Application of Open Web API: The Impact of Crude Oil Stocks Change Announcements on Crude Oil Price Volatility

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***Abstract* - This interdisciplinary study focuses on the impact of financial news announcements on crude oil price volatility. The information released by free Open web API Services is increasing rapidly. So far the correlation between oil price and news announcements was described based on daily crude oil closing prices. Localizing the exact starting point of increasing volatility requires intraday price changes. We propose an interdisciplinary IT-method to extract intraday crude oil price data from Open web API Services to capture the exact effect of the US inventory announcements at the time of news arrival. Intraday data in 30minutes intervals were applied. We found that volatility decreases before the arrival of the announcement and increases afterwards. For capturing the effect of unexpected amount of change in inventory, the difference between real and expected amount of change was introduced in the model and is statistically significant.**

***Index Terms* - Open Web API, Web Data Extraction, Energy Economy, Volatility prediction , Crude Oil Price**

I. INTRODUCTION

Global Economy is closely tied to energy. Fossil energy still turns out to be the worldwide most wanted energy source. Price discovery of oil, like many other commodities, has been on the focus of studies in the area of financial market. Crude oil prices react to a variety of factors ranging from oil market fundamentals, economic condition and geopolitical issues [1]. Price elasticity of oil is very small [2,3] and this leads to very high changes and volatility in oil price. Frequently released economic news and announcements are supposed to have an impact on the short term crude oil price volatility. Researchers have tried to investigate the effect of news announcements on the price of different commodities in the financial markets. One of the major issues which may affect the results is time frequency of data. This is an important issue, because different news is announced in a single day and the whole effects of them determine the daily price. Most of the research groups used daily and weekly data, because they can be obtained easily and are available free of charge. Investigating the effect of specific news on price volatility demands intra-daily frequency data. Sometimes several news are announced at the same time. This makes it difficult to assess the effect of individual news.

The bigger part of the studies on volatility in financial markets have focused on economic news. The US crude oil inventory is announced usually on every Wednesday afternoon at 14:30 GMT –01:00 (Greenwich Mean Time). The crude oil inventory is one of the largest inventories in the world based on EIA (U.S. Energy Information Administration) data and is the only crude oil inventory which is released on a weekly basis. The changes in the inventory are an important element in global oil market as it demonstrates the balance of supply and demand in the US market as the biggest oil consumer worldwide [4]. This news is the most directly related news announcement to the oil market. Bu [5] studied the effect of US inventory changes on oil price using daily data. She found that inventory shocks have no effect on daily conditional variance but negatively impact return.

Hence, the role of essential macroeconomic indicators became very helpful in market analysis. Due to numerous indicators crude oil prices are highly volatile. Thus, there is a big interest for analysts and also for commodity producing and exporting countries to make them more predictable. According to this, the development of applicable volatility models is crucial [6]. This requires the identification and examination of those macroeconomic indicators representing an impact on crude oil prices. Among the most important we find the Gross National Product (GNP), unemployment rates, stock-prices, stock indices and the Crude Oil Stock change, etc. They are frequently announced and released by several governments and organizations, e.g. the EIA which shows a vivid example for Open Government Data (OGD).

Literature Review

Financial markets are characterized with high levels of volatility as they are very liquid and many players are involved, which range from financial institutes, hedgers and companies to personal investors. Financial risk management tools are significantly depending on future volatility.

Numerous studies have tried to explain the dynamic of volatility in different markets. They have been able to explain the dynamic of the markets to some extent, but the results show conflict behaviors. Others have tried to explain the behavior of volatility by investigating the impact of news announcements. Based on the market efficiency hypothesis, any released information must be immediately incorporated in prices and oil price is not an exception and macroeconomic announcements must directly impact oil prices [7].

Previous research shows that volatility follows an intraday and intraweek pattern. The question is how much of this volatility is related to news announcements. Ederington and Lee believe that announcements can explain this phenomena [8]. Some studies argue that news result in increase of volatility, e.g. DeGennaro and Shrieves studied announcements of US and Japanese news on their relating exchange rate [9], Eddelbüttel and McCurdy investigated the impact of news density at any given hour [10], Melvin and Yin measured the number of news stories for Germany and found a strong relationship between news and volatility [11]. In contrast, it has been argued that announcements could reduce volatility. DeGennaro and Shrieves show that unscheduled announcements result in decreased volatility for 20 minutes [9]. In another study Bomfim found that daily U.S. equity volatility is very sensitive to unexpected U.S. monetary policy announcements and increases significantly [12]. A further study [13] showed, that U.K. equity market volatility decreases at the time of macroeconomic announcements.

Another important issue is finding news which impact volatility significantly. Kim and Verrecchia found that the surprise factor in economic data impact the behavior of traders [14]. Flannery and Protopapadakis found that only CPI and PPI cause significant changes on the S&P 500 from 1988 to 1992 [15].

Market reaction to news also depends on the economic condition and the level of uncertainty in the market. Fleming and Remolona argue that markets react stronger to news when a high degree of uncertainty exists in the market [16]. Hess et al. confirm positive adjustments of commodity futures due to the news of higher inflation and real activity during recessions and in contrast, no reactions during economic expansions [17].

Volatility in one market can be caused by spillover of volatility in another market. In this case news indirectly impacts other markets. Some studies have focused on this issue such as Roache and Rossi which conduct that in commodity market [18].Some studies are conducted for the stock market such as Hsin [19] and also Harju and Hussain [20].

While numerous studies have been carried out in financial markets, there has been little focus on commodity market particularly on crude oil. The studies conducted by Kilian and Vega [21], Chatrath et al. [22], and Belgacem et al. [23] have focused on the impact of news announcement on crude oil price. The latter study states that the results of the researches differ from each other based on data frequency (daily, weekly, and monthly) and business cycle.

II.HYPOTHESIS AND METHODOLOGY

Our approach proposes an interdisciplinary IT-method which is supposed to be a helpful tool to capture the exact effect of the US inventory announcement at the time of news arrival and is based on the extraction of intraday crude oil price data from public Open web API (Application Programming Interface) Services in 30min intervals.

The exact point in time of several economic events is supposed to be in close connection with crude oil price volatility. Price data sets and their quality play an important role in prediction analysis. Most of the time-series data sets of crude oil volatility research are available in a daily frequency or per hour. However, these frequencies are not sufficient for uncovering the effects of the exact point in time of the news announcement on the price return volatility.

Data Retrieval

In our approach a framework uses web API which provides the possibility to get Open web API financial data, e.g. crude oil future prices.

The open data providers Google and Yahoo! Finance give limited access to their historical public price data sets. This means they allow only a limited amount of data sets per hour/IP-address to be extracted. This limitation refers to the amount of requests per time unit, representing a varying number among different providers. However, a completely automatic data processing requires unlimited access to released open data. Thus, we have decided to choose a semi-automatic data processing procedure as follows:

Data were extracted and stored with computer no. 1 until the maximum number of requests allowed were performed. Yet the limit was finished for computer no. 1, computer no. 2 started to extract data – if possible up to 24 hours. Depending on the data provider limitations, even more than two computers can be applied, if necessary.

In our approach we extracted time series of open financial data from the web API provider Yahoo! Finance which were automatically requested and stored in a database in 30minutes intervals. Yahoo! Finance developed the query language YQL (Yahoo! Query Language) to facilitate data selection and retrieval from APIs via a web console and enables the manipulation and combination of different data sets. After these modifications the resulting XML or JSON data sets can finally be a subject to other computer languages.

Data Analysis

As described above we developed a methodology to obtain intraday data in 30 minutes intervals. This helped us to analyze the oil price at the exact time of the news announcement. A lot of news in different areas disseminate and influence markets. Oil price is expected to respond to all of the relating news and the closed price is then under effect of a combination of that news. Using daily data, however, may not accurately reveal useful information about the impact of specific news such as inventory changes on price. Intraday data bring the advantages to analyze the price at the time of news arrival. Our approach was performed on a set of 30 minutes interval data for WTI crude oil during the period of Dec 1, 2014 to Oct 12, 2015. First we used augmented Dickey-Fuller to test for the existence of unit root in the price series. The test indicates that the series is not stationary at level but stationary at first difference.

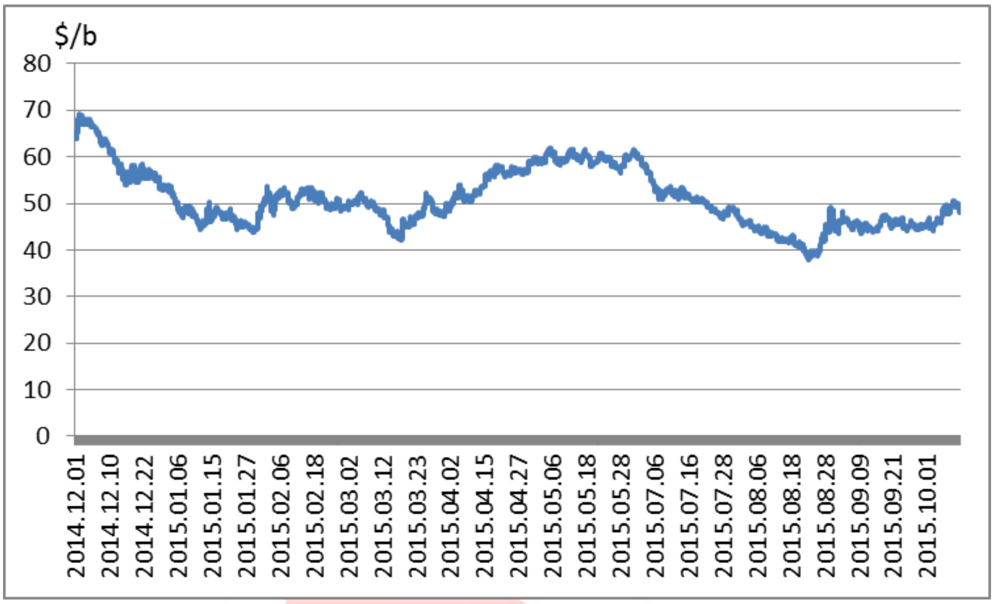


Figure 1: Trend of WTI crude oil price; x= time, period from Dec 1, 2014 to Oct 12, 2015; y= Crude Oil price in US-Dollar per barrel;

Since the price of derivatives follows a random walk process, we derived the return series (R) from oil price. This series is then used to estimate oil price volatility in the market. Return series is normally distributed with a specific mean usually around zero. Augmented Dickey-Fuller test shows that the series is not suffering from unit root and is stationary at level.

R = log (WTI) - log (WTI(-1))
R: return
WTI: West Texas Intermediate crude oil

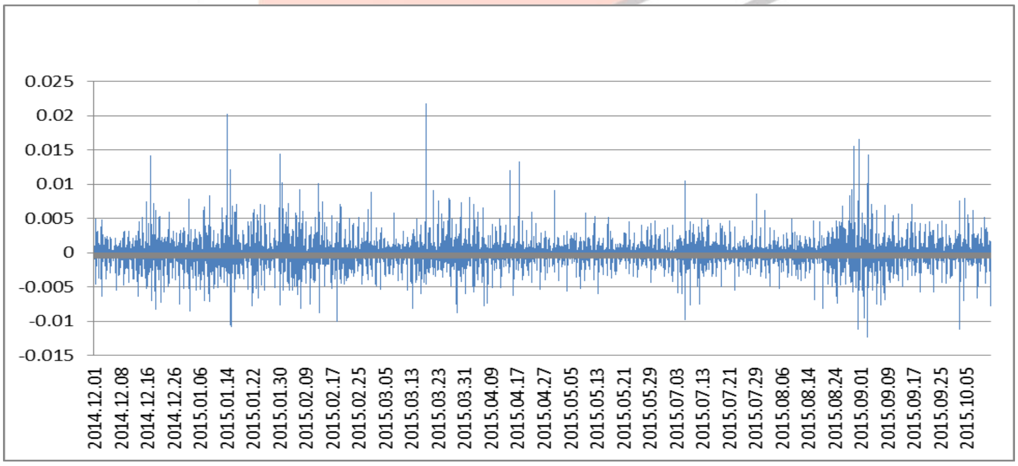


Figure 2: Trend of return (R) on crude oil price. Shows the pattern of return series with a mean around zero.

This series is tested for existence of unit root by augmented Dickey-Fuller and the null hypothesis was rejected. Return series of oil price is used to estimate volatility in the price. For this purpose first the return is regressed on a constant using an ordinary least square. Then the residuals are tested for existence of serial correlation and heteroscedasticity. For this purpose the residual is regressed on its lagged values for serial correlation and squared residuals is also regressed on its lagged values to test for heteroscedasticity. There are different approaches to calculate or estimate volatility in market. As most of the studies have used the GARCH model we also used Bollerslev's Generalized Autoregressive Conditional Heteroscedasticity [GARCH (p,q)] specification (1986):

$$R = \text{constant} + \epsilon_t$$

$$\delta_t^2 = \propto + \sum_{j=1}^{k} \alpha_j \epsilon_{t-j}^2 + \sum_{j=1}^{p} \beta_j \delta_{t-j}^2 + \mu$$

δ^2 is the variance of ϵ

In the formula the current variance is a function of lagged squared residuals and variance.

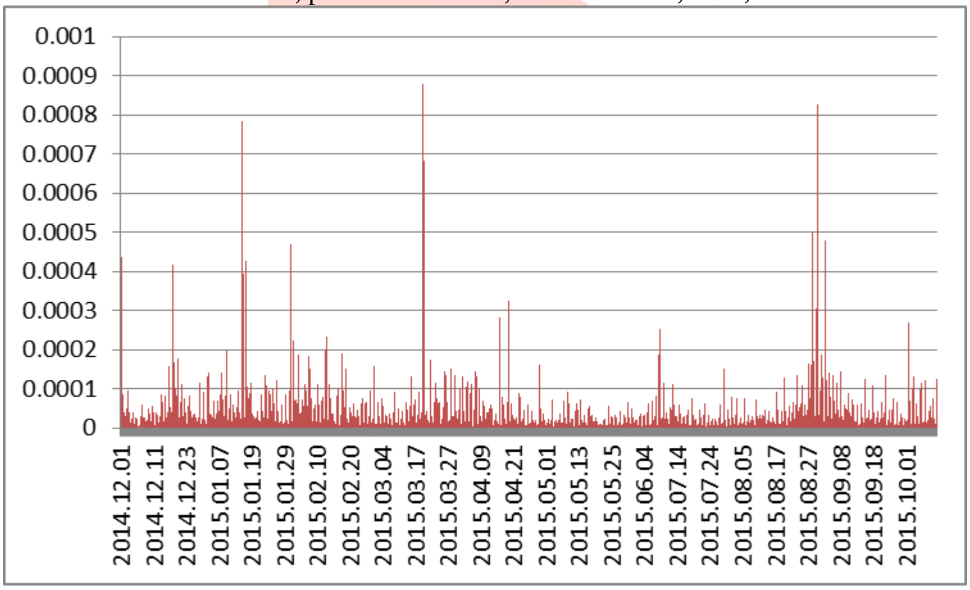
The US crude oil inventory is the only oil market fundamental factor which has the lowest periodical of weekly announcement. The main fundamental factors of oil market are demand and supply which are published on a monthly basis from different sources. The major advantages of inventory factor are that it contains information about surplus or shortage of oil in the market. In other words it balances the oil market by absorbing extra oil or meeting extra demand especially in short term. The information about changes in oil inventory is usually released on Wednesday by the US energy information administration (EIA) at 14:30 GMT (-01:00). Expectation about the volume of change is published on Tuesdays by Reuters. However, the market participants expect to see a change in inventory around the expected amount. A significant difference between the expected and the real change can be considered as a shock in the market. This means that there is an unbalance somewhere in the oil market and thus the price has reacted to this situation. This can be a source of a high degree of volatility which needs careful investigation.

III.EMPIRICAL RESULTS

We used return series for deriving volatility series. For this purpose first return series is regressed on a constant and the residuals are tested to check for serial correlation. The result could not reject the existence of serial correlation. The search for eliminating the serial correlation in return series resulted in using the form of ARMA (4,4). In the next step the residual is tested for the effect of Arch using LM test which was not rejected. A GARCH (1,1) model appeared to be a proper form for removing Arch effect in residuals (model 1 in table 1). Finally model 1 is used to estimate volatility of the oil price.

The estimated volatility is depicted in figure 3. As it can be seen most of the volatility values are around zero and lie under 0.0001. Some spikes in volatility are obvious in the pattern. These spikes most likely are related to unexpected news about economic, geopolitics issues and oil market condition which need more detailed analysis.

Figure 3: Estimated Crude Oil Volatility
x=time, period from Dec 1, 2014 to Oct 12, 2015,



As mentioned, one of the major news announcements related to the oil market is the US crude oil inventory change, which usually is announced on every Wednesday. Reaction of the market to this news can be different based on the amount and expected values. In general it is expected that announcement, regardless of its content, results in changes in volatility and unexpected amount creates more volatility in the market. For better graphical illustration of volatility, several trends on Wednesday are depicted in figure 4. Obviously, volatility starts at time near 14:30 GMT (-01:00) but with different size. The volatility decreased very rapidly after this time. Bu [5] found that the effect of inventory shocks weakens in rapid growth periods and disappears in steep fall market. In figure 5 extreme degrees of volatility are illustrated for three days in which inventory change is announced. It is obvious that the market has shown a different reaction to the news around the announcement time. The other issue is that the shock in volatility can sustain in the market based on the conditions in the market and the arrival of novel news.

Figure 4: Crude Oil Price Volatility in Sample Days;
x=time, 24 hour period, y=volatility

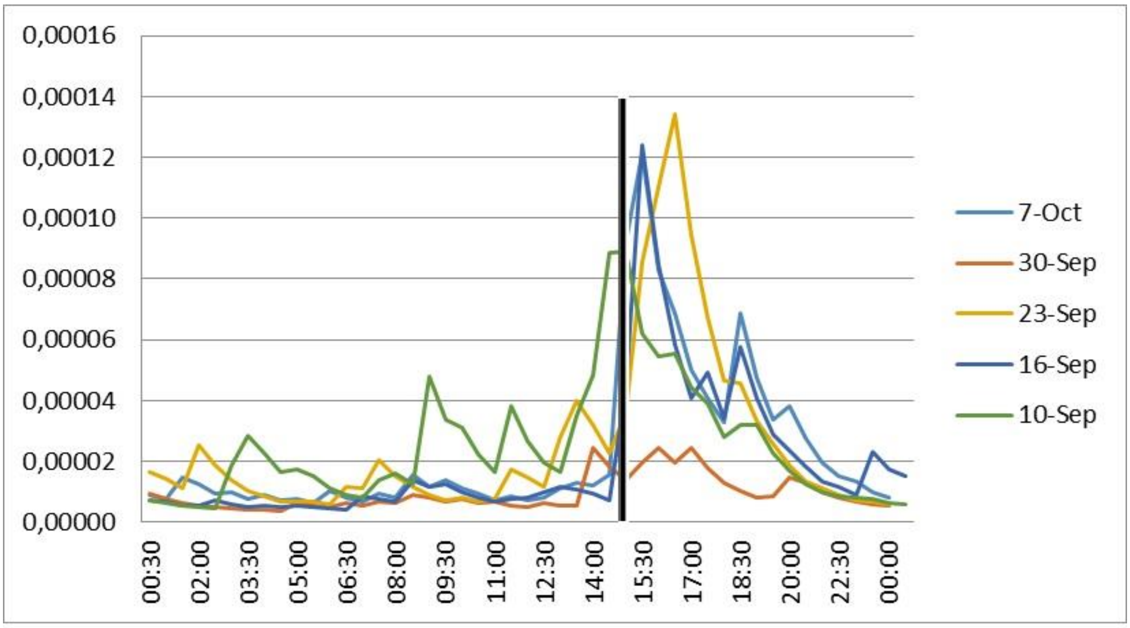
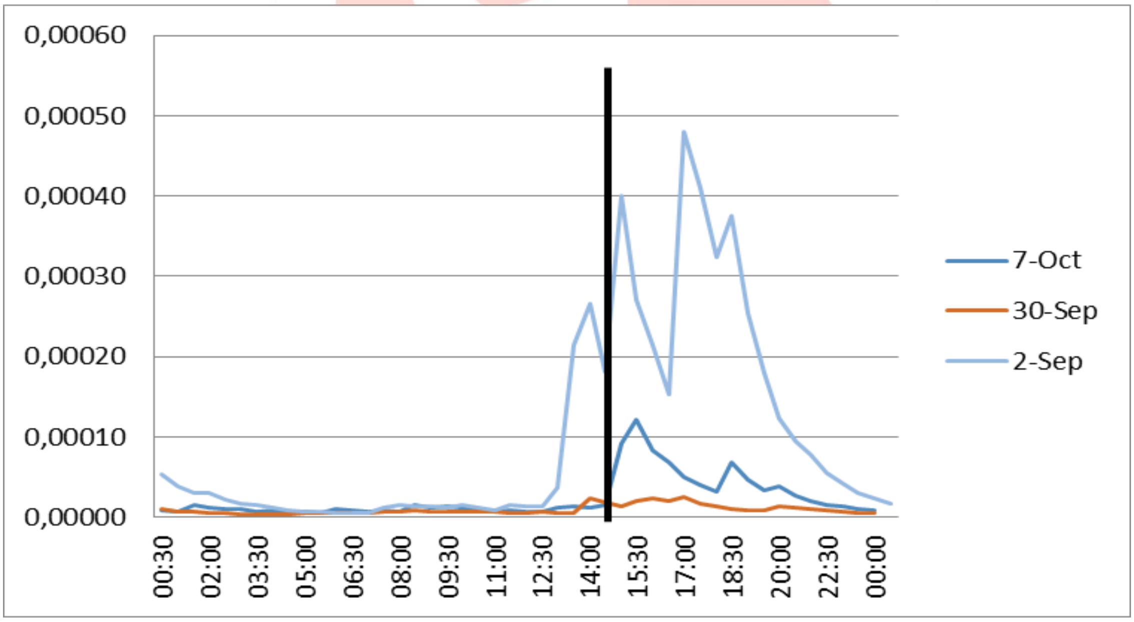


Figure 5: Extreme Crude Oil Price Volatility; x= time, overlapping 24-hour-periods during three different days of news announcement release; y=volatility



In order to capture the common spikes in volatility a dummy variable is introduced into the model which takes value 1 in the time of announcement and zero otherwise. We also used lag values of dummy variable in the model to capture the survival of the effect over time period (model 2 in table 1). As it was investigated by Bu [5] in order to capture the shock in volatility we added a variable to capture this effect. This variable is determined based on the difference between realized data in the market and expected value of changes in the US crude oil inventory (model 3 in table 1). This declares how unexpected changes in the inventory impact volatility.

The estimated results show that the dummy variable and its lagged value are statistically meaningful. As the coefficient of the dummy variable with one lag is statistically significant with negative sign it indicates that the market is less volatile prior to the news announcement. But the sign of the dummy variable is positive which indicates an increase in volatility after crude oil stock changes has been announced. In addition to this the coefficient for the difference between realized and expected values of inventory is also statistically significant and reveals that the higher data against market expectation create more volatility in the oil price.

Table I: Results of the Models; Probabilities in parentheses

Model	**1**	**2**	**3**
Mean Equation			
Constant	-0.00007 (0.00)	-0.00007 (0.00)	-0.00007 (0.00)
AR(4)	-0.78 (0.00)	-0.85 (0.00)	-0.799 (0.00)
MA(4)	0.79 (0.00)	0.86 (0.00)	0.81 (0.00)
Variance Equation			
Constant		0.000001 (0.00)	0.000001 (0.00)
ϵ_{t-1}^2	0.329 (0.00)	0.304 (0.00)	0.299 (0.00)
σ_{t-1}^2	0.67 (0.00)	0.688 (0.00)	0.689 (0.00)
$Dummy_t$		0.0001 (0.016)	0.0001 (0.016)
$Dummy_{t-1}$		-0.000076 (0.00)	-0.000085 (0.00)
Real – Expected Value			0.00000001 (0.00)

IV.CONCLUSION

In this study the crude oil price volatility has been estimated and the effect of the US inventory changes on the volatility has been investigated. For this purpose the intraday data in 30 minute intervals has been adapted. The intraday data enabled us to search for the exact effect of the announcement on volatility rather than using daily data which reflects the effect of a combination of news announced during the day. In this study we found that announcement of the US crude oil inventory on every Wednesday is highly correlated with the increased volatility in crude oil price at the exact point in time of news arrival. We also added another variable to investigate the effect of unexpected values for inventory in the market. This variable is also statistically significant and shows that release of unanticipated amount of inventory can create more volatility in the market at the time of news arrival.

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