to enlarge operations which immediately improve access of households to credit and the financial system, and the support by the government sectors of remarkable rises in investments in productive research and innovation dissemination.

This study also identifies the prominent part of external elements in driving domestic food price in the oil-importing and oil-exporting economies. As such, the tasks to monetary policymakers are determining the target degree of inflation. Structural shifts in global oil price and global food price index can cause negative changes in the trend inflation. As a result, a long-term equilibrium of domestic food price index is influenced by changes in GDP per capita, the real exchange rate, the real money supply, industrial production and the global energy and food prices. Besides, due to a shock in global agricultural commodity prices, the capacity of monetary policy in stabilising domestic food price backward to the targeted level is restricted. In the case of oil importing countries, a negative change in the agricultural markets can result in the lower level of inflation rate dynamics given the current target degree which is at 2.5%±

-1.5%. As such, monetary policymakers in oil-importing countries need to take actions immediately to offset the food price shock in order to preserve the stability of the price and to weaken the accomplishment of multiple policy aims and objectives.

The Central Bank or the Monetary Authority enhances the flexibility of monetary system to accommodate for monetary policy objectives. In the past, Monetary Authority of Singapore adjusted their monetary policy to cope with food price shocks. For example, from the onset of the global financial crisis in 2007, unlike other countries, Singapore employed the system of exchange rate rather than interest rate as the major tool of monetary policy. The choice of the basket, band and crawl features of the exchange rate has served as an influential anchor of price stability for Singapore's economy. The effective exchange rate system helps to keep Singapore's food inflation relatively stable over the past 30 years (Yang, 2017). In terms of actions of the Central Bank, a tolerance band preserve the flexibility of the central banks in accommodating the maintenance of other policy objectives (Gnan, Kwapil, & Valderrama, 2018). Besides, the point target helps the central bank to anchor inflation expectations (Buono & Formai, 2018). Thus, for monetary policies, policymakers should ensure that the inflation targeting plays an important role in derailing financial stability and economic enlargement.

For oil-exporting countries, monetary policy plays a crucial role in managing food inflation expectations. In the Asian economies, authorities operate their monetary policies within an inflation targeting frameworks. Inflation expectations should be better anchored. In the context of an economy without a monetary anchor, policymakers need to measure the risks of dislodging inflation anticipations. As a result, an economy will face a less favourable inflation-output combination. Besides, at a time of future global uncertainties, the oil-exporting economies will also face a lower possibility of unduly slowing economic growth.

Besides, there are three other challenges to monetary policymaking in both the case of oil-importing and oil-exporting economies. First, since global oil price and agricultural commodity price have long-lasting impacts on inflation, authorities and policymakers have an important task in differentiating between the transient and permanent influence of the price shocks to formulate a proper policy framework. How the central bank responds to global oil price and global food price changes plays a vital role in determining whether the economies could face the great trade-offs in terms of output fluctuations (Bhattacharya & Jain, 2020). Nevertheless, in case monetary policy fails to respond, the anchoring of inflation expectations is adversely influenced (Berganza, Borrallo, & del Río, 2018). Secondly, there is a debate that whether headline inflation serves as a priority method for an economy. In particular, headline inflation is driven by external macroeconomics shocks while core inflation, serving as an

alternative goal, is not a positive underlying inflationary pressure (Feldkircher & Siklos, 2019). Lastly, monetary policymakers face another issue of determining an appropriate level of inflation target.

In terms of domestic food demanding and supplying, an essential question concerning how monetary policies is to react to the increasing food prices relates to the permanency of a sudden change to food prices. Since food price hikes depend on weather conditions, food price appears to be temporary. In these case, and given well-anchored inflation anticipations, monetary policymakers should pay high attention to the underlying rate of inflation, which is proxied by a series core measures of the inflation rate. As a result, the conduct of this monetary policy avoids an undue vulnerability in employment and output.

5.4 Future Research

This study presents insights and outlooks into domestic food inflation response to a monetary shock and some performance to address vulnerability-related food price analysis. It leads to some new research queries and directions for upcoming research. These emerging issues are important for the impacts of global price shocks to establish better causality and relate empirical and theoretical analysis to financial theory and equilibrium approaches. Below are some main areas identified for future research.

First of all, the study could further analyse the link of excessive events and extreme vulnerability to human welfare and community. The methodological explanation about diverse ways to examine vulnerability and excessive events are crucial to explain the concept of vulnerability and for the events which are the most approachable for welfare analysis. Therefore, future research could centralise on how households, companies and governments expect vulnerability and global price shocks. This could assist on the risk and the degree to which expected shocks differ from unanticipated shocks of social and human welfare. Secondly, in terms of game theoretic modelling of cooperation in coping with global oil price shock and food security, trading activities and storage cooperation could be clarified to raise resilience in food and energy systems.

The next issue is the analysis of regulatory policy instrument in agricultural markets. The influence of speculation and financialization on food price is unspecific on how temporary or permanent position limitations and the taxes of transacting fees which will affect the formation of domestic price, vulnerability and spillovers in the food markets. Thus, agent-based structure can provide a role model for providing policy tools in a context and setting the agent follow predefined behavioural registrations and rules. Another important issue is to

examine the issue of Covid-19 pandemic which is currently a biggest challenge and impact on food prices, consumption, the volatile agricultural commodity price and economic equilibrium approaches. Developing a model integration in the direction of Covid-19 pandemic crisis is crucial not only for clarifying the influence of market risks on the long run improvements but also for appropriately integrating lockdown scenarios issues into agricultural economic and financial structures.

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