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Modeling of the Dynamics Relationship between World Crude Oil Prices and the Stock Market in Indonesia

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ABSTRACT

This study aims to examine the dynamics of the relationship between world crude oil prices and Indonesian stock market within the period of January 1, 2004 to December 31, 2013. The world crude oil prices referred to the price of West Texas Intermediate crude oil, whereas the composite indexes at the Indonesian Stock Exchange were used as indicators of the stock market in Indonesia. Daily data were analyzed by employing the LVAR causal model. The test results showed that there was a significant dynamical relationship between world crude oil prices and Indonesian composite index, both in the long-term and in the short-term. The dynamics of this relationship is positive, meaning that if the world crude oil price rises (falls), then the composite index also rises (falls). This finding is in the need for Indonesian government to be considered in their economic policy, as well as for investors to manage their investment portfolio.

Keywords: World Crude Oil Price, Stock Price, LVAR Analysis
JEL Classifications: C51, C58, G12, Q41, Q43

1. INTRODUCTION

Oil plays an important role in global economy. All countries need oil to meet the needs of their manufacturing industries, transports, and electricity. Given the crucial role of oil as raw material, all non-oil-producing countries have to import oil to meet their domestic needs for oil. This is also the case for oil-producing countries that have limited production. In addition to the effect of a limited supply of oil and OPEC cartel, demands for imports of world oil can affect the price of world oil (Moebert, 2007).

Changes in oil prices can therefore affect the economy of a country (Cuepers and Smeets, 2015). Higher oil prices can influence economy in the forms of: transfers of wealth from oil-consuming countries to oil-producing countries, a rise in the cost of production of goods and services, and impact on inflation, consumer confidence and financial markets (Nandha and Faff, 2008). An increase in production costs will reduce corporate profits (Le, 2014). As a result, dividend payment is reduced and stock price falls. Inflation caused by rising oil prices will encourage central bank authorities to curb inflation through a policy that increases interest rate (Benada, 2014). An increase in interest rates will cause investors to shift their investment from the stock market to the bond market, causing stocks demand to go down and, eventually, share price to drop (Basher and Sadorsky, 2006). For oil-exporting countries, an increase in oil price will raise public revenue, spending (expenditure), and investment, which in turn will cause greater production and lower labor. Share price will respond positively to these events. The reverse, however, applies to oil importing countries (Filis et al., 2011).

In the history of oil prices, the crude oil price of West Texas Intermediate (WTI) has been fluctuating and showing a rising trend since 1948 (Williams, 2011). In particular, in the period between 2004 and 2013 the WTI crude oil prices rose from US $ 32.72 per barrel at the beginning of January 2004 into US$ 98.17 per barrel at the end of December 2013. The highest price occurred on July 2, 2008, reaching US $ 145.31 per barrel (www.tonto.eia.gov). The increase in crude oil prices was then followed by the rise of stock prices in some countries. In the United States, the SP500 index fluctuates. Although the stock index fell sharply at the position of SP500 816.21 on December 1, 2008, in the period of 2004-2013 the SP500 index showed a trend to rise from 1,191.37 on January 3, 2004 to 2,058.90 on December 31, 2013 (www.google.com/finance). In Indonesia, the composite stock price index (CSPI) also fluctuated and increased from 493.79 on January 1, 2004 to 4,291.88 on December 31, 2013 (www.duniainvestasi.com).

The rise in oil prices has attracted the attention of many researchers in the field of economics and finance. Studies on the relationship between oil prices and stock prices or stock returns have been carried out, among others, by Kling (1985), Chen et al. (1986), Huang et al. (1996), Jones and Kaul (1996), Narayan and Narayan (2010), Filis (2010), Lee and Zeng (2011), Mohanty et al. (2011), Samadi et al. (2012), Fowowe (2013), Arouri and Rault (2014), and Guesmi (2014). Despite this quite large body of research, however, no consensus has been achieved yet regarding the results of the studies. Some studies indicate a positive relationship between oil prices and stock prices (Narayan and Narayan, 2010; Mohanty et al., 2011; Guesmi, 2014; Arouri and Rault, 2014). Others, however, report that there is a negative correlation between oil prices and stock prices (Jones and Kaul, 1996; Filis, 2010). The results of other studies even showed no association between oil prices and stock prices (Kling, 1985; Chen et al., 1986; Huang et al., 1996; Samadi et al., 2012; Fowowe, 2013). Such differences may occur due to potential changes in the structure (break), and global oil price shock at one particular time within the period of the study (Rashid and Kocaaslan, 2013; Lee and Zeng, 2011). Change in the structure is related to the distribution of the study period, so the difference in the results of the research may originate from the oil price shock at every sub period of the research. Lin et al. (2010), and Kang and Ratti (2015) conducted their study in China in different periods and came up with different results. Similarly, Nwosa (2014) conducted a study in Nigeria and found that the long-term and short-term results of the analysis showed a different relationship. It appears that studies on the relationship between oil prices and stock prices have generally been carried out in developed countries by, among others, Mohanty et al. (2011), and Sukcharoen et al. (2014), and not many studies have been conducted in developing countries, among those few who did this are Narayan and Narayan (2010) and Nwosa (2014).

Indonesia is a developing country that has oil refineries where crude oil is produced. However, the country's crude oil production is still insufficient to meet domestic demand, so that every year Indonesia has to import oil from other countries (Toharso, 2010). Due to its declining crude oil production and growing demand of global crude oil (EIA, 2014), since 2003 Indonesia has fell into the category of crude oil net-importer countries (Wang et al., 2013).

This study aims to examine the dynamics of the relationship between crude oil prices and stock markets in Indonesia within the period from January 1, 2004 to December 31, 2013, and establishes the model of the relationship both in the long and in the short term. The analysis tool used is an LVAR causal model proposed by Agung (2009). Analysis of the dynamics of the relationship in the short term is conducted by firstly splitting the 2004-2013 period into ten subperiods, each with a 1-year period starting from January 1 to December 31. The dynamics of the relationship were then examined by using dummy variables on each of the subperiods. Such relation may also obtained by applying signal relations as introduced in Cahyono (2014), where the prediction of the dynamics on itself by applying the trend of the dynamics (Cahyono et al., 2012), and the temporal probability density function (Adam et al., 2014).

2. THEORY AND REVIEW OF LITERATURE

In theory, the relationship between oil prices and stock prices can be explained by the cash flow models, as follows. Stock prices (p) can be expressed as the discounted value of expected cash flows, i.e.

$$p = \frac{E(c)}{E(r)} \tag{1}$$

in which c is the dividend stream and r the discount rate. Furthermore, the stock return (R) is:

$$R = \frac{dp}{p} = \frac{d(E(c))}{E(c)} - \frac{d(E(r))}{E(r)} \tag{2}$$

in which $d(.)$ expresses the differential operator (Huang et al., 1996). It is known from (1) that an increase (decrease) in current dividend expectations $E(c)$ will increase (decrease) stock prices (p). Similarly, the increase (decrease) in the discount rate expectations E(r) will lower (raise) the stock price (p). It can also be seen from (2) that an increase (decrease) in share price (p) will increase (decrease) return (R). Furthermore, oil prices can affect stock prices through changes in cash flow expectations, as well as in the expectations of discount rate (Ratti and Hasan, 2013). Oil is a production input needed by a company to run its production process. If there is no substitution to this production factor, increased oil prices will raise the cost of production. High production costs will lead to rising prices of goods and end services. Consequently, demands for goods and services are reduced and corporate profits fall, all these will cause the stock price to go down. An increase in the price of goods as a result of the increase in oil prices can lead to inflation. A higher inflation expectations raise the discount rate, which negatively affects stock prices (Narayan and Narayan, 2010; Basher et al., 2012). A rise in oil prices is often seen as an indicator of impending inflation, and the central bank of a country will respond to this event by raising interest rates. A rise in interest rates will render bond investments more attractive than stock investment, and this will cause the stock price to fall (Halac et al., 2013). The effect of oil price shocks on the supply of the stock price is positive on oil-exporting countries, while the effect of oil price shocks on the demand of some oil-importing countries is negative (Filis et al., 2011; Cashin et al., 2014)

The relationship between oil price shocks and stock market in China was also investigated by Cong et al. (2008) in the same period, i.e. between January 1996 and December 2007. The multivariate analysis of vector autoregression was employed to analyze monthly data. The results of the analysis showed that while the oil price shock did not influence the stock index of non-oil companies, it did affect the stock index of oil companies. Lin et al. (2010) examined the relationship between oil price shock, in terms of demand shock and supply shock, and the stock market of Greater China (China, Hong Kong, and Taiwan) in the period from July 1997 to September 2008. The results of the examination using the SVAR analysis on the monthly data indicated that there was an influence of oil price shocks on stock prices in the three countries. However, this effect was different from country to country. While the demand shock affected negatively the stock market in Taiwan, it affected Hong Kong's stock market positively. In China, the shock of oil demand had no significant effect on the country's stock market. In terms of supply shock, oil prices positively affected the stock market in Hong Kong and China. A more recent study on the relationship between oil prices and stock prices in the period of 1998-2011 was conducted by Kang and Ratti (2015). The result of a test using the VAR model showed that oil demand shock had a negative effect on stock returns.

Nwosa (2014) studied the relationship between domestic and international oil prices and stock prices in Nigeria within the period from January 1985 to April 2010. The test results which used the VECM analysis on quarterly data indicated that in the long run, there was a one-way relation between the two variables, i.e. the domestic oil prices affected the price of the stock. In contrast, there was no relationship between the domestic and international oil prices and stock prices in the short term. In the same period, i.e. from January 1995 to December 2011, Effiong (2014) also examined the effect of oil price shocks in terms of demand and supply of the Nigerian stock market. Using the structural vector auto-regression to examine data, the result of analysis showed that while the stock market responded negatively to the oil supply shock, it responded positively to shock oil demand.

Horng and Chang (2010) examined the impact of oil prices on stock market return in Thailand and Philippine within the period from March 2005 to November 2008. By using the IGARCH models to analyze data, they found that there was a significantly positive relationship between oil prices and stock market in both countries.

Lee and Hao (2012) looked into the effects of asymmetric oil price on the S&P500 stock price in the United States from January 1, 1992 to November 7, 2006. Using the MTAR models to analyze data, the researchers reported that oil prices and stock prices were asymmetrically co-integrated. Furthermore, they found a one-way relationship between the two variables, that is, oil price affected stock price.

Azar and Basmajian (2013) conducted a study on the effect of oil price shocks on stock prices in Kuwait and Saudi Arabia. They found that the stock markets in both countries were positively influenced by the price of oil.

Dagher and El Hariri (2013) investigated the effect of oil price shocks on stock market Lebanon in the period from October 16, 2006 to October 7, 2012. The results of VAR analysis and Granger causality test showed that the oil price shock had a positive impact on stock prices.

3. DATA AND METHODOLOGY

3.1. Data

Data in this study were comprised of data of world crude oil prices and data of stock price indexes as an indicator of the stock market in Indonesia. The data of crude oil prices referred to the prices of WTI in USD units per barrel, whereas the data of stock price indexes were taken from CSPI issued by the Indonesia Stock Exchange. The data of WTI crude oil were obtained from www.tonto.eia.gov, and the data of the stock price indexes from www.duniainvestasi site.

The data of WTI crude oil price is expressed in x^0, and the data of stock price index in y^0. Both of the x^0 and y^0 variables were daily data spanning from January 1 to December 31, 2013. Since norecording of the two types of data was done on holidays (Sundays), a linear spline interpolation proposed by Cohen (2011) was carried out to complement the data. The formula used to interpolate the data of stock price index (x^0), for instance, is

$$x_t^0 = \frac{x_2^0 - x_1^0}{t_2 - t_1} t + \frac{t_2 x_1^0 - t_1 x_2^0}{t_2 - t_1}, t_1 < t < t_2$$

in which x_1^0 refers to the data of stock price index on day t_1, x_2^0 to the data of stock price index on day t_2, and x_t^0 to the data of stock price index resulted from linear interpolation on day In this case, January 1, 2004 was accorded with day t=0, January 2, 2004 with day t=1, and so on. Thus, December 31, 2013 was accorded with day t=3653. The periode from January 1, 2004 to December 31, 2013 was henceforth called the 2004-2013 period, and constituted a long-term period.

3.2. Methodology

Econometric analysis tool that is used to examine the dynamics of the relationship between world crude oil prices and stock price index is an LVAR (p, q) causal model proposed by Agung (2009). The model of the dynamics of the long-term relationship is as follows

$$y_t = a_0 + \sum_{i=1}^{p} a_i y_{t-i} + \sum_{j=0}^{q} b_j x_{t-j} + \varepsilon_t \tag{1}$$

in which $x = \ln(x^0)$, y $\ln(y^0)$, p and q time lag, and ε_t error term at t time. Enders (2004) proposed a formulation which is different from (1), i.e.:

$$y_t = a_0 + \sum_{i=1}^{p} a_i y_{t-i} + z_t \tag{2}$$

in which z_t can be one or the sum of several quarters in $\sum_{j=0}^{q} b_j x_{t-j} + \varepsilon_t$

Quarter z_t is called the forcing process. If the trends of world crude oil price and stock price index are co-integrated, then the quarter of error correction is added to models 1 and 2. The multiplier (λ) of the independent variable x to the dependent variable y in the causal model 1 (Heij et al., 2004), is

$$\lambda = \frac{\sum_{i=0}^{q} b_i}{1 - \sum_{i=1}^{p} a_i} \quad (3)$$

The value of $\lambda > 0$ indicates a positive dynamics of relationship, whereas $\lambda < 0$ shows a negative one.

An analysis on the dynamics of short-term relationship was undertaken by dividing the 2004-2013 period into ten subintervals of time. Mathematically, the subinterval of time k (k=1, 2, …, 10) is expressed in $(t_k,t_{k+1}) = \{t \backslash t_k \leq t < t_{k+1}\}$ where t discreet point of time, and k the number of time subintervals. Here t_k, constitutes the time value of t that is in accord with January 1 each year, thus t_k = 0,366 731, 1096, 1461, 1828, 2193, 2558, 2923, 3289, 3653. These ten subintervals of time were called the time sub periods: 2004, 2005, 2006, 2007, 2008, 2009, 2010, 2011, 2012, and 2013. Next, it is necessary to define the dummy variable of D_{kt} (t time) at each subinterval of the –k time (k = 1,…,10) by using the following formula:

$$D_{kt} = \begin{cases} 1, t\epsilon\left(t_k, t_{k+1}\right) \\ 0, t \notin \left(t_k, t_{k+1}\right) \end{cases}$$

The model of dynamics of the relationship between the price of world crude oil (x) and the index of stock price (y) with dummy variable is

$$y_t = \sum_{k=1}^{10}\left(a_{k0} + \sum_{i=1}^{p} a_{ki} y_{t-i} + \sum_{j=0}^{q} b_{kj} x_{t-j} + (\varepsilon_t)\right) D_{kt} \quad (4)$$

If the trends of the prices of both world crude oil (x) and the index stock price (y) are co-integrated at each subinterval of time, then a variable of error correction is added to model (4). Furthermore, if the quarter in the addition (4) is expressed in y^k, (k = 1,2,…,10), then

$$y_t^k = a_{k0} + \sum_{i=1}^{p} a_{ki} y_{t-i} + \sum_{j=0}^{q} b_{kj} x_{t-j} + \varepsilon_t, t\epsilon\left(t_k, t_{k+1}\right) \quad (5)$$

is the model of the dynamics of the relationship between world crude oil price and stock price index at a subinterval of time k. The model of the relationship dynamics (5) is called a model of short-term relationship dynamics. The nature of the relationship can be positive or negative, depending on the sign of λ obtained in (3).

To examine the dynamics of the relationship, the following stages were taken. Firstly, data stationary was tested by using the Augmented Dickey-Fuller Test. Testing the time series data stationary of world crude oil price (x), for example, is conducted by examining the significance of ρ parameter from equation:

$$D\left(x_t\right) = \alpha_1 + \delta_1 t + \rho_1 x_{t-1} + \sum_{i}^{m} \varnothing_i D\left(x_{t-i}\right) + (\varepsilon_t)$$

in which $D(x_t)$ is the first difference transformation of world crude oil price variable (x) at time t. In this test, the x variable is stationary if the absolute value of ADF-statistics is higher that the absolute value of ADF-critics at the level of significance α(1% or 5%). Secondly, a co-integration test was conducted by employing the Two Steps Engle-Granger Test. According to Noriega (2012), the first step is to determine the errors variable in the regression equation between x and y variables. The second step is to test the stationary of the error variable. If the error variable is stationary, then both of x and y variables are said to be co-integrated. Thirdly, the dynamics of the relationship is examined by estimating model 1 and testing the significance of its parameters by administering the P value F statistics test on all of its parameters, and p-value t-statistics test on each regression parameter. The following hypotheses formula is used to test the long-term relationship

H_0: all b_j=0, j=1,2,3,…,q (there is no relationship)

H_1: there is at least one $b_j \neq 0$, j=1,2,3,…q (there is a relationship)

whereas the hypotheses formula used to test the short-term relationship are

H_0: all b_{kj}=0, j=1,2,3,…,q; k = 1,2,…10 (there is no relationship)

H_1: there is at least one $b_{kj} \neq 0$, $j=1,2,\ldots,q$; $k=1,2,\ldots 10$ (there is a relationship)

The existence of relationship dynamics is determined by the criterion of P value F-statistics or the criterion of P value t-statistics that is lower than the critical P value at the level of significance α (1% or 5%).

In testing the dynamics of the relationship, two phases of estimation are conducted, namely: (a) an estimation of the model (1) until a significant result of estimation is obtained in accordance with the criterion of P value F statistics and there is a significant coefficient of the x variable in accordance with the criterion of P value t statistics test, and (b) a re-estimation that excludes insignificant variables. In this test, a decision is made by taking into account the criterion for the existence of a non-spurious relationship (non-spurious regression), that is, the coefficient of determination (R^2) is lower than the Durbin Watson statistic. The testing process also takes into account the best models criterion specified by the Akaike Information Criterium information criterion.

4. ESTIMATION RESULTS

4.1. STASIONARY TEST

The results of ADF estimation test on the data of world crude oil prices and stock price indexes are summarized in Table 1. As can be seen on Table 1, the absolute value of ADF-statistics of the time series data of world crude oil price and stock price index is higher than the absolute value of ADF-critics. Therefore, world crude oil price and stock price index are stasionary at the first difference, both in the periode of 2004-2013 and in all of the subperiods.

4.2. Cointegration Test

The error variables in the results of estimation through the regression equation between world crude oil price and stock price index within the periode of 2004-2013 and all of the sub periods are expressed respectively as follows: *Res0, Res1, Res2, Res3, Res4, Res5, Res6, Res7, Res8, Res9,* and *Res10*. The estimation result of testing the co-integration of world crude oil price and stock price index is summarized in Table 2.

The absolute value of ADF-statistics: *Res0, Res1, Res3, Res4, Res5, Res6, Res7, Res8, Res9,* and *Res10* was lower that ADF-critics. Thus, all of those variables were not stationary. Only variable *Res2* was stationary at the level of significance 5%. Therefore, world crude oil price and stock price index were co-integrated in the subperiode 2005 at the level of significance 5 %. The two variables were not co-integrated throughout the period of 2004-2013 as well as the other subperiods.

4.3. Relationship Test

The estimation of causal model 1 or 2 both during the periode 2004-2008 and in the subperiods regarding the dynamics of the relationship between world crude oil price and stock price index is summarized in Table 3. What follows is an analysis of the relationship dynamics.

In the periode of 2004-2013, the coefficient $D(x_t)$ was significant by 5%, the coefficient $D(x_{t-1})$ and the coefficient $D(x_{t-2})$ were siginificant by 1%, and the multiplier was λ=0.14. Thus, in the long term, there was a dynamic relationship between world crude oil price and stock price index. The nature of this relationship was positive, indicating that if the price of world crude oil increased (decreased), then the stock price index also increased (decreased). The dynamics of this relationship began to occur on January 1, 2004 (time lag q=0). The model of this long-term dynamic relationship is as follows:

$$D(y_t) = 0.0004 + 0.1517D\left(y_{t-1}\right) + 0.0190D\left(x\right) + 0.0853D\left(x_{t-1}\right) + 0.0334D(x_{t-2})$$

In the sub period of 2004, the coefficient $D(x_{t-9})$ was significant by 5% with the multiplier λ=0.08. In the sub period of 2005, the coefficient $D(x_{t-7})$ was significantby 1% with the multiplier λ=0.10. In the sub period of 2006, the coefficient $D(x_{t-1})$ was significant by 1% with the multiplier λ=0.122. In the sub period of 2007, the coefficient $D(x_t)$ was significant by 5% and the coefficient $D(x_{t-1})$ was significant by 1% with the multiplier λ=0.23. In the sub period of 2008, the coefficient $D(x_{t-1})$ was significant by 1% with the multiplier λ=0.11. In the sub period of 2009, the coefficient $D(x_{t-1})$ was significant by 1% with the multiplier λ=0.06 In the sub period

Table 1: Statistical results of an estimation test on the research variables' stationary

Period	Variable	t statistics	1% critical value	5% critical value	P*
2004-2013	D (x_t)	−57.75957	−3.431955	−2.862134	0.0001
	D (y_t)	−12.74002	−3.431962	−2.862138	0.0000
2004	D (x_t)	−18.89613	−3.448111	−2.869263	0.0000
	D (y_t)	−17.24425	−3.448111	−2.869263	0.0000
2005	D (x_t)	−18.58578	−3.448161	−2.869285	0.0000
	D (y_t)	−7.481391	−3.448414	−2.869396	0.0000
2006	D (x_t)	−18.28562	−3.448161	−2.869285	0.0000
	D (y_t)	−12.06001	−3.448211	−2.869307	0.0000
2007	D (x_t)	−19.82355	−3.448161	−2.869285	0.0000
	D (y_t)	−17.99139	−3.448161	−2.869285	0.0000
2008	D (x_t)	−7.311812	−3.448466	−2.869419	0.0000
	D (y_t)	−3.304991	−3.448943	−2.869629	0.0154
2009	D (x_t)	−10.21161	−3.448312	−2.869351	0.0000
	D (y_t)	−11.83697	−3.448211	−2.869307	0.0000
2010	D (x_t)	−17.14956	−3.448161	−2.869285	0.0000
	D (y_t)	−12.15237	−3.448262	−2.869329	0.0000
2011	D (x_t)	−12.25143	−3.448211	−2.869307	0.0000
	D (y_t)	−14.22434	−3.448262	−2.869329	0.0000
2012	D (x_t)	−3.545910	−3.448889	−2.869605	0.0074
	D (y_t)	−13.26417	−3.448211	−2.869307	0.0000
2013	D (x_t)	−17.75413	−3.448161	−2.869285	0.0000
	D (y_t)	−16.02229	−3.448161	−2.869285	0.0000

*McKinnon (1996) one-sided P values

Table 2: Statistical results of an estimation test on the co-integration of world crude oil price and stock price index

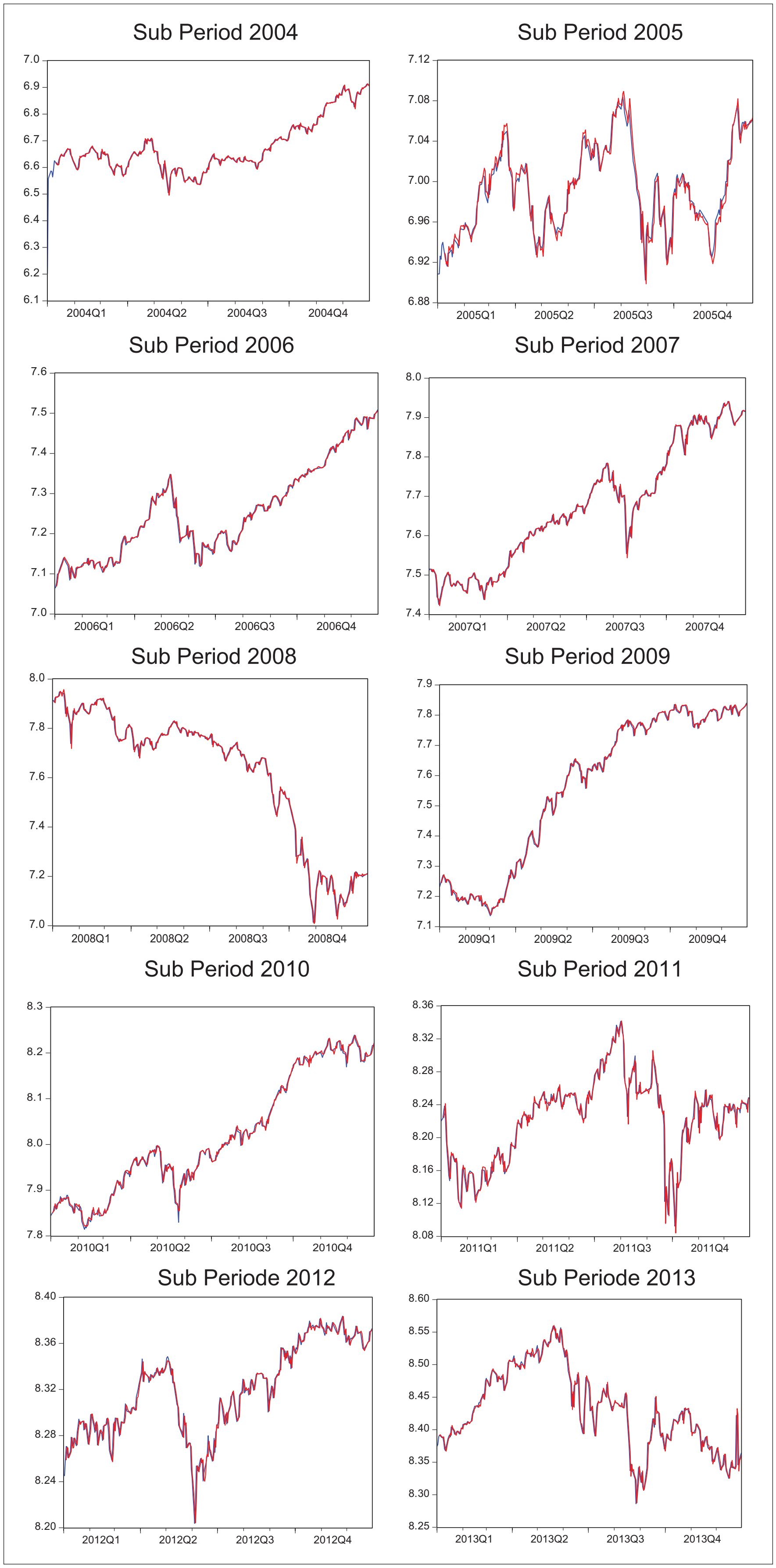
Period	Variable	t statistics	1% critical value	5% critical value	P*
2004-2013	*Res*0	−1.383935	−3.431962	−2.862138	0.5917
2004	*Res*1	−1.393729	−3.448062	−2.869241	0.5858
2005	*Res*2	−3.281438	−3.448161	−2.869285	0.0165
2006	*Res*3	−1.001495	−3.448161	−2.869285	0.7538
2007	*Res*4	−1.029903	−3.448111	−2.869263	0.7435
2008	*Res*5	−2.801803	−3.448062	−2.869241	0.0590
2009	*Res*6	−2.724284	−3.448111	−2.869263	0.0709
2010	*Res*7	−2.358532	−3.448262	−2.869329	0.1544
2011	*Res*8	−0.448902	−3.448262	−2.869329	0.8976
2012	*Res*9	−1.494364	−3.448161	−2.869285	0.5356
2013	*Res*10	0.620946	−3.448111	−2.869263	0.9902

*McKinnon (1996) one-sided *P* values

Table 3: Statistical results of estimation test on dynamic relationship between world crude oil price and stock price index

Period	Variable	Coefficient	t statistic	P	R^2 and DW
2004-2013	C	0.000375	2.097846	0.0360	R^2: 0.053
	D (y_{t-1})	0.151681	9.294670	0.0000	*DW*: 2.011
	D (x_t)	0.018962	1.970403	0.0489	
	D (x_{t-1})	0.085275	8.848628	0.0000	
	D (x_{t-2})	0.033400	3.431085	0.0006	
2004	D (y_{t-1})	0.333781	6.703561	0.0000	R^2: 0.115
	D (x_{t-9})	0.053356	1.987220	0.0477	*DW*: 1.951
2005	$Res2_{t-1}$	-2.11E-05	-2.157394	0.0316	R^2: 0.086
	D (y_{t-1})	0.236897	4.632636	0.0000	*DW*: 2.023
	D (x_{t-7})	0.078821	3.099251	0.0021	
2006	C	0.001229	2.455293	0.0145	R^2: 0.030
	D (x_{t-1})	0.122323	3.334103	0.0009	*DW*: 1.855
2007	D (y_{t-1})	0.169333	3.300658	0.0011	R^2: 0.051
	D (x_t)	0.084456	2.179873	0.0299	*DW*: 1.987
	D (x_{t-1})	0.102303	2.648865	0.0084	
2008	D (y_{t-1})	0.226128	4.465476	0.0000	R^2: 0.067
	D (x_{t-1})	0.085114	2.855752	0.0045	*DW*: 2.036
2009	C	0.001560	2.674621	0.0078	R^2: 0.019
	D (x_{t-1})	0.060701	2.638144	0.0087	*DW*: 1.822
2010	C	0.000937	2.054849	0.0406	R^2: 0.149
	D (x_{t-1})	0.245694	7.975373	0.0000	*DW*: 2.018
2011	D (x_{t-1})	0.166027	5.056764	0.0000	R^2: 0.130
	D (x_{t-2})	0.171747	5.228244	0.0000	*DW* : 1.992
2012	D (x_{t-1})	0.069760	3.139689	0.0018	R^2: 0.040
	D (x_{t-2})	0.057768	2.601310	0.0097	*DW*: 1.910
2013	D (y_{t-1})	0.128430	2.491387	0.0132	R^2: 0.042
	D (x_{t-2})	0.207414	3.191572	0.0015	*DW*: 1.978

Figure 1: Signal dynamics of the relationship between world crude oil prices and the stock price index is based on the model 6



of 2010, the coefficient $D(x_{t-1})$ was significant by 1% with the multiplier λ=0.25. In the sub period of 2011, the coefficient $D(x_{t-1})$ and the coefficient $D(x_{t-2})$ was significant by 1% with the multiplier λ=0.34. In the sub period of 2012, the coefficient $D(x_{t-1})$ and the coefficient $D(x_{t-2})$ was significant by 1% with the multiplier λ=0.13. In the sub period of 2011, the coefficient $D(x_{t-2})$ was significant by 1% with the multiplier λ=0.24 It can therefore be concluded that in the short-term there existed a dynamic relationship between world crude oil price and stock price index. The nature of this relationship was positive, indicating that if world crude oil price rose (fell), then the stock price index also rose (fell). The model of the relationship dynamics, which was resulted from the estimation, is

$$\begin{aligned} D(y_t) = &\left[0.3338D\left(y_{t-1}\right) + 0.053D(x_{t-1})\right]D_{1t} \\ &+\left[-2.11*10^{-5}Res2+0.2369D\left(y_{t-1}\right)+0.0788D(x_{t-1})\right]D_{2t} \\ &+\left[0.0012 + 0.1223D(x_{t-1})\right]D_{3t} \\ &+\left[0.1639D\left(y_{t-1}\right)+0.0845D\left(x_t\right)+0.1023D(x_{t-1})\right]D_{4t} \\ &+\left[0.2261D\left(y_{t-1}\right) + 0.0851D(x_{t-1})\right]D_{5t} \\ &+\left[0.0016 + 0.6107D(x_{t-1})\right]D_{6t} \\ &+\left[0.0016 + 0.2457D(x_{t-1})\right]D_{7t} \\ &+\left[0.166D\left(x_{t-1}\right) + 0.1718D(x_{t-2})\right]D_{8t} \\ &+\left[0.07D\left(x_{t-1}\right) + 0.0578D(x_{t-2})\right]D_{9t} \\ &+\left[0.1284D\left(y_{t-1}\right) + 0.2074D(x_{t-2})\right]D_{10t} \end{aligned} \quad (6)$$

It must be stated here that, for the dynamic relationship between world crude oil price and stock price index to occur, a time break was needed, ranging variously between 0 and 9 days. As a way of example, in the subperiod of 2005, the dynamic relationship between world crude oil price and stock price index occured after a 9 days break, whereas in the sub period of 2006 it happened without any time break. Figure 1 shows the dynamics of this relationship in the form of signal process. The red curve, which coincides with the blue curve, indicates a dynamic relationship, whereas the pieces of the blue curve on the left side of the red curve indicate insignificant dynamics of relationship.

CONCLUSION

This study attempted to examine the dynamics of the relationship between world crude oil prices and Indonesian stock market within the period from January 1, 2004 to December 31, 2013. Data of crude oil prices were taken from the daily price of WTI crude oil. Daily data of the prices of composite stock were used as the indicator of Indonesian stock market. The general univariate LVAR model was employed to examine the dynamics of the relationship. Period I from 1 January to 31 December 2004 was considered as the long-term period, whereas the sub period between 1 January and 31 December each year was considered as the short-term period.

The test results show that both world crude oil prices and stock prices were stationary at the first difference, not only in the long-term but also in the short-term period. The result of the co-integration test also shows that the trends of both world crude oil prices and stock price index were co-integrated in the sub period of 2005. In the period from 2004 to 2013 and in the other sub periods, the trends of these two variables were not co-integrated.

Overall, the test results show that there was a significant dynamics in the relationship between world crude oil prices and Indonesian stock price index, both in the long-term and short-term. This relationship was positive in that if the price of crude oil increased (decreased), then the stock price index also increased (decreased). Based on the time period of the study, the dynamics of long-term relationships have occurred since January 1, 2004, while the short-term dynamics of the relationship varied. This finding is in the need for Indonesian government to be considered in their economic policy, as well as for investors to manage their investment portfolio.

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