Formulating and Estimating of Dynamic Nonlinear Model of Korea's Bilateral Trade Balance

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Abstract

This paper formulates and estimates the dynamic nonlinear trade model for Korea. We use monthly time series data for the period from 2000 to 2017. We employ EGARCH (1,1)-GED model which allows the positive and negative shocks to have asymmetric influences on volatility. The Johansen co-integration test is applied and finds the long run relationship among oil price, exchange rate and trade balance does exist. With respect to Indonesia as one of oil exporting countries, we find that an increase in oil prices leads to a declined trade balance as imports rise more than exports. Appreciation in IDR also leads to a declined trade balance as exports fall more than imports. For Korea as one of oil importing countries, an increase in oil prices leads to an improved trade balance as exports rise more than imports. Appreciation in KRW leads to a declined trade balance as exports fall more than imports. Oil price volatility reduces trade balance both in Indonesia and Korea. Oil price has negative effects on Indonesia's trade balance and positive effects on Korea's trade balance. Indonesian and Korean currency appreciation against US dollar have a negative impact on trade balance in Indonesia and Korea respectively. This information will contribute to Indonesian and Korean policy makers in making policies for their trade.

Keywords: trade balance, oil price, real effective exchange rate, oil exporters, oil importers

1. Introduction

In recent years, oil prices and exchange rates have changed significantly. Large number of studies has analyzed the impacts of oil prices and exchange rates on trade balance separately. There are plenty of studies focusing on the relationship between Korea's trade and exchange rate. Korea's major export industries are highly responsive to the bilateral exchange rate, volatility and third country effects, whereas Korea's imports are mostly insensitive to changes in those three factors (Baek, 2014; Köse 2018). For the impact of the real exchange rate on the trade balance between Korea and the rest of the world, exchange rate does not affect the trade balance (Chang, 2005; Hemalatha, 2016). The exchange rate has a significant effect on Korea's trade balance with the U.S., but not with Japan (Ali & Haseb, 2019; Kim, 2009; Chang'ach 2018).

There are number of studies focusing on the impacts of oil shocks on trade balance. Le and Chang (2013) examine the relationship between oil price shocks and trade balances in Malaysia, Japan and Singapore, and they find that oil prices do impact oil importers' and oil exporters' trade performances differently. Rafiq, Sgro, and Aspergis (2016) examine the effects of oil price shocks on oil exporters' and oil importers' external balances (Jermsittiparsert, 2016; Hassan & Alanazi 2018). They find that an increase in oil prices leads to an improved real oil trade balance, and a decrease in oil prices is found to be beneficial for both total and oil balances in oil exporting countries. And decline in oil prices have a negative impact on both total and real trade balances in oil importing countries.

There are few of studies focusing on the effects of exchange rate and oil price on trade balance. This issue has so far received little attention. In other words, a little study ha attempted to assess the effects of exchange rate and oil price on trade balance together. Kim (2012); Teba 2017 examines the effects of KRW/CNY real exchange rate and international oil price on Korea's petro-chemistry products to China, and finds that the rise of KRW/CNY real exchange rate or oil price have strongly negative relation with exports to China. Yim (2014) examines mutual influence among export volume, oil price and exchange rate in Korea, and finds that exports volume, oil price and exchange rate in Korea Granger cause export volume, oil price and exchange rate.

The contribution of this paper is to employ both real effective exchange rate and oil price together in a model to

capture the effects on trade balance accurately. And this study examines the oil price rise effect and oil price fall effect separately to advance our understanding of the dynamic relationship among oil price, real effective exchange rate and trade balance (ARUNA 2018).

The rest of this paper is organized as follows: section 2 describes the data used for the analysis and the empirical model. Section 3 shows the empirical results. Finally, section 4 concludes this paper.

2. Data and Methodology

This study examines the monthly exports, imports, trade balance, oil price and real effective exchange rate for the period from January 2000 to December 2017. The values of exports and imports are collected from the Korea Trade Statistics. Oil price and real effective exchange rate are taken from Bank for international settlements. BIS effective exchange rate in converted to its real value by using CPI (2010=100) as a deflator.

Due to the kurtosis, autocorrelations and the volatility clustering property of the time series log return of variables, we adopt GARCH-family models developed by Bollerslev (1986) to analyze the data. Hansen and Lunde (2005) have compared a large number of volatility models and found no evidence that a GARCH(1,1) is outperformed by more sophisticated models in their analysis of exchange rate, whereas the GARCH(1,1) is inferior to those models that can accommodate a leverage effect in their analysis of IBM returns. The symmetric GARCH model allows the conditional variance to be dependent upon previous own lags. The standard symmetric GARCH model has a number of potential shortcomings. Symmetric GARCH models cannot take into consideration asymmetry and other factors. Although the GARCH model can characterize the volatility clustering, it fails to explain asymmetric volatility. In other words, GARCH model cannot find leverage effect.

EGARCH and GJR-GARCH model can explain the influence of the lagged residual on volatility, and they can be used for the analysis of the leverage effect. The EGARCH model was proved by Nelson (1991), he introduces the exponential GARCH or EGARCH model to present improvements over the standard symmetric GARCH models. The EGARCH model has the property that it presents the asymmetric response of volatility to positive and negative news. Also, this model commonly used as it shares some of its properties with GARCH model. Glosten, Jagannathan, and Runkle (1993) also propose and prove another asymmetric GARCH model, known as the GJR-GARCH model.

The probability distribution of asset returns often exhibits fatter tails than the standard normal distribution. The existence of heavy-tailed is probably due to a volatility clustering. In addition, another source for heavy-tail seems to be the sudden changes in asset returns. An excess kurtosis also might be originated from fat tail. Moreover, in practice, the returns are typically negatively skewed. In order to capture this phenomenon, the GED distribution is also considered in our analysis (Dutta, 2014; Habib & Mucha 2018). Alternative GARCH models were estimated, and we find the EGARCH (1,1)-GED model to provide the best fit in this study. So this paper use EGARCH (1,1)-GED model to investigates the effects of oil price and exchange rate on trade balance of Korea and Indonesia.

3. Empirical Results

This study conducted an empirical analysis on three variables, namely, oil price, real effective exchange rate and trade balance. This study used the nonlinear optimization techniques to get the maximum-likelihood estimates of EGARCH (1,1)-GED model, based on the Marquardt algorithm.

Unit root test are crucial in examining the stationarity of the time series data, so we utilize the augmented Dickey-Fuller (ADF) test to test the stationary of the variables. Optimal lag order is chosen according Akaike information criterion (AIC). All variables are non-stationary in levels and stationary in first difference at 1% significance level. We use the Ljung-Box Q statistics to see whether the time series used for the analysis are white noise, and the results show that the time series are not white noise. And we use the co-integration test to test the long-term equilibrium relationship between the variables, and the results show that one co-integrating equation exists at 5% significance level.

Table 1 provides the oil price and real effective exchange rate (Indonesia Rupiah) effects on Indonesia's trade balance with Korea. The results show that oil price is positively related with Indonesia's exports and imports to Korea. However, the relationships are not statistically significant. We find that the rise of oil price leads to a decrease in Indonesia's trade balance to Korea based on the coefficient (-1.2347), and this is arises as imports increase more than exports. And we cannot find significant effect of the real effective exchange rate of Indonesian Rupiah on Indonesia's trade balance to Korea based on the coefficient (-0.0030). From the size of the estimated coefficients, we can conclude that Indonesia's trade balance to Korea is more sensitive to the oil price fluctuation in comparison to the exchange rate fluctuation. The coefficient on the e in variance equation are significantly different from zero (-11.7344), indicating the increase of oil price volatility leads to an decrease in Indonesia's trade balance to Korea.

Table 1. Indonesia's trade with Korea

Variables	Exports	Imports	Trade Balance
α	0.0030(0.29)	0.0690(0.48)	0.2322(8.39)**
β	0.0792(0.83)	0.3020(0.93)**	-1.2347(8.24)**
γ	-0.4373(2.28)**	-0.2000(0.43)	-0.0030(1.36)
A	-3.9886(5.58)**	-3.0740(4.13)**	2.5004(4.07)**
B	0.1434(0.70)	0.2548(1.02)	-0.1816(0.94)
C	0.7631(3.26)**	1.0021(4.16)**	0.3726(1.59)
D	-0.1143(0.96)	-0.2780(1.93)**	-0.1816(0.94)
E	0.1421(0.10)	-0.8264(1.48)	-11.734(3.64)**
F	-11.703(3.05)**	5.5727(1.22)	-4.3794(0.65)
LL	107.74	26.14	347.04

Note: Values in parenthesis are z-statistics. * and ** indicate significance at the 5% and 1% levels, respectively. β denotes oil price, γdenotes exchange rate, e denotes oil price volatility and f denotes exchange rate volatility.

Table 2 presents the oil price and real effective exchange rate (Korea Won) effects on Korea's trade balance with Indonesia. The results show that oil price is positively related with Korea's exports and imports to Indonesia. However, the relationships are not statistically significant. We find that the rise of oil price leads to an increase in Korea's trade balance to Indonesia based on the coefficient (1.9444), and this is arises as exports increase more than imports. And the results show that exchange rate is negatively related with Korea's exports and imports to Indonesia. However, the relationships are not statistically significant. The real depreciation of the Korean Won leads to a decrease in Korea's trade balance to Indonesia based on the coefficient (-4.7573), and this is arises as exports decrease more than imports. From the size of the estimated coefficients, we can conclude that Korea's trade balance to Indonesia is more sensitive to the exchange rate fluctuation in comparison to the oil price fluctuation. The coefficient on the e in variance equation are significantly different to zero (-10.4551), indicating the increase of oil price volatility leads to an increase in Korea's trade balance to Indonesia.

Table 2. Korea's trade with Indonesia

Variables	Exports	Imports	Trade Balance
α	0.0028(0.03)	0.0012(0.11)	-0.0224(9.20)**
β	0.3141(0.22)	0.0867(0.60)	1.9444(7.25)**
γ	-0.7538(1.16)	-0.2795(0.52)	-4.7573(5.61)**
A	-2.7038(3.91)**	-4.1249(4.69)**	1.6003(2.92)**
B	0.3671(1.58)	0.0837(0.36)	0.2249(0.93)
C	1.0089(3.92)**	0.6648(2.98)**	0.2399(0.66)
D	-0.3490(2.32)*	-0.1514(1.24)	-0.1599(0.47)
E	-0.7924(0.47)	0.6658(0.36)	-10.455(3.04)**
F	1.5453(0.20)	-9.0225(1.22)	12.7711(0.89)
LL	25.91	103.95	342.61

Note: Values in parenthesis are z-statistics. * and ** indicate significance at the 5% and 1% levels, respectively. β denotes oil price, γdenotes exchange rate, e denotes oil price volatility and f denotes exchange rate volatility.

We divide total period into the period of oil price and oil price fall to investigate whether the impacts of oil price and exchange rate on trade balance are different in the periods of oil price rise and fall.

Table 3 presents the oil price and real effective exchange rate (Korean Won) effects on Korea's trade balance with Indonesia in the period of oil price rise. The results show that oil price is positively related with Korea's exports to Indonesia, and negatively related with Korea's imports to Indonesia. However, the relationships are not statistically significant. We find that the rise of oil price leads to an increase in Korea's trade balance to Indonesia based on the coefficient (3.3954), and this is arises as exports increase but imports decrease. And the results show that real effective exchange rate is negatively related with Korea's exports and imports from Indonesia. However, the relationships are not statistically significant. The real depreciation of the Korean Won leads to a decrease in Korea's trade balance to Indonesia based on the coefficient (-2.5666), and this arises as exports decrease more than imports. From the size of the estimated coefficients, we can conclude that Korea's trade balance to Indonesia in the period of oil price rise is more sensitive to the oil price fluctuation in comparison to the exchange rate fluctuation. The coefficient on the e in variance equation are significantly different from zero (-14.6891), indicating the increase of oil price volatility leads to a decrease in Korea's trade balance to Indonesia.

Table 3. Korea's trade with Indonesia: the rise of oil price

Variables	Exports	Imports	Trade Balance
α	0.0192(1.13)	0.3194(1.38)	-0.1701(4.83)**
β	0.3805(1.35)	-0.0961(0.48)	3.3954(8.27)**
γ	-0.9259(1.26)	-0.8021(1.23)	-2.5666(2.91)**
A	-2.9523(4.14)**	-4.1199(2.86)**	0.3011(0.93)
B	0.3177(1.44)	0.0680(1.09)	0.5280(5.62)**
C	0.9268(3.96)**	0.6138(2.08)**	0.7657(1.76)
D	-0.2563(1.58)	-0.1571(0.91)	-0.8179(2.93)**
E	-0.3489(0.20)	-0.5104(0.20)	-14.689(4.33)**
F	8.4264(0.96)	-5.4912(0.52)	13.0097(0.89)
LL	129.51	71.34	294.68

Note: Values in parenthesis are z-statistics. * and ** indicate significance at the 5% and 1% levels, respectively. β denotes oil price, γdenotes exchange rate, e denotes oil price volatility and f denotes exchange rate volatility.

Table 4 presents the oil price and real effective exchange rate (Korean Won) effects on Korea's trade balance with Indonesia in the period of oil price fall. The results show that oil price is positively related with Korea's exports and imports from Indonesia. However, the relationships are not statistically significant. We find that the rise of oil price leads to a decrease in Korea's trade balance to Indonesia based on the coefficient (-2.2076), and this is arises as imports increase more than exports. And the results show that real effective exchange rate is negatively related with Korea's exports and positively related with imports from Indonesia. The real depreciation of the Korean Won leads to a decrease in Korea's trade balance to Indonesia based on the coefficient (-9.7113), and this is arises as exports decrease but imports increase. From the size of the estimated coefficients, we can conclude that Korea's trade balance to Indonesia in the period of oil price fall is more sensitive to the real effective exchange rate fluctuation in comparison to the oil price fluctuation.

Table 4. Korea's trade with Indonesia: the fall of oil price

Variables	Exports	Imports	Trade Balance
α	0.0013(0.10)	-0.0010(0.05)	0.1738(9.99)**
β	0.1988(3.41)**	0.6194(0.57)	-2.2076(11.7)**
γ	-3.8763(4.62)**	0.6729(0.57)	-9.7113(11.3)**
A	-5.5624(3.71)**	-5.7319(2.48)**	4.6014(0.70)
B	0.5698(4.28)**	-0.3358(0.53)	0.0108(0.01)
C	0.7388(3.61)**	0.5784(1.10)	-0.3044(0.28)
D	-0.0864(0.31)	-0.1514(1.24)	-0.0344(0.03)
E	0.0520(0.38)	1.7772(0.51)	-2.4398(0.30)
F	-30.204(2.57)**	-0.2064(0.01)	10.6151(0.29)
LL	115.43	135.11	199.98

Note: Values in parenthesis are z-statistics. * and ** indicate significance at the 5% and 1% levels, respectively. β denotes oil price, γdenotes exchange rate, e denotes oil price volatility and f denotes exchange rate volatility

4. Conclusion

This paper addresses the issue of dynamic nonlinear trade balance model for Korea. We empirically examine the impacts of oil price and real effective exchange rate on trade balance in small open economies that heavily depend on trade. The rise of oil price leads to decrease in Indonesia's trade balance to Korea and leads to increase in Korea's trade balance to Indonesia. Indonesia's trade balance to Korea is more sensitive to oil price fluctuation in comparison to the exchange rate fluctuation. Conversely, Korea's trade balance to Indonesia is more sensitive to the exchange rate fluctuation. Oil prices have negative effects on Indonesia's trade balance and positive effects on Korea's trade balance. Indonesian and Korean currency appreciation against US dollar have a negative impact on trade balance in Indonesia and Korea. An important implication that can be derived from the empirical results is that the depreciation of Korean Won may improve the trade balance. Another important implication is that in the period of oil price fall, Korea's trade balance to Indonesia is more sensitive to the depreciation of Korean Won, compared to the period of oil price rise. Therefore, exchange rate should be carefully managed especially in the period of oil price fall. This information will contribute to Indonesian and Korean policy makers in making for their trade.

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