14th National Convention on Statistics (NCS)
Crowne Plaza Manila Galleria, Quezon City
October 1-3, 2019

LINKAGE BETWEEN STOCK AND COMMODITY MARKETS' VOLATILITY IN THE PHILIPPINES

by

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ABSTRACT

In this paper, I will contribute to the emerging empirical literature dealing with the relationship between commodity and stock markets. Our sample consists of commodities covering various sectors over the period. Relying on a large panel of raw materials (energy, metals, agricultural, food, ...) allows us to study whether commodities constitute a homogenous asset class with regard to their links with stock markets, and whether the crisis has engendered a financialization of commodity markets.

I've used EViews in order to employ all the necessary methods in determining the relationship between commodities like oil and gold to stock market volatility (PSEi). The methods employed were Augmented Dickey Fuller test (ADF) to find the stationarity, Exponential Generalized Autoregressive Conditional Heteroscedasticity (EGARCH) to to capture the existence of volatility clustering in both commodity and stock markets, and Autoregressive Conditional Heteroscedasticity (ARCH) to establish the existence of time-varying volatility clustering phenomenon in the crude oil and gold price time series.

Findings of this study among others can benefit financial managers in the portfolio construction in the presence of oil and gold price fluctuations. This information can be helpful for formulating short term and long term investment strategies.

1. Introduction

In this paper, I will contribute to the emerging empirical literature dealing with the relationship between commodity and stock markets. Also, the volatility of these markets will be compared over a period of time. A commodity market is a market that trades in primary economic sector rather than manufactured products. On the other hand, a stock market, equity market or share market is the aggregation of buyers and sellers (a loose network of economic transactions, not a physical facility or discrete entity) of stocks (also called shares), which represent ownership claims on businesses.

Based on other studies of other countries concerning the relationship between stock markets and commodity markets, I would have a similar study but only in the Philippines and a different period of time. Here, I would test the validity of their relationship. I would also compare the past performance of volatility among the markets to its current state.

2. Literature Review

When evaluating the interaction between financial assets/markets and commodities most of the literature focuses on time-varying correlation analysis and the diversification effect that commodities could bring to an investor's portfolio. The main finding that emerges when examining this strand of literature is that the correlation between the commodity and stock markets is time varying with an unclear relationship during the 2007-2008 financial crisis, with possible attribution of this uncertain relation to differences in models, commodities and markets examined and the periods covered in each study. There is a growing literature investigating the relationship between commodity prices and equity markets or financial assets. This section presents a short literature review of papers that focus on the dynamics between commodity prices and equity markets.

According to Creti, Joëts & Mignon (2012), they show the correlations between commodity and stock markets using dynamic conditional correlation (DCC) GARCH methodology and prove that they evolve through time and are highly volatile, particularly since the 2007-2008 financial crisis. The latter has played a key role, emphasizing the links between commodity and stock markets, and underlining the financialization of commodity markets. At the idiosyncratic level, a speculation phenomenon is highlighted for oil, coffee and cocoa, while the safe-haven role of gold is evidenced.

Thuraisamy, Sharma, & Ali Ahmed, (2013) in their paper, they tested spillover effects between Asian equity market volatility and the volatility of the two most dominant commodities, namely, crude oil and gold futures. They find that volatility shocks in established and mature equity markets, such as the Japanese market, spill over to the crude oil and gold futures markets, while immature markets tend to have spillover effects from commodity futures to equity markets (Thuraisamy, Sharma, & Ali Ahmed, 2013).

Rossi (2012) further explore the linkage between equity, commodity, and the exchange rate markets, focusing in particular on studying its evolution over time. They document that a country's equity market value has significant out-of-sample predictive ability for the future global commodity price index for several primary commodity-exporting countries. They find, hoIver, little evidence of in-sample predictive ability, even after allowing for instabilities (Rossi, 2012).

Kang study examines causal relationships between international food commodity prices and daily stock indices in China, including Shanghai Stock Exchange (SSE) and Shenzhen Stock Exchange (SZSE), during 2000-2010. The empirical results show that both
China's stock indices have bilateral Granger causality relationships with international food commodity futures including wheat, corn, soybean, and soybean oil, while rough rice is found to have a unilateral Granger causal relationship with these stock indices (Kang, Hu, & Chen, 2013).

3. Data and Methodology

Data

The objective of this study is to examine the effect of oil and gold price fluctuations on the volatility of stock markets from the Philippines (PSEi). Composite index of each market, as the main indicator of the selected stock market, is utilized for this purpose. For oil price, the price of crude oil from www.indexmundi.com from September 2010 to April 2018. For the gold price, data of gold bullion are collected from www.indexmundi.com from September 2010 to April 2018. For PSEi data, the monthly stock price index data used in this study is the daily closing prices of stock index of each market collected from online database https://finance.yahoo.com from January 2000 to May 2018.

Methodology

In order to examine the relationship between commodities like oil and gold to stock market volatility (PSEi), I employed the Exponential Generalized Autoregressive Conditional Heteroscedasticity (EGARCH) model. The model is applied in cases where data exhibit evidence on non-stationarity, where an initial differencing step (corresponding to the "integrated" part of the model) can be applied to remove the non-stationarity to ensure the results of estimation is not spurious. In doing so, I test for unit root for all variables employing the augmented Dickey-Fuller (ADF).

Augmented Dickey-Fuller (ADF) Test

The Augmented Dickey Fuller Test (ADF) is unit root test for stationarity. Unit roots can cause unpredictable results in your time series analysis. It is of the form (no intercept nor trend option):

$$\Delta y_t = (\rho - 1) y_{t-1} + \phi_1 \Delta y_{t-1} + \ldots + \phi_p \Delta y_{t-p} + \varepsilon_t$$

There is an increased probability that the null hypothesis of non-stationary will be accepted if I keep on adding deterministic components into the regression model.
This is to ensure whether I can use the time series stochastic models to examine the dynamic behavior of volatility of the returns. The ADF test statistics are presented in Table 1.

Autoregressive Conditional Heteroscedasticity (ARCH)

In the ARCH, the conditional variance of the error term u_t is modeled as being normally distributed with mean zero and variance σ_t^2, where the σ_t^2 is expressed as a function of past squared error values ut as stated in Eq. 2. In estimating an ARCH model, it is required that the unknown coefficients (α_0, α_1, $\alpha_2 \ldots \alpha_q$) are non-negative since the variance cannot be negative. If these coefficients are positive and the recent squared residuals are large, the ARCH model predicts that the current squared error will be large in magnitude in the sense that its variance σt2 is large (Stock and Watson, 2012).

Exponential Generalized Autoregressive Conditional Heteroscedasticity (EGARCH)

The EGARCH model of Nelson (1991) explicitly allows for asymmetries in the relationship between return and volatility. It can account for the leverage effect feature of the financial time series. The conditional variance equation of Nelson's EGARCH model is expressed as:
Where:

$$\ln(h_t) = \omega + \sum_{i=1}^{q} \alpha_i g(z_{t-i}) + \sum_{j=1}^{p} \gamma_j \ln(h_{t-j})$$

$$g(z_t) = \theta z_t + \gamma[|z_t| - E|z_t|]$$

$$z_t = \epsilon_t / \sqrt{h_t}$$

In this model, the conditional variance is transformed into logarithmic form as opposed to the conditional variance implying that the leverage effect is exponential rather than quadratic. The logarithmic transformation also avoids complication of artificially imposing parameter restriction required to ensure non-negative conditional variance. The existence of asymmetric impact requires $\gamma \neq 0$. γ is typically estimated to be less than zero so that for $\gamma<0$, negative shocks will have a larger impact on future volatility than positive shocks of the same magnitude. The process to be stable, it is still required that $|\beta|<1$.

4. Findings

Table 1 provides some descriptive statistics of all variables used. The skewness coefficients show that they are negatively skeId except for gold price. Meanwhile, the kurtosis coefficients show that commodity price index and crude oil have heavier tails than gold price and PSEi.

The commodity prices and stock market indices do not exhibit any deterministic trend and their fluctuations are around the origin line, indicating a stationary process. Yet, these graphical inferences are not sufficient and reliable enough to say about the stationarity level, thus a robust unit root tests such as ADF is required. Results of the ADF unit root tests are reported in Table 2. From Table 2, results from the ADF test show that the all variables exhibit stationarity integrated in the first difference. In other words, the estimated t-statistics are not significant for the price indices, indicating that the null hypothesis of ADF test cannot be accepted and the price series is nonstationary. HoIver the computed t-statistics of the return series are highly significant indicating that the return series are stationary. Therefore, due to the stationarity of the return series, these series will be used in the modeling.

The existence of volatility will be examined not only on the crude oil and gold bullion prices, but also on the composite index of Philippine Stock Exchange. For this purpose, ARCH (1) structure is applied for crude oil and gold bullion prices and consequently the EGARCH model will be used for PSEi not only in order to capture the existence of volatility clustering in such markets, but also to capture the asymmetric effect in each market. The result for ARCH (1) is presented in Table 3.

In ARCH (1) model, the autoregressive and moving average (ARMA) component are taken into account in the mean equation in order to overcome the problem of serial-correlation, since the inclusion of such components reduce chances of dependency of residuals, as shown in Table 5. With regards to the outcome of each ARMA-ARCH model, and especially due to the significance of squared form of residuals, it can be concluded that enough evidence on the existence of time-varying volatility clustering phenomenon in the crude oil and gold price time series. The results of the diagnostic tests, such as heteroscedasticity and serial-correlation are reported in Table 5. Therefore, up to this point it is proven that the oil and gold prices are experiencing the volatility clustering phenomena; hence I can proceed to examine the impact of these variables on the volatility of Philippine stock market. In doing so, first, I need to proof that PSEi are also experiencing the volatility clustering phenomena, second, to proof the existence of asymmetric effect in these markets and finally through a stepwise addition of both crude oil and gold prices, changes in the asymmetric effect coefficient could be observed. Such procedures are in line with Mohammad et.al, (2011) and Alok et.al, (2007) who suggest that any increase in the absolute value of such coefficient is interpreted as a rise in market volatility. For this purpose, exponential form of generalized autoregressive heteroscedasticity (EGARCH) is employed and the results are presented in Table 4. For the EGARCH, in order to check whether our developed models are statistically significant and reliable, I use Ljung-Box serial correlation and ARCH-heteroscedasticity on the residuals and the results show that the developed EGARCH model for PSEi are valid. With regard to the EGARCH model, the estimated coefficient represents the existence of asymmetric behavior in response of variable (or time series) under studied, shown by k in Equation (5). The negative and significant value of this coefficient indicates the existence of asymmetric effect in that market and therefore “bad news” will affect the market and make it more volatile than the “good news” of the same magnitude.

For the next step, crude oil price will be included to the EGARCH model and changes in the behavior of corresponding coefficient of asymmetric effect (k) will be observed. By doing so, not only the effect of oil price on the return of PSEi will be examined, but also the impact of oil price volatility on the volatility of PSEi can be detected. From the Table, it is shown that the impact of oil price on the mean equation of Philippine stock market index is positive and significant; indicating that any increase in the crude oil price will increase the return of PSEi. From the variance equation, C(4) is the impact of the spillover effect of crude oil price to PSEi which is 1%. Moreover, C(5) is the leverage effect which is also 1% and positive so bad news has less impact than a good news. Lastly, C(6) is the GARCH effect or the persistence of past volatility which is alos 1%. This finding shows that, for the case of Philippines, stock market can provide a good hedge against the oil market fluctuations.

Results of diagnostic tests of serial-correlation and heteroscedasticity confirm on the validation of the models. With regard to the inclusion of gold prices to the EGARCH model, the results are reported in Table 4. Some notable findings from Table 6 are, firstly, gold price is not significant in any of the mean equations which show that there is no strong and significant relationship between gold price and Philippine stock market. In other words, changes of the gold price could not affect the return of stock markets in Philippines during the period of this study. Secondly, in the variance equation, C(4) is the impact of the spillover effect of gold price to PSEi which is -0.576502. Moreover, C(5) is the leverage effect which is also -0.092674 and negative so bad news has more impact than a good news. Lastly, C(6) is the GARCH effect or the persistence of past volatility which is -0.258674. Therefore, it can be concluded that for the case of Philippines investment in the gold market cannot hedge the volatility of stock market. The results of the diagnostic tests on the residuals of EGARCH model with the inclusion of gold price reflect the validity of the developed model.

5. Conclusion

This study examines the influence of oil and gold price volatility on the volatility of the Philippine Stock markets. Applying ARCH and EGARCH model on monthly data stock returns, crude oil and gold prices from January 2000 to May 2018, the findings of this study partly supported previous studies on the importance of oil and gold price fluctuations on stock markets activities and provide evidence on the significant influence of oil price volatilities on Philippine stock market's volatility only. Thus, indicating that oil price innovations and especially its negative shocks intensified the fluctuations of Philippine stock markets and increased risk of investment in these markets. Regarding the impact of gold price fluctuations on the Philippine stock markets, I found evidence that the spillover effect cannot hedge the volatility of stock market. Findings of this study among others can benefit financial managers in the portfolio construction in the presence of oil and gold price fluctuations. This information can be helpful for formulating short term and long term investment strategies.

TABLE 1: Descriptive Statistic of all Commodity Market (Gold and Crude Oil) and Stock Market

	Commodity Price Index	Crude Oil	Gold	PSEi
Mean	184.7049	4389.723	64793.62	42.92163
Median	183.93	4434.68	65231.22	43.18
Maximum	210.37	5047.78	76380.41	44.93
Minimum	150.37	3351.08	53878.43	40.67
Std. Dev.	10.83812	366.8239	6537.54	1.157326
Skewness	-0.6	-0.72659	0.066796	-0.44317
Kurtosis	4.829261	3.537212	1.69512	2.416076
Jarque-Bera	8.575275	4.300632	3.082669	2.018413
Probability	(0.013737)	(0.116447)	(0.214095)	(0.364508)

TABLE 2: Results of the ADF Unit Root Tests

Variables	**ADF**	
	Intercept	Trend & Intercept
PSEi	-0.008917	-1.048016
Commodity Price Index	0.525607	-0.495577
Crude Oil	0.383129	-0.632160
Gold	-0.042902	-0.887169

TABLE 3: Oil and Gold Price Volatility Modeling

Variable	Mean Equation		Variance Equation	
	Constant	AR (1)	Constant	u_{t-1}^2
log(Crude Oil Price)	0.006751 (0.009173)	0.30777 (0.128395)	0.000642 (0.000649)	0.450584 (0.182070)

Variable	Mean Equation		Variance Equation	
	Constant	AR (5)	Constant	u_{t-1}^2
log(Gold Price)	0.004856 (0.004930)	0.309619 (0.098120)	0.001323 (0.000841)	-0.117834 (0.076104)

Note: Reported values in parentheses are standard error

TABLE 4: Results of EGARCH modeling on the Return of Commodity Prices and Stock Market Indices

	Mean Equation		Variance Equation			
	Constant	AR (1)	C(3)	C(4)	C(5)	C(6)
PSEi	-0.013113 (0.003299)	0.142774 (0.053490)	-0.531026 (0.601225)	0.176576 (0.150809)	-0.011649 (0.086561)	0.926540 (0.097618)
Crude oil	0.000099605 (0.009981)	0.005000 (0.094658)	-5.120064 (18.93648)	0.010000 (0.273462)	0.010000 (0.221086)	0.010000 (3.664798)
Gold	0.005431 (0.004860)	0.294133 (0.094428)	-8.305863 (2.989406)	-0.576502 (0.373500)	-0.092674 (0.230124)	-0.258674 (0.430763)

Note: Reported values in parentheses are standard error

TABLE 5: Results of Diagnostic Tests – Oil Price (ARIMA – ARCH Models)
Heteroskedasticity ARCH test on Oil-Price Equation

F-statistic	35314422	Prob. F(27,58)	0.0000
Obs*R-squared	85.99999	Prob. Chi-Square(27)	0.0000
Scaled explained SS	85404325	Prob. Chi-Square(27)	0.0000

Oil-Price Equation	Period	1	2	3	4	5	6	7	8	9	10
	AC	0.325	0.069	-0.104	-0.099	-0.014	0.027	0.069	-0.046	-0.034	0.057
	PAC	0.325	-0.040	-0.128	-0.027	0.040	0.011	0.044	-0.096	0.014	0.102
	Q-statistic	9.9077	10.363	11.404	12.364	12.384	12.456	12.933	13.149	13.266	13.609
	Prob	0.002	0.006	0.010	0.015	0.030	0.053	0.074	0.107	0.151	0.192

TABLE 6: Results of Diagnostic Tests –Gold Price (ARIMA – ARCH Models)
Heteroskedasticity ARCH test on Gold-Price Equation

F-statistic	13546.54	Prob. F(27,62)	0.0000
Obs*R-squared	89.98475	Prob. Chi-Square(27)	0.0000
Scaled explained SS	2360748.	Prob. Chi-Square(27)	0.0000

Gold-Price Equation	Period	1	2	3	4	5	6	7	8	9	10
	AC	0.128	-0.057	-0.088	-0.021	0.274	0.101	-0.007	-0.156	-0.028	-0.030
	PAC	0.128	-0.074	-0.072	-0.004	0.275	0.024	0.000	-0.125	0.033	-0.125
	Q-statistic	1.5386	1.8441	2.5872	2.6290	10.040	11.063	11.068	13.563	13.644	13.736
	Prob	0.215	0.398	0.460	0.622	0.074	0.086	0.136	0.094	0.136	0.185

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