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Economic Effects of Oil and Food Price Shocks in Asia and Pacific Countries: An Application of SVAR Model

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ABSTRACT

This study investigates the economic effects of external oil and food price shocks in the context of selected Asia and Pacific countries including Australia, New Zealand, South Korea, Singapore, Hong Kong, Taiwan, India and Thailand. The study is conducted within the framework of SVAR model using quarterly data over the period 1980 to 2010 although start date varies based on availability of data. The study reveals that resource poor countries that specialize in heavy manufacturing industries like Korea and Taiwan are highly affected by international oil price shocks. Oil price shocks negatively affect industrial output growth and exchange rate and positively affect inflation and interest rates. On the other hand, oil poor nations such as Australia and New Zealand with diverse mineral resources other than oil are not affected by oil price shocks. Only exchange rates are affected by oil price shocks in these countries. Furthermore, countries that are oil poor but specialized in international financial services are also not affected by oil price increase. Similarly, developing country Like India with limited reserve of oil is not affected by oil price shock. However, Thailand possessing a number of natural resources other than oil is not accommodative of oil price shocks. Limited impact of food prices can be recorded for India, Korea and Thailand in terms of industrial output, inflation and interest rate. The major impact of food prices is that it helps depreciating real effective exchange rate for almost all countries except Singapore. As a whole, the effects of external oil and food prices depend on the economic characteristics of the countries. The empirical results of this study suggest that oil and food prices should be considered for policy and forecasting purposes especially for Korea, Taiwan and Thailand.

Keywords: oil price; food price; shocks; economic effects; Asia; Pacific; SVAR

1. Introduction

Skyrocketing commodity prices create tensions in the countries regardless of the development status in general and in particular world oil and food price increase intensify it. Because of being necessity commodities and having relatively inelastic demand these two commodities are matter of concerns worldwide. The oil price shocks began in 1970s attracted attentions of many researchers. Oil price shocks have been regarded one of the many reasons for global economic slowdown especially for oil importing countries (Hamilton 1983, Hamilton 1996, Hamilton 2003). High food prices during 1970s also created huge crises worldwide leading to a famine in 1973-74. Recent increase of both oil and food prices renewed the interests of all concerned. It is now generally agreed that increase in oil prices help declining economic activities of the oil importers countries. It is also believed that oil price also help food prices to increase and joint hike of these two prices even worsen the situation. Oil is engine for economic activities and so increase in oil prices have direct impact on many economic activities while food is not any direct input for any production. But that must not be the reasons to ignore food prices. Food importers and exporters both may be affected by food prices. It may increase import bill for importers, may create pressure on wages, and may condense the food export demand for food exporters. This is how food prices may contribute to the downturn of economic activities of both food exporters and importers countries. Although many studies document the impacts of oil prices on economic activities in developed countries and partially in the countries outside the USA and Western Europe, dearth of studies are available in the context of the impacts of food prices.

The aim of the current study is to examine the impacts of world oil and food prices on industrial production, inflation, real effective exchange rate, interest rate and stock prices in the context of Australia, New Zealand, South Korea, Singapore, Hong Kong, Taiwan, India and Thailand. These Asia pacific countries hold important positions in the context of world in terms of oil consumption; economic growth; share in world GDP; and economic freeness to world economies. In addition, all these countries are net oil importers while some of these are food exporters, e.g. Australia, New Zealand, India and Thailand and some are food importers, e.g. Korea, Singapore, Hong Kong, Taiwan. Moreover, all these countries are export oriented. A very few studies are available to address the impacts of oil prices in these countries and no studies are available on the effects of food prices. Hence, the current study sheds light on the impacts of oil and food prices on these countries and identifies similarity and disparity among them in terms of the effects. The study is conducted within the framework of structural VAR model using quarterly data for the period of 1980 to 2010 although start date varies for some countries based on the availability of data for all series. Different linear and non-linear transformations of oil and food prices are used to estimate models.

The remaining part of the paper is structured as follows. Section 2 discusses and summarises existing literature; section 3 provides an overview of the theoretical channels of oil and food price shocks to the economic variables; section 4 introduces data and their sources; methods used in the analysis of data are presented in section 5 while section 6 reports empirical results; section 7 discusses the findings with possible policy implications and limitations; and section 8 draws relevant conclusions of the study.

2. Literature Review

Strand literature is available dealing with oil price-macroeconomic relationship although not many studies focus on food price-macroeconomic relationship. In this section we briefly discuss available literature on the impacts of oil and food price shocks related to this study. We limit our survey to the net oil importer countries' perspective. We start discussion with oil price and will end up with the impacts of food prices.

The impacts of oil prices on macroeconomic activities have been studied widely beginning with the pioneering work of Hamilton (1983). Using Sims' (1980) VAR approach to US data for the period 1948-1980, the author shows that oil price and the USA's GNP growth exhibit a strong correlation. The author also reports that oil prices increased sharply prior to every recession in the US after World War II. Following Hamilton, a number of studies document the adverse impact oil prices on the GDP of the USA (Gisser and Goodwin 1986, Mork 1989, Lee *et al.* 1995, Hamilton 1996, Hamilton 2003).

Some studies focus on the effects of oil prices under the framework of market structures. The effects of oil price increase on output and real wages have been shown by Rotemberg and Woodford (1996) in an imperfectly competitive market scenario. In their study, it has been shown that 1 percent oil price increase contributes to 0.25 percent output and 0.09 percent real wage decline. And these results have been supported by Finn(2000). Finn studies oil price and macroeconomic relationship under perfect competition. According to the author, the adverse effect of oil price increase on economic activity is indifferent to the market structure. Regardless of the structure of the market, perfect or imperfect, oil price increase negatively affects economic activity.

The impacts of oil prices have also been studied in the sectoral level using individual sectorwise data. Applying tests to micro level panel data, Keane and Prasad (1996) provide evidence that oil price increase negatively affect real wage, however, for skilled workers the result is different. In their study, they disentangled labour in terms of their skill level and found that impact of oil price on real wage varies for skills. In a similar study, Davis et al. (1997) document that oil price played a dominant role in regional unemployment fluctuation and employment growth since 1970. In another study, Davis and Haltiwanger (2001) employing VAR in a sectoral format demonstrate that oil shocks play a prominent role to the short run fluctuation of job destruction. The results are asymmetric that oil prices response was only to job destruction and not to job creation and they find that the impact of oil price shock is almost double than monetary shocks for US data they estimate for the period of 1972 to 1988. Lee and Ni (2002), applying identified VAR model with US industry level data, examine the effects of oil price shocks on various industries and report that oil price has short run effects on the output of industries. Tests also identify that oil shocks affect both demand and supply of industries. It reduces the supply of oil intensive industries and at the same time demand for some other industries like automobile declines. Likewise, Lippi and Nobili (2009) study structural shocks (oil costs, industrial production and other macro economic variables) on US data and add evidence that negative oil supply shocks reduce US output and positive oil demand shock has positive and persistent impact on GDP. In a recent study, Francesco(2009) illustrates, with UK manufacturing and services sector data, that in linear data oil price shocks have positive impact on both the output of manufacturing and services sector while asymmetric specification reveals that oil price increases influence to contract manufacturing output and does not affect services sector. However, services sector responds to oil price decrease while manufacturing sector does not.

What might be the causes of asymmetric effects of oil price shocks? Is it the result of monetary policy or something else? Hamilton (1988) provides an explanation that the reason of asymmetry might be the adjustment cost of oil price change while a different explanation is reported by Ferderer (1996). According to his findings, sectoral shocks and uncertainty could lie behind asymmetry, and monetary channel is not responsible for asymmetric effect of oil price shock. However, Bernanke et al.(1997) establish that the effect of oil shock on economy is not due to the change of oil price rather contractionary monetary policy is responsible for asymmetric effect of oil price shocks. They suggest that monetary policy can be utilised to minimise consequences of recessions which, however, is criticised by Hamilton and Herrera (2004). In reply to Hamilton and Herrera's challenge Bernanke et al. (2004) reconfirm that intensity of any exogenous shocks depend on the response of the monetary authority's reaction on the shock. They restate their findings that the negative impacts of an oil price on output are decreased when the endogenous response of the funds rate is reduced. Balke et al. (2002) in their empirical study find that asymmetry transmits through market rate of interest and monetary policy is not solely responsible for asymmetric effects. In a recent study Lee et al.(2009) provide evidence for Korea that monetary responses to oil shock affect economic activity and accommodative policy responses provide better results.

A set of studies are also available in the literature regarding oil data specification. Most of the studies are based on log real price of oil in linear form. But the question is whether oil data really generate in linear process? This issue attracted attention of many scholars. In this regard pioneering effort has been put forward by Mork (1989). Mork (1989) used data of oil price increase and decrease to show the asymmetric effects of oil price on the US GDP. After Mork, Hamilton (1996) also proposed a nonlinear measure of data what he termed as flexible approach to nonlinear modelling of oil data. His measure is termed as net oil price increase (NOPI). Following Hamilton, Lee et al.(1995) provided another nonlinear measure of oil price using GARCH models which is known as volatility adjusted series of oil price. Asymmetric effects of oil price shocks on the economic activities are documented in some recent studies as well (Andreopoulos 2009). In a different line of study, Kilian and Vigfussion (2009) document that these kinds of asymmetric specifications of oil price increase and decrease as misspecifications. In their study, they establish that structural models of asymmetric effects of energy price increase and decrease cannot be estimated by a VAR representation. They proposed an alternative structural regression of tests of symmetry to estimate models. They suggest a fundamental change required in methods to estimate asymmetric effects of oil energy price shocks although this evidence is noted as complementary rather than challenge by Hamilton (2010).

Some studies focus on the magnitude and strength of oil price shocks. One of those is Burbidge and Harrison (1984). By using VAR approach they demonstrate that oil price has adverse effects on the macroeconomic variables in five OECD countries. However, they show that oil price shock of 1973-74 was different from that of 1979-1980. During 1973-74 the influence of price over macroeconomic variables were quite strong in their findings. Similar findings are drawn in Blanchard and Gali (2007). In that paper the authors argue that oil price shock of 1970s and 2000s are quite different because of four reasons: lack of concurrent adverse shock with recent oil shocks; smaller share of oil in production; more flexible labour markets and improved monetary policy. According to them, because of these four reasons recent effects of oil price is milder than 1970s. Using Markov-state switching approach Raymond and Rich (1997) demonstrate that net real oil price increases contribute to the switches of mean growth rate of GDP during 1973-75 and 1980 recessions and it partially explains the shift of 1990-91 recessions. Bohi (1991) reports that role of oil price shocks to recessions of 1970s was not supported by data. According to his study, there is no connection between energy intensity and economic activity variables from manufacturing industries of four industrialised countries. He suggested that monetary policy can be alternative explanations of recessions.

In the same line, Hooker (1996) by using multivariate Granger causality tests argues that there is no linear or asymmetric relationship between oil price and macroeconomic variables. Mentioning oil price as an endogenous variable Hooker pointed out that oil price no longer Granger causes many macroeconomic indicators of the USA after 1973 though evidence is found before 1973. However, in a different kind of study Hooker as one of the co-authors (Carruth *et al.* 1998) document that real oil prices Granger cause unemployment in the USA. In line with Hooker (1996), Segal (2007) argues, oil price shock is no longer a shock. Citing monetary policy as one of the important routes of oil price transmission the author argues that when oil prices pass through to core inflation, interest rates are raised by monetary authority which consequently slows down economic growth and therefore oil price has relatively small effect on the macroeconomy.

Most of the studies we have discussed so far are based on the US data but there are a number of studies which deal with data from other regions of the world. Bjørnland (2000) studies the dynamic effects of aggregate demand, supply and oil price shocks for data set taken from the U.S., UK, Germany and Norway and provide evidence that the oil price maintains negative relationship with GDP for all countries but Norway. Cuñado and Gracia (2003) study the behaviour of oil price and GDP movement in some European countries by using cointegrating VAR approach. Although mixed results for different countries found, they provide the evidence that oil price has negative effects on overall macroeconomic activity. However, volatility adjusted measure suggested by Lee et al. (1995) document that there is no evidence that macroeconomic effects of oil price depend on the volatility. Using a Factor-Augmented Vector autoregressive approach Lescaroux and Mignon (2009) report positive relationship between oil price and CPI, PPI and interest rates and negative impact of oil price shock on output, consumption and investment for China. In similar line, Tang et al.(2010) study short and long run effects of oil price on China; by using structural vector autoregressive (SVAR) model they show that increase of oil price negatively affect output and investment but positively affect inflation and interest rate or in other words, they document adverse effect of oil price shock on macro economy of China.

By using nonlinear specification of oil price measure Zhang and Reed (2008) show that in the case of Japan, asymmetric effect of oil price shocks to economic growth exists. To observe the macroeconomic effects of oil price shocks Cologni and Manera(2009) use different regime switching models for G-7 countries and establish that different nonlinear definitions of oil price contribute to better description of oil impact to output growth and they also found that explanatory role of oil shocks to different recessionary episodes changed across time. Asymmetric impacts of oil price on economic activities were also studied by Huang et al. (2005). They apply multivariable threshold model to the US, Canada and Japan's data. Their study reports that oil price change has better explanatory power on economic activities than oil price volatility.

A number of studies focus on the relationship between oil price and exchange rates. Some studies report that there is causality from oil price to exchange rates (Amano and van Norden 1998, Akram 2004, Benassy-Quere *et al.* 2005, Lizardo and Mollick 2010). Some others report that exchange rate influence the prices of crude oil(Brown and Phillips 1986, Cooper 1994, Yousefi and Wirjanto 2004, Zhang *et al.* 2008) while few studies show that oil prices do not have any relationship with exchange rates(Aleisa and Dibooglu 2002, Breitenfeller and Cuaresma 2008).

Studies also contribute to the association between oil prices and stock prices. Jones and Kaul (1996) for the US and Canada; Papapetrou (2001) for Greece; Sadorsky (1999, Sadorsky 2003) for the US; Basher and Sadorsky (2006) for some emerging markets; and (Park and Ratti 2008) for the US and 13 European countries report that oil prices negatively affect stock prices. However, few studies find little or no relationship between oil and stock prices (Huang *et al.* 1996, Chen *et al.* 2007, Cong *et al.* 2008, Apergis and Miller 2009)

So far different dimensions of oil price shocks have been discussed in light of the literature available since 1983 to earliest 2010. The survey of literature have shown the causes of oil price shocks along with its consequences to the economic activities mainly adverse effects with minor exception of it and researches are still on to find even more compact conclusion about the oil price shocks. The question whether oil price shocks still matter for the economic activities are being answered even in recent studies (Lescaroux 2011).

Now we focus on the studies available on the effects of food price to macroeconomy. As stated above that food price has not been widely studied, however, the available literature in regards to the effects of food prices on macro variables are presented as follows. Abott et al. (2009) identify depreciation of U.S. dollar, change in consumption and production and growth in bio-fuel production as major drivers of food price hike. Aksoy and Ng (2008) study whether food price good or bad for net food importers and they reveal mixed results that for low income countries food price shocks deteriorate the food trade balances whereas for middle income countries the trade balances improve due to food price shocks. von Braun (2008) reports that net food importer countries become affected by high food prices. Galesi and Lombardi (2009a), document that oil and food price shocks have different inflationary effects. For their sample period (1999-2007) they find that the inflationary effects of oil price mostly affect developed regions whereas food price shocks affect emerging economies only.

To sum up, the literature shows that most of the studies are based on developed countries and only few are available outside G-7 countries. Although the impacts of oil prices have been studied widely the impacts of food prices have not been attended in the empirical studies. And thus the objective of this study is to focus on these unattended areas of study. This study intends to assess the impacts of both oil and food prices to a number of Asia and Pacific countries namely Australia, New Zealand, Korea, Singapore, Hong Kong, Taiwan, India and Thailand. The choice of the study area is rationalized in terms of lack of studies in the Asia Pacific region. The countries are considered as well representation of the region because two of these countries are from South Pacific (Australia and New Zealand), two countries from ASEAN (Singapore and Thailand), two countries from greater China (Hong Kong and Taiwan) and one from East Asia (South Korea) and one from South Asia (India). Due emphasis has been given to the emerging and newly developed countries as well as openness to the international economy. Because of these reasons we do not include Japan and China. As mentioned earlier, few or no studies are available in these countries. To the best of our knowledge, the available studies in these areas are as follows. Faff and Brailsford(1999) find relationship between oil price and stock market returns in Australia. They report positive sensitivity of oil and gas related stock prices to oil prices while negative sensitivity is reported for paper, packaging, transport and banking industries. Valadkhani and

Mitchell (2002), using input-output model, report that oil price helps increase consumer price indices in Australia and the strength of shock is stronger during 70s than the recent period. Gil-Alana (2003) reports that real oil prices and unemployment maintain a cointegrated relationship. Gounder and Bartlett (2007) document adverse impacts of oil prices to the economic variables of New Zealand. Negative impacts of oil prices to economic activities of South Korea and Thailand and no significant impacts in the case of Singapore are reported in Cuňado and Gracia(2005). Hsieh (2008) also reports that oil prices help declining real GDP of Korea. In the case of Singapore, Chang and Wong (2003) document marginal impacts of oil prices on the macroeconomic activities and no evidence of adverse impacts of oil prices to are reported for Hong Kong in Ran et al.(2010). Managi and Kumar (2009) using VAR models register that oil prices Granger causes industrial production in India. Rafiq et al.(2009) show that oil price volatility exerts adverse impacts on the macroeconomic variables in Thailand.

The paucity of studies in these countries is one of the main inspirations for the persuasion of the current study. This study would be distinct from the existing studies in these areas in different aspects. First, we use latest data until 2010 which includes two major oil shocks of 2007-08 and 2010. Inclusion of these recent shocks will enhance understanding of the impacts of oil prices on economic activities. Second, the study considers both oil and food price shocks in the model to examine the dynamic interactions of these two variables to the economic variables of the concerned countries. Finally, we implement the study within the framework structural VAR model which is rarely used in previous studies in general and is not used in particular for the countries covered by this study.

3. Transmission channels of oil and food price shocks to economic activities

Theoretical argument about the relationship between oil price and food prices is now eased off. It is well documented that oil prices transmit to economic activities through different channels. According to Brown and Yücel (2002), the channels of shocks transmission are classical supply side effects, income transfer from oil importers to oil exporter countries, real balance effect and monetary policy. In line with above channels, Lardic and Mignon (2008) added that oil price increase may affect inflation, consumption, investment and stock prices. These channels have been found effectual in many empirical studies both in developed and developing countries.

On the other hand, food prices are becoming a major issue worldwide. It is argued that oil and food prices both are responsible for slowing down world economic growth. Few studies focused on the food price and macroeconomic relationship (Headey and Fan 2008, Abott *et al.* 2009, Galesi and Lombardi 2009b, Hakro and Omezzine 2010). These studies provide evidence that food prices transmit to the macroeconomic variables such as inflation, output, interest rate, exchange rate and terms of trade. Based on these theoretical constructs, we develop following transmission channel for the purpose of this study, as shown in Figure 2, for analyzing oil/food price-macroeconomic relationships.

We start with two price shocks- oil and food. When oil price increases manufacturing cost increases and as a result industrial production falls. From food importers' point of view, the import bills increase which leads to decrease the net exports causing national output to fall. From food exporters' point of view, when food prices increase globally the demand for food export decrease which ultimately reduces the net export a part of national output. The other explanation could be when food prices increase, the employees seek higher wages. If that happens, demand for labour decreases and production hampers which ultimately decreases production. It is now well agreed in theory that when global oil and food price increase inflation increases worldwide. Because of oil and food price increase when inflation increases it increases demand for money. As money demand increases the rate of money market interest rate increases. Moreover, the increase of inflation and interest rate due to oil and food price shock may have adverse effect on the exchange rates. It is also plausible to infer that when other macroeconomic indicators are adversely affected by oil and food price shocks, it will hamper the profitability of industries which will reduce the demand for stock in the financial market. As a consequence, the stock prices in the market will decrease.

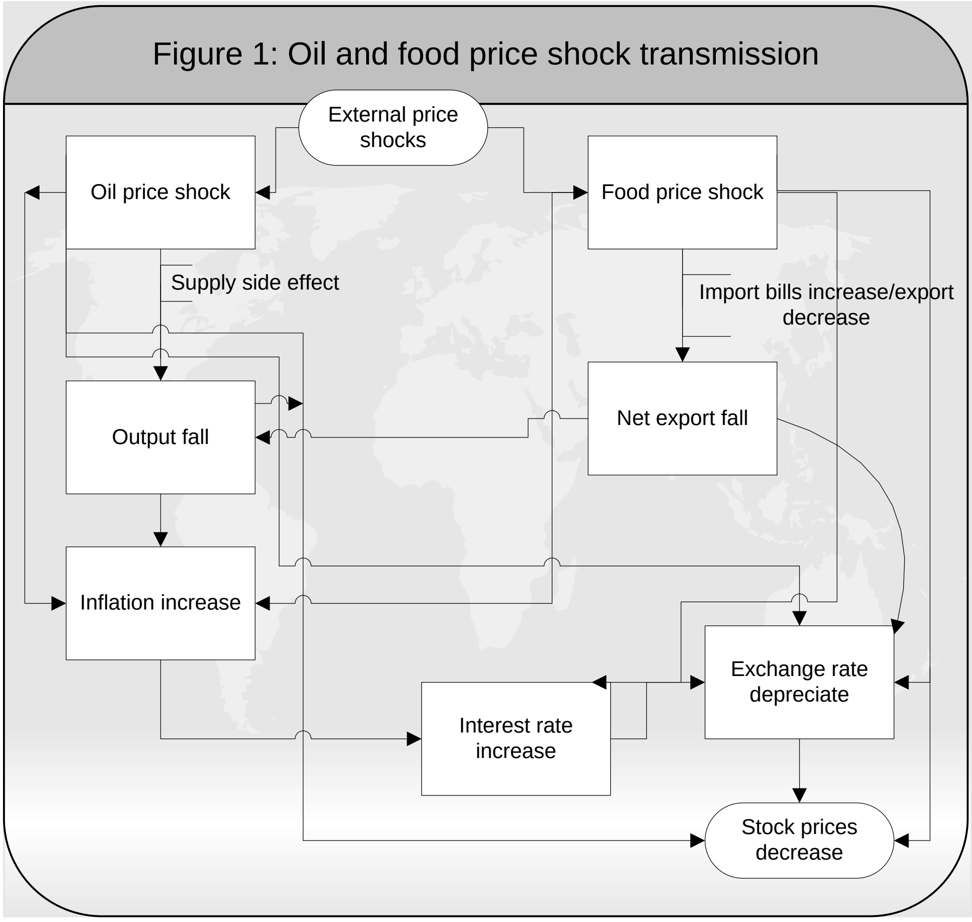


Figure 1: Oil and food price shock transmission

4. Data and sources

We use data for world oil and food prices along with selected macroeconomic and financial variables such as industrial/manufacturing production indices (IP/MP), consumer price indices (CPI), lending rate (IR), real effective exchange rate (REER), and stock price indices (SPI) for 8 Asia and Pacific countries namely Australia (AUS), New Zealand (NZ), South Korea (KOR), Singapore (SIN), Hong Kong (HK), Taiwan (TWN), India (IN) and Thailand (TH). As proxy for world oil price we use Dubai spot prices measured in US$ per barrel because Dubai price is more relevant to these Asia and Pacific countries and also Dubai price is internationally more trading index in the context of Asia and Pacific. For world food price, world food price indices are used. Our main objective is to check the impacts of oil and food prices to industrial production growth and inflation. However, we add exchange rate and interest rate to examine the channels of external and monetary sector. We also add stock price indices to assess the impacts in the financial sector. Data are mainly sourced from International Financial Statistics (IFS) of IMF. Seasonally adjusted series are collected for IP/MP from IFS database. In the case of other series data are seasonally adjusted by US census-X11 in Eviews.

It has been argued that the effects of oil price shocks to macroeconomic variables are mild after 1980s and onwards. We thus target to collect quarterly data over the period 1980 to 2010 to examine this proposition. However, because of unavailability of data the start date varies country to country. For Australia data for all series are available from 1980Q1 to 2010 Q2 making total 122 observations. In the New Zealand case, data are available for the period 1987Q1 to 2010Q3 making a total of 93 observations. The availability of data helps to collect data after major economic reform in New Zealand economy. Korean data are available for the period 1980Q3 to 2010Q3 making a total of 121 observations. Singapore data are available from 1985Q1 to 2010Q4- a total of 104 observations. We find 67 available observations for Hong Kong from 1994Q1 to 2010Q2 2010. Available data for Taiwan is only 26 observations over the period 2003Q4 to2010Q4. We collect 69 available observations for all series for India ranging from 1999Q1 to 2010Q2. Data for Thailand is available from 1997Q1 to 2010Q4 forming a total of 54 observations.

Taiwanese data are not available from IFS database and thus we search different sources for data. Sources of Taiwan data include central bank of Taiwan, Taiwan stock exchange, National Statistics, and Taipei foreign exchange development. Monthly REER data is collected from Taipei foreign exchange development that covers from January 2000 to December 2010). Data obtained from National Statistics are consumer price index (CPI). Monthly REER and CPI are converted to quarterly series using cubic spline interpolation method. Share price index (SPI) data are collected from Taiwan stock exchange corp. in monthly from and interpolated to quarterly series. Lending rate (LR) data is collected from

Taiwan central bank. Industrial production index is collected from department of statistics under Ministry of economic affairs. REER and MPI series for Thailand are collected from Bank of Thailand in monthly frequencies and then interpolated to quarterly series. REER series for India has been collected form Reserve Bank of India (RBI) bulletin in monthly format base year for which is 1993-94 since January 1993 to 2010 and then interpolated to quarterly series.

We use real oil (ROP) and food prices (RFP) in domestic currencies for each country. In order to transform nominal oil/food price to real price we use nominal exchange rate and CPI for every country. The real series are computed in the following way:

$rop_t / rfp_t = op_t / f_t p * \frac{e_t}{cpi_t}$ Where rop_t/rfp_t stands for real oil or food prices; op_t/fp_t represents nominal oil/food prices, e_t stands for nominal exchange rate while cpi_t represents consumer price indices.

In the case of both oil and food price four series of data are generated by using raw data. With a view to observe the effects of external price shocks, the first series are used in level data as it is. Following Mork (1989) the asymmetric form of oil price and food price are computed as follows:

$O_t/F_t^{+} = O_t/F_t$, if $O_t/F_t > 0$ or 0 otherwise

$O_t/F_t^{-} = O_t/F_t$, if $O_t/F_t < 0$ or 0 otherwise

Where O_t/F_t is the rate of change of real price of oil or food.

Following Hamilton's (1996) fashion, the net oil price increase/net food price increase for four quarter (NOPI4/NOFI4) is calculated in the following way:

$NOPI_t = \max[0, OP_t - \max(op_{t-1}, op_{t-2}, op_{t-3}, op_{t-4})]$

$NOFI_t = \max[0, FP_t - \max(fp_{t-1}, fp_{t-2}, fp_{t-3}, fp_{t-4})]$

The nonlinear specification of oil data provided by Lee et al. (1995) in a GARCH (1, 1) framework are as follows O^*_t:

$$o_t = \alpha + \sum_{i=1}^{k} \beta_i o_{t-i} + \varepsilon_t$$
$$\varepsilon_t = e_t \sqrt{h_t}, e_t \sim N(0,1)$$
$$h_t = \gamma_0 + \gamma_1 \varepsilon^2_{t-1} + \gamma_2 h_{t-1}$$
$$o*_t = \max(0, \hat{\varepsilon}_t / \sqrt{h_t}$$

Similarly, we compute scaled food price increase following above method of Lee et al. (1995). We use industrial production growth (EG) and growth of CPI (inf)[1] instead of level data for other series except interest rate we transform data into natural logarithm.

5. Methodology

The econometric methods used in this study are as follows. This study covers almost 30 years quarterly data ranges from 1980 to 2010. In this long span of time many structural changes happened in the countries covered by this study. To be on the safe side, we first test for the structural breaks in the series included in the study. Literature provides several tests to identify structural breaks in time series data of which we employ two here. We use both the Lumsdaine-Papell (Lumsdaine and Papell 1997) and Lee-Strazicich(Lee and Strazicich 2003) unit root tests to determine possible breaks in macroeconomic time series. Second, we check the order of integration for data by using both Augmented Dickey Fuller (ADF) (Dickey and Fuller 1979) and Phillips-Perron(1987) unit root tests. Based on the properties of series, we proceed for further investigation whether we need to conduct cointegration test or not. If we find all series integrated with order 1, I(1) we will proceed for cointegration test. If all series are not integrated with order 1 or in other words, we find mixture of both I(0) and I(1) the we will follow some common practices, in line with Farzanegan (2009), Tang et al.(2010) and Iwayemi and Fowowe (2011) estimating model in structural VAR framework in level without losing the exact properties of data.

As an estimation procedure, we develop 7 variable structural vector autoregressive (SVAR) models. In fact, we develop three models; one with world oil price shock as exogenous variable (SVAR-6); one with world food price shock as exogenous variable (SVAR-6) and the third one with both oil and food price shocks in the same model (SVAR-7). We briefly introduce SVAR framework in the following section.

[1] $EG = IP_t\text{-}IP_{t-1}/IP_t$ and inflation(inf)= $CPI_t\text{-}CPI_{t-1}/CPI_t$

[2] Although we did not require cointegration tests for multiple series we conducted bivariate cointegration tests to check long run relationship between oil/food price and macroeconomic variables (for example, oil price and CPI or food price and

5.1 Structural vector autoregressive (SVAR) model specification

We start with the following structural VAR(p) model as provided by Breitung et al.(2004).

$$AX_t = A_1X_{t-1} + \dots\dots\dots + A_pX_{t-p} + B\varepsilon_t$$

Where A is a *k x k* invertible matrix of structural coefficients, X_t is the vector of endogeneous variables (SPI_t, $REER_t$, IR_t, INF_t, EG_t, OP_t/FP_t), $\varepsilon_t \sim (0, \Sigma_\varepsilon)$. A_is are *k x k* matrices which captures dynamic interactions between the k variables while B is another *k x k* matrix of structural coefficients representing effects of structural shocks and p is the number of lagged terms which will be determined by information criteria, SC.

The corresponding estimable reduced form model can be obtained by pre-multiplying the above model with inverse of matrix A, A^{-1} as written below:

$$X_t = A_1^*X_{t-1} + \dots\dots\dots + A_p^*X_{t-p} + \mu_t$$

Where A_i^* is equal to $A^{-1}A_i$. The reduced form residuals relates to the structural residuals as follows:

$$\mu_t = A^{-1}B\varepsilon_t \text{ Or, } A\mu_t = B\varepsilon_t$$

Where $\mu \sim (0, \Sigma_\mu)$, A and B are k x k matrices to be estimated while Σ_μ is the variance covariance matrix of reduced form residuals and contains k(k+1) distinct elements (Amisano and Giannini 1997).

In the next step, to identify structural form parameters we have to place restrictions on the parameter matrices. To make model parsimonious and to avoid invalid restrictions, consistent with common practices, we place just/exact identifying restrictions. The main assumptions regarding parameter restrictions are as follows. We assume that structural variance covariance matrix; Σ_ε, is a diagonal matrix and is normalized to be an identity matrix, I_k. We follow recursive identification scheme and thus we assume that A is an identity matrix while B is an upper triangular matrix. The contemporaneous relationships among the variables are captured by B.

Once we have defined our matrices, we now need the number of restrictions. According to Breitung et al.(2004), when one of the A or B matrix is assumed to be identity then we need K(K-1)/2 additional restrictions to be placed, where K is the number of variables. In our case we have 6 variables and 7 variables models; therefore, we need 15 (6 variables) or 21(7 variables) additional restrictions to estimate models.

For these additional restrictions we look into the economic theory. Let us first introduce our 6 variable SVAR model with external oil price. Regardless of the economic conditions of eight different economies covered by this study we assume, in line with Tang et al.(2010), that oil price is exogenous and other variables are endogenous. We order variables as (spi, reer, ir, inf, ip and op) for the 6 variable model with oil price. Oil price is included in the model in different format of nonlinear transformation as mentioned in the data section. The matrix format of the ordering is as follows:

$$\mathrm{B}\varepsilon = \begin{pmatrix} b_{11} & b_{12} & b_{13} & b_{14} & b_{15} & b_{16} \\ 0 & b_{22} & b_{23} & b_{24} & b_{25} & b_{26} \\ 0 & 0 & b_{33} & b_{34} & b_{35} & b_{36} \\ 0 & 0 & 0 & b_{44} & b_{45} & b_{46} \\ 0 & 0 & 0 & 0 & b_{55} & b_{56} \\ 0 & 0 & 0 & 0 & 0 & b_{66} \end{pmatrix} \begin{pmatrix} \varepsilon_{spi} \\ \varepsilon_{reer} \\ \varepsilon_{ir} \\ \varepsilon_{\inf} \\ \varepsilon_{eg} \\ \varepsilon_{op} \end{pmatrix}$$

For this ordering, we assume that oil price shock is not affected contemporaneously by other shocks and it can affect all other endogenous variables and thus we place 5 restrictions here, ($\varepsilon_{op} = b_{66}. \varepsilon_{op}$). Second, we assume that industrial production or economic growth is affected by itself and oil prices and hence we put 4 restrictions ($\varepsilon_{eg} = b_{55}. \varepsilon_{eg} + b_{56}. \varepsilon_{op}$). Third, we assume that for the contemporaneous period inflation/CPI shock is only affected by itself, output shock and oil price shock while these three affect all other variables. Here we put 3 restrictions, ($\varepsilon_{inf} = b_{44}. \varepsilon_{inf} + b_{45}. \varepsilon_{eg} + b_{46}. \varepsilon_{op}$). Fourth shock in the list is short term interest rate. We assume that it is not affected by real exchange rate and stock price shocks (2 restrictions) for the contemporaneous period while it is affected by all other shocks, ($\varepsilon_{ir} = b_{33}. \varepsilon_{ir} + b_{34}. \varepsilon_{inf} + b_{35}. \varepsilon_{eg} + b_{36}. \varepsilon_{op}$). For the remaining 1 restriction, we assume stock price shock do not affect real exchange rate while all other shocks may influence it, ($\varepsilon_{reer} = b_{22}. \varepsilon_{reer} + b_{23}. \varepsilon_{ir} + b_{24}. \varepsilon_{inf} + b_{25}. \varepsilon_{eg} + b_{26}. \varepsilon_{op}$).

Similarly, we construct order for our next model of 6 variables with world food price shock as exogenous variable. We just replace oil price with food price and hence the order becomes as (spi, reer, ir, inf, ip and fp). Food price shocks will be used in different formats of nonlinear transformations. We check the effects of food prices on macroeconomic variables because recent increase food prices attracted attention for all concerned. In our sample, we have both food net exporters and net food importer countries; therefore, we can distinguish the magnitudes and signs of effects. Food prices can affect economic growth because it will increase import bill for the importer countries which reduces net export. For the exporter countries, when prices increase the demand may decrease which affects export and thus the output growth. When international food prices increase, it transmits to other countries through different channels. The arguments we make for oil price model also applies to food price models and thus we do not repeat those here. The matrix representation of the restrictions for second model is as follows:

$$\mathrm{B}\varepsilon = \begin{pmatrix} b_{11} & b_{12} & b_{13} & b_{14} & b_{15} & b_{16} \\ 0 & b_{22} & b_{23} & b_{24} & b_{25} & b_{26} \\ 0 & 0 & b_{33} & b_{34} & b_{35} & b_{36} \\ 0 & 0 & 0 & b_{44} & b_{45} & b_{46} \\ 0 & 0 & 0 & 0 & b_{55} & b_{56} \\ 0 & 0 & 0 & 0 & 0 & b_{66} \end{pmatrix} \begin{pmatrix} \varepsilon_{spi} \\ \varepsilon_{reer} \\ \varepsilon_{ir} \\ \varepsilon_{\inf} \\ \varepsilon_{eg} \\ \varepsilon_{fp} \end{pmatrix}$$

Finally, we introduce our third model of 7 variables (includes both food and oil price shocks) where we put 21 restrictions. In this model, again we assume oil price as purely exogenous which is not affected by any other shocks for contemporaneous period. Second, we assume that food price is affected by itself and oil price shock and then these two shocks affect output growth, inflation and so forth. The matrix representation of restrictions in B matrix for our third model is demonstrated below:

$$\mathrm{B}\varepsilon = \begin{pmatrix} b_{11} & b_{12} & b_{13} & b_{14} & b_{15} & b_{16} & b_{17} \\ 0 & b_{22} & b_{23} & b_{24} & b_{25} & b_{26} & b_{27} \\ 0 & 0 & b_{33} & b_{34} & b_{35} & b_{36} & b_{37} \\ 0 & 0 & 0 & b_{44} & b_{45} & b_{46} & b_{47} \\ 0 & 0 & 0 & 0 & b_{55} & b_{56} & b_{57} \\ 0 & 0 & 0 & 0 & 0 & b_{66} & b_{67} \\ 0 & 0 & 0 & 0 & 0 & 0 & b_{77} \end{pmatrix} \begin{pmatrix} \varepsilon_{spi} \\ \varepsilon_{reer} \\ \varepsilon_{ir} \\ \varepsilon_{\inf} \\ \varepsilon_{eg} \\ \varepsilon_{fp} \\ \varepsilon_{op} \end{pmatrix}$$

6. Empirical results

6.1 Time series properties of data

Table 1 displays results of the Lumsdaine-Papell (LP) and Lee-Strazicich (LS) unit root test results for all the series in logarithmic form including CPI, IP, REER, SPI, ROP and RFP while lending rate LR is at non-log form. The tests are conducted on the original series only because we assume that breaks (if determined) appear in any series would also be applicable to transformed series, for example, if any break date is found in CPI it would be the same for inflation, growth rate CPI. Table1 shows that none of the Australian macroeconomic variables show any structural break over the period 1980-2010. All series are found to be nonstationary with the only exception of interest rate series without any break. Consumer price index series for New Zealand is found to be stationary at 5 percent level of significance and LS test identified a trend break at the third quarter of 1989. All other series for New Zealand are nonstationary without any break over 1980-2010 periods. All of the Korean macroeconomic series are found to be nonstationary identified by both LP and LS tests. While no breaks are identified in any of the series, in CPI an intercept break has been detected at fourth quarter of 1997 by LS test. In the case of Singapore, as per the results of LP test, industrial production index and interest rate series are stationary without break while all other series are nonstationary without any break. According to LS test, consumer price index and interest rate series are stationary while LP test results show all series are nonstationary. Real effective exchange rate is found to be nonstationary with break at the fourth quarter of 2001 by LS test. While LP test results show all the Taiwanese series are nonstationary without any break, LS test results reveal that IP and SPI are stationary with break at first quarter of 2009 and second quarter of 2008 respectively. ROP and RFP are found to be stationary without any break. In addition, LS test also identified that REER is nonstationary with a break at the second quarter of 2008. The Indian macroeconomic series are found to be nonstationary without any break by LP test except real effective exchange rate. Real effective exchange rate is found to be stationary with two breaks at third quarter of 1998 and fourth quarter of 2004. LP test results show that IP, REER and LR series are stationary without any break while all other series are nonstationary. Thai real effective exchange rate is found stationary with break at the first quarter of 1997 by LP test while all other series are nonsationary. LS test results indicate that CPI and RFP are stationary while all other series are nostationary without any break.

As discussed above, macroeconomic series of Australia and Singapore have no structural breaks while few series of other countries show structural breaks. Excepting Taiwan, in the case of the rest of the countries one series is found to have structural break. Since both LP and LS tests do not indicate breaks commonly and except one series other series are free of break we estimate models with full sample of data for these countries. As three series of

Taiwan are found with break during the second quarter of 2008 we intended to estimate model for Taiwan for the sample until the first quarter of 2008. However, because of the unavailability enough observations we cannot split samples into two and thus we estimate full sample in the case of Taiwan as well.

According to Table 1, IR series for Australia; CPI and ROP for New Zealand; IP and IR for Singapore; CPI and IR for Hong Kong; IP, SPI, ROP and RFP for Taiwan; IP, REER and IR for India; and REER and RFP for Thailand are stationary at level.

Table 1 Unit root test using structural break

Country		**Lumsdaine-Papell Unit Root Test**						**Lee-Strazicich Unit Root Test**					
	Series	**TB1** **TB2**	**Y_{t-1}**	**D_{1t}**	**DT_{1t}**	**D_{2t}**	**DT_{2t}**	**TB1** **TB2**	**S_{t-1}**	**D_{1t}**	**DT_{1t}**	**D_{2t}**	**DT_{2t}**
AUS	CPI	1989:1 2000:2	-0.198 (-5.899)	0.012 (3.498)	-0.002 (-5.681)	0.006 (2.529)	0.000 (3.329)	1988:4 1998:1	-0.212 (-5.189)	-0.005 (-0.882)	-0.007 (-4.486)	0.003 (0.577)	-0.007 (-3.908)
	IP	1984:4 1999:2	-0.262 (-4.975)	0.025 (2.757)	0.001 (1.326)	0.027 (3.469)	-0.001 (-4.211)	1988:1 1999:2	-0.424 (-4.422)	-0.031 (-1.823)	0.017 (2.718)	0.003 (0.178)	0.018 (2.961)
	REER	1984:4 2002:4	-0.292 (-5.240)	-0.063 (-3.017)	-0.001 (-0.063)	0.038 (2.129)	0.002 (2.504)	1985:2 1999:3	-0.413 (-4.842)	0.066 (1.555)	-0.047 (-2.626)	-0.002 (-0.064)	-0.009 (-1.080)
	IR	1988:4 1994:1	-0.330[a] (-7.292)	1.311 (3.128)	-0.208 (-5.466)	0.354 (1.162)	0.177 (5.394)	1988:3 1992:3	-0.563 (-6.493)	0.449 (0.708)	-0.624 (-3.145)	0.840 (1.400)	-1.107 (-3.972)
	SPI	1984:4 2005:2	-0.263 (-4.930)	0.131 (2.876)	0.000 (0.250)	0.107 (2.465)	-0.007 (-2.718)	1985:3 2003:4	-0.441 (-4.870)	-0.096 (-1.170)	0.103 (2.722)	-0.061 (0.771)	0.012 (0.727)
	ROP	1985:4 1999:3	-0.469 (6.368)	-0.347 (-4.559)	0.000 (0.147)	0.222 (3.859)	0.009 (3.398)	1987:1 1999:2	-0.517 (-5.333)	-0.024 (-0.170)	-0.101 (-2.192)	0.069 (0.471)	0.185 (0.434)
	RFP	1988:3 2002:4	-0.464 (-6.402)	-0.115 (-3.815)	0.002 (1.670)	-0.092 (-3.137)	0.002 (2.163)	1988:2 2008:1	-0.411 (-5.314)	0.084 (1.315)	-0.067 (-3.371)	0.030 (0.465)	0.047 (2.001)
NZ	CPI	1986:3 1998:3	-0.181[b] (-6.847)	0.033 (5.251)	-0.003 (-6.458)	-0.009 (-2.622)	0.000 (1.215)	1989:03 1999:03	-0.403 (-5.508)	0.011 (1.362)	-0.035[a] (-11.180)	-0.001 (-0.149)	-0.005 (-2.455)
	MP	1994:4 2002:1	-0.204 (-4.464)	0.078 (4.642)	-0.000 (-1.322)	0.046 (3.426)	-0.000 (-0.593)	1986:2 1994:3	-0.240 (-4.181)	0.071 (2.463)	-0.032 (-3.026)	-0.037 (-1.294)	0.064 (4.098)
	REER	1986:3 2003:3	-0.197 (-4.684)	0.050 (2.983)	0.000 0.540	0.051 (3.113)	0.000 (0.279)	1985:4 2000:1	-0.243 (-4.738)	-0.0145 (-0.404)	0.030 (2.558)	0.005 (0.166)	-0.010 (-1.325)
	IR	1992:1 1998:2	-0.288 (-6.401)	-0.958 (-3.233)	0.110 (3.495)	-1.120 (-4.619)	-0.010 (-0.771)	1993:1 1999:2	-0.288 (-6.401)	-0.958 (-3.233)	0.110 (3.495)	-1.120 (-4.619)	-0.010 (-0.771)
	SPI	1987:3 2005:2	-0.275 (-5.309)	-0.262 (-5.138)	-0.012 (-3.765)	0.084 (1.492)	-0.011 (-2.969)	1987:2 1993:1	-0.285 (-4.439)	0.287 (2.580)	-0.161 (-4.493)	-0.056 (-0.521)	0.207 (4.613)
	ROP	1985:4 1999:1	-0.442[c] (-6.549)	-0.424 (-5.093)	0.000 (0.129)	0.231 (3.988)	0.010 (3.446)	1985:3 1999:3	-0.432 (-5.093)	0.420 (2.668)	-0.275 (-4.079)	0.034 (0.220)	0.317 (5.042)
	RFP	1986:3 2002:3	-0.338 (-5.561)	-0.0138 (-0.378)	0.001 (0.911)	-0.092 (-3.021)	0.004 (3.135)	1986:3 2007:4	-0.393 (-4.579)	-0.125 (0.160)	-0.056 (-2.649)	0.115 (1.682)	0.053 (2.157)
KOR	CPI	1989:4 1998:2	-0.239 (-5.848)	0.022 (4.511)	0.000 (3.543)	-0.006 (-1.032)	-0.001 (5.878)	1991:3 1997:4	-0.0842 (-5.244)	0.003 (0.539)	-0.005 (-2.919)	0.041[a] (7.064)	-0.006 (-4.556)
	IP	187:1 1999:2	-0.506 (-5.267)	0.070 (2.925)	-0.006 (-4.248)	0.062 (3.541)	-0.000 (-1.559)	1988:2 1999:3	-0.849 (-5.694)	0.107 (3.429)	0.010 (1.211)	0.061 (1.930)	-0.023 (-3.060)
	REER	1997:3 2005:4	-0.362 (-6.636)	-0.187 (-6.045)	-0.001 (-1.156)	0.090 (2.590)	-0.012 (-4.711)	1997:2 2004:2	-0.326 (-5.041)	0.087 (1.590)	-0.067 (-4.310)	-0.008 (-0.162)	0.103 (4.311)
	IR	1993:4 1998:2	-0.174 (-5.880)	-0.710 (-2.092)	0.128 (4.255)	-1.766 (-5.234)	-0.125 (-4.147)	1985:2 1999:1	-0.170 (-4.073)	-0.181 (-0.305)	0.522 (2.327)	-0.518 (-0.851)	-0.212 (-1.740)
	SPI	1986:4 1997:3	-0.251 (-5.596)	0.300 (4.203)	-0.006 (-2.034)	-0.161 (-2.995)	0.005 (3.504)	1987:3 1997:3	-0.3281 (-5.055)	-0.210 (-1.890)	0.178 (3.327)	-0.374 (-3.605)	-0.063 (-2.343)
	ROP	1985:4 1993:2	-0.557 (-6.296)	-0.388 (-4.289)	0.002 (0.398)	-0.225 (-3.270)	0.018 (3.732)	1987:4 1997:1	-0.514 (-6.019)	-0.115 (-0.723)	-0.077 (-1.706)	-0.146 (-0.919)	0.114 (3.129)
	RFP	1988:3 2004:2	-0.372 (-5.103)	-0.114 (-2.988)	0.003 (1.951)	-0.106 (-2.650)	0.010 (3.915)	1995:2 2006:1	-0.457 (-4.927)	0.017 (0.216)	0.050 (2.749)	0.035 (0.436)	-0.005 (-0.216)
SIN	CPI	1990:3 2004:3	-0.116 (-4.752)	0.009 (3.588)	-0.000 (-0.176)	-0.005 (-1.598)	0.001 (3.476)	1990:4 2001:1	-0.097 (-4.163)	-0.001 (-0.153)	-0.002 (-1.902)	0.000 (0.063)	-0.003 (-2.615)
	IP	1987:1 2000:4	-0.529[b] (-7.112)	0.134 (4.300)	0.008 (4.246)	-0.080 (4.246)	-0.001 (-0.446)	1985:4 1991:2	-0.764 (-4.998)	-0.134 (-2.264)	0.050 (2.342)	0.030 (0.506)	-0.098 (-4.632)
	REER	1985:4 1998:2	-0.161 (-3.550)	-0.044 (-4.192)	-0.001 (-2.790)	-0.033 (-5.256)	-0.001 (-3.858)	1993:2 2001:3	-0.134 (-4.518)	0.000 (0.004)	0.011 (2.959)	-0.027 (-1.985)	-0.012 (-2.681)
	IR	1986:2	-0.444[a]	-0.849	0.128	-0.418	-0.036	1886:1	-0.314	0.125	-0.290	-0.156	0.104

		1991:4	(-7.734)	(-3.695)	(5.289)	(-2.637)	(-3.012)	1998:4	(-3.922)	(0.447)	(-1.867)	(-0.514)	(1.862)
	SPI	1993:2 2004:2	-0.356 (-5.149)	0.097 (1.726)	-0.010 (-3.189)	0.133 (2.158)	0.004 (1.226)	1993:1 2001:4	-0.728 (-5.123)	-0.015 (-0.148)	0.089 (2.596)	0.232 (2.204)	-0.118 (-3.549)
	ROP	1985:4 1999:1	-0.419 (-5.428)	-0.206 (-2.942)	0.004 (0.786)	0.214 (3.785)	0.015 (3.892)	1990:1 1998:4	-0.770 (-5.117)	-0.326 (-2.256)	0.177 (3.878)	-0.285 (-1.910)	0.278 (4.944)
	RFP	1991:1 1998:2	-0.377 (-5.110)	-0.106 (-3.906)	0.002 (2.022)	-0.060 (-2.653)	0.004 (2.170)	1991:1 2003:1	-0.336 (-4.755)	-0.049 (-0.954)	-0.023 (-1.745)	-0.023 (-0.448)	0.057 (3.759)
HK	CPI	1994:1 2006:1	-0.059 (-3.943)	0.011 (2.232)	-0.001 (-4.271)	0.003 (0.759)	0.001 (1.815)	1994:1 2002:4	-0.147[a] (-5.931)	0.009 (1.245)	-0.003 (-0.919)	0.007 (0.889)	-0.015 (-4.630)
	IP	1986:1 2004:4	-0.309 (-6.259)	0.181 (5.492)	0.003 (0.704)	0.262 (8.987)	-0.008 (-4.746)	1990:1 2001:1	-0.475 (-5.807)	0.048 (1.297)	-0.045 (-4.256)	0.06 (2.184)	-0.084 (-4.922)
	REER	1986:4 1996:4	-0.171 (-5.230)	-0.169 (-1.004)	0.011 (3.768)	0.052 (3.429)	-0.004 (-5.582)	1992:2 2001:4	-0.193 (-3.841)	-0.063 (-2.564)	0.040 (4.219)	0.052 (2.153)	-0.061[b] (-5.861)
	IR	1991:2 2000:4	-0.207 (-5.258)	-1.850 (-4.367)	0.020 (3.291)	-0.958 (-4.463)	-0.018 (-2.115)	1997:2 2004:4	-0.501[c] (-5.542)	-0.516 (-1.445)	0.695 (3.510)	-0.537 (-1.478)	0.390 (3.820)
	SPI	1999:1 2003:3	-0.342 (-4.248)	0.184 (2.482)	-0.015 (-2.032)	0.124 (1.936)	0.020 (3.088)	2000:1 2005:2	-0.876 (-4.947)	0.032 (0.267)	-0.043 (-1.121)	-0.112 (-0.966)	0.256 (4.543)
	ROP	1985:4 1999:1	-0.408 (-5.320)	-0.220 (-2.935)	-0.002 (-0.454)	0.164 (2.997)	0.021 (4.359)	1997:2 2005:3	-0.433 (-5.230)	0.068 (0.474)	0.018 (0.557)	-0.159 (-1.107)	0.121 (2.534)
	RFP	1989:1 1998:2	-0.347 (-5.133)	-0.058 (-2.351)	-0.004 (-2.418)	-0.080 (-2.909)	0.012 (4.818)	1990:4 2000:1	-0.358 (-5.281)	0.013 (0.287)	-0.035 (-2.656)	0.008 (01.167)	0.044 (4.091)
TWN	CPI	1986:4 1994:1	-0.281 (-5.084)	-0.008 (-1.502)	0.003 (5.038)	0.009 (1.902)	-0.002 (-5.552)	1993:2 2000:3	-0.269 (-5.131)	-0.028 (-3.261)	0.013 (3.434)	0.023 (2.829)	-0.010 (-4.019)
	IP	1988:1 2006:2	-0.189 (-3.380)	0.633 (3.469)	0.003 (2.608)	0.004 (1.247)	-0.002 (-2.164)	2006:4 2009:1	-0.418[a] (-19.68)	0.006 (2.267)	-0.008 (-4.730)	0.018 (5.841)	-0.027 (-13.45)
	REER	1988:2 2003:4	-0.521 (-4.664)	2.647 (4.619)	-0.004 (-3.070)	0.030 (2.947)	0.002 (1.638)	2004:1 2008:2	-2.138 (-6.349)	0.018 (1.312)	0.008 (1.136)	0.068 (3.863)	-0.075[a] (-6.361)
	IR	1989:1 2002:4	-0.227 (-5.416)	1.043 (4.287)	0.039 (3.270)	-0.765 (-3.641)	0.013 (1.630)	1988:4 2004:2	-0.312 (-5.170)	-0.969 (-2.239)	1.374 (5.054)	-0.115 (-0.291)	-0.573 (-3.857)
	SPI	2001:1 2006:2	-0.576 (-4.599)	-0.231 (-2.127)	0.036 (1.436)	0.076 (1.031)	-0.012 (-1.745)	2002:4 2008:2	-4.294[a] (-7.067)	-0.142 (-1.717)	0.013 (0.216)	0.029 (0.413)	-0.387 (-7.601[a])
	ROP	1985:4 1997:4	-0.468 (-5.919)	-0.247 (-3.245)	0.003 (0.469)	-0.194 (-3.205)	0.015 (4.695)	1989:3 1999:1	-0.413[c] (-5.619)	0.018 (0.124)	0.124 (2.810)	0.234 (1.610)	0.003 (0.080)
	RFP	1995:2 2001:1	-0.380 (-4.781)	0.065 (2.030)	-0.010 (-3.936)	-0.042 (-1.320)	0.017 (4.827)	1995:4 2000:4	-0.430[c] (-5.432)	0.043 (0.750)	0.016 (0.915)	0.230 (3.965)	-0.041 (-1.823)
IN	CPI	1997:4 2006:2	-0.263 (-4.421)	0.019 (2.513)	-0.003 (-4.711)	-0.006 (-0.664)	0.004 (4.702)	1994:2 2003:4	-0.203 (-4.334)	-0.002 (-0.161)	0.001 (0.408)	0.010 (0.827)	-0.013 (-2.442)
	IP	1991:1 2000:4	-0.448 (-4.275)	-0.075 (-5.204)	-0.001 (-0.685)	-0.064 (-4.278)	0.001 (1.357)	1989:1 2000:2	-0.633[c] (-5.408)	-0.087 (-3.090)	0.060 (4.647)	0.029 (1.077)	-0.028 (-3.608)
	REER	1998:3 2004:4	-0.828[a] (-14.45)	-0.448[a] (-13.81)	0.007 (5.045)	0.266 (10.09)	-0.011[a] (-8.11)	1998:3 2005:1	-0.714[c] (-5.683)	0.215 (2.869)	-0.236 (-5.016)	-0.010 (-0.155)	0.222 (5.070)
	IR	1991:1 1996:2	-0.205 (-4.124)	-0.048 (-2.205)	-0.048 (-2.215)	-0.246 (-0.969)	0.039 (1.909)	1996:2 2006:3	-0.474[c] (-5.643)	-0.373 (-0.683)	-0.901 (-5.150)	-0.857 (-1.577)	1.2243 (4.166)
	SPI	1991:1 2004:3	-0.276 (-6.169)	0.2857 (4.800)	-0.010 (-4.654)	0.174 (3.162)	0.007 (2.289)	1991:3 2001:3	-0.318 (-4.853)	-0.069 (-0.582)	0.135 (2.961)	-0.056 (-0.489)	-0.047 (-1.509)
	ROP	1985:4 1997:4	-0.501 (-6.402)	-0.033 (-4.091)	0.011 (2.094)	-0.152 (-2.671)	0.010 (3.593)	1990:1 1998:2	-0.401 (-5.164)	-0.340 (-2.384)	0.241 (4.385)	-0.292 (-2.031)	0.016 (0.520)
	RFP	1988:1 1998:2	-0.394 (-5.724)	0.072 (2.681)	0.005 (2.995)	-0.133 (-4.231)	0.000 (0.230)	1987:2 1998:2	-0.368 (-4.789)	-0.070 (-1.253)	0.063 (3.253)	-0.127 (-2.270)	-0.052 (-3.412)
TH	CPI	1989:1 1996:1	-0.179 (-4.671)	0.006 (1.534)	0.001 (4.175)	-0.012 (-3.093)	-0.001 (-3.568)	1990:2 1999:1	-0.218[c] (-5.331)	-0.018 (-0.974)	-0.007 (-2.262)	-0.012 (-1.507)	-0.009 (-4.878)
	IP	1997:1 2003:2	-0.376 (-5.481)	-0.072 (-3.893)	-0.001 (-0.121)	0.048 (2.926)	-0.001 (-1.441)	1998:1 2008:1	-0.652 (-4.983)	-0.014 (-0.494)	-0.048 (-2.682)	0.037 (1.273)	-0.056 (-0.056)
	REER	1997:1 2005:2	-0.739[a] (-8.445)	-0.172[a] (-8.521)	-0.009 (3.902)	0.059 (3.902)	0.006 (4.089)	1998:1 2003:3	-0.619 (-6.008)	-0.098 (-2.227)	-0.017 (-0.841)	-0.007 (-0.191)	0.009 (0.937)
	IR	1985:4 1998:3	-0.196 (-5.902)	-0.823 (-3.019)	0.016 (0.894)	-1.408 (-5.460)	-0.011 (-1.496)	1994:2 2001:4	-0.340 (-5.281)	0.885 (1.675)	0.412 (2.848)	0.171 (0.340)	-0.674 (-3.468)
	SPI	1998:1 2003:3	-0.501 (-4.861)	-0.159 (-1.420)	0.198 (1.300)	0.286 (3.115)	0.001 (0.142)	2001:3 2008:1	-0.434 (-4.424)	-0.253 (-2.485)	0.230 (4.265)	0.194 (1.789)	-0.242 (-3.846)
	ROP	1985:4 1999:1	-0.457 (-5.912)	-0.270 (-3.584)	0.003 (0.648)	0.249 (4.104)	0.012 (3.635)	1995:2 2008:1	-0.487 (-5.293)	-0.129 (-0.879)	0.111 (3.536)	0.442 (2.878)	-0.170 (-3.192)
	RFP	1997:2 2002:2	-0.435 (-6.010)	0.127 (3.504)	-0.001 (-0.643)	0.069 (2.039)	0.006 (2.224)	1987:3 1991:4	-0.654[b] (-5.783)	-0.071 (-1.122)	0.074 (2.802)	0.065 (1.047)	-0.053 (-2.537)

Next, we employ conventional unit root tests to determine the order of integration for the nonstationary series along with some transformed series of IP, CPI, OP and FP for all countries. Table 2 presents results of unit root tests conducted by augmented Dickey-Fuller

(ADF) and Phillips-Perron(PP) unit root test. Unit root tests reveal that the evidence of stationarity for level series is mixed while all transformed series are stationary at level. It can be noted that for Australia all series are nonstationary at level while they are stationary at first difference. IR and REER series for New Zealand and Korea are found to be stationary at level while all other series are stationary at first difference. Almost all the series for all other countries are found stationary at their first differences.

Having established the order of integration we proceed for the VAR estimation procedure particularly SVAR. As discussed in the methodology section, we do not go for cointegration because we have found the mixed evidence of I (0) and I (1) order among the series[2].

Table 2 Results of unit root tests

	AUS	NZ	KOR	SIN	HK	TWN	IN	TH
CPI	I(1)	**I(0)**	I(1)*	I(1)	**I(0)**	I(1)	I(1)	I(1)
INF	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)
SPI	I(1)	I(1)	I(1)	I(1)	I(1)	**I(0)**	I(1)	I(1)
IR	**I(0)**	I(0)	I(0)	**I(0)**	**I(0)**	I(1)	**I(0)**	I(1)
REER	I(1)	I(0)*	I(0)*	I(1)	I(1)	I(1)	**I(0)**	**I(0)**
IP	I(1)	I(1)	I(1)	**I(0)**	I(1)*	**I(0)**	**I(0)**	I(1)
EG	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)
RFP	I(1)	I(1)	I(1)	I(1)	I(1)	**I(0)**	I(1)	**I(0)**
NOFI	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)
FP+	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)
FP-	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)
SOFI	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)
LROP	I(1)	**I(0)**	I(1)	I(1)	I(1)	**I(0)**	I(1)	I(1)
OP+	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)
OP-	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)
NOPI	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)
SOPI	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)

Note: Unit root tests have been performed by both ADF (Augmented Dickey-Fuller) and PP (Phillips-Perron) methods. I(1) implies that the series is nonsationary at level, however, stationary at first differences which is confirmed by both ADF and PP test.
Bold **I(0)** indicates series are stationary at level either in LP or LS test
I(0) indicates that series is stationary at level.
I(0)* represents that the series is level stationary at ADF test while it is nonstationary at PP test
I(1)* means the series is level nonstationary at ADF while in PP it is stationary

Now we turn to estimate the VAR models. We estimate models with different specifications of oil and food prices. For the brevity purpose we do not report all results. We identify the relative performance of models based on the lowest information criteria. Both AIC and SC criteria as shown in Table 3 indicate that models with NOPI as proxy for oil price and NOFI as proxy for food prices perform better than models that include other specifications. Therefore we report results of SVAR models only with NOPI and NOFI specifications.

[2] Although we did not require cointegration tests for multiple series we conducted bivariate cointegration tests to check long run relationship between oil/food price and macroeconomic variables (for example, oil price and CPI or food price and IP). Tests results provide no evidence of cointegration between oil/food price and any macroeconomis series.

Table 3 Relative performance of models

		Models with CPI and IP at levels		Models with CPI and IP in growth rate	
Country	Models	AIC	SC	AIC	SC
Australia	ROP (RFP)	-17.07697 (-18.69567)	-16.10653 (-17.72523)	1.643486 (0.109013)	2.619108 (1.084635)
	NOPI4 (NOFI4)	-19.01105 (-20.54233)	-18.02487 (-19.55616)	-0.286658 (-1.800708)	0.699518 (-814532)
	ROP+ (RFP+)	-9.170613 (-18.45812)	-8.194991 (-1748249)	9.526793 (0.250267)	10.50241 (1.225889)
	ROP- (RFP-)	-7.978330 (-18.00280)	-7.002708 (-17.02718)	10.75997 (0.720651)	11.73559 (1.696273)
	SOPI (SOFI)	-18.25596 (-13.09202)	-1727509 (-12.11115)	0.479859 (5.664741)	1.460726 (6.545608)
New Zealand	ROP (RFP)	-17.31332 (-19.07781)	-16.17695 (-17.94145)	1.584934 (-0.371090)	2.721300 (0.765276)
	NOPI4 (NOFI4)	-18.96624 (-20.72100)	-1782987 (-19.58463)	-0.255700 (-2.027159)	0.880665 (-0.890793)
	ROP+ (RFP+)	-8.903014 (-9.714522)	-7.766648 (-8.5781157)	9.879078 (9.020350)	11.01544 (10.15672)
	ROP- (RFP-)	-7.818844 (-9.078588)	-6.682479 (-7.942222)	10.92942 (9.575373)	12.06579 (10.71174)
	SOPI (SOFI)	-13.54162 (-13.16695)	-12.40525 (-12.03059)	5.208307 (5.530642)	6.344672 (6.667008)
Korea	ROP (RFP)	-13.35477 (-14.87795)	-12.30562 (-13.82880)	4.978935 (3.621604)	6.028082 (4.670752)
	NOPI4 (NOFI4)	-15.30315 (-16.81988)	-14.25400 (-15.77073)	3.022300 (1.604145)	4.071447 (2.653292)
	ROP+ (RFP+)	7.967950 (7.149424)	9.017098 (8.198572)	26.32318 (25.66092)	27.37232 (26.71007)
	ROP- (RFP-)	9.108107 (7.671566)	10.15725 (8.720713)	27.40921 (26.00336)	28.45836 (27.05251)
	SOPI (SOFI)	-9.931060 (-1067466)	-8.881912 -9.619333	8.424427 (7.734274)	9.473575 (8.789599)
Singapore	ROP (RFP)	-18.54292 (-20.63708)	-17.46856 (-19.56273)	-0.076817 (-2.089581)	0.997538 (-1.015225)
	NOPI4 (NOFI4)	-20.39027 (-22.57345)	-19.31591 (-21.49909)	-1.913455 (-4.138210)	-0.8390099 (-3.063854)
	ROP+ (RFP+)	-10.34260 (-11.40764)	-9.268242 (-10.33329)	8.195938 (7.013105)	9.270290 (8.087461)
	ROP- (RFP-)	-9.041827 (-10.78621)	-8.041827 (-9.711856)	9.474217 (7.728441)	10.54857 (8.802796)
	SOPI (SOFI)	-14.76252 (-14.66159)	-13.68816 (-13.58072)	3.701210 (3.808571)	4.775565 (4.889442)
Hong Kong	ROP (RFP)	-15.30287 (-16.92225)	-13.90945 (-15.52884)	-14.73660 (-16.51576)	-13.34318 (-15.12234)
	NOPI4 (NOFI4)	-16.33509 (-17.90041)	-1494167 (-16.50699)	-15.84642 (-17.51254)	-14.45300 (-16.11913)
	ROP+ (RFP+)	-2.782997 (-4.126986)	-1.389581 (-2.733569)	-2.340396 (-3.824068)	-0.946979 (-2.430652)
	ROP- (RFP-)	-1.522621 (-3.407123)	-0.129205 (-2.013706)	-1.293543 (-3.142687)	0.099874 (-3.142687)
	SOPI (SOFI)	-11.15229 (-10.51796)	-9.758877 (-9.124541)	-10.79750 (-10.26125)	-9.404079 (-8.867831)
Taiwan	ROP (RFP)	-27.79412 (-28.06732)	-24.05059 (-24.32379)	-9.806751 (-9.778903)	-6.032461 (-6.004613)
	NOPI4 (NOFI4)	-29.41465 (-28.28715)	-25.67112 (-24.54362)	-11.25056 (-10.64074)	-7.476266 (-6.866451)
	ROP+ (RFP+)	-11.97108 (-11.49312)	-8.227554 (-7.749592)	6.396268 (6.198128)	10.17056 (9.972418)
	ROP- (RFP-)	-10.92641 (-11.23243)	-7.182885 (-7.488903)	6.964473 (6.708723)	10.73876 (10.48301)
	SOPI (SOFI)	-23.55958 (-21.76764)	-19.81605 (-17.99335)	-5.497711 (-3.939545)	-1.723421 (-0.136653)
India	ROP (RFP)	-12.77136 (-14.43708)	-11.42227 (-13.08799)	6.109153 (4.464949)	7.458250 (5.824046)
	NOPI4 (NOFI4)	-14.13250 (-15.82010)	-12.78340 (-14.47100)	4.624968 (3.039586)	5.974065 (4.388683)
	ROP+ (RFP+)	2.730818 (1.561440)	4.079915 (1.913111)	21.52521 (20.47275)	22.47430 (21.82185)
	ROP- (RFP-)	4.174667 (2.260601)	5.523764 (3.609699)	22.94593 (21.02763)	24.29523 (22.37673)
	SOPI (SOFI)	-8.574705 (-8.892300)	-7.225608 (-7.543202)	10.21289 (10.13972)	11.56199 (11.48882)

Thailand	ROP (RFP)	-16.97891 (-18.51970)	-15.43193 (-16.97271)	-16.19290 (-17.30175)	-14.64591 (-15.75477)
	NOPI4 (NOFI4)	-17.97615 (-19.32396)	-16.42916 (-17.77698)	-16.91605 (-18.38293)	-15.36607 (-16.83594)
	ROP+ (RFP+)	-1.619526 (-2.160991)	-0.072539 (-0.614003)	-0.549011 (-1.237080)	-0.997976 0.309907
	ROP- (RFP-)	-0.465334 (-1.984002)	-1.081654 (-0.437015)	-0.088004 (-1.274428)	1.458983 (0.272559)
	SOPI (SOFI)	-13.04117 (-12.68016)	-11.49419 (-11.13317)	-12.12896 (-11.82287)	-10.58197 (-10.27588)

Note: Figures are values of information criteria with different specification of oil prices and values in parentheses are for food price specifications

6.2 Granger causality tests

Table 4 reports results for Granger causality tests for each of the variables. As can be seen, Australian and New Zealand's selected macroeconomic variables show similar response to oil and food price shocks. Only real effective exchange rates are found to be Granger caused by net oil and food price increase while no evidence of Granger causality can be observed for other variables. In the case of Korea, excepting stock price indices, Granger causality can be found for all other variables from both oil and food price increase. Singapore is the only country where tests fail to show any evidence of Granger causality from oil and food price increase to any of the variables. Low evidence of causality can be viewed for Hong Kong and Thailand as well. Unidirectional causality is found form oil price to interest rate and from food price to real effective exchange rate in Hong Kong. A unidirectional causality from oil price to industrial production growth is found statistically significant for Thailand while no evidence can be found for all other variables. In Taiwan, unidirectional causalities from oil price to all other variables are found to be statistically significant at least at 5 percent level of significance. However, evidence from food price is statistically significant only for real effective exchange rate. Marginal evidence of causality form oil and food price shocks are also evident for some of the India's macroeconomic variables. Unidirectional causality from oil price to interest rate and from food price to stock price indices, real effective exchange rate and industrial growth are statistically significant at 10 percent level of significance.

Table 4 Results of Granger causality/block exogeneity Wald tests

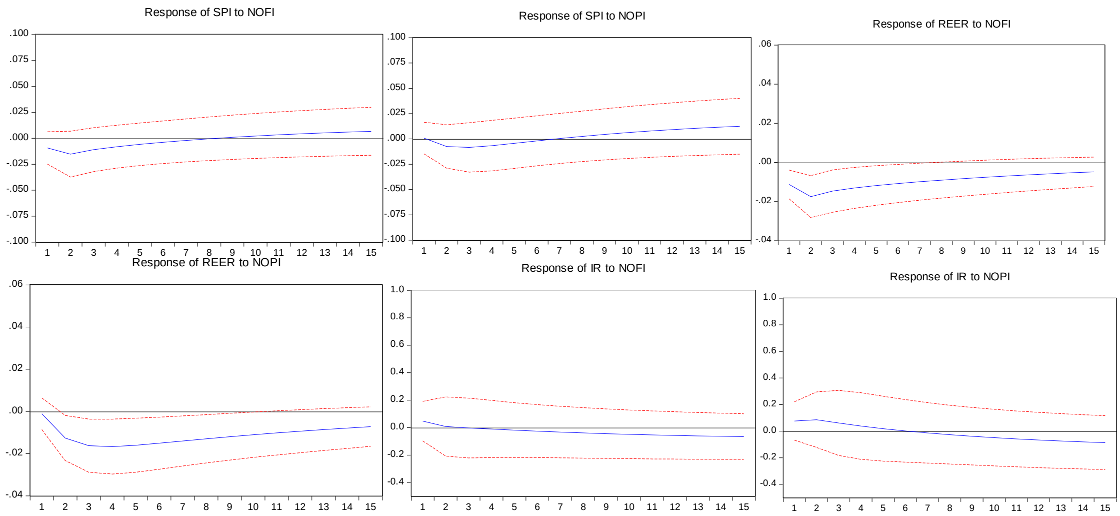
Variables	AUS		NZ		KOR		SIN		HK		TWN		IN		TH	
	NOPI	NOFI	NOPI	NOFI	NOPI	NOFI	NOPI	NOFI	NOPI	NOFI	NOPI	NOFI	NOPI	NOFI	NOPI	NOFI
SPI	0.49 (0.48)	1.11 (0.29)	2.27 (0.13)	0.06 (0.79)	1.70 (0.19)	0.05 (0.81)	0.05 (0.81)	0.05 (0.82)	0.04 (0.82)	0.52 (0.46)	5.36[b] (0.06)	1.59 (0.44)	0.63 (0.42)	3.19[c] (0.07)	1.20 (0.27)	0.59 (0.44)
REER	9.28[a] (0.00)	3.09[c] (0.07)	5.02[b] (0.02)	18.82[a] (0.00)	33.42[a] (0.00)	89.59[a] (0.00)	1.82 (0.17)	0.04 (0.83)	0.00 (0.96)	5.19[b] (0.02)	23.68[a] (0.00)	12.75[a] (0.00)	0.43 (0.50)	3.02[c] (0.08)	2.14 (0.14)	0.12 (0.72)
IR	0.30 (0.58)	0.02 (0.88)	0.04 (0.83)	0.00 (0.96)	25.23[a] (0.00)	80.35[a] (0.00)	0.07 (0.77)	0.83 (0.36)	4.92[b] (0.02)	0.58 (0.44)	5.27[b] (0.07)	2.40 (0.30)	3.63[c] (0.05)	1.90 (0.16)	0.34 (0.55)	0.20 (0.65)
INF	0.11 (0.73)	0.09 (0.76)	1.91 (0.16)	0.83 (0.35)	9.36[a] (0.00)	21.90[a] (0.00)	0.19 (0.65)	0.09 (0.76)	0.86 (0.35)	0.04 (0.83)	6.36[b] (0.04)	0.26 (0.87)	0.02 (0.86)	0.00 (0.99)	0.10 (0.74)	1.79 (0.18)
EG	0.00 (0.98)	0.07 (0.78)	0.79 (0.37)	0.68 (0.40)	3.87[b] (0.04)	11.57[a] (0.00)	0.05 (0.81)	0.74 (0.38)	0.18 (0.66)	0.46 (0.49)	5.05[b] (0.07)	3.16 (0.20)	0.01 (0.90)	3.01[c] (0.08)	6.11[b] (0.01)	0.00 (0.94)

Note: entries are chi-square test statistics at degrees of freedom of 1 in all cases except Taiwan. Degree of freedom for Taiwan is 2. Lag length are selected by SC criteria. Values in parentheses are p-values.
[a, b, c] indicate significance at 1%, 5% and 10% level.

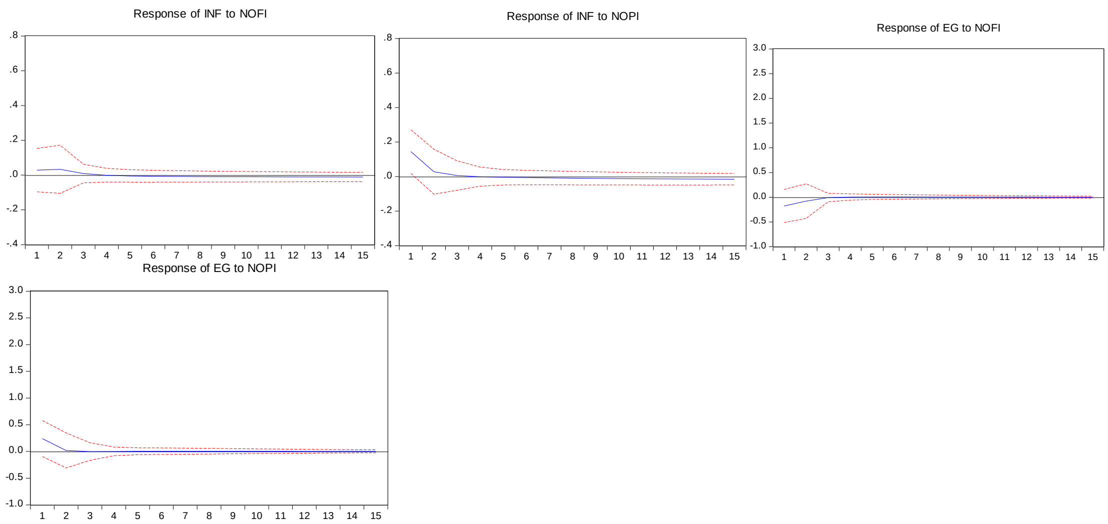
6.3 Impulse response analysis

Figure 2 displays responses of Australia's macroeconomic variables to oil and food price shocks[3]. Although most of the impulse response functions shown in Figure 3 are not statistically significant the signs of the responses in most cases are consistent to the theory. As can be viewed, the stock price indices and the real effective exchange rate respond negatively with one standard deviation (S.D.) innovation in net oil and food price increase while interest rate and inflation respond positively. The growth of industrial production responds negatively with food prices while the response with oil price is positive. Following the oil price shock, stock price decreases and it takes around 7 quarters to ease off. Real exchange rates react highly to both oil and food price shocks and do not reach to zero level even after 15 periods. Interest rate increases by 9 percent following the food price shock while it increases by approximately 13 percent for oil price shock and reaches to zero level after around 2 and 7 quarters respectively. Effects of shocks to inflation and industrial growth are rather short- lived. Positive response of inflation dies out in 3 quarters while it takes only 2 quarters for industrial growth rate (negative to food and positive to oil price shocks).

Figure 2 Impulse responses of Australia macroeconomic variables to NOFI and NOPI



[3] We estimated 3 models for every country as stated in the methodology section but we report results for only third model which includes both oil and food prices because all models produce qualitatively similar results. However, results of other two models are available from authors upon request.



The responses of economic variables of New Zealand to the oil and food price shocks are presented in Figure 3. All the variables respond, consistent with underlying theories, to oil and food price shocks. Stock prices, real effective exchange rates and industrial growth decrease with one S.D. shock from oil or food price while interest rate and inflation respond positively. Due to the shock in food prices stock prices decrease about 2 percent at the first quarter and after a slight improvement in the second quarter it remains negative until after 4 years. Although stock prices due to one standard deviation oil price shock do not decrease at the first quarter it keeps falling until fifth quarter up to 5 percent and then keeps negative even after 4 years period. Real effective exchange rate reacts negatively, about 1 percent, at the first quarter in response to both food and oil price shocks and then keep falling until 2 percent and then gradually improves over the 15 periods. Interest rates react distinctly to food and oil price shocks. Due to one S.D. innovation in food prices interest rate increases by 4 percent and then dies out quickly in 5 quarters while due to oil price shock the rate increases by 9 percent and takes about 3 years to die out. Similarly, shocks of food and oil prices have different impacts to inflation. Due to food price shock inflation increase by 4 per cent at the first quarter and then dies out in 5 quarters while the rate of increase due to oil price is 8% at the first quarter and goes up to 12 percent and persists up to 2 years. Food and oil prices pose similar impacts on the industrial growth rates. Following food and oil price shocks industrial growth rates fall by around 3 percent and die out quickly in 5/6 quarters.

Figure 3 Impulse responses of New Zealand macroeconomic variables to NOFI and NOPI

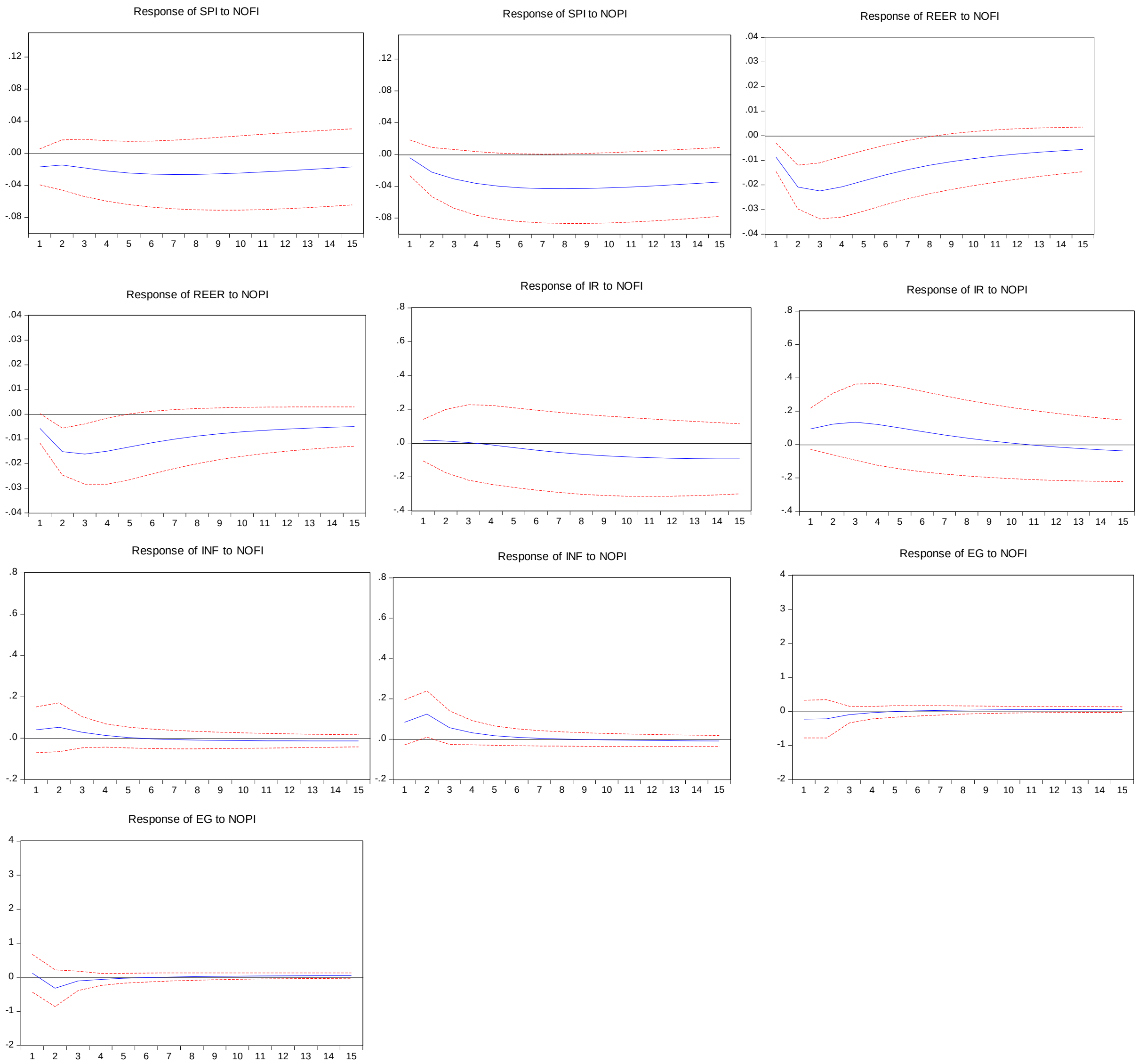


Figure 4 exhibits responses of Korean macroeconomic variables to one standard deviation of food and oil price shocks. As can be seen, consistent with theories, oil and food price shocks adversely affect the major macroeconomic variables. Most of the impulse response functions are statistically significant. The stock prices respond negatively to both food and oil price shock. The magnitude and the persistency of shocks are almost the same. Shocks to the stock prices persist around 2.5 years. Both oil and food price shocks negatively affect real effective exchange rate. Because of one standard deviation shock exchange rate depreciates around 2 percent at the first quarter and then deteriorates up to 4 percent and takes more than 4 years to go back to equilibrium level. Interest rate reacts more than any other variables. Due to food price shock at the first quarter interest rate increases by 11 percent and goes up to 41 percent at the second period and then dies out in 2 years. For oil price shock the interest rate increases by 3 percent at the first quarter and then goes up to 29 percent in second quarter. The shock persists around 1.5 years. Inflation rate reacts a slight differently to food and oil price shocks. Due to the food price shock, inflation increases by 7 percent in the first quarter and then goes up to 26 percent in the second quarter, however, the effect of shocks dies out only after 3 quarters. On the other hand, inflation goes down by 9 percent following the oil price shocks and goes up immediately in the second quarter and keeps going up 22 percent. The effect of shocks dies out very quickly (only in 3 quarters). Similar effects as of inflation can be observed in the case industrial growth. Due to food price shock, industrial production falls by 3 percent in the first quarter and then goes below to 12 percent at the second quarter while the effects diminishes at the end of 3 quarters. In the case of oil price shock, the industrial production growth starts falling from 6 percent and goes as below as 12 percent in 1 quarter, however, the effects of shock persist just up to 9 months.

Figure 4 Impulse responses of Korean macroeconomic variables to NOFI and NOPI

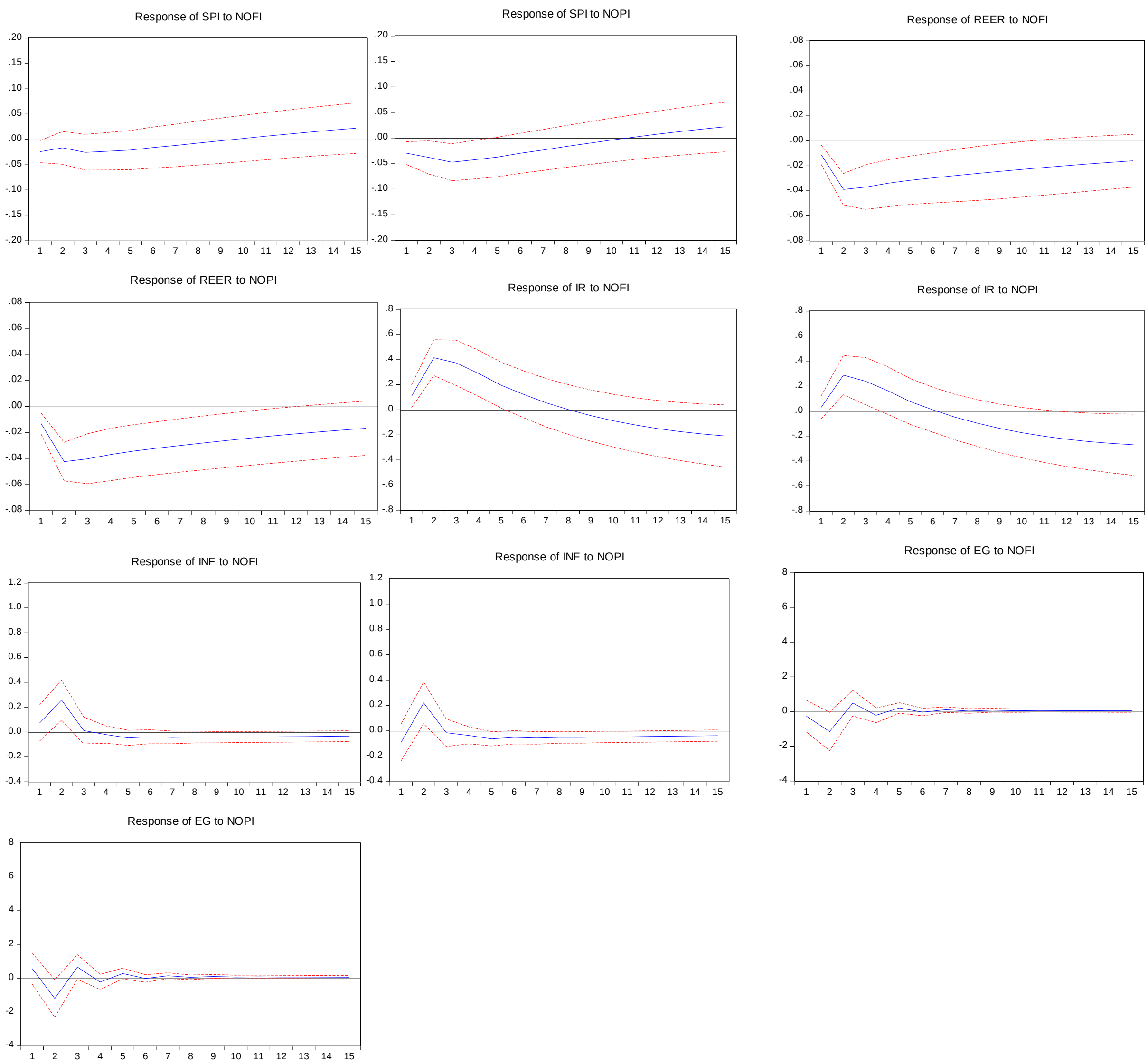


Figure 5 shows the impulse responses of Singaporean economic variables to the shocks of world food and oil prices. Although the patterns of the response functions are consistent with economic theories the magnitudes of impacts are very insignificant or marginal. As can be noted, the stock prices and real exchange rates respond negatively to the food and oil price shock but the magnitude of the effects are close to zero. Interest rates starts increasing following the food price shock and goes up to 3 percent and then diminishes gradually while due to oil price shocks, the rate increases by 4 percent and then starts declining. Following the food price shock, inflation goes up by around 4 percent and then declines gradually while for oil price shock the rate of inflation starts increasing and goes up to 2 percent during second quarter and then dies out at the end of third quarter. Industrial production growth starts declining following the food price shocks and goes as below as 9 percent but also very short-lived and the effects of oil price shock to industrial production is unclear.

Figure 5 Impulse responses of Singapore macroeconomic variables to NOFI and NOPI

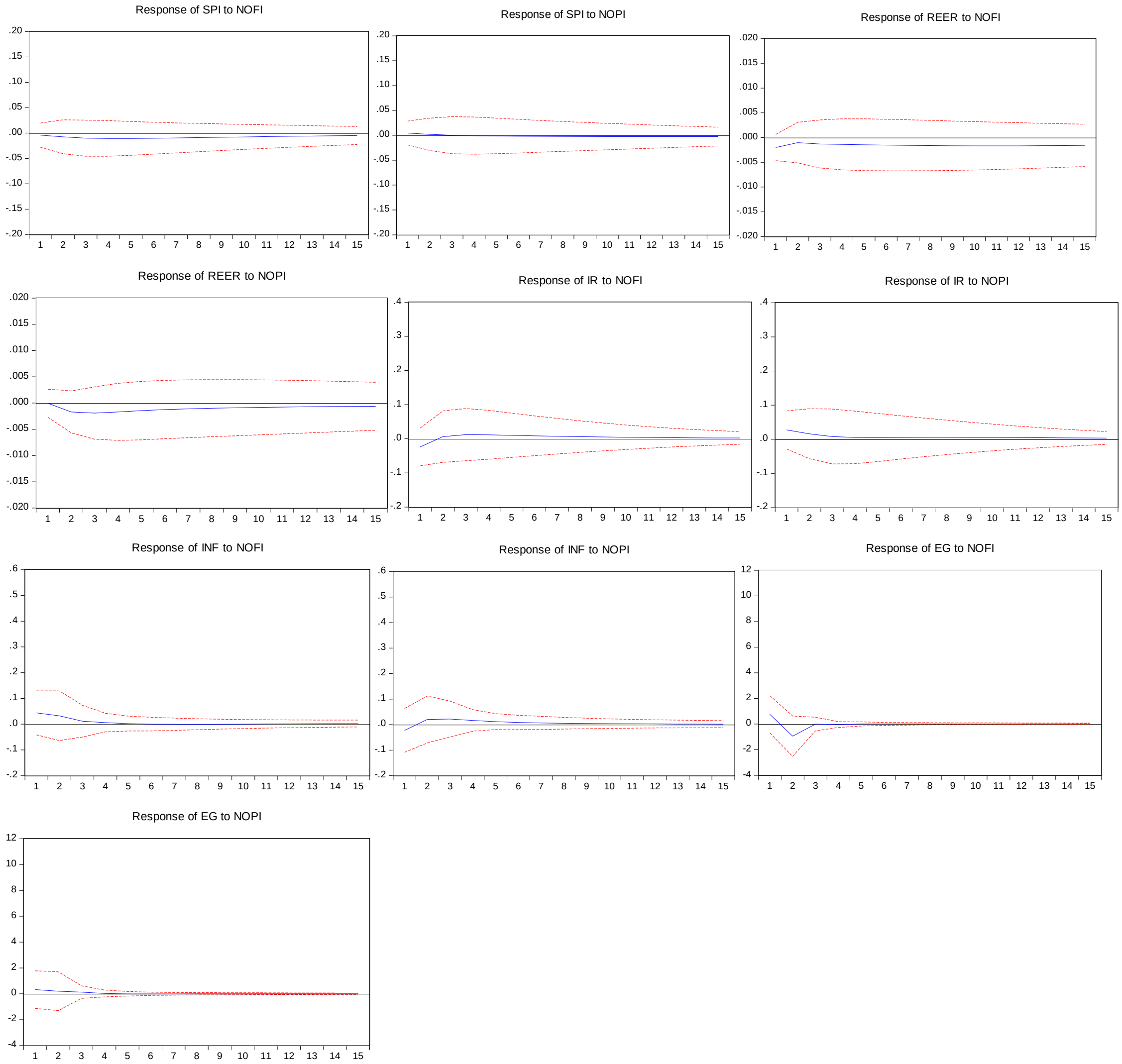


Figure 6 depicts the responses of Hong Kong economic variables to net food and oil price shocks. Hong Kong variables show some interesting results which somehow contradict with theories, for example, stock prices respond positively with both oil and food price shocks, interest rate drops following the food price shocks and the growth of industrial production rises following the oil price shock while it falls rapidly and dies out in second quarter. However, theoretically consistent results are available for real effective exchange rate, inflation and partly for interest rate and industrial production growth. The real effective exchange rate depreciates following both food and oil price shocks and the effects of shocks due to food prices last longer than oil price shocks. The rate of interest increases about 5 percent following the oil price shocks and goes up to 18 percent and then diminishes gradually at 12th quarter. The inflation rate goes up following one time shock of both food and oil prices; however, the persistency is higher in the case of food price shock. The industrial production goes down following the food price shocks but it recovers very quickly. Overall, the impact of food and oil price shocks to Hong Kong economy is mild.

Figure 6 Impulse responses of Hong Kong macroeconomic variables to NOFI and NOPI

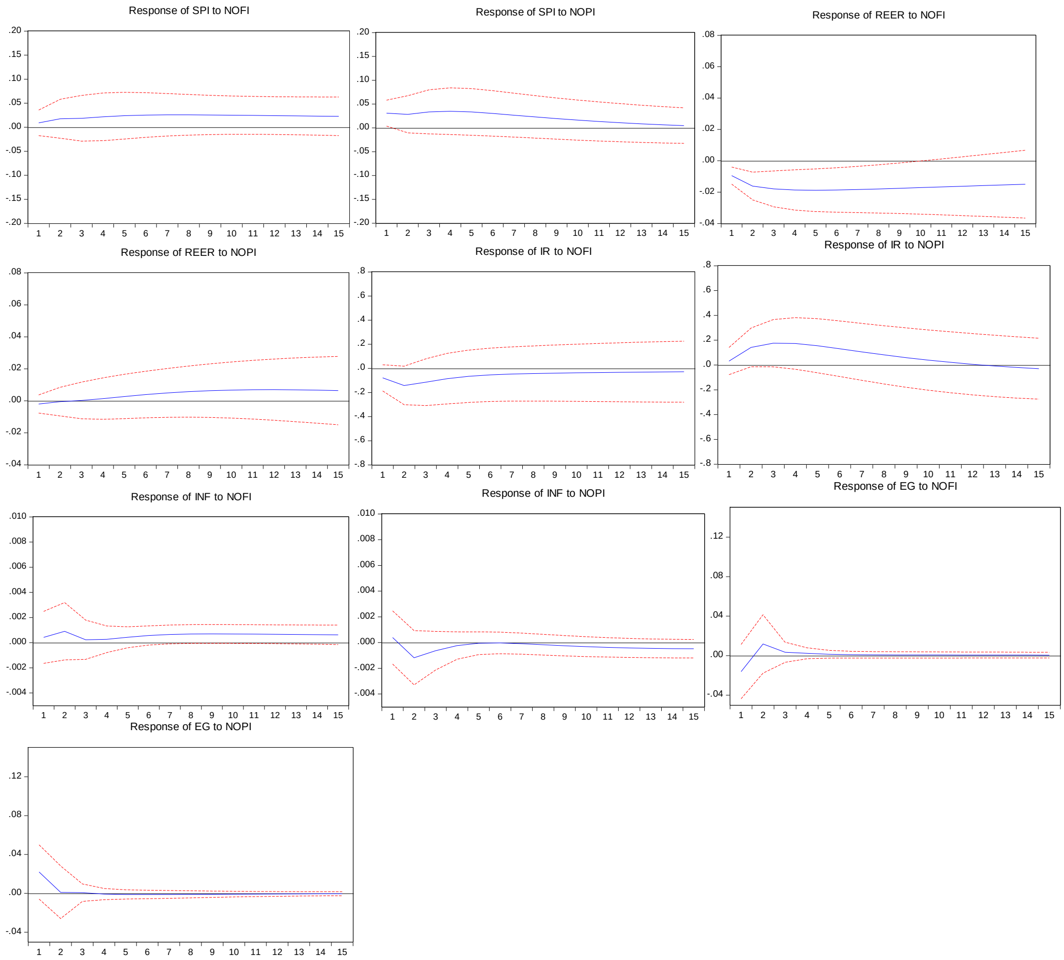
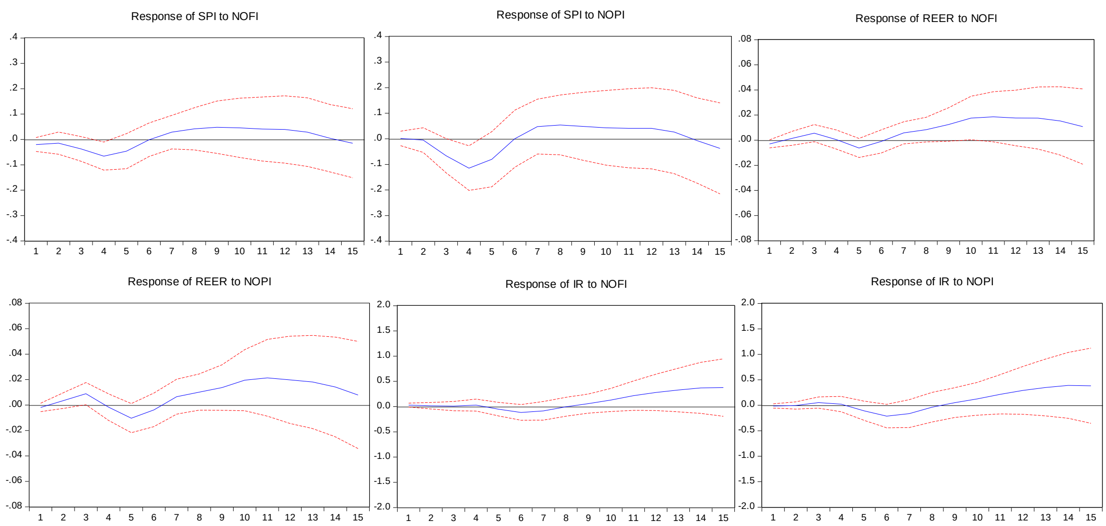


Figure 7 portrays responses of Taiwan macroeconomic variables to the structural one S.D. shock of external food and oil prices. Almost all the variables show theoretically consistent response to the food and oil price shocks. The responses are also statistically significant in most cases. The stock prices keep dropping until around 7 percent due to food price and 10 percent due to oil price shocks and the die out at around 7 periods. The real effective exchange rate drops mildly with the food and oil price shocks and recovers very quickly. The interest rate increases by 3 percent following food price shocks and sustains until the fourth quarter while it does not show any immediate response to oil price shock, however, after second quarter it increases by 5 percent and remains until the fourth quarter. The inflation rate starts increasing from -20 percent following the food price shock and goes up to 20 percent at the end of third quarter and then diminishes quickly though this is not statistically significant. And due to oil price shock it starts increasing from zero level and goes up to 20 percent and remains that high until disappears in fourth quarters. The industrial production growth shows the highest negative impact among all other variables. It decreases sharply following food and oil prices shocks and stays negative more than ten quarters.

Figure 7 Impulse responses of Taiwan macroeconomic variables to NOFI and NOPI



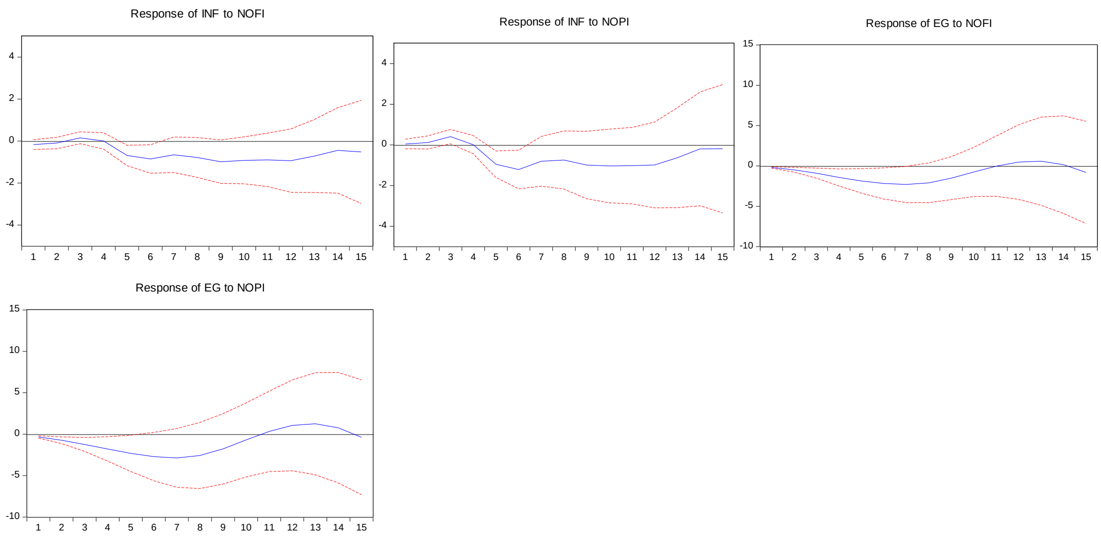
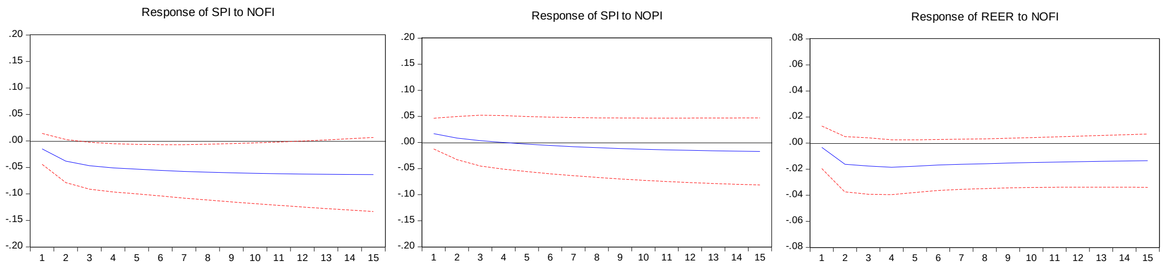


Figure 8 represents impulse responses of Indian macroeconomic variables to one standard deviation structural shocks to external food and oil prices. As can be seen in Figure 9, although in many cases the responses are not statistically significant the signs of responses are theoretically consistent in most cases. Food price shocks show negative impacts on stock prices, real effective exchange rate and industrial production growth and positive impacts on interest rate and inflation. Effects of shocks to stock prices, real effective exchange rates and inflation are mild while substantial effects can be observed in the case of interest rate and industrial production growth. On the other hand, oil price shocks pose positive impacts to stock prices and interest rate and negative effects to inflation and industrial growth leaving unclear impacts on real effective exchange rate. Due to both the shocks persistent effects can be observed in the case of real effective exchange rate and interest rates. Although real effective exchange rate is stationary the effects of shocks do not reach to back to equilibrium even after fifteen quarters.

Figure 8 Impulse responses of Indian macroeconomic variables to NOFI and NOPI



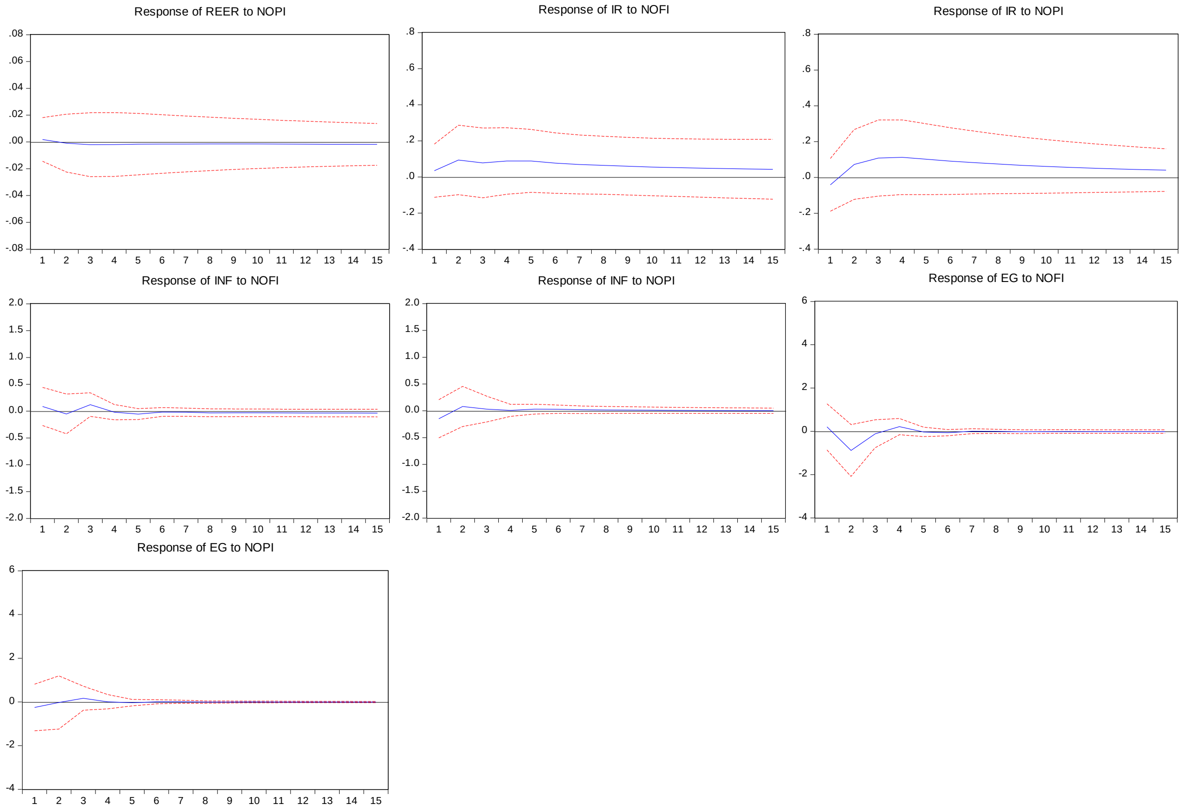
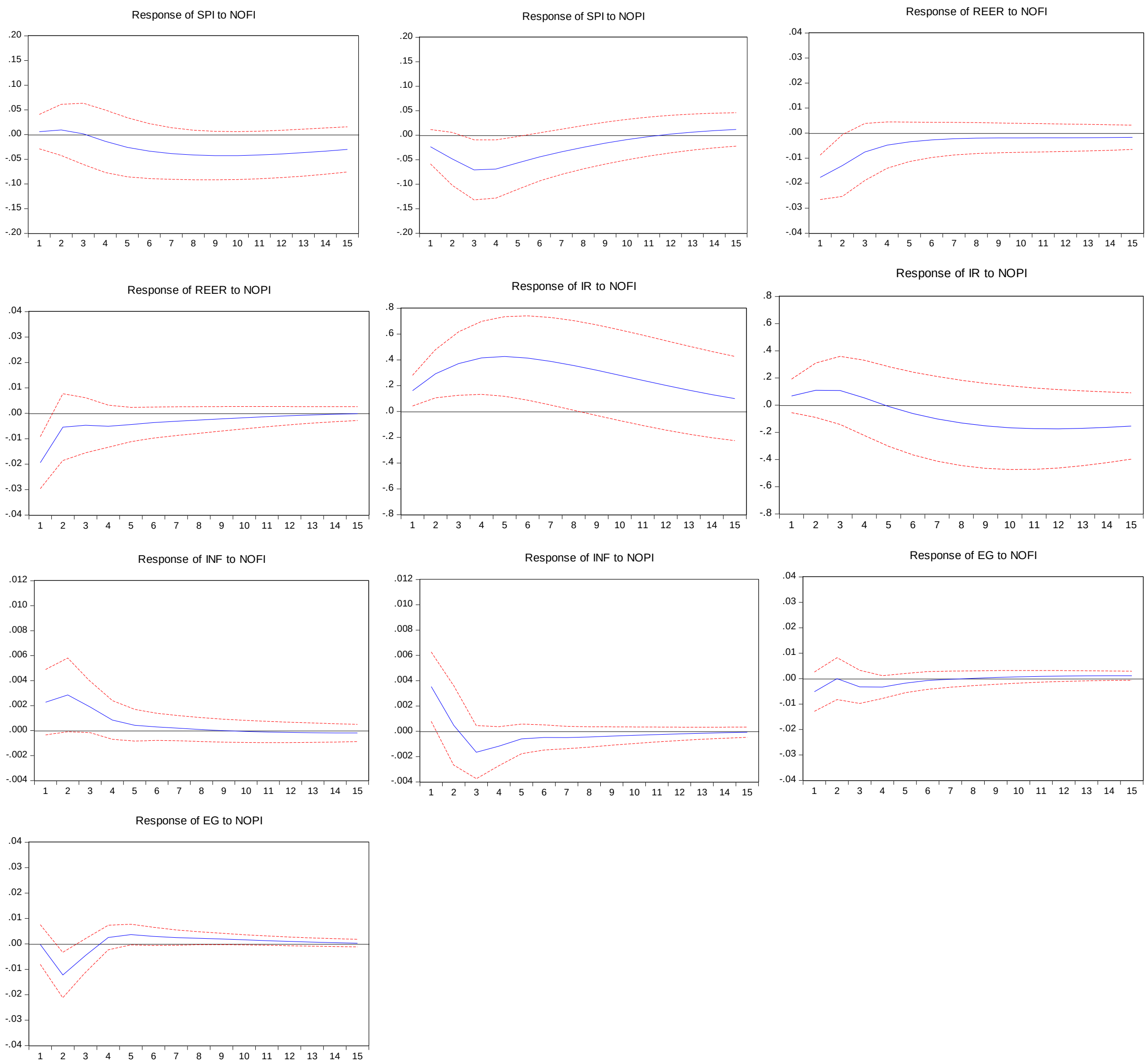


Figure 9 illustrates the impulse responses of selected Thai macroeconomic variables to the structural one standard deviation shocks of food and oil prices. The effects of food and oil price shocks are found to be statistically significant in most cases and are also statistically significant. The stock prices respond positively with food price shock at the first quarter but quickly after second quarter it starts declining and remains negative for a long period of time while due to oil price shock it drops about 5 percent and remains negative until 11th quarters. The real effective exchange rates fall by 2 percent following the food and oil price shocks and the effects of shocks diminish in around 4 years. The interest rate is found to be more sensitive to the food price shock. It increases more than 20 percent following the shock and stays for a longer period. However, the effect of shocks due to oil price is rather short-lived and the magnitudes are also lower (about 8 percent). Both food and oil price shocks put forth inflation to up although the effects is shorter due to oil price shock. The industrial production responds negatively following the food and oil price shocks. The effects of oil price shock persist longer than the food price shock.

Figure 9 Impulse responses of Thai macroeconomic variables to NOFI and NOPI



6.4 Forecast error variance decomposition (FEVD) analysis

Table 4 shows forecast error variance decompositions for different variables in response to the oil and food price shocks for the 1, 5, 10 and 15 quarters. Variance decompositions results are in general supported by impulse response analysis. The stock price indices in Australia and Singapore are found to be almost zero responsive to the food and oil price shocks. The variation in New Zealand stock prices due to oil price shock at first quarter is only 0.14 percent while it is 2.42 percent for food price shocks. The effects of shocks gradually increase and at the end of fifteen quarters oil price and food prices explain 13.15 and 4.70 percents of variation in stock prices respectively. In the case of Korean stock prices, the proportion of forecast error variance due to oil price is 6.25 percent in the first period while it is 4.22 percent for food price shocks. The proportion increases up to 11.57 percent in the 5th quarter for oil prices and then declines gradually and for food prices it decrease after the first quarter. The oil price shock contributes 7.50 percent variation to Hong Kong stock prices at the first period and then gradually declines while the contribution of food price shock is only 0.64 percent at the first period and reaches up to 6.80 percent at the end of fifteen quarters. In Taiwan, the contribution of oil price shocks to stock prices is only 0.03 percent at the first period while contribution of food price shock is 7.78 percent. The proportions increase until 5th quarter (44.76 percent) for oil prices and until 10th quarter (19.60 percent) for food prices. The contribution of oil price shock to Indian stock prices is marginal, only 1.87 percent at the first period and then declines gradually. And the contribution of food prices starts from 1.48 percent at the first quarter and increases up to 17 percent at the end of 15 quarters. Oil price shocks have substantial contribution to the variation of stock prices in Thailand while the contribution of food price shock is marginal at the first period. However, at the end of 15 quarters the contributions of both the price shocks are more than 10 percent.

The oil and food price shocks substantially contribute to the variation of real effective exchange rate in each country excepting Singapore. Although the contribution of oil price shock to Australian exchange rate is 0.07 percent at the first quarter it increases substantially during subsequent periods reaching highest as 15 percent at 15th quarter. Food price shock contributes to the variation of Australian exchange rate by 7.64 percent at the first quarter; reaches up to 11.21 percent at the 5th quarter and then decreases gradually. The oil and food price shocks explain 3.87 and 8.96 percents of the variation of New Zealand real effective exchange rate at the first quarter of the shock and then proportions increase gradually up to 10th quarter before starts falling. The shares of oil and food price shocks to the variation of Korean real effective exchange rate are 9.42 and 6.82 percents respectively at the first period and then keep rising. In Hong Kong, in the variation of real exchange rate the oil price shocks have marginal contribution (0.73 percent); however, the contribution of food price shock is noticeable (16.68 percent) at the first quarter. The ratio of oil and food price shocks in the variation of Taiwanese real effective exchange rate are 4.81 and 11.82 percents respectively at the first quarter while these keep rising until the 10th quarter. Although oil price shock has almost zero percentage share to the variation of Indian real effective exchange rate, the contribution of food prices are not ignorable. The contribution of food price shocks is 0.22 percent following the shock while it increases up to 10.32 percent at the end of 15 quarter. The oil and food price shocks contribute 23.48 and 19.48 percents to the variation of Thai real effective exchange rate respectively at the first period keep substantial contributions at the subsequent periods.

Interest rates in Australia and Singapore are found to be insignificantly responsive to the oil and food price shocks. The variation in interest rate due to oil and food price shocks is less than 1 percent in both cases even after 15 quarters. The contribution of oil and food prices to the variation of interest rates is observed to be higher in Korea, Taiwan and Thailand ranging from more than 5 percent to 28 percent at 15th quarter. The contribution of food price shocks as proportion to the variation in interest rate in New Zealand, Hong Kong and India seem to be lower than the contribution of oil price shocks.

The variance decompositions for inflation show that in the variation of the Singaporean and Indian inflation rates the contribution of oil and food price shocks are negligible (around 1 percent). In Australia the contribution of oil price shock to the variation of inflation is 4.35 percent following the shock at the first quarter and then diminish gradually while contribution of food price shocks seem to be insubstantial. The New Zealand inflation varies 2.34 and 0.54 percents due to oil and food price shocks respectively at the first quarter and then the effects keep increasing until the 15th quarter. The role of oil and food price shocks to the variation of Korean inflation is 1.43 and 0.89 percents respectively at the first quarter while the proportions increase in subsequent quarters. Although the contribution of oil and food prices to the variation of Hong Kong inflation is less than 1 percent at the first quarter the proportions increase more up to more than 3 percent at the 15th quarter. The Taiwan inflation seems to be most sensitive to both oil and food price shocks. The contribution of oil and food prices is 18.33 and 14.97 percents respectively during the 15th quarter. The variation of Thai inflation is found to be highly explained by oil and food price shocks at the first quarter (11.58 and 4.79 percents) and the proportions go up to more than 12 percent at the 15^{th} quarter.

In terms of the industrial production growth, the contribution of oil and food price shock is mild for Australia, New Zealand, Singapore and India. Like many other variables, the role of oil and food price shocks to the variation of industrial growth can be observed for Korea, Hong Kong, Taiwan, and Thailand. Although the proportions of oil and food price shocks in the variability of industrial growth for Korea and Thailand are low at the first quarter, they increase in the subsequent quarters while significant contributions are viewed in Hong Kong and Taiwan following the shock in the first quarter.

Table 5 Forecast error variance decompositions

Variables	Horizon	AUS		NZ		KOR		SIN		HK		TWN		IN		TH	
		NOPI	NOFI	NOPI	NOFI	NOPI	NOFI	NOPI	NOFI	NOPI	NOFI	NOPI	NOFI	NOPI	NOFI	NOPI	NOFI
SPI	1	0.01	1.19	0.14	2.42	6.25	4.22	0.14	0.12	7.50	0.64	0.03	7.78	1.87	1.48	3.23	0.20
	5	0.60	1.69	7.43	3.29	11.57	3.75	0.04	0.65	8.20	2.78	44.76	15.87	0.47	11.67	17.97	1.10
	10	0.45	0.99	11.82	4.65	8.46	2.64	0.05	0.83	8.27	5.17	42.31	19.60	0.51	15.55	16.98	7.60
	15	0.99	0.88	13.15	4.70	6.69	2.65	0.07	0.86	7.37	6.80	27.07	13.76	0.78	17.05	14.93	11.48
REER	1	0.07	7.64	3.87	8.96	9.42	6.82	0.00	2.23	0.73	16.68	4.81	11.82	0.07	0.22	23.48	19.48
	5	11.22	11.21	15.35	29.61	33.63	28.35	0.92	0.87	0.30	31.47	29.41	11.51	0.08	7.05	16.50	19.98
	10	13.91	10.58	15.68	29.76	34.55	29.49	0.71	0.96	1.63	28.44	32.96	22.92	0.10	9.32	16.69	19.51
	15	14.60	10.34	15.77	29.16	34.82	29.98	0.56	1.09	2.15	22.73	21.76	18.07	0.12	10.76	16.55	19.76
IR	1	0.93	0.36	2.42	0.08	0.36	5.06	0.93	0.71	0.49	3.08	1.66	8.10	0.44	0.32	2.22	12.52
	5	0.60	0.08	3.24	0.06	10.88	28.11	0.41	0.36	9.08	4.34	8.88	2.75	3.01	2.31	1.70	32.74
	10	0.48	0.21	2.39	0.69	8.86	17.94	0.35	0.33	6.24	2.58	20.68	8.87	3.54	2.67	2.40	32.48
	15	0.86	0.48	2.07	1.63	12.93	15.33	0.36	0.33	4.44	1.96	23.35	19.78	3.56	2.79	5.15	28.33
INF	1	4.35	0.17	2.34	0.54	1.43	0.89	0.27	1.01	0.21	0.25	0.52	7.87	0.98	0.34	11.58	4.79
	5	3.79	0.35	7.35	1.45	8.35	9.90	0.69	1.23	2.25	1.45	37.37	18.29	1.03	0.97	11.94	12.41
	10	3.66	0.39	7.07	1.50	9.66	10.46	0.70	1.14	2.24	3.52	34.90	24.77	1.06	1.07	12.25	12.17
	15	3.69	0.46	6.98	1.69	10.51	10.95	0.69	1.11	3.00	5.26	18.33	14.97	1.05	1.26	12.29	12.20
EG	1	1.73	0.94	0.20	0.70	1.43	0.31	0.18	1.06	3.69	1.99	62.33	14.49	0.32	0.21	0.00	3.21
	5	1.69	1.09	1.72	1.41	6.32	4.73	0.25	2.35	3.59	3.10	41.46	25.30	0.33	3.07	14.76	3.96
	10	1.69	1.09	1.72	1.47	6.40	4.76	0.25	2.34	3.62	3.12	34.91	22.68	0.32	3.08	15.60	3.78
	15	1.69	1.09	1.82	1.63	6.45	4.79	0.25	2.34	3.63	3.13	24.71	15.40	0.33	3.08	15.59	4.13

7. Discussion, policy implications and limitation

The empirical results of this study reasonably reflect the background characteristics of economies covered by the study. The Australian and New Zealand economies are found less affected by international oil and food price shocks. The channel which found to be significant for these two countries is real effective exchange rate. In both countries the exchange rates depreciate followed by oil and food price shocks. Although Australia and New Zealand have little amount of proven oil reserve, these two countries possess a number of other mineral resources which dominate the energy sector, for example, According to IEA, in 2008 Australia produces 99 percent of electricity by using different fuels including coal as major (76 percent) and only 1 percent electricity comes from oil. In 2008, New Zealand produces 99.97 percent electricity from other sources than oil out of which 75 percent comes from hydro and gas plants. Only 0.03 percent is produced using oil as fuel. The main uses of oil in these countries are for transportation. Industrial production indices do not include transport cost directly and that could be one possible reason that industrial production are found to be not responsive to oil price shocks. The reasons for which industrial production are not affected by oil price shocks are also applicable for stock prices. These alternative mineral resources help Australia to accommodate oil supply shocks. Both of these countries maintain inflation targeting monetary policy which could be the reason to accommodate the oil price shock through inflation and interest rate. Because of being net food exporters in the world market Australia and New Zealand economy are not adversely affected by food price shocks. The depreciation of exchange rate following oil and food price shocks should not be taken as adverse for these countries because it may increase the demand for export goods.

The four Asian tiger economies are found to behave mainly in two ways to oil and food price shocks. Korea and Taiwan specialized in manufacturing and information technology are found to be much affected by oil and food price shocks while Singapore and Hong Kong specialized in international financial services are found not affected. Korea being a resource poor country is most vulnerable to oil and food price shocks. Korea is fifth in the top net importers list of oil and third in the list of top consumers as non oil producing countries after Japan and Germany. The findings related to oil price shock on macroeconomic variables of Korea is consistent with Cuňado and Gracia (2003) and Hsieh (2008). Possible interpretation can be as follows. Heavy industries in Korea are also dependent on the electricity generated mostly by imported oil. Because of this dependency on oil, oil price increase badly affects industrial output. When industrial output decreases inflation may rise. Because of the increased money demand for importation of oil the domestic interest rate increases. Korea also needs to import most of the food products which obviously put negative impacts to import bills and thus to the other macroeconomic variables. Taiwan has the similar economic characteristics as of Korea. The reasons why Korean output and other variables are impacted by oil price shocks are also applicable to Taiwan case. However, Taiwan is found to be more accommodative to food price shocks. The major channel through which food price shocks transmit to Taiwan economy is real exchange rate. Since Taiwan does not import much food products the effects of food price shocks are not that severe as oil price is. Singapore and Hong Kong economies are dependent in financial services and financial services are not much dependent on oil like industrial productions. That might be possible reasons that these countries are not much affected by oil price shocks. In Singapore case, selected variables are found not responsive to either oil or food price shocks which is partly consistent with Chang and Wong (2003) and Cuňado and Gracia (2003). Chang and Wong (2003) report that oil price has marginal impact on GDP, CPI and unemployment rate in Singapore. However, Cuňado and Gracia (2003) show that there is no causal relationship between oil price and Singaporean economic growth although they document evidence of causal relationship between oil price and inflation. In Hong Kong oil price shocks found to be transmit through interest rate channel while other variables are not significantly responsive to the oil price shock which is consistent to Ran et al.(2010). The reason could be the increase of money demand due to excess expenditure on imported oil. In terms of food price shock, exchange rate is found as the channel to be transmitted. Hong Kong lacks of arable land which forced it to import all of its food products needed. Because of this reason there must be pressure on import bills which help Hong Kong dollar to be depreciated.

In Indian case, food prices have dominant impact on the macroeconomic variables than oil prices. The major channel through which oil price shock transmits to Indian economy is interest rate derived from money demand for importing oil. India has proven reserve of oil to meet 25 percent of domestic demands and also has coal and other mineral resources which are used for generating energy in the country. India meets most of its domestic energy demand through its coal reserves. Because of these reasons, manufacturing output is not dependent on the imported oil. This could be one of reasons that Indian industrial productions are not affected by oil price shocks although this findings contradict to Managi and Kumar (2009). However, due to food price hike the labour forces in the industrial sector may demand higher wages and thus demand for labour decreases which decreases output in the industrial sector. Once output decreases the stock price also decreases. However, the situation improves rapidly because of exchange rate depreciation.

Although there is lack of evidence of Granger causality, impulse response and variance decompositions functions in the sense of statistical significance suggest that Thai macroeconomic variables such as stock prices, real effective exchange rates and industrial output are found to be adversely affected by oil price shock which is consistent to Rafiq et al. (2009). On the other hand, real effective exchange rate, interest rate and inflation are found to be adversely affected by food price shocks. Although Thailand uses natural gas mostly for generating energy the demand for oil is also high. Since industrial outputs hampers, the stock prices decrease. Real effective exchange rates are on pressure because of excess import bill due to oil price increase. And because of global food price increase, the demand for Thai food might decrease. The export earning decreases that helps exchange rates to depreciate. As net export falls it may increase inflation. The adverse effect of food prices on inflation in Thailand is consistent to Galesi and Lombardi (2009a). They state that developing countries price levels are much affected by food prices than oil price shocks.

Overall, the empirical results suggest that the resource poor countries specialized in the production of heavy manufacturing industries dependent on oil like Korea are Taiwan are most vulnerable to oil price shocks. These countries may adopt different conservatory measures and switch to renewable energy sectors to cope with oil price shocks. Countries like Australia and New Zealand which have diverse mineral resources other than oil are better in coping oil price shocks. The only adverse effects these countries get the depreciation of local currency which, in other words, is good for their export sector. Developed countries which specialized in financial services such as Singapore and Hong Kong are accommodative of oil price shocks. Developing countries specialized both in primary and manufacturing products like India with diverse mineral resources are also not vulnerable to oil price shocks. However, Thailand the case of Thailand is different. Although it possesses huge amount of natural gas its industrial output are affected by oil price shock and also being major exporter food the economy is negatively exposed to external food price shocks. Thailand thus need external shocks accommodative policies along with enhance of using alternative sources of energy.

As mentioned earlier, we use selected macroeconomic and financial variables and interpret results based on the findings in regards to the selected variables. The impact of both oil and food prices could be different if we would have used GDP data instead of industrial production and also would include government or private expenditure data. The results could also be different if terms of trade and trade balance data were used. Therefore, when take the findings for implications this limitation should be taken into consideration. The study can be extended to over identified structural VAR model.

8. Conclusions

The objective of this study was to investigate the effects of world oil and food price shocks to selected macroeconomic variables of Australia, New Zealand, Korea, Singapore, Hong Kong, Taiwan, India, and Thailand. By employing structural vector autoregressive (SVAR) models, the study reveals that resource poor countries that specialize in heavy manufacturing industries like Korea and Taiwan are mostly affected by international oil price shocks. Increase in oil prices reduces the growth of industrial production, real effective exchange rate and stock prices and increases inflation and interest rates in these countries. On the other hand, oil poor nations such as Australia and New Zealand with diverse mineral resources other than oil are not affected much by oil price shocks. The only channel which is affected by price shocks in these two countries is real effective exchange rates. Increase in oil and food prices help depreciating exchange rates in these countries. Countries which are oil poor but specialized in international financial services such as Singapore and Hong Kong are also not affected by oil price shocks. Developing countries with diverse natural resources with limited reserve of oil e.g., India is negligibly affected by oil price shocks. Indian interest rate show positive response to oil price shocks. In contrast, Thailand being resource rich country other than oil is not accommodative of oil price shocks. Thai stock prices, stock prices and industrial production growth respond negatively to the oil price shocks while oil price increase has positive influence on inflation and interest rate. Industrial outputs of food exporter countries like Australia, New Zealand, and Thailand are not affected by global food price shocks. However, output of India is adversely affected by global food price shocks. Among food importer countries except Korea other countries' output are also not adversely affected by food price shocks. Increases food prices help depreciation of exchange rates in almost all countries except Singapore. The evidence of effects of food prices on stock prices are almost nil except India. Positive pressure of food prices on inflation and interest rate are found for Korea and Thailand only. The findings suggest that Korea, Taiwan and Thailand may design effective policy measures to cope with oil price shocks. Renewable energy sources could be one of the options for these countries to accommodate oil price shocks. Food reserve increase and enhanced local production can help countries to cope with food price shocks.

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