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US stocks in the presence of oil price risk: Large cap vs. Small cap

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Abstract

This study queries the act of making generalization about the dynamics of returns and volatility spillovers between oil price and U.S. stocks by merely considering only large cap stocks. It argues that this kind of generalization may be misleading, as the reactions of large cap, mid cap and small cap stocks to change in oil prices are not expected to be uniform. Our findings show that it is correct to make generalization about oil-U.S. stock relationship with large cap stocks when analysing returns spillovers, but the generalization is incorrect when considering stock caps returns volatility spillovers, particularly under falling and relatively stable oil prices.

Keywords: Market capitalization, U.S. stocks, oil price dynamics

JEL Classification: G11, Q43

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1. Introduction

The role of developed financial markets in picking winner from losers by re-allocating investment capital from “declining “ to “growth” industries is show by Wurgler (2000). It the sorting mechanism which ultimately classifies the market into large, mid and small cap gradations for U.S. firms. The relationship between global oil price and U.S. stock prices has been widely investigated. Many studies have documented this relationship in terms of correlation and shocks, returns and volatility spillovers (see for example, Kilian and Park, 2009; Mollick and Assefa, 2013; Salisu and Oloko, 2015; Alsalman, 2016). However, most of these studies examine this relationship with large cap stock, usually S&P 500, but make generalization about U.S. stocks. The purpose of this study is to document that this kind of generalization may be misleading, as the reaction of large cap and small cap stocks to oil price variations are expected to be different.

Particularly, ignoring the fact that the reaction of large cap and small cap stocks to oil price shocks may vary makes researchers to state inadvertently, that investors in large cap stocks are faced with similar incidence as investors in small caps in the face of oil price shock. But this conclusion may be misleading! Switzer (2010) examined the relative performance of U.S. and Canada small cap and large cap stocks in the face of economic shocks precisely, under recession and recovery. His study shows that small-cap firms outperform large caps in the year subsequent to an economic trough but tend to lag in the year prior to the business cycle peak. This indicates that the reaction of small cap and large cap to external shocks may be different. Banz (1980) and Dias (2013) are two studies which come close to in linking risk-adjusted returns and value-at-risk differentials to size of market cap respectively. However, our work differs from both studies in contextual focus by delineating the effect of oil price risk on a triumvirate of

three major US stocks cap, and methodological leanings towards multivariate-GARCH approach.

In this study, we propose to demonstrate that the impact of oil price shocks on different U.S. stock caps varies by examining the effect of oil price shock on large cap, mid cap and small cap stocks. Large cap stocks are owned by big, notable companies with high credibility; hence, these stocks are less risky compared to small cap stocks which are highly volatile. From experience, U.S. stock market analysts gathered that small caps earn higher return than large cap in the period of tranquility and large caps earn higher return in the crises period.

We propose to adopt VARMA-CCC-AGARCH developed by McAleer et al. (2009) to examine the nature of returns and volatility spillovers from oil to stock market. This will enable us to appreciate and compare the magnitude and significance of the effect of oil price shocks on the volatility of different stock caps. More so, since the reaction of different stock caps to oil price shock may be different when oil price shock caused rising oil price and falling oil price, as against the period of tranquility, we also examine the reaction of different stock caps under the periods of rising, stable and falling oil price. In addition, we examine the implication of variation in the reaction of different stock cap levels to oil price shock, for optimal portfolio management of oil-U.S. stock portfolio.

The remainder of this study will be organized as follows. Section 2 shall describe the data and present preliminary analyses. Section 3 shall discuss the model Section 4 shall present the results and its analysis. Section 5 will conclude the paper.

2.0 Data and Preliminary analysis

The data used in this study are daily data for oil price and for different caps (Large, Mid, and Small) of United States stocks between October, 2002 and March, 2017. Oil price is proxied by WTI benchmark, while S&P 500, S&P 600, and S&P 400 are used to represent large cap, small cap and mid cap stocks, respectively. The data are sourced

from Thompson Reuters. The return series (r_t) for oil and different stock caps are computed as the percentage of first difference of the logarithm of their respective prices; (p_t) that is, $r_t = 100 * [\Delta \log(P_t)]$.

Figure 1 shows the trend relationship between oil price and U.S. stock caps (Large, Mid and Small). The relationship between the two markets is categorized under four sub-periods based on the dynamics of oil price during the period under consideration. The first period between October 30, 2002 and July 3, 2008 is a period of rising oil price occasioned by booming demand and stagnant production (Economou, 2016). The second period from July 4, 2008 to December 30, 2010 is classified as the period of global financial crisis. The 2007 – 2008 global financial crisis originates from financial market and spills over to oil market. Hence, positive oil price – U.S. stocks relationship observed during this period may be largely attributed stock market shock rather than oil price shock.

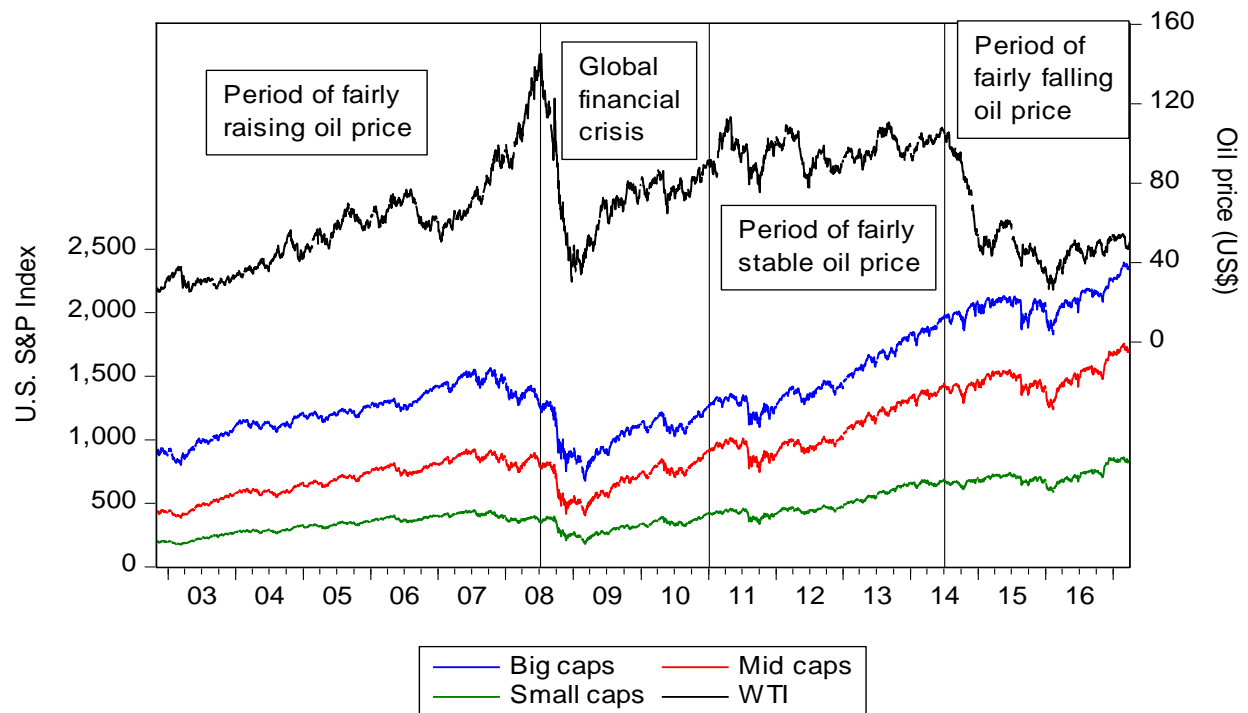


Figure 1: Trend relationship between oil price and U.S. stock caps (Large, Mid and Small)

Furthermore, the third period from December 31, 2010 to June 30, 2014 represents the period of relatively stable oil price. No significant oil price shock was observed during this period and oil price stabilizes at \$96.42 per barrel. The last period from July 1, 2014 to March 30, 2017 is classified as the period of relatively falling oil price. This is the most recent oil price shock, and it has been attributed to combined effect of unprecedented positive shocks to actual and expected non-OPEC oil production and unexpectedly weak growth of global petroleum demand (Baumeister & Kilian, 2016). Meanwhile, empirical analysis will be required to distinguish the reaction of U.S. stock caps (Big, Mid and Small) to oil price shock under the periods of fairly raising, stable and falling oil prices.

Meanwhile, we conduct descriptive statistics, residual tests, asymmetric test and correlation test as part of our preliminary tests. The striking results include evidence of fat tailedness, autocorrelation and conditional volatility displayed by all the series. Asymmetric test by Engel and Ng (1993) also suggests the significance of asymmetric information in each of the market, and also Engle-Sheppard (2001) conditional correlation test reveals that the null of constant conditional correlation cannot be rejected¹. To remedy the statistical problems and account for asymmetries and constant conditional correlation, VARMA - CCC- AGARCH by McAleer et al. (2009) was adopted.

3.0 The Model

This study will adopt VARMA - CCC- AGARCH by McAleer et al. (2009) as conditioned by our preliminary analysis. This model extends VARMA - CCC- GARCH by Ling and McAleer (2003) to capture the effect of asymmetric information in the conditional variance equation. The structural and statistical properties, including the necessary and sufficient condition for stationarity and ergodicity of VARMA-CCC-

¹ Detailed result of the preliminary analyses is available on demand from the authors.

GARCH and VARMA-CCC-AGARCH are detailed in Ling and McAleer (2003) and McAleer et al. (2009) respectively.

As multivariate GARCH models usually consist of conditional mean and conditional variance equations, the conditional mean equation for the VARMA - CCC- AGARCH being considered in this study can be defined as below:

$$\begin{aligned} r_{1,t} &= \mu_1 + \phi_1 r_{1,t-1} + \theta_1 r_{2,t-1} + \varepsilon_{1,t} \\ r_{2,t} &= \mu_2 + \phi_2 r_{2,t-1} + \theta_2 r_{1,t-1} + \varepsilon_{2,t} \end{aligned} \quad (1)$$

where $r_{1,t}$ and $r_{2,t}$ represent stock caps returns (large, mid and small caps) and oil returns, respectively; μ is the constant term; the effect of own return spillover in the model is measured by ϕ , and the effect of cross market return spillover is measure by θ .

On the other hand, the conditional variance equation can be expressed as:

$$\begin{aligned} h_{1t} &= c_1 + \alpha_{11}\varepsilon_{1t-1}^2 + \alpha_{12}\varepsilon_{2t-1}^2 + \gamma_1\varepsilon_{1t-1}^2 I_{1,t-1} + \beta_{11}h_{1t-1} + \beta_{12}h_{2t-1} \\ h_{2t} &= c_2 + \alpha_{21}\varepsilon_{1t-1}^2 + \alpha_{22}\varepsilon_{2t-1}^2 + \gamma_2\varepsilon_{2t-1}^2 I_{2,t-1} + \beta_{21}h_{1t-1} + \beta_{22}h_{2t-1} \end{aligned} \quad (2)$$

where h_{1t} and h_{2t} represent the conditional variance for stock caps returns and oil returns, respectively; and ε_1^2 and ε_2^2 are the respective shocks from stock caps and oil returns. Evidently, the significance of the coefficient of oil shock (ε_2^2) in the equation for stock caps volatility (h_{1t}) is important to achieving the objective of this study. The conditional covariance between the stock caps and oil returns can be expressed as; $h_{12t} = \rho_{12} \times \sqrt{h_{1t}} \times \sqrt{h_{2t}}$ where ρ_{12} is the coefficient of constant conditional correlation.

More so, the main difference between the model specifications of CCC-GARCH and CCC-AGARCH is the inclusion of the Glosten, Jagannathan and Runkle (1993) (GJR hereafter) asymmetric effect in the latter. Hence, the effect of asymmetric information in each market on the volatility of the market is measured by the coefficient of the multiplicative market shocks and GJR effect $I_{i,t}$. Notice that, $I_{i,t} = 1$ if $\varepsilon_{i,t-1} < 0$ and $I_{i,t} = 0$ otherwise [where $i = 1, 2$]. If the γ_i is positive and statistically significant, it

implies that negative shocks increase the volatility of series i by more than positive shocks of the same magnitude.

4. Results and Empirical analyses

Table 2 presents the empirical result for the analysis. It consists of mean equation, variance equation, and model diagnostics. The mean equation analyses the effect of own and cross market return spillovers on the market returns, while variance equation analyses the effect of lagged own and cross market shocks and lagged own and cross market conditional variance on the conditional volatility of the market. Also, as we proposed that oil price shocks do not necessarily have uniform effect on different U.S. stock caps, we attempt to examine the variation in the reaction of the different stock caps to oil price shocks. Meanwhile, since oil price shocks generate sudden rise or sudden fall in oil prices, we examine the reaction of different stock caps to oil price shocks during the episodes of relatively rising and falling oil price, in addition to the full sample period and the period of relatively stable oil price. Model residual diagnostics in Table 2 shows that autocorrelation and ARCH effect are adequately captured.

From the mean equation result, we found that there is insignificant return spillover from oil price to U.S. stocks, as indicated by insignificant coefficient of θ_1 . This suggests that a rise or fall in oil asset returns do not have any significant impact on U.S. stocks returns. This result holds for large, mid and small stock caps, and under full sample, rising oil price, stable oil price and falling oil price periods. Hence, we may confirm that variation in oil price and oil asset returns do not have a significant effect on U.S. stocks, irrespective of whether it is large cap, mid cap or small cap. This implies that it is correct to make generalization about oil-U.S. stock relationship with large cap stocks when analysing return spillovers.

Furthermore, from the variance equation, the result reveals that the effect of oil price shock on U.S. stock is insignificant under the full sample period. This is indicated by insignificant coefficients of α_{12} . This implies that oil price shock do not have significant impact of the conditional volatility of U.S. stocks, regardless of whether we are considering large cap, mid cap or small cap. This conclusion is however refuted for large and mid caps during the period of relatively stable oil price, and for small caps during the period of relatively falling oil price. Specifically, contrary to the general conclusion that oil price shocks contribute insignificantly to U.S. stocks volatility, oil price shock is found to have negative significant effect on the volatility of large cap and mid cap stocks when oil price is fairly stable, and has positive significant effect on the volatility of small cap stocks when oil price is fairly falling.

Evidently, our results reveal that though variation in oil asset returns do not have significant impact on U.S. stocks return (regardless of the level of stock caps), oil price shocks may not affect different level of stock caps uniformly, depending on strength and direction of the oil price shock. When oil price shock is strongly positive that it caused oil prices to increase, this may occur due to negative supply shock or positive demand shock, all categories of U.S. stock caps do not respond significantly. This is explained by insignificant coefficients of α_{12} under the period of relatively rising oil price. However, when oil price shock is strongly negative and caused oil prices to fall, large cap and mid cap do not react significantly, but the volatility of small cap stocks increases. This may be explained by the positive significant coefficient of α_{12} for small cap stocks under the period of falling oil price. This indicates that oil price shock that lead to falling oil price causes the volatility in small cap stocks to increase while having insignificant impact on the volatility in large cap and mid cap stocks. However, when oil price shock is weak and caused very mild variation in oil prices, there is significant reduction in the volatility of large cap and mid cap stocks, but insignificant impact on small caps stocks. This may be explained by the negative significant coefficient of α_{12}

for large cap and mid cap stocks during the period of relatively stable oil price. This indicates that in the period of relative oil price tranquillity, when oil price shock is very weak, volatility in large cap and mid cap stocks reduces but the volatility in small cap stock is insignificantly affected.

Summarily, our results suggest that small cap stocks are the most volatile of the three categories of stock caps; its volatility increases swiftly when oil price shock leads to falling oil price and do not reduce significantly even in the period of relative oil price tranquillity, when the volatility in large cap and mid cap stocks will reduce significantly.

Table 1: Estimation results for VARMA-CCC-AGARCH model

	Full sample			Rising oil price			Stable oil price			Falling oil price		
	Large cap	Mid cap	Small cap	Large cap	Mid cap	Small cap	Large cap	Mid cap	Small cap	Large cap	Mid cap	Small cap
Mean equation												
μ_1	0.025**	0.030**	0.031*	0.034	0.048**	0.048	0.022	0.013	0.014**	0.030	0.017	0.015
ϕ_1	-0.060***	-0.001	-0.033*	-0.074**	0.027	0.002	0.033	0.025	-0.059*	-0.107**	-0.053	-0.073*
θ_1	-0.002	-0.006	-0.007	0.0006	-0.004	-0.012	0.002	0.014	-0.012	-0.002	0.003	0.017
μ_2	0.002	0.003	0.006	0.098	0.106*	0.099	-0.010	-0.017	-0.003	-0.140	-0.145*	-0.147
ϕ_2	-0.052***	-0.057***	-0.052***	-0.086**	-0.092***	-0.094***	-0.032	-0.015	-0.029	-0.072*	-0.072*	-0.061
θ_2	0.091***	0.092***	0.064***	0.096	0.109	0.093	0.038	0.026	-0.008	-0.063	-0.016	-0.037
Variance equation												
c_1	0.019***	0.025***	0.024***	0.003	0.009***	0.030	0.009	0.025***	0.004***	0.019	0.088**	0.148***
c_2	0.012	0.013	0.015*	0.392*	0.496*	0.587**	0.006	0.004	0.164***	0.592*	0.173	-0.269
α_{11}	-0.020***	-0.003	-0.001	0.0006	-0.013	-0.035***	-0.061***	-0.045**	-0.055***	0.0001	0.041	0.058*
α_{12}	-0.004	-0.003	-0.003	0.004	-0.004	-0.010	-0.032***	-0.031***	-0.0004	-0.007	0.017	0.036**
α_{21}	-0.055***	-0.049***	-0.044***	-0.169**	-0.166***	-0.102*	-0.025**	-0.028**	-0.145***	-0.045	-0.085	-0.124
α_{22}	0.011*	0.014**	0.013**	0.012	0.027	0.025	-0.0008	0.002	0.071***	0.085**	0.086	0.079**
β_{11}	0.894***	0.906***	0.925***	0.926***	0.937***	0.926***	0.788***	0.835***	1.000***	0.559***	0.533***	0.658***
β_{12}	0.029**	0.021*	0.022	-0.159	-86.42***	-90.156*	0.208***	0.160**	0.005***	0.261	0.245**	0.119
β_{21}	0.187**	0.133***	0.124***	-1.970	73.726	79.848	0.062	0.113**	1.601***	1.537	2.665***	3.322
β_{22}	0.946***	0.946***	0.945***	0.829***	0.851***	0.828***	0.959***	0.941***	0.334***	0.676***	0.603***	0.599***
γ_1	0.182***	0.129***	0.102***	0.077***	0.074***	0.103***	0.302***	0.224***	0.097***	0.367***	0.145***	0.059

γ_2	0.060***	0.060***	0.061***	0.049	0.041	0.059	0.058***	0.063***	0.188***	0.056	0.042	0.042
ρ_{21}	0.222***	0.243***	0.216***	-0.068**	-0.0001***	-0.0001	0.395***	0.394***	0.392***	0.294***	0.314***	0.283***
Model Diagnostics												
AIC	6.922	7.220	7.501	6.653	6.963	7.281	5.953	6.364	6.611	6.930	7.226	7.532
SBC	6.955	7.252	7.533	6.735	7.045	7.363	6.057	6.467	6.714	7.054	7.350	7.657
Log-L	-12541.2	-13081.4	-13591.5	-3889.4	-4071.9	-4258.7	-2591.5	-2771.5	-2879.7	-2375.2	-2477.4	-2583.4

Source: Computed by the authors

Note: Asterisks, *, ** and *** indicates significance at 10%, 5% and 1% levels respectively.

Table 2: Residual Diagnostics for Independent Series

Statistics	Oil price- Large caps		Oil price- Mid caps		Oil price- small caps		Oil price- Large caps		Oil price- Mid caps		Oil price- Small caps	
	Full sample						Rising oil price					
	Large caps	WTI	Mid caps	WTI	Small caps	WTI	Large caps	WTI	Mid caps	WTI	Small caps	WTI
Ljung-Box (5)	7.890	2.282	7.878	2.302	6.631	2.048	5.237	1.471	5.142	1.306	5.241	1.635
Ljung-Box (10)	13.151	4.361	13.261	4.377	11.153	3.979	11.653	5.337	16.595*	6.018	17.382*	6.519
McLeod-Li (5)	7.380	17.327***	5.040	15.784***	7.850	15.325***	5.749	1.942	6.631	1.983	5.522	2.111
McLeod-Li (10)	13.924	20.013**	13.818	18.184*	16.307*	17.627*	8.178	2.820	10.618	3.052	14.760	3.070
	Stable oil price						Falling oil price					
Ljung-Box (5)	8.569	2.264	12.611**	1.875	10.014*	1.546	4.468	1.996	6.244	1.991	5.389	1.887
Ljung-Box (10)	12.103	2.861	19.316*	2.592	13.983	2.963	9.256	6.801	11.863	6.598	9.686	5.943
McLeod-Li (5)	5.012	9.290*	5.550	8.353	17.028***	4.615	2.318	1.438	1.070	1.365	0.654	1.089
McLeod-Li (10)	10.034	10.647	14.367	9.749	27.882***	5.539	6.441	9.090	6.488	7.643	5.118	4.554

6. Conclusion

This study queries the act of making generalization about the dynamics of returns and volatility spillovers between oil price and U.S. stocks by merely considering only large cap stocks. It argues that this kind of generalization may be misleading, as the reactions of large cap, mid cap and small cap stocks to change in oil prices are not expected to be uniform. We employ VARMA-CCC-AGARCH model to account asymmetries and constant conditional correlation, in addition to dealing with autocorrelation and ARCH effect residual problems. Our findings show that it is correct to make generalization about oil-U.S. stock relationship with large cap stocks when analysing returns spillovers, as the result of return spillovers from oil price to U.S. stocks holds for large, mid and small stock caps, and under full sample, rising oil price, stable oil price and falling oil price periods. However, the results show that the generalization is incorrect when considering stock caps returns volatility spillovers, particularly under falling and relatively stable oil price. This is evident as the result shows that volatility of small cap stocks increases swiftly when oil price shock leads to falling oil price and do not reduce significantly even in the period of relative oil price tranquillity, when the volatility in large cap and mid cap stocks will reduce significantly.

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