Estimating the Effects of Global Oil Market Shocks on Australia's Merchandise Trade

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Abstract

In this paper, we study the dynamic responses of Australia's international commodity market to global oil market structural shocks. Employing monthly data which cover 1986M6–2013M1, our findings indicate that oil price increases driven by shocks in global economic activity as well as oil-specific demand significantly influence merchandise exports and accordingly, merchandise trade in long-term. Furthermore, oil price disruptions driven by global oil supply shocks strongly affect merchandise exports and hence, merchandise trade for more than a year. The responses of merchandise imports, however, are reported to be modest and persistent for a few months. Finally, uncertainty to global real oil price shocks, which is formed by over 3-month real oil price volatilities in real price of oil, influences Australia's international commodity market statistically negatively.

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Keywords: Oil price volatility, Australia's merchandise trade, structural oil market shocks, Oil price volatility.

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1. Introduction

By the time of refining crude oil in ancient China in 2000 BC, oil has widely been utilized in almost every aspect of humans' life. Numerous studies conclude that oil price increases forecast most of recessions. In a seminal work, Hamilton (1983) find that an oil price increase had preceded all recessions other than that of the 1960s' in the US. This finding motivated other economists to continue such research for the post-World War II period. Where many of them confirmed the Hamilton's (1983) finding, Bernanke *et al.* (1997) conclude that the recessions of 1973, 1979 and 1990 are attributable to monetary policy, not oil price shocks (e.g. Gisser and Goodwin, 1986 and Burbidge and Harrison, 1984). Other than economic effects of changes in price of crude oil as a tradable commodity, oil is often considered as international trade impetus: oil price fluctuations may cause uncertainty in future price index. This in turn, causes consumers to postpone their purchases of durable commodities and firms to reschedule their investment which generates delay. Afterward reduction in aggregate demand due to decline in domestic consumption and investment expenditure may reduce international trade.

As a big sector forming economic output, international trade may transfer the effects of global oil price shocks to GDP. The main body of research suggests that oil price shocks exhibit significant influences on the international trade. For instance, Backus and Crucini (2000) show that oil price movements explain much of the trade changes during 1972–1987. Employing a dynamic equilibrium model for eight developed countries, they find that volatility in terms of trade is better explained by relative oil price than exchange rate volatility. This finding has been confirmed with several studies. For example, using a structural VAR model, Otto (2003) confirms the positive relationship between oil price shocks and terms of trade. More importantly, the relationship pattern is shown to be similar among developing and small OECD countries. Likewise, Baffes (2007) shows that oil price shocks have strong effects on the price of traded commodities. Using annual data for 35 primary commodities traded internationally during 1960–2005, he concludes that increase in oil price reduces industrial production by declining disposable income and hence, the price of tradable commodities responds significantly to the oil price shocks. Finally, using an autoregressive distributed lag model, Hassan and Zaman (2012) find that oil price shocks influence international trade of Pakistan negatively.

As opposed to aforementioned studies demonstrating significant effects of global oil price shocks on international trade, some believe that current evidences are not enough to support the presence of such influences. Expanding the framework presented by Backus and Crucini (2000), Bodenstein *et al.* (2011) find that under the complete financial market's condition, oil price shocks have no effect on the non-oil terms of trade, where such effect is reported to be statistically significant under incomplete financial market condition. Chen and Hsu (2012) employ data set covering 84 different countries to compare the effects of oil price shocks among net oil importing and net oil exporting countries. They show that oil price shocks have negative impacts on international trade of net oil importing countries while such effects are insignificantly positive in net oil exporting countries. Finally, Le and Chang (2013) find that the effects of oil price shocks are country-specific. Using Toda and Yamamoto (1995) causality test and generalized impulse-response functions, they show that in Japan as an oil importing country, oil price is known to be cause of both oil and non-oil trade balances while in Malaysia as an oil exporting country, such causation is running from oil price shocks to oil and overall trade balances. In Singapore, as an oil refinery country, however, no causality is detected between such variables. Korhonen and Ledyaeva (2010), Bollino (2007), Kilian *et al.* (2009) and Rebucci and Spatafora (2006) have conducted further studies in this field.

Reviewing the current literature highlights three major gaps: first and most importantly, there is no study addresses the effects of oil price shocks on international trade of an economy with roughly equal oil production and consumption such as Australia. Detecting such evidence is supposed to be sensible where major oil market crises could be adjusted replacing domestic crude oil. Second, there is not enough evidence addressing responses of international trade to structural oil market shocks. It is unclear yet whether oil price shocks driven by diverse origins affect Australia's terms of trad identically. Finally, restricted number of studies addresses the issue using monthly frequent data while monthly data can produce dynamic advantages for estimation purposes.

The existing gaps in the current literature motivates us to study the effects of global oil price shocks driven by different supply and demand origins on Australia's merchandise trade. To do so, we first estimate separated structural oil market shocks driven by different origins using structural vector auto regressive (SVAR) model proposed by Kilian(2009). To clarify our approach, we then consider possible dynamic nonlinear causation running from oil market shocks to merchandise trade variables. Rejection of the null hypothesis in this case will strengthen our findings resulted from dynamic linear models. Finally, due to the importance of uncertainty to future oil price changes and its effects on international commodity market, we calculate oil price volatility using several measurement methods and then, we analyse impulse-response functions using vector autoregressive (VAR) approach. The remainder of this article is presented as follows: Section 2 locates Australia's merchandise trade position within top trading partners and possible trade-offs with global oil price changes. Sections 3 and 4 present data, methodology and empirical results, respectively. Finally, section 5 summarises the findings. The outcomes of this paper may suit academics and researchers, policy decision makers and market activists.

2. Global Oil Price and Australia's International merchandise Trade

Research outcomes indicate that technological progress in international shipping during 1850–1913 has led to significant reductions in nations' cost of international trade (Harley, 1980, 1989; North, 1958, 1968; Saif and Williamson, 2004). Econometric evidences have also subsequently linked shipping cost declines to rapid growth in trade during the first stages of globalisation (Estevadeordal *et al.*, 2003). However, there is no evidence supporting such shipping cost declines for the recent years. Countries with adjacent borders trade roughly 23 per cent of global international trade by value; such portion is 1–5 per cent in Africa, Middle East and Asia, 10–20 per cent in Latin America and 25–35 per cent in Europe and North America (Hummels, 2007). For non-adjacent countries, obviously, nearly all merchandise trade is done through ocean and air.

<TABLE 1 ABOUT HERE>

Australia as a country with no adjacent neighbours and being surrounded by the ocean utilises only ocean and air for international trade shipping. Thus, dealing with farther partners compared with other countries has raised its cost of trade and hence, any shock in global oil price is expected to influence its trade volume sensibly. Tables 1–2 summarise some statistics of Australia's international trade with top 10 partners. Table 1 indicates that more than a quarter of Australia's exports, which contributes 5.5 per cent to the Australia's GDP, is traded with China and the US through more than 22 thousands kilometres overall distance. This is more interesting if we know that 16.50 per cent out of 21 per cent exports to the top 10 partners is allocated to merchandise trade. This indicates that Australia's merchandise trade is more costly than trade of services. The closest export market among top 10 countries is New Zealand with more than 4 thousands kilometres distance, which attracts just over half per cent of Australia's exports. On the other hand, Australia's top importing partners involve top exporting partners with Germany and Thailand being replaced with India and Taiwan (Table 2). Consequently, the overall importing distance from top 10 partners is longer than exporting distance to top 10 countries presented in Table 1. Table 2 also shows that China holds the first rank among Australia's trading partners by feeding 15 per cent of Australia's total imports. Furthermore, the share of the US, UK, and Germany from Australia's total imports is considerable: as the farthest partners among top 10 countries, they provide 19.6 per cent of Australia's total imports. In short, the far distance from trade partners and the high ratio of merchandise trade out of total international trade highlights the significant contribution of oil price shocks in Australia's cost of trade.

In addition to shipping cost, the volume of trading oil-substitute or oil-complementary goods is considered to be important on effects of oil market shocks on merchandise trade. Based on

Australian Department of Foreign Affairs and Trade statistics, more than 17 per cent of total exports is allocated to coal and natural gas, which are considered to be strong substitutes for crude oil. These materials may be more demanded due to oil price shocks and hence, raise Australia's exports. On the other hand, crude petroleum, passenger cars and goods vehicles, which re within the list of top 10 importing goods, form more than 13.7 per cent of total imports. This indicates that an oil price shock may reduce such imports due to their oil-complementary nature. However, oil shocks driven by domestic progressive economic activity or increasing oil-specific demand may have diverse influence.

<TABLE 2 ABOUT HERE>

To investigate global oil price and Australia's international trade co-movements, we plot Figure 1, which illustrates Australia's visible international trade series against global oil price changes for the period of 1986M1–2012M11. In this Figure, oil price has been measured in real US dollars per barrel and Australia's merchandise trade has been measured in billions of US dollars. The Figure indicates that global oil price movements, which fluctuate ascendingly over 2008 crisis, moves convergently with Australia's merchandise trade. Accordingly, three types of fluctuations are modified: prior to 1999, 1999–2002 and after 2002. During the first period, no significant relationship between oil price and merchandise trade is evident. The calculated correlation coefficient of –0.55 confirms such independency. Afterwards, the trends fluctuate more similarly within the second period; the correspondent correlation coefficient is equivalent to 0.66. Finally, both variables move comparatively alike after 2002. Our calculated correlation coefficient of 0.80 demonstrates such co-movement. Altogether, due to the high volume of merchandise trade within overall Australia's international trade, we expect that global oil price changes affect Australia's international trade more significantly during the time.

< FIGURE 1 ABOUT HERE >

3. Data and Methodology

3.1. Data

In this study, we collect monthly data of Australia's visible international exports and imports from Organisation for Economic Co-operation and Development (OECD). Furthermore, we need to collect Australia's nominal exchange rate and consumer price index of the US and Australia from OECD to calculate real values of trade, exports and imports in real US dollars. We also collect West Texas Intermediate (WTI) daily spot oil prices from Energy Information Administration (EIA).

Finally, we collect monthly global crude oil production (thousands of barrels per day) from EIA and the index of real economic activity in industrial commodity market from Kilian's personal webpage. The dataset covers the period of 1986M6-2013M1.

3.2. Oil Price Volatility

Price of crude oil and petroleum products can be influenced easily by events which potentially disrupt the flow of oil and its products to the mostly oil-intensive industries and accordingly, to commodity markets. Such events induce real oil price to be unstable and volatile. Consequently, volatile oil price creates uncertainty about future oil supply or demand, which can lead to higher volatility in oil price and so on. The current literature confirms the linkage between oil price volatility and market uncertainty about future oil price. More importantly, real oil price volatility has been used as an index to measure uncertainty about future oil price (e.g. Elder and Serletis, 2010).

Reviewing the current literature, there are common methods to calculate oil price volatility. These approaches include standard deviation volatility (VSD), realized volatility (VR) and GARCH(1,1) model volatility (VGARCH). To estimate each, we first need to calculate daily oil price return as follows:

$$r_t = \log(pod_t) - \log(pod_{t-1}) \tag{1}$$

where r_t denotes daily oil price return and pod_t is WTI daily oil price index. Now, each volatility index is calculated using the following formulations:

$$VSD_t = \left(\frac{1}{D-1}\sum_{t=1}^{D}(r_t - \frac{1}{D}\sum_{t=1}^{D} r_t)^2\right)^{\frac{1}{2}} \tag{2}$$

$$VR_t = \sum_{t=1}^{D} r_t^2 \tag{3}$$

$$VGARCH_t = \frac{1}{D}\sum_{t=1}^{D}\sigma_t^2 \tag{4}$$

where D indicates the number of monthly trading days and σ_t^2 is the GARCH(1,1) term using squared residuals of r_t on its mean. Finally, monthly oil price volatility is measured by averaging calculated GARCH terms.

< FIGURE 2 ABOUT HERE >

< TABLE 3 ABOUT HERE >

The calculated correlation coefficients of three mentioned volatility indices indicate that they measure oil price volatility fairly similarly. Such coefficients are reported to be equivalent to Corr(VSD, VRV) = 0.924, Corr(VSD, VGARCH) = 0.932 and Corr(VRV, VGARCH) = 0.997. Furthermore, to consider the consistency of the measured volatilities, we plot Figure 2 which merges the GARCH oil price volatility — Equation 4 — and the correspondent events. As Kilian (2009) shows, major oil price shocks are preceded by the structural supply shocks prior to 1992 where recent oil price shocks are driven mostly by global demand shocks. In conjunction with Kilian (2009), Hamilton (2009a, 2009b) and Filis *et al.* (2011), Figure 2 shows coincidence of global oil price volatility with major events driving oil price shocks. For example, oil-specific demand shock during 1990 – 1991 is fitted with the Iraq invasion in Kuwait, First War in Iraq and the Collapse of the Soviet Union. Likewise, Chinese Economic Growth and Global Financial Crisis during 2006 – 2009 are known to be major origins driving oil price shocks through aggregate demand mechanisms.

3.3. Structural Shocks and model specification

In this paper, we estimate crude oil market shocks using a two block structural shocks proposed by Kilian(2009). The standard SVAR model is specified as below:

$$\boldsymbol{AY_t} = \alpha + \sum_{i=1}^{24} \boldsymbol{B_i Y_{t-i}} + \varepsilon_t \tag{5}$$

In this Equation, $\boldsymbol{Y} = (\Delta OS, \Delta RA, \Delta OP)'$ indicates log-difference of global oil supply, Kilian index of global real economic activity and log-difference of global real oil price, respectively. The exogenous error terms (ε_t) are assumed to be serially and mutually structural innovations. $\boldsymbol{A}$ is a full rank matrix such that $\boldsymbol{A^{-1}}$ is a recursive structure defining the reduced form $e_t = \boldsymbol{A^{-1}}\varepsilon_t$. Such decomposition is presented as follows:

$$e \equiv \begin{pmatrix} e_t^{\Delta OS} \\ e_t^{\Delta RA} \\ e_t^{\Delta OP} \end{pmatrix} = \begin{bmatrix} a_{11} & 0 & 0 \\ a_{21} & 0 & 0 \\ a_{31} & a_{32} & a_{33} \end{bmatrix} \begin{pmatrix} \varepsilon_t^{Oil\ supply\ shock} \\ \varepsilon_t^{Aggregate\ demand\ shock} \\ \varepsilon_t^{Other\ oil-specific\ shock} \end{pmatrix} \tag{6}$$

Consequently, the structural innovations present oil market shocks as follows: crude oil supply shocks are unanticipated innovations to global crude oil production. Shocks to the global demand for industrial commodities (aggregate demand shocks) are those innovations to global real economic activity, which are not explained by crude oil supply shocks. Oil-specific demand shocks, which are interpreted as precautionary demand shocks, are innovations to real price of oil that cannot be explained by oil supply shocks or aggregate demand shocks.

There are some restrictive assumptions behind the above decomposition. Firstly, oil supply innovations do not respond to shocks in aggregate demand and other oil-specific shocks in the short-term. This lets oil supply shocks to be considered exogenously. In practice, it is only oil-producers who have control over oil production and hence, at least one month delay is needed for aggregate demand or other oil specific shocks to influence supply of oil. Secondly, global economic activity responds to global oil price shocks immediately, while oil-specific shocks have no effects on global economic activity in the short-term. Kilian(2009) explains how oil-specific shocks may influence global economic activity after a month. Finally, As Kilian(2009) and Kilian and Park(2009) believe, other oil-specific shocks are interpreted as precautionary demand shocks, which are induced by the expected shortfalls in oil supply. These shocks do not respond to exchange rate innovations in a country within 1 month as they are mainly caused by uncertainty in future global oil supply.

To investigate the linear responses of Australia's merchandise trade variables to the estimated shocks in crude oil market obtained from Equations 5 and 6, we follow Kilian(2009) linear approach to measure impulse-responses. Consider the following Equation:

$$M_{ht} = \delta_{hj} + \sum_{i=0}^{24} \varphi_{hji} \hat{S}_{hjt-i} + \omega_{hjt} \qquad h = j = 1, 2, 3 \qquad (7)$$

Where M and $\hat{S}$ denote log-difference of merchandise trade variables and estimated shocks using Equations 5 and 6, respectively. As we have three merchandise trade variables as well as three structural oil market shocks, h and j take values equivalent to 1–3. In addition, δ is the constant term and ω is the error term. The purpose of estimating Equation 7 is to obtain the model coefficients (φ). Such coefficients report trade responses to each shock impulses during a 24-month horizon. Consequently, the number of lags is determined by the maximum horizon of the impulse-response function. It is also worth noting that the error terms are potentially serially correlated. This provides biased estimation to obtain standard errors. To avoid such problem, we employ bootstrap simulations to obtain standard errors. Finally, we decompose country-specific forecast error variance of each shock to determine the contribution of each shock to variations in merchandise trade variables.

3.4. *Parametric nonlinear model*

The parametric nonlinear model employed in this paper has first been applied by Mackey and Glass (1977). They employed a bivariate noisy procedure in describing physiological control system using Chaos Theory. Their model has been modified with essentials in different sciences. One of the economic modifications has been done with Kyrtsou and Labys (2006). The test is similar to the linear Granger causality test. However, it contains the Mackey–Glass model process with special parameters, which are estimated using ordinary least squares method. Given the estimated oil price shocks ($\hat{S}$) and merchandise trade variables (M), the test is conducted through the following formulations:

$$M_{it} = \alpha_{j11}\left(\hat{S}_{jt-\tau_1}\right)\left(1+\hat{S}^{c_1}_{jt-\tau_1}\right)^{-1} - \delta_{j11}\hat{S}_{jt-1} + \alpha_{i12}\left(M_{it-\tau_2}\right)\left(1+M^{c_2}_{it-\tau_2}\right)^{-1} - \delta_{i12}M_{it-1} + u_t \quad (8)$$

$$\hat{S}_{jt} = \alpha_{j21}\left(\hat{S}_{jt-\tau_1}\right)\left(1+\hat{S}^{c_1}_{jt-\tau_1}\right)^{-1} - \delta_{j21}\hat{S}_{jt-1} + \alpha_{i22}\left(M_{it-\tau_2}\right)\left(1+M^{c_2}_{it-\tau_2}\right)^{-1} - \delta_{i22}M_{it-1} + \varepsilon_t \quad (9)$$

In this Equation, oil market shocks are obtained using SVAR model presented in Section 3.3. Merchandise trade variables are delivered in log-difference. Also, $\tau = max(\tau_1, \tau_2)$ is the calculated integer delays, c is the constant and $t = \tau, \tau+1, \ldots, N$. As we have three merchandise trade variables and three structural oil market shocks, i and j take values equivalent to 1–3. The parameters α and δ present linear and nonlinear effects of the cause variables over dependent variables, respectively. Finally, the two error terms u_t and ε_t are assumed to be *N(0,1)*. The integer delays τ_i and constants c_i are chosen prior estimating the model using Schwarz criterion and likelihood ratio. If oil market shocks are found to be nonlinear Granger cause of merchandise trade, α_{11} should be significantly different from zero (the null hypothesis). Thus, we need to estimate Equation 9 once with no constraint and once with the constraint of zero value of α_{11}. Assuming $\hat{\vartheta}$ and $\hat{\mu}$ are the residuals of such unconstrained and constrained nonlinear models, respectively. We then calculate a Fisher-distributed statistic as below:

$$S_F = \frac{(S_c - S_u)/n_c}{S_u/(T - n_u - 1)} \sim F(n_c, T - n_u - 1) \quad (10)$$

where $S_u = \sum_{t=1}^{T} \hat{\vartheta}^2$, $S_c = \sum_{t=1}^{T} \hat{\mu}^2$, $n_u=4$ due to estimating four parameters in the Mackey–Glass model and $n_c=1$ as there is one parameter needed to be zero when estimating constrained model. The parametric nonlinear causality test is also fitted to test asymmetry in nonlinear causal relationships. However, we may conduct the asymmetric version of the test if any nonlinear causality is detected.

4. Empirical results

4.1. Nonlinear Causality

To consider the existence of dynamic effects of oil market shocks on Australia's merchandise trade variables, we first test whether any nonlinear causation is detected in the model. This strengthen our outcomes and clarifies our approach toward detecting effects of dynamic oil price shocks.

<TABLE 4 ABOUT HERE>

Table 4 demonstrates the results of modified nonlinear causality test. The test delivers F-distributed statistics showing the significance of nonlinear causation of oil supply shocks, aggregate demand shocks and other oil-specific shocks over merchandise exports, imports and total trade volume. The model is dynamic and employs pre-determined temporal lags and power parameters, which are not displayed in Table 4. The Table shows that none of the reported test statistics is statistically significant. This indicates that the null of non-causation of cause variables could not be rejected and hence, oil market shocks may not affect Australia's international commodity market nonlinearly. This finding strengthens our linear dynamic approach in conducting impulse-response analysis presented in the next sections.

4.2. Responses of merchandise trade variables to global oil market shocks

In this section, we investigate responses of Australia's merchandise exports, imports and trade to shocks in global crude oil market estimated by Equations 6 and 7. Figure 3 illustrates the estimated results. The Figure shows that shocks in crude oil market influence merchandise trade variables statistically significant and positive.

Firstly, the effects of an unanticipated increase in global oil supply, which reduces oil price, on merchandise exports can be evident after 3 months and then, they remain strongly positive for 1.5 years. However, the Figure shows that the responses might be positive even after the second year. Merchandise imports, on the other hand, respond weaker than exports to global oil supply shock; it takes less than 3 months for such responses to appear and remain positive for a few months. The positive effects of oil supply shocks on exports and imports induce positive responses of total merchandise trade, which is clearly seen in Figure 3. The positive responses of total merchandise trade to global oil supply shock, which appear after 3 months, proceed for a year and is reported to be weaker than exports' and stronger than imports' responses. The positive responses of merchandise trade variables to shocks in global oil supply, which reduces oil price, can be attributable to afterward reduction in shipping costs. Additionally, the stronger effects of such shocks on merchandise exports than imports shed lights on the importance of Australia's exporting commodities in economies of trading partners. However, abovementioned increase in merchandise trade is not reported to be continued in the long-term as discussed before.

<FIGURE 3 ABOUT HERE>

Secondly, unanticipated increases in global aggregate demand influence merchandise exports after 6 months substantially positively. Such effects are persistent for more than 2 years. It seems that Australia's merchandise exports are highly sensitive to fluctuations in global economic activity in the long-term. This indicates that in spite of significant positive effects of a shock in global economic activity on oil price proposed by Kilian(2009), Australia's merchandise exports are substantially increasing and hence, there is still enough capacity to invest on exporting industries. Conversely, merchandise imports do not exhibit strong responses to global aggregate demand shocks; the short-term effects of global aggregate demand shocks on merchandise imports could be evident after 6 months and proceed for 4 months. This is attributable to progressive demand for Australia's capital and intermediate goods. Furthermore, the responses of total merchandise trade are substantially positive for 2 years. This finding modifies the stable position of Australia's international commodity market responding to shocks in global economic activity.

Finally, as Kilian(2009) discusses, oil-specific demand shocks present precautionary demand shocks driven by expectations about future oil supply shortfalls. These shocks are supposed to influence real price of oil strongly. Figure 3 shows that such shocks exert significant pressure on merchandise exports; the long-term substantial positive responses are evident after 3 months and are persistent for long-term. The typical exporting materials could justify the positive response of merchandise exports to oil-specific demand shocks; metallurgical coal and LNG, as main exporting commodities, are supposed to be strong substitutes for crude oil in the market. Given that oil-substitute commodities need long time to be utilized, the estimated long-term horizon for merchandise exports is consistent with this assumption. This could be one major reason explaining why an unanticipated increase in crude oil price driven by precautionary demand shocks raises global demand for Australia's exports in the long-term. In addition, Figure 5 shows that merchandise imports respond positively to oil-specific demand shocks. Such responses, which are reported to proceed for a year, have a 3-month lag delay. Uncertainty about shortfalls in future oil supply may explain such temporal positive response to oil-specific demand shocks. Overall, total merchandise trade volume significantly increases after 3 months and proceeds for more than2 years.

4.3. *Contribution of oil price shocks to variations in merchandise trade variables*

To quantify the contribution of oil price shocks to variations in merchandise trade variables, we employ the variance decomposition analysis. Figure 4 shows the variance decomposition results of forecasting errors in Australia's international commodity market at the forecast lengths of 1, 6, 12 and 24 months, respectively. The contribution of oil supply shocks to variations in merchandise exports and total trade volume is much greater than other oil market shocks', particularly in the short-term (1 month). Oil supply shocks explain more than 99 per cent of variations in merchandise exports in the short-term. Such explanation power significantly decreases in the long-term and reaches to 30 per cent by 2 years. The estimated high contribution of oil supply shocks to variations in total merchandise trade is coming from strong responses of merchandise exports to oil supply shocks; oil supply shocks contribute much less to variations in merchandise imports and the estimated contribution is fluctuated during the time.

<FIGURE 4 ABOUT HERE>

On the other hand, where aggregate demand shocks explain more than 51 per cent of variations in merchandise imports, they contribute nothing to merchandise exports in short-term. Thus, the 7.5 per cent contribution of such shocks to variations in total trade in short-term is attributable to responses of merchandise imports. However, aggregate demand shocks have increasing role in explaining the variations in merchandise exports and accordingly, merchandise trade in the long-term.

Finally, where oil-specific demand shocks explain the least variations in merchandise trade, their contribution to variations in merchandise imports are reported to be greater than the contributions of other shocks in the long-term. It is also worth noting that oil-specific demand shocks explain less than 1 per cent of all variations in merchandise trade variables in short-term. However, the contributions of these shocks significantly increases in the long-term which are reported to be stronger in case of merchandise imports.

4.4. *Responses of merchandise trade variables to global oil price volatility*

Investigating the effects of uncertainty to future oil price on economic variables have been of great interest of researches. For instance, Pindyck (1991) suggests that oil price uncertainty explains the recessions of 1980 and 1982. Ferderer (1996) finds adverse effects of oil price uncertainty on the US output during 1970–1990 and Hooker (1996) believes that such effects were stronger after 1973. Finally, oil price uncertainty seem to be high since the mid 1980's (Elder and Serletis, 2010).

We use oil price volatility as an index presenting uncertainty to future oil price. To consider dynamic responses of Australia's merchandise trade variables to real oil price volatility, we employ VAR impulse-response function. Figure 5 illustrates responses of Australia's merchandise trade, exports and imports to oil price volatility described in Section 3.2. The Figure shows that firstly, due to highly correlated measured indices of oil price volatility, the responses exhibit very similar trend. Such similarity is mostly evident in responses to RV and GARCH indices. Secondly, the estimated direction of responses to oil price volatility satisfies our expectations; an unanticipated shock in oil price volatility affects merchandise exports and imports subsequently negatively. In both cases, such influences need 3–4 months to appear. This indicates that market activists respond to permanent oil price instability negatively and hence, temporary oil price fluctuations, which may take less than 3 months in average, do not affect merchandise exports and imports. The findings are consistent with Chen and Hsu (2012).

<FIGURE 5 ABOUT HERE>

Finally, Figure 5 illustrates that the magnitude of responses of merchandise imports to oil price volatility are greater than merchandise exports'. Where the reduction in merchandise imports and exports are not equivalent, the RV and GARCH volatility indices imply greater responses of merchandise imports to shocks in oil price volatility. Consequently, it is expected that total merchandise trade be reduced due to unanticipated changes in oil price volatility. This conclusion is modified by negative responses of merchandise trade to shocks in oil price volatility illustrated in Figure 5. An unanticipated shock in oil price volatility exerts substantial negative influences on aggregate merchandise trade after 4 months. Again, the reported delay implies that Australia's international commodity market responds to permanent variations in oil price shocks, which are persistent for 4 months.

5. Conclusion

As a country surrounded by ocean with no adjacent country sharing joint land borders, Australia trade internationally through ocean and air. Furthermore, high volume of oil-substitute exports and highly oil-intensive imports has raised the expected elasticity of Australia's international trade to shocks in global oil market. In this paper, we study responses of Australia's international commodity market to structural global oil market shocks and global oil price volatility. Our findings indicates that shocks in global oil market affects merchandise trade variables significantly. The findings of the paper and their implications could be summarized as below:

Firstly, global oil supply shocks, which induce global oil price disruptions, mainly affect merchandise trade with 3 months delay. Such positive effects are due to stronger responses of merchandise exports than imports. The positive effects of oil supply shocks on merchandise trade are attributable to reduction in cost of shipping. Anyhow, the effects of oil supply shocks will proceed no longer than 1.5 years. Oil supply shocks also explain more than 99 per cent of variations in merchandise trade in short-term and much less in long-term.

Secondly, Global aggregate demand shocks exert substantial long-term positive effects on merchandise exports and trade where such effects are reported to be minor and temporary on merchandise imports. These responses are generally less strong than that to oil supply shocks even though they seem more persistent. They also appear after 6 months in average. The substantial positive effects of aggregate demand shocks on merchandise exports modify the importance of Australia's exporting commodities in progressive global economic activity. This finding indicates that further investment on exporting industries may provide substantial benefits. The modest short-term rise in merchandise imports implies growth in Australia's economic activity alongside other countries. Aggregate demand shocks explain half of variations in merchandise imports in short-term where they have no contribution to variations in merchandise exports. The contribution of aggregate demand shocks to variations in merchandise exports, however, increases in long-term. This induces increasing contribution to variations in merchandise trade in long-term.

Thirdly, expectations about future oil supply shortfalls, which induce oil-specific (precautionary) demand shocks, influence merchandise exports and trade substantially positively in the long-term. Merchandise imports, however, respond positively for less than a year. The effects of oil-specific shocks appear in 3 months in average. Long-term effects of oil-specific demand shocks on Australia's merchandise trade could be attributable to exporting high volume of oil-substitute commodities such as metallurgical coal and LNG. This finding shows that again, further investment on exporting manufactures and oil-substitute commodities may benefit Australia's international commodity market. Additionally, oil-specific demand shocks explain most of the variations in merchandise imports in long-term. Such contribution is reported to be constant in a 2-year horizon.

Finally, our findings indicate that Australia's international commodity market responds strongly negatively to uncertainty in global oil market. Any shock in real oil price volatility, which reflects uncertainty in oil market, influences merchandise trade, exports and imports after 3–4 months. Thus, an unexpected shock in real oil price is considered temporary when it persists for less than 3 months. This finding suggests market activists to consider market fluctuations resulted from over 3-month oil price volatilities.

For further study, it is recommended to develop the research by considering domestic oil prices and real exchange rate. In addition, firm level investigations, which cover domestic oil-intensive and non-oil-intensives exporting industries may provide detailed guidelines for investors developing exporting industries. Finally, testing for asymmety in responses of international commodity market to oil price shocks would deliver complementary information for market activists to feed the market needs properly.

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Tables

Table 1 Australia's Top 10 Export Markets (2013)

Country	*Rank*	*Goods*	*Services*	*Total*	*share*	*Distance (KM)*
China	1	94655 (6.03)	6881 (0.44)	101536 (6.47)	31.9	7482.73
Japan	2	47501 (3.03)	1991 (0.13)	49492 (3.15)	15.5	6859.99
Republic of Korea	3	1961 (1.25)	1675 (0.11)	21285 (1.36)	6.7	6840.02
United States	4	958 (0.61)	5951 (0.38)	15531 (0.99)	4.9	15201.49[a]
India	5	9517 (0.61)	1921 (0.12)	11438 (0.73)	3.6	7822.21
New Zealand	6	7399 (0.47)	3626 (0.23)	11025 (0.70)	3.5	4162.27
Singapore	7	5659 (0.36)	3549 (0.23)	9208 (0.59)	2.9	4381.46
Taiwan	8	7356 (0.47)	704 (0.04)	8060 (0.51)	2.5	5623.92
United Kingdom	9	3859 (0.24)	3982 (0.25)	7841 (0.50)	2.5	15223.07
Malaysia	10	5561 (0.35)	1664 (0.11)	7225 (0.46)	2.3	4751.42
Total exports		**263467 (16.79)**	**55175 (3.51)**	**318642 (20.30)**	**100.0**	

Notes: Goods, Services and Total values are in millions of Australian dollars. Export share of GDP in parenthesis. (a) denotes the closest distance through the Pacific Ocean.

Source:
Department of Foreign Affairs and Trade.
Australian Bureau of Statistics.
Distancefromto website.

Table 2 Australia's Top 10 Import Sources (2013)

Country	*Rank*	*Goods*	*Services*	*Total*	*share*	*Distance (KM)*
China	1	47250 (3.01)	2079 (0.13)	49329 (3.14)	15.0	7482.73
United States	2	26681 (1.70)	12430 (0.79)	39181 (2.49)	11.9	15201.49[a]
Japan	3	18914 (1.20)	2307 (0.15)	21221 (1.35)	6.5	6859.99
Singapore	4	12933 (0.82)	4943 (0.31)	17878 (1.14)	5.4	4381.46
Thailand	5	11393 (0.72)	2439 (0.15)	13832 (0.88)	4.2	5797.85
Germany	6	11428 (0.73)	1665 (0.11)	13099 (0.83)	4.0	14482.43
United Kingdom	7	6195 (0.39)	5848 (0.37)	12044 (0.77)	3.7	15223.07
Malaysia	8	9480 (0.60)	1464 (0.09)	10944 (0.70)	3.3	4751.42
Republic of Korea	9	10168 (0.65)	646 (0.04)	10813 (0.69)	3.3	6840.02
New Zealand	10	7401 (0.47)	3131 (0.20)	10532 (0.67)	3.2	4162.27
Total imports		**258936 (16.50)**	**69870 (4.45)**	**328806 (20.95)**	**100.0**	

Notes: Goods, Services and Total values are in millions of Australian dollars. Import share of GDP in parenthesis. (a) Indicates the closest distance through the Pacific Ocean.

Source:
Australian Department of Foreign Affairs and Trade.
Australian Bureau of Statistics.
Distancefromto website.

Table 3 Main Events and Their Correspondent Oil Price Volatilities

Identification	*Event*	*Year*
E.1	Non-OPEC oil production acceleration	1986
E.2	Iraq Invasion in Kuwait	1990
E.3	First War in Iraq	1991
E.4	OPEC oil production cuts	1998
E.5	OPEC oil production cuts	1999
E.6	September Terrorist Attack in the US	2001
E.7	PDVSA workers' strike	2002
E.8	Second War in Iraq	2003
E.9	Global Financial Crisis	2008

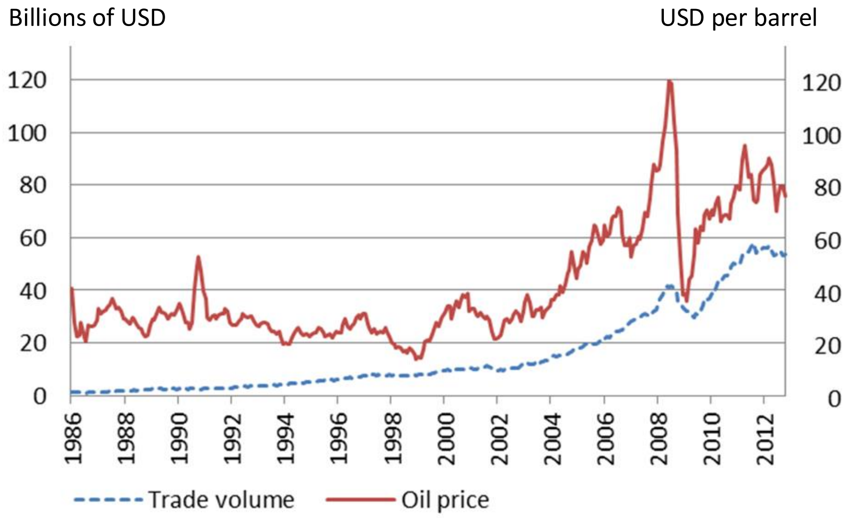
Table 4 Parametric nonlinear M-G model test

Cause variable	*Effect variable*		
	Export	*Import*	*Trade*
Oil supply shock	0.6858	1.3158	0.0718
Aggregate demand shock	0.2467	0.0238	0.3427
Other oil-specific shocks	0.3387	0.1758	0.3017

Notes: The test statistics are F-distributed. The null hypothesis indicates that there is no nonlinear causal relationship running from oil market shocks to Australia's merchandise trade variables.

Figures

Figure 1 The Australian Visible International Trade Volume Versus Global Oil Price (1986–2012)



Source: OECD

Figure 2 Oil Price Volatility (GARCH Model) and Major Events: 1986M1 – 2013M5

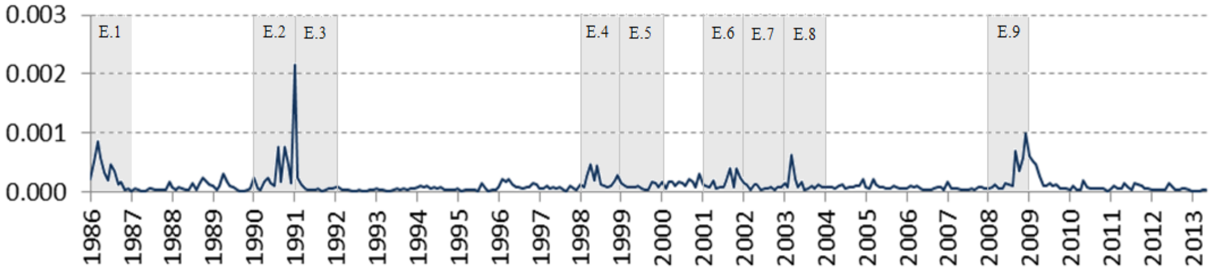
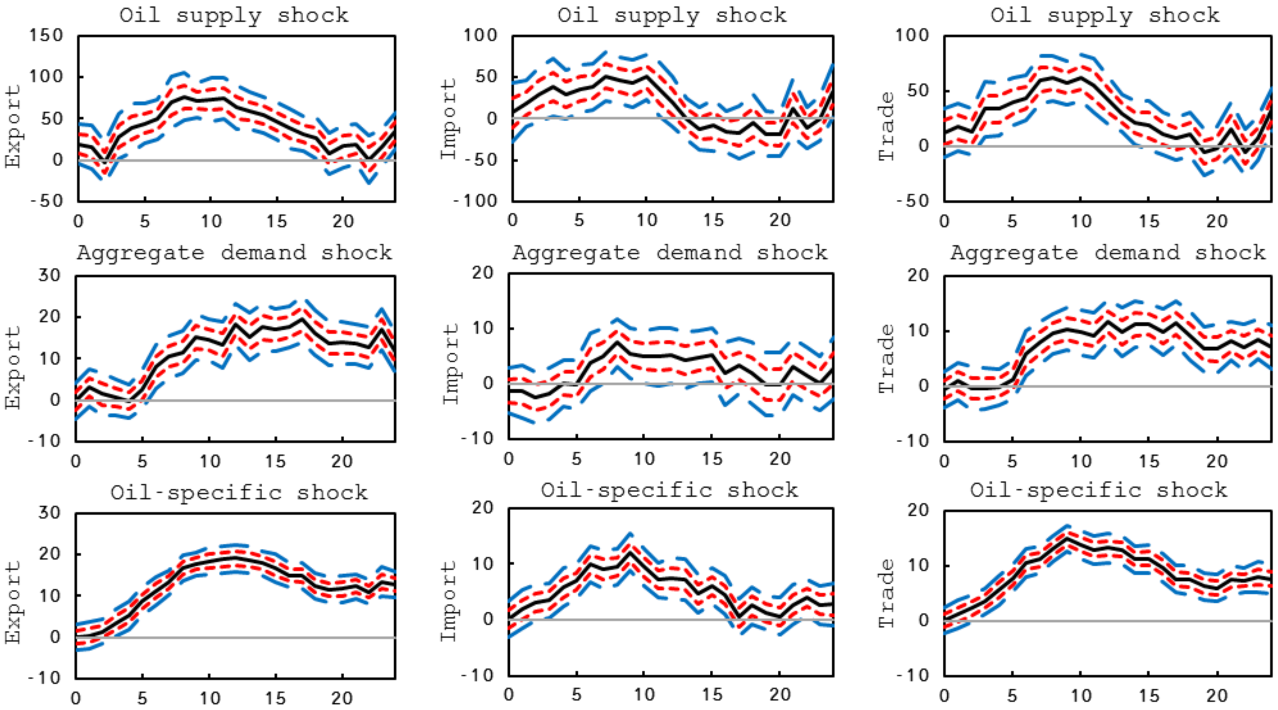


Figure 3 Cumulative responses of merchandise trade variables to oil market shocks



Notes: The Figure shows cumulative responses of Australia's merchandise trade variables to global oil market structural shocks using Equations 5 and 6. One and two standard error bands are estimated using bootstrap simulation.

Figure 4 Forecast error variance decomposition of oil market structural shocks

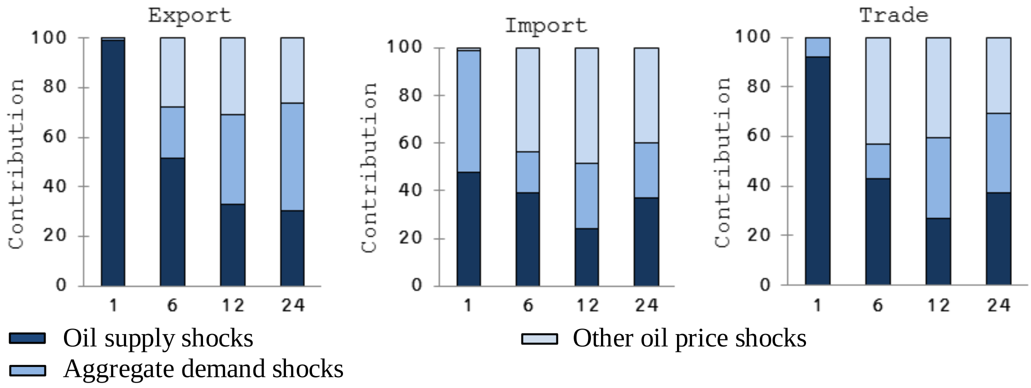
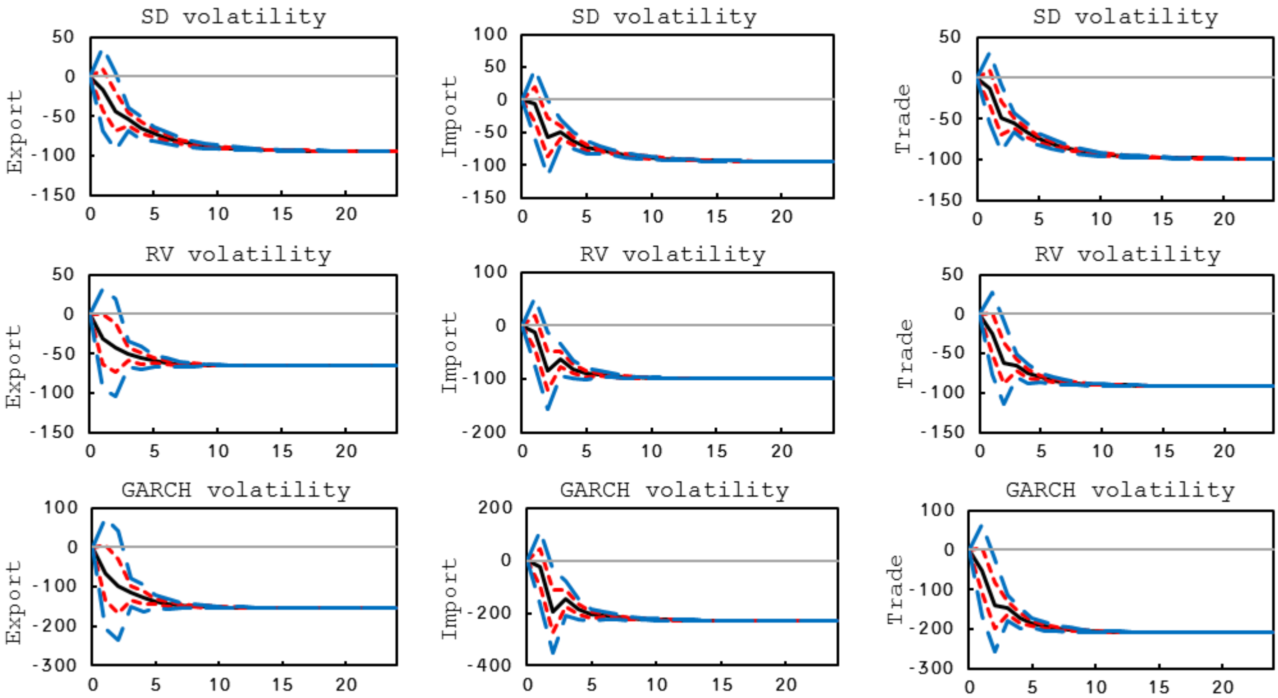


Figure 5 Cumulative responses of merchandise trade variables to oil price volatility



Notes: The Figure shows cumulative responses of Australia's merchandise trade variables to global oil price volatility. One and two standard errors are displayed in the figures.