An Econometric Analysis between Commodities and Financial Variables: The Case of Southeast Asia Countries

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Abstract

This paper provides econometric analysis on the relationship between commodities (crude oil and gold) and two commodity-relevant financial variables (exchange rate and the equity index). The case study involves Southeast Asia countries which is Malaysia, Thailand and Indonesia. In this paper, world oil and gold prices are utilized, while exchange rates refer to national currency against U.S. Dollar. The leading stock index of each country is used as a proxy for the stock market. For that reason, FBM KLCI of Malaysia, IDX Composite of Indonesia and SET Index of Thailand (SET Index) are analyzed. The result confirms that there are dynamic correlations between commodities and financial variables among Southeast Asia countries. This paper also reveals the existence of feedback relationship for stock index and exchange rate nexus. Thus, the implementation of the stock and exchange rate policies should be carefully executed as both markets impact each other.

Keywords: correlations, Granger causality, gold, oil, exchange rate, stock, index

1. Introduction

Oil and gold has been known as the strategic commodities that are vastly traded in the global economy. Augmented number of research done on these two commodities of late is signaling the exceptional roles of the said commodities towards the economy. It has been observed that the fluctuation of the world price of oil and gold can be used as an indicator, for example in the case of world oil price; a hike in oil price has a notation that it will affect the economic activities: See: (Arouri, Jouini and Nguyen, 2012; Basher, Haug and Sadorsky, 2012; He, Wang and Lai, 2010; Lizardo and Mollick, 2010; Rafiq, Salim and Bloch, 2009).

Historically, soaring and/or violent fluctuation of price of this 'black gold' has an adverse impact on the growth of global economy and financial market (He et al., 2010; Masih, Peter and De Mello, 2011) and inadvertently could trigger inflation and recession. Bhar and Malliaris (2011) reported that the oil price hike from 2004 to 2006 has slowed down the world economy. Global oil prices are rising at a fast rate making it impossible for the economy to keep up with it. This was due to the fact that price hike in oil surge the cost of production for corporation thus lowering down their profit margin.

[*]**Acknowledgement:**The authors wish to express gratitude to the Research Management Institute of MARA University of Technology for funding support.

To minimize this, products and goods were sold at a higher price and this has led to inflation. Yahya, Hussin, Muhammad, Razak and Tha (2013) have also observed numerous oil price fluctuations and came to a conclusion that an increase in the oil price level could act as a trigger in slowing down economy while inflation increases.

Gold is considered as a leader in the precious metals market which widely being used as an industrial commodity as well as good investment portfolio. While the price of crude oil is the most volatile in the commodity market, gold on the other hand has a value-preserving ability (Baur & McDermott, 2010). Their research which used samples spanning from the late 70's until 2009 has established that the price of gold has the ability to adapt and to confirm to the changes in the inflation rate, thus dub this precious metal as a 'safe haven' during financial crises.

While the highly sensitive segments in the financial markets are equity market and foreign exchange market. This is because both markets will quickly be reflected if there is any changes in the related policy. For example, the exchange rate of a certain currency is not fixed but highly volatile and that would bring an impact to a country's growth rate. This is due to competitiveness price of an import/export of an input and output depends on the fluctuation of exchange rate. To illustrate, let's consider currency appreciate, exporter will lose their international competitiveness which consequently brings the sales and profits down and also decline in the stock price. The opposite scenario will happen if currency depreciate.

Researchers and academia have long before put their interest to study variables related to finance and economic of a country especially among developed countries. However, the interest has been shifted to emerging and developing markets rather than developed markets alone. This might be due to the rising in the economies of the so called underdog countries. International Finance Corporation (IFC) has defined 'emerging market' as a stock market that is in transition, increasing in size, activity or level of sophistication. The term 'emerging market' is applied to a country making an effort to change, and improve its economy to reach the same level of 'developed market'. And, most of the Southeast Asia countries have been listed as the emerging economies.

Thus, the specific objective of this study is to examine the dynamic correlations among two highly internationally traded commodities; oil and gold and two commodity-relevant financial variables; exchange rate and the equity index among Southeast Asia countries. The rest of this paper is divided into four sections. The second section briefs on the overview of previous literatures; section three discusses on the research methodology, followed by findings and analysis in section four and section five concludes the research.

2. Literature Review

The study on the relationship or interaction among various economic indicators has always been a major interest of the researchers, policy makers and practitioners. However, recently the study on the interaction between highly traded commodity and other financial indicators has arisen. Wang, Wang and Huang (2010) who investigate the relationship between prices of oil and gold, exchange rate and equity markets of Taiwan, China, Japan, United State (US) and Germany found that there exist long-run cointegration among all variables in each country except for US. Empirically, the findings support that there exist bidirectional relationship between crude oil, gold and Taiwan stock market. Bhunia (2013) who employs the similar variables for the case of India also found that there is long-run cointegration among all variables under study.

Gold has been considered as the best investment over centuries and also stands as a good portfolio diversifier as the price of gold move to the opposite direction with another financial asset (Kristof, 2011). In fact, in times of economic and political uncertainties, many have chosen gold to store the value of their wealth. See: (Aggarwal and Lucey, 2007 and Joy, 2011). Previous study by Capie, Mills and Wood (2005) also claimed that gold can be a hedge to foreign exchange market. A study by Sujit and Kumar (2011) who examine the cointegration between gold, oil, exchange rate and stock return have come out with the conclusion that volatility in exchange rate market is derived from another three variables. They also summarized that gold price fluctuations depend on the commodity itself not from oil price and other index. The finding is also in line with research paper by Bilal, Abu Talip, Haq, Khan and Naveed (2013) and Shahzadi and Chohan (2011) who reported that there is no long-run relationship between Karachi Stock Exchange (KSE) equity index and the price of gold. Bashiri (2011) also found the same conclusion of no correlation between gold-index nexus for Armenia and Iran over 2005-2010 periods.

Other study by Basher et al. (2012) support that oil prices determine the movement of exchange rate among emerging economies. In particular, the study which utilised impulse response functions indicates that the rise of oil prices would weaken the emerging stock markets and exchange rate.

Some researchers limit their study on the examination between equity index and exchange rate nexus among emerging markets: See: (Chowdhury, 2004; Doong et al., 2005; Md-Yusof and Abd Rahman 2013). Arouri et al. (2011) who used generalised VARGARCH approach have explored the link between Gulf Cooperation Council (GCC) equity markets and crude oil over period of 2005 to 2010. Their findings suggested that there is volatility trasmission between crude oil prices and GCC equity markets. Another papers which share the same findings are those by Fayyad and Daly (2011), Fillis, Degiannakis, Floros (2011) and Mohanty, Nandha, Turkistani and Alaitani (2011) in particular conclude that oil market is not a good hedge against losses in stock market during financial turmoil.

The papers by Burbridge and Harrison (1984), Gisser and Goodwin (1986), Loungani (1986), Mork (1989), Guo (2005), Breitenfellner and Crespo (2008) are example of studies which test on the causal relation between oil price and macro-economic variables. Substantial number of researchers keen to study the impact of oil price shocks to the world economy due to fluctuation of oil prices which bring major impact to the world economy. Bénassy-Quéré, Mignon and Penot (2007) who explores the oil price-dollar integration over a period of 1974 to 2004 claimed that the causality run from oil price to dollar. See: (Amano and Van Norden, 1998; Liu, 2010; Novotny, 2012) for similar findings in their studies.

The above discussion illustrates that there is no theoretical or empirical consensus on the direction and the sign of the relationship between crude oil, gold, exchange rate and stock market index. Thus, this paper attempts to provide new empirical evidence identifying the correlation of the commodity and financial sector using data from three Southeast Asia countries over 20 years of study (1993-2013). These countries have beenselected due to relatively little research has focused on the relationship between commodity and financial variables on the said countries

3. Data and Methodology

In analyzing the dynamic correlation between commodities and financial variables among emerging economies, crude oil (Crude Oil Dated Brent U$/BBL) and gold (Gold Bullion LBM U$/Troy Ounce) are selected as proxy for commodities. While, exchange rate and the leading index for each country are chosen to represent financial variables. As for this research, the prominent stock index of each countries are selected; Malaysia (FBM KLCI), Thailand (SET Index) and Indonesia (IDX Composite). The period under study spans from November 8, 1993 until November 8, 2013 (20 years of study). These weekly data are gathered from *Datastream*and transformed into natural logarithm for further analysis.

A group of econometrics approaches are utilized in order to achieve the objectives of this paper. However, a significant problem associated with econometrics estimation using non-stationary variables is spurious (nonsense) regression. Yule (1926) says that spurious regression can persist in large samples with non-stationary time series. Thus, unit root tests are conducted in order to secure a valid, meaningful and non-spurious regression. There are several tests available for unit root or non-stationarity testing. The pioneer work on testing on unit root test for time series data was carried out by Dickey and Fuller (Fuller, 1976 and Dickey and Fuller, 1979). The objective of the test is to verify the null hypothesis that $\beta = 1$ in $y_t = \beta y_{t-1} + u_t$against one-sided alternative $\beta < 1$. In conducting the DF test, it was assumed that the error term, μ_t was uncorrelated or in other words, the test only valid if μ_t is white noise.

Thus, both discoverers 'augment' the test by adding the lagged values of the dependent variable ΔY_t. The test which is known as Augmented Dickey-Fuller (ADF) consists of estimating the following regression:

$$\Delta Y_t = \beta_1 + \beta_2 t + \delta Y_{t-1} + \alpha_i \Sigma \Delta Y_{t-i} + \varepsilon_t$$

where$\varepsilon_t$is a pure white noise error term and where $\Delta Y_{t-1} = (Y_{t-1} - Y_{t-2})$.

Another unit root test conducted in this study is Phillips-Perron (PP) Unit Root test. Phillips and Perron (1988) have developed a more comprehensive theory of unit root. The tests are similar to ADF tests but the PP unit root test different from the ADF tests in terms of how it treats the serial correlation and heteroskedasticity in the errors. In particular, the PP tests ignore any serial correlation in the test regression, whereas the ADF tests use a parametric autoregression to approximate the Autoregressive Moving Average (ARMA) structure of the errors in the test regression.

The test usually gives similar conclusions as the ADF tests, and the calculation of the test statistics is complex. Both ADF and PP unit root tests employ that the series is not stationary as the null hypothesis whereas rejection of the null hypothesis supports stationarity.

Cointegration theory is an innovation in theoretical econometrics that has created the most interest among economists in the last decade. Economically speaking, two variables will be cointegrated if they have a long-term, or equilibrium relationship between them. The variables in a cointegrating relationship can wander around over time since they are non-stationary. However, there are some economic/financial forces that can stop them wandering too far from each other. Even though there are a number of methods for testing cointegration have been proposed in the literature, Gonzalo (1994) has supported that the Johansen procedure is relatively superior over other method for testing the order of cointegration. Thus, Johansen and Juselius (1990) cointegration test is adopted to assess for the dynamic correlation between commodities and financial variables. The objective of Johansen and Juselius (JJ)cointegration test is to examine the existence of long-run cointegration among variables. There are two test statistics namely; Trace and Max Eigenvalue in this JJ cointegration test. The test procedure is sequential where the null hypothesis of zero cointegrationvector is utilized against at most one. The test statistics for JJ cointegration test are formulated as follows:

$$\lambda_{trace}(r) = -T\sum_{i=r+1}^{g}\ln(1-\hat{\lambda}_i)$$

$$\lambda_{\max}(r, r+1) = -T\ln(1-\hat{\lambda}_{r+1})$$

whereλ_i is the estimated value for the *i*th ordered eigenvalue from the Π matrix.

λ_{trace} tests the null that the number of cointegrating vectors is less than equal to *r* against an unspecified alternative.

λ_{trace} = 0 when all the λ_i = 0, so it is a joint test.

$\lambda_{\max}$ tests the null that the number of cointegrating vectors is *r* against an alternative of *r*+1.

JJcointegration test provide critical values for the 2 statistics. The distribution of the test statistics is non-standard.

The critical values depend on:

1. The value of *g*-*r*, the number of non-stationary components
2. Whether a constant and / or trend are included in the regressions.

If the test statistic is greater than the critical value from Johansen's tables, reject the null hypothesis that there are *r*cointegrating vectors in favour of the alternative that there are more than *r*.

The dependence of one variable with another variable does not necessarily imply causation. In another words, the direction of influence or causality cannot be proved with the existence of interdependency among variables. Fortunately, the 'causality' can be tested in time series vector autoregression where the test is first proposed by Granger in year 1969. 'Causality' in literal sense in statistical analysis is controversial. Notion of Granger causality; for example an event (say A) cannot cause another event (say B) that already took place. In another words, if A happens before B, A can cause B but B cannot cause A. Statistically, if past values of a variable (X) can help predicting the current value of another variable (Y), then X causes Y. Thus, Granger causality is a test of 'precedence' or a test of 'predictability'. It is stated that information to predict the value of a variable *(Y)* is held in its past values, which is formulated as:

$$Y_t = \alpha + \sum_{i=1}^{k}\beta_i Y_{t-i} + \varepsilon_t$$

If there is past values of other variable (say *X*) that can improve the prediction of *Y*, then in that sense *X* is taken to Granger cause *Y*. The following equation is carried out for estimation:

$$Y_t = \alpha + \sum_{i=1}^{k}\beta_i Y_{t-i} + \sum_{i=1}^{k}\phi_i X_{t-i} + \varepsilon_t$$

Then, to test the null hypothesis the restricted F-test is computed. If null hypothesis is rejected, it indicates causality runs from *X* to *Y*. The Granger causality test describes only short-run relationship between variables. However, it might be the case of additional long run relationship exists between variables.

To assess for the long term effects, standard Granger causality test augmented with error-correction terms can be used. The augmented Granger causality test is formulated as follows:

$$\Delta Y_t = \alpha_1 + \sum_{i=1}^{k} \beta_{1i} \Delta Y_{t-i} + \sum_{i=1}^{k} \phi_{1i} \Delta X_{t-i} + \lambda_1 \varepsilon_{t-1} + u_{1t}$$

$$\Delta X_t = \alpha_2 + \sum_{i=1}^{k} \beta_{2i} \Delta Y_{t-i} + \sum_{i=1}^{k} \phi_{2i} \Delta X_{t-i} + \lambda_2 \varepsilon_{t-1} + u_{2t}$$

Specifically, the causality test outcome can be divided into four cases:

(i) *Unidirectional causality*eg: *X* Granger causes *Y* but *Y* does not Granger cause *X*
(ii) *Unidirectional relationship* (converse) eg: *Y* Granger causes *X* but *X* does not Granger cause *Y*
(iii) *Feedback*, or bidirectional causality eg: *X* Granger causes *Y* and *Y* Granger causes *X*
(iv) *Independence* eg: *X* does not Granger cause *Y* and *Y* does not Granger cause *X*

4. The Findings

4.1 Unit Root Test

To establish the degree of integration among variables, Augmented Dickey Fuller (ADF) and Phillip Perron (PP) unit root tests are conducted. The results of unit root tests are presented in **Table 1**.

Table 1: Results of Unit Root Tests

Variables	**Level**		**First Difference**	
	Augmented Dickey Fuller	**Phillips Perron**	**Augmented Dickey Fuller**	**Phillips Perron**
LGOLD	0.2225(21)	0.3022	-6.4107***(20)	-32.4355***
LOIL	-1.0262(0)	-1.0079	-16.6299***(3)	-32.1524***
LKLCI	-1.3712(12)	-1.3351	-8.9740***(11)	-31.8815***
LSET	-1.3684(4)	-1.3183	-15.1498***(3)	-30.9460***
LIDX	0.09188(11)	-0.1187	-10.7955***(10)	-35.7031***
LMYR	-1.8007(14)	-1.8931	-7.1953***(13)	-39.0737***
LBAHT	-1.9152(16)	-1.8658	-7.9366***(15)	-30.2316***
LRUPIAH	-2.0939(21)	-1.9567	-5.7780***(20)	-37.5697***

Note: *** (**) and * denotes significant at 1%, 5% and 10% significant level respectively. Figure in the parenthesis represents optimum lag length selected based on Akaike Info Criterion.

Although two different unit root tests are employed, the results of both the ADF test and the PP test are similar. The ADF and PP tests agree in classifying the commodities and financial variables of all emerging economies as I(1) that is they are non-stationary in level but become stationary after first differencing. All the variables are significant at 1% confidence level with optimum lag length is selected based on Akaike Info Criterion. Thus, reject the null hypotheses that the series have unit roots in the level estimations of the variables.

4.2 Johansen Juselius Cointegration Test

Next, the structures of linkages among variables are examined using the JJcointegration test. The lag length for the VAR is chosen so that the error terms are serially uncorrelated. This research indicates that setting the lag length up to 24 is adequate to render the error terms serially uncorrelated in conducting the test. The results of Johansen Juseliuscointegration test are reported in **Table 2**.

Table 2: Results of Johansen Juselius Cointegration Tests

H_0	*Malaysia*		*Thailand*		*Indonesia*	
	Trace	**Max**	**Trace**	**Max**	**Trace**	**Max**
r=0	156.0[a]	47.16[a]	246.6[a]	69.91[a]	181.4[a]	54.05[a]
r≤1	108.8[a]	44.24[a]	176.7[a]	65.00[a]	127.3[a]	46.78[a]
r≤2	64.59[a]	33.89[a]	111.7[a]	58.31[a]	80.58[a]	43.30[a]
r≤3	30.70[a]	30.70[a]	53.43[a]	53.43[a]	37.27[a]	37.27[a]

Note: r denotes the number of cointegrating vectors. Numbers in parentheses next to r=0 until r≤3 represent the 5% critical values of the test statistic. An ([a]) indicates rejection of the null hypothesis of no-cointegration at 5% level of significance.

As being illustrated in Table 2, the Trace and Maximal Eigenvalue statistics suggest the presence of at least three cointegrating vector for each emerging country. This means that the crude oil and gold are tied together with the exchange rate and index for each country in the long run and their deviations from the long-run equilibrium path will be corrected. Accordingly, the results suggest the existence of dynamic correlation between commodities and financial variables among Southeast Asia countries under study.

4.3 Granger's Causality Test

The presence of cointegration has rules out non-causality among variables. Thus, Granger causality test is conducted to confirm the causal direction. **Table 3** below shows the results of Granger causality test.

Table 3: Results of Granger Causality Tests

Dependent variables		***LGOLD***	***LOIL***	***LCURRENCY***	***LINDEX***
Malaysia	LGOLD		24.7206	24.1141	19.1089
	LOIL	24.3406		17.7519	17.3727
	LCURRENCY	26.0389	46.5827***		71.1530***
	LINDEX	30.9763	38.0605**	101.46***	
Thailand	LGOLD		15.5595	14.3664	15.8507
	LOIL	19.3080		13.9692	25.9785*
	LCURRENCY	15.5309	24.2700*		23.5876*
	LINDEX	29.5529**	22.4514	32.7646***	
Indonesia	LGOLD		23.8309	18.5372	19.6677
	LOIL	23.5611		19.6647	37.1640**
	LCURRENCY	13.6723	45.0999***		71.5575***
	LINDEX	18.4502	26.6104	60.7807***	

Note: The boldface categories denote the dependent variables; *, ** and *** indicate rejection region of the causality at the 10%, 5% and 1% confidence levels, respectively.

The results of Granger causality test suggests that there are *bidirectional causality* between the leading index and exchange rate for each Southeast Asian countries (Malaysia, Thailand and Indonesia) under study. The results are consistent with the research previously done by Bahmani-Oskooee and Sohrabian (1992), Chowdhury (2004), Doong et al. (2005) and Md-Yusof and AbdRahman (2013). The findings indicate that anything happen to the value of Malaysian currency in relation to US Dollar either appreciate or depreciate will give an impact towards Bursa Malaysia and vice versa. It was happened during the 1997 Asian financial crisis as well as the 2008 global financial crisis, whereby Malaysia's foreign currency market was badly affected and so too was the equity market. Thus Southeast Asian governments have to be cautions in the implementation of equity market and exchange rate policies as such policies would influence each other.

Other than that the causality test reveals that exchange rate Granger causes crude oil *(unidirectional causality)* in Malaysia, Thailand and Indonesia. The finding is contradicted to the study by Amano and Van Norden (1998), Lizardo and Mollick (2010) and Bénassy-Quéré et al. (2007) however, confirms the discoveries by Liu (2010) and Novotny (2012).

According to Liu (2010), the relationship between exchange rate and crude oil is unstable due to multiple structural breaks over the sample period and also time-varying in terms of impact magnitude. This partially explains why researchers have mixed results over study on exchange rate and crude oil nexus.

Despite the finding on causal direction between exchange rate-index and exchange rate-crude oil, gold has remained as the least affected commodity by other variable and also stand as the commodity that play fewest role in affecting another variables. According to Sujit and Kumar (2011), the fluctuations in gold prices are largely dependent on the prices of gold itself rather than crude oil and other indices. The results are also in line with the previous literature by Bilal et al. (2013) who documented that no causal interaction exists among average gold prices and stock indices. The result also suggests that gold is the strong safe haven, by moving against other assets which is in contrast to Baur and McDermott, 2010.

5. Conclusions

All of the previous literatures discuss on the correlation between commodities and financial variables done their research mostly on the developed countries. Not many studies focus on the Asian countries especially Southeast Asian countries. Thus, this paper is the first of its kind to contribute to the recent areas of financial economics. Some of the major findings that can be extracted from the empirical studies are as follows:

i. There is *bidirectional causality* between the leading index and exchange rate for each Southeast Asian countries (Malaysia, Thailand and Indonesia)
ii. Exchange rate Granger causes crude oil *(unidirectional causality)* in all Southeast Asia countries; Malaysia, Thailand and Indonesia.
iii. Gold is the least affected commodity and also commodity that play fewest role in affecting another variables

The findings of this research have several implications especially in terms of portfolio diversification. To invest in Southeast Asian countries, investors should be more cautious since anything happen to the stock market will have an effect to the exchange rate and vice versa. The appreciation and depreciation of exchange rate definitely will affect the return of the investment. Besides that individual/institutional investor should have closer look to any policy regarding exchange rate as it has feedback effect towards leading index for most of the countries under study. Still, gold remain as safe haven in portfolio diversification among commodities.

The result of this paper is also useful to the Southeast Asian governments particularly in the enforcement of equity market and foreign exchange policies as such policies would impact each other. The three Southeast Asian countries also should sit together and discussed on the policy concerning the stock market and foreign exchange market. A consensus framework should be vigilantly constructed so that the effect of financial crisis will be reduced should there be any more crises in the future.

Since this paper focused on Southeast Asia countries, it is suggested that future researcher conduct the similar study in different countries or compare between two sets of countries. Future researcher might also take into consideration the effect of major structural breaks which this paper has not taken into consideration. It is also recommended to use another choice of variable as a proxy of financial variables and more advance method for further research.

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