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Analysis of the Impact of Fund Behavior on WTI Crude Futures Market

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Abstract: In recent years, uncertainties in the international community have increased, and the factors affecting crude oil futures prices are often diversified. This paper studies the driving factors of three dimensions that influence the price of crude oil and focuses on the influence of the financial dimension on the price of crude oil. At the same time, the multivariate regression model is constructed to conduct an empirical analysis to judge the factors that can affect the crude oil futures price and the correlation between the occurrence of special events and the crude oil price fluctuation.

Keywords: Macro policy, Supply demand and financial factors, Multiple regression analysis.

1. Introduction

As we move into the 21st century, the world, especially developing countries' demand for energy, is increasing. As one of the most important resources in the world energy markets, oil plays an important role in world economic growth. The international oil market has shown that the international crude oil price has risen sharply and fluctuated violently in recent years. Take the WTI spot contract, considered by investors to be the benchmark price for the international energy market, as an example: In recent 20 years, it peaked at $145.18 a barrel in July 2004, and in April 2020, its price even fell to $37.63 a barrel. EIA[1]

At present, investment funds in the century financial market are mainly divided into four categories, and hedge funds and ETFs are closely linked with energy products, especially oil. Hedge funds are small in scale, but they can directly influence international crude oil prices through high frequency trading, quantitative trading, and other means.

Index funds have attracted huge inflows, topping $10 trillion, because of the pandemic, and it also has a great influence on the international crude oil price trend. Take the S&P Goldman Sachs commodity index as an example: WTI accounts for 12 percent of its index composition and becomes the largest single investment commodity in its index. Also, USO has become the largest oil ETF, and WTI accounts for 90 percent of its portfolio.

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2. The Driver of Oil Prices

Energy finance has become a new popular field in the world depending on the financialization of energy commodities. The expression of energy pricing began to transfer to marketization because of the continuous enrichment of energy derivatives, such as futures and options, in the 21st century. There is a term to describe this process called energy financialization, and it means that the price of energy commodities usually shows the price exceeds the supply and demand fundamentals [2]. In this case, the financial properties of energy commodities begin to exaggerate. In order to analyze the oil price drivers, it divides into three dimensions: macro policy, supply demand, and financial factors.

To begin with, oil is the most consumed disposable energy resource in the world. The policy is one of the significant factors influencing the gas price, and three oil shocks lead to the price growing at an accelerating rate. During the 20th century, OPEC announced export oil restrictions to strike Israel, which caused the price to increase from around 3 dollars to 13 dollars. U.S. Department of State [3] In the Iran Iraq war, Iran announced the policy to stop exporting oil caused an oil shortage, and the price of gas increased from 15 dollars to 39 dollars. Krista [4] The Gulf War reduced oil production, which caused crude oil to nearly double. Krista [4] Through these three big oil crises, people found that the price of crude oil was influenced by the output of middle east countries, the impact of political turmoil, and the method of middle east countries against western sanctions. Therefore, crude oil and its derivatives futures contracts began to show in the market to reduce the pricing controlled based on market supply and demand.

Moreover, supply and demand are the main factors that determine the long term direction of oil prices. This research needs many published data and research reports, such as Oxford energy studies, Platts, and Argus energy reports [5]. For the supply differences part, Pierru [5] uses the surplus production capacity of OPEC as the correlation indicator representing changes in crude oil demand and supply, and it finally shows that OPEC expansion of surplus capacity can help reduce volatility in oil prices. Kilian [6] regards shale oil as the supply factor of crude oil in the U.S., and he found the increase of supply has little influence on oil price by using the structure vector autoregressive (SVAR) model. Oil demand has an even more significant influence on oil prices except for the supply differences. French [7] indicated that oil prices rise as people's demand falls and inventories run low by looking at the historical trend. For example, people do not need to travel or go out during COVID-19. In other words, there is less demand, and the inventories increase, so the prices fall.

Furthermore, the financialization of commodities has changed the traditional pricing mechanism for crude oil. The “commercialization” of a commodity can be described when the following two conditions are satisfied, and here commodity indicates the oil price. The oil price indicated an obvious correlation from the previous uncorrelation. The other is that the oil market began to increase the connection with financial investment, such as foreign exchange, stock, interest rate, and others. The foreign exchange rate can be an example of the connection between changing oil prices and financial factors. Reboredo [8] used a detrended cross-correlation to analyze the connection between exchange rate and the oil price. They found out that there was a negative interdependence between exchange rates and the oil prices when the global financial crisis and vice versa by using the ρDCCA model. Mo [9] also found the same result by using Hiemstra, Jones test, Diks and Panchenko test, and variable parameter structure vector autoregressive model. Also, the same result was found in the analysis of Akram [10], who used the SVAR model. In this case, we can see that supply and demand are no longer the key factors in determining oil prices.

3. The Relevance of Energy to Financial Markets

The relevance of energy products to the Stock market, energy products to the bond market, and energy products to the currency market. This paper would consider the relationship in the data set altogether

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named financial market relationship. The relationship includes the overall inference and influences at impressive backgrounds. We define a "positive relationship" as a financial market that stabilizes oil prices and reflects the right expectations about crude oil supply and demand. A "negative relationship," on the contrary, should represent that our financial market is incapable of manipulating oil price, and speculation would exaggerate the vibration of oil price.

Before we start the research, we suppose first that the relationship between oil price and investment from financial departments is negative. This relationship helps with adjusting the price of crude oil, smoothing its vibration, and leveling future prices. This guess is based on financial products considering oil and other investigators' conclusions.

3.1. Positive Relevance

The paper Literature Review and Frontier Direction Exploration of Energy Finance by Gong Xu, Ji Qiang, and Lin Boqiang [11] investigated the relativity of oil prices with other energy products, other products, and the financial market. The result supports our guess that their relationship exists. Jin Hongfei and Jin Hun [12] researched international oil prices and 14 Chinese Stock industries with the Two factor GED-GarCH-M model, and their result is that the influence is positive for oil and gas stocks. Their research also included the relationship between oil price and other manufacturing and other resources stocks. The result ranges from no significant relationship to a negative one, which is beyond our research. NYMEX [13] regard that hedge fund holders tend to hold their funds longer than other investigators. Thus they cannot be the destructive factor from the financial market to the oil price. Furthermore, this is further supported by Rippler [14], that volume of the future oil market only takes up to 1/3 of the whole volume of the oil market.

3.2. Negative Relevance

The negative relevance expected financial market increase the instability of the oil market and increase the risk within. Du and He researched S&P price and WTI price with the Granger causality test method [15]. Their result is that significant positive risk spillover exists from these two sets of data, and the spillover dramatically increased from 2008. Mensi and his group [16] took data of crude oil price and stocks of developed areas, and the result they found confirmed what He and Du found: the tail dependence exists, and oil price and stock market have risk spillover in between. OPEC [17] argues that besides political reasons, speculation is one essential factor of the high rise of oil prices and the dramatic fluctuation.

4. Construction of Multiple Regression Model

In order to study the influencing factors of WTI crude oil price, the principal component analysis method of SPSS software was used to reduce the dimension, and a multiple regression model was used to analyze the relationship between WTI crude oil price and various influencing factors.

4.1. Modeling step

(1) The logarithm is the original variable to eliminate the heteroscedasticity of data.
(2) Data standardization eliminates the influence of dimension and order of magnitude.
(3) Correlation judgment between indicators uses correlation analysis to do single factor screening, remove weak correlation indicators, and conduct multiple linear regression tests.
(4) The principal component analysis is used to reduce dimension and determine the expression of the principal component factor.
(5) Principal component factor multiple linear regression, get the contribution value and its

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expression equation.

(6) According to the expression of principal component factor and regression equation, independent variables' multivariate linear regression equation is obtained.

4.2. Multiple Linear Regression

Uncertain events, such as the Sino US trade war and global COVID-19 pandemic, have a tremendous impact on the global economy. At the same time, uncertain factors have become an important research object in academic circles. Even the fluctuation of crude oil price alone is influenced by many factors, such as oil supply, demand, inventory, Dow Jones Industrial Average, and the dollar index. Based on these, the construction of this model not only studies the factors that affect the fluctuation of crude oil price but also studies the relationship between the occurrence of uncertain events and the fluctuation of crude oil price.

(1) Formula:$Y=C+\beta_1 \ln X_1 + \beta_2 \ln X_2 + \cdots + \beta_i \ln X_i + \varepsilon$， $i \in \{1, 2, 3 \cdots n\}$

In the formula, Y is WTI crude oil price; C is a constant value;β_i is the coefficient of the ith explanatory variable; LnX_i is the natural logarithm of the original variable data; ε is the error term; X_i is the raw data, including oil supply, demand, inventory, Dow Jones Industrial Average and U.S. dollar index.

(2) For the convenience of recording the original data X_i in matrix form X（$m * n$）

$$X=\begin{bmatrix} x_{11} & x_{12} & \cdots & x_{1n} \\ x_{21} & x_{22} & \cdots & x_{2n} \\ \cdots & \cdots & \cdots & \cdots \\ x_{m1} & x_{m2} & \cdots & x_{mn} \end{bmatrix}$$

Xmn represents the indicator of the nth month in the year.

(3) The confidence level of the model is 95%, and the significant level is $\alpha = 0.05$.

(4) According to the regression analysis results of the model, the equation is obtained:

According to the statistics

(5) F-test the whole model and make assumptions:

$$H0: R=0, \text{Significantly}$$

$$H1: R \neq 0, \text{Not significant } i \in \{1, 2, 3 \cdots n\}$$

5. Model Analysis Results

5.1. Model Summary

As shown in Table 1, $R^2 = 0.729$, this shows the independent variable can explain 72.9% of WTI oil price change.(More than 30%,acceptable)

Table 1: Model Summary.

Model Summary [b]					
Model	R	R^2	Adjusted R Square	Std.The error of the Estimate	Durbin-Watson
1	.854[a]	.729	.721	12.23360	.544

a. Predictors:(Constant), American crude oil production/unit: thousand barrels, DOW J, input, USDX, production (data from U.S. Energy Information Administration https://www.eia.gov/)

b. Dependent Variable： WTI（dollar/barrel）

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5.2. Coefficients Text

Table 2: Coefficient table before adjustment.

Coefficients [a]								
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	281.139	16.791		16.744	.000		
	USDX	-2.937	.184	-1.082	-16.003	.000	.343	2.917
	DOW J	-2.983E-5	.000	-.027	-.608	.544	.820	1.220
	input	5.353E-5	.000	.113	2.239	.026	.618	1.617
	production	4.266E-5	.000	.144	1.094	.276	.090	11.056
	American crude oil production/unit: thousand barrels	.000	.000	.153	1.369	.173	.125	7.995

a.Dependent Variable ：WTI（dollar/barrel）

In Table 2, sig values are used to test the correlation between independent and dependent variables. Tolerance and VIF are used to detect multicollinearity between independent variables.

(1) Test of Sig.:$USDX = 0$ Excellent significance;$DOW\ J = 0.544 > 0.05$ Not significant;$input = 0.026 < 0.05$ Significant;$production = 0.276 > 0.05$ Not significant; $American\ crude\ oil\ production = 0.173 > 0.05$ Not significant.

(2) Collinearity test:

a. Tolerance test: $production = 0.09 < 0.2$ is multi Collinearity

$American\ crude\ oil\ production = 0.125 < 0.2$ is multi Collinearity

b. VIF test (Derivative of tolerance)

Production =11.056 >5 is multi Collinearity

American crude oil production =7.995 >5 is multi Collinearity

(3) This paper adopts the stepwise regression method to deal with multicollinearity: the stepwise regression method can avoid the independent variables with multicollinearity entering the equation simultaneously to a certain extent and can also eliminate the insignificant independent variables.

Table 3: Coefficient table after adjustment.

Coefficients [a]								
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std.Error	Beta			Tolerance	VIF
1	(Constant)	265.827	10.197		26.069	.000		
	USDX	-2.229	.116	-.821	-19.160	.000	1.000	1.000
2	(Constant)	305.857	12.268		24.931	.000		
	USDX	-2.978	.181	-1.097	-16.461	.000	.361	2.770
	production	.000	.000	.345	5.178	.000	.361	2.770
3	(Constant)	281.846	16.542		17.038	.000		
	USDX	-2.904	.182	-1.070	-15.918	.000	.348	2.874
	production	8.088E-5	.000	.273	3.685	.000	.286	3.493
	input	4.742E-5	.000	.100	2.138	.034	.720	1.389

a. Dependent Variable： WTI（dollar /barrel）

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Table 3 shows the coefficients after excluding multicollinearity, make the coefficient conform to multiple regression equation. According to the statistics, take USDX, production, input as the independent variables， $R^2 = 0.720$.

The final model is Y=281.846-2.904X_1+8.088X_2+4.742X_3

X_1 is USDX, X_2 is production, X_3 is input.

6. Conclusion

The correlation between DOW Jones Industrial Average and the WTI oil price change is remarkable, but Dow J is related to other independent variables. Therefore, in order to ensure the accuracy of the equation, DOW J is excluded. In the statistical process, reasonable data is essential, and the factors considered in this paper are not comprehensive. In the future, with the increase of uncertain factors, the discussion on the influencing factors of oil prices should not stick to the discussion of the influencing factors themselves but should study the correlation between oil price fluctuations and international emergencies based on the time dimension, and put forward more practical suggestions.

References

[1] *EIA. Cushing, OK Crude Oil Future Contract 1[EB/OL]. 2021.12.13. https://www.eia.gov/dnav/pet/hist/RCLC1D.htm.*

[2] *Zhang, D. Energy finance: Background, concept, and recent developments. Emerging Markets Finance and Trade, 54(8), 1687–1692.*

[3] *U.S. Department of State. (n.d.). Oil Embargo, 1973–1974. U.S. Department of State. Retrieved December 3, 2021. https://history.state.gov/milestones/1969-1976/oil-embargo.*

[4] *Krista, R. (n.d.). How world events have affected oil prices: Professional Roofing Magazine. How world events have affected oil prices. Retrieved December 3, 2021. https://www.professionalroofing.net/WebExclusives/Story/How-world-events-have-affected-oil-prices--12-01-2008/195.*

[5] *Huntington, H. G. Measuring oil supply disruptions: A historical perspective. Energy Policy, 115, 426–433.*

[6] *Kilian, L. The impact of the Shale Oil Revolution on U.S. oil and gasoline prices. SSRN Electronic Journal.*

[7] *Matthew, F. U.S. Energy Information Administration - EIA - independent statistics and analysis. Crude oil demand returns faster than supply, increasing prices and reducing inventories - Today in Energy - U.S. Energy Information Administration (EIA). Retrieved December 3, 2021. https://www.eia.gov/todayinenergy/detail.php?id=50296.*

[8] *Reboredo, J. C., Rivera-Castro, M. A., & Zebende, G. F. Oil and US dollar exchange rate dependence: A detrended cross-correlation approach. Energy Economics, 42, 132–139.*

[9] *Mo, B., Nie, H., & Jiang, Y. Dynamic linkages among the gold market, US dollar and crude oil market. Physica A: Statistical Mechanics and Its Applications, 491, 984–994.*

[10] *Akram, Q. F. Commodity prices, interest rates, and the dollar. Energy Economics, 31(6), 838–851.*

[11] *Gong X, Lin B Q. Jump risk, structural breaks, and forecasting crude oil futures volatility[J]. Chinese Journal of Management Science, 2018, 26(11): 11-21.*

[12] *Jin H F, Jin L. The impact of international oil prices on China's stock market--An empirical analysis based on industry data [J]. Journal of Financial Research, 2010, (2): 177-191.*

[13] *NYMEX. A review of recent hedge fund participation in NYMEX natural gas and crude oil futures markets[R]. New York: NYMEX，2005.*

[14] *RIPPLE R. Energy futures market trading versus physical commodity usage: a playground for manipulation or a miscalculation?. Macqarie Economics Research Papers，2006.*

[15] *Du L, He Y. Extreme risk spillovers between crude oil and stock markets[J]. Energy Economics, 2015, 51: 455-465.*

[16] *Mensi W, Hammoudeh S, Shahzad S J H, Shahbaz M. Modeling systemic risk and dependence structure between oil and stock markets using a variational mode decomposition based copula method[J]. Journal of Banking & Finance, 2017, 75: 258.*

[17] *OPEC. OPEC reassures the market of a continuing commitment to stability [R].Viena: OPEC，2006.*