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What the Great Recession did to the Oil Market:

A Study in the Factors that Determine the Price of Oil.

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Introduction

Since the industrial revolution crude oil has been a fundamental part of technological progression as well as just a principle component of our everyday life. Crude oil is the main component for gasoline, asphalt, lubricants, clothes, perfumes, and many more. This is a characteristic that makes oil a natural resource that can become a country's blessing, and curse at the same time. Since it is such an important component of our daily lives, the market of oil has been a topic of interest to economists and politicians for many years. According to a special TV feature from CNBC, until the 1960s the prices of the petroleum market was determined by multinational oil companies from the United States. A group of oil producing countries therefore created an organization that would decide how much output to maintain in their reserves to be able to control and stabilize the market of oil. OPEC controls 80% of the world's oil reserves but only one third of the global oil market. They did not have actual influence on the prices of oil until 1973, when they set up an embargo to the United States due to their intervention in the Israeli-Arab war, which end up spiking prices of oil. OPEC's influence in determining the prices of oil has fluctuated throughout the years. Still, some major events throughout the years have proved that maybe OPEC is losing its control over the oil market. Therefore it would be suspected that econometric tests could show when the relationship between OPEC and the price of oil have had a structural break.

This research will determine if the relationship between the prices of oil and OPEC's production is still as related as it used to be before the US implemented the fracking method in their oil production. According to a CNN article, fracking account for more than half of the US oil production when back in the year 2000 it only made up 2% of the total oil production. Recently the US has become for the first time in many years an oil exporter, according to the US Energy

Information Administration, in June of 2018 they surpassed Russian and Saudi Arabia production levels. Since the Unites States has become a great influence in the oil market, this research will analyze if OPEC's production still has influence to the price of oil by comparing it to the US oil production. To do this, two models will be created, one will show the relationship between oil price and US oil production and one will shows the relationship between oil price and OPEC oil production. Based on this information it is suspected that there was some kind of structural break in the oil market resulting from this change in the United States' implementation of fracking.

Literature Review

In an article written by Karadeloglou, P., Kaufmann, R. K., & Sanchez, M. in 2007, the authors come up with "An Econometric Model of the World Oil Market Development and Risks". In this article the authors construct the demand curve for the market as well as the supply curve to be able to test out what are the possible outcomes of a shock in the market. In their research they found that demand is a log-linear function of the real GDP, real oil prices, and a time trend representing efficiency changes. In this research they found that the supply behavior is different between Non-OPEC countries and OPEC countries. The supply behavior for Non-OPEC countries is determined by the measure of production costs, and the oil price. For the OPEC countries though, there is two different types of production, the competitive and the cooperative. The competitive production is based on the capacity that a particular country can produce and the cooperative production is based off of the difference between the world oil demand and the production of non-OPEC countries. After running a regression model the authors were able to find a rule, in which they determined, that the price of oil is determined by the days of further consumption of crude oil stock, OPEC production quota, the difference between OPEC production and the quota, the capacity utilization by OPEC, and a war variable (to take into account the Persian Gulf War). In

their conclusion, the authors state that a "collapse of OPEC cooperation may have negative consequences for oil consuming nations, despite the reduction in average price" (Karadeloglou, P., Kaufmann, R. K., & Sanchez, M. (2007)). In this research, the authors found a direct relationship between changes in OPEC behavior and oil prices. What this research fails to study is the increasing influence non-OPEC countries such as the US, Canada and Russia have had since the great recession of 2008.

In a previous article (Kaufmann, R. K., Dees, S., Karadeloglou, P., & Sanchez, M. (2004)) the same authors had tested some of this variables, and determined that they *Granger Caused* real oil prices but, real oil prices did not *Granger Cause* these variables. In this same study they did not take into account variables such as war, the difference between what OPEC countries produced and the quota. The two variables mentioned, war and difference between actual production and quota, were found to be statistically significant in the determination of oil prices.

This paper focuses on the effects of fracking method on the oil market. In an article written in 2010, Fan, Y., & Xu, J. H., they study more in depth the effects of three major events. To be able to do this, the authors first came up with the main drivers of oil price determination. In their research they state that price of oil is determined by gold price, stock price, speculation, and exchange rate fluctuations. In the econometric analysis the article gives a linear regression model in which they end up addressing that other additional variables such as Baltics Dry Index, the S&P 500 Index, and the US dollar index matter in their model. To further specify their model, the authors were careful to take into account the 9/11 attacks (represented as a dummy variable), and the percent of noncommercial traders. In their explanation, the authors specify that in their research they fail to take into account factors such as wars. War can further affect the price of oil, like the case of the Persian Gulf War. In this research, they found that during the global economic crisis

some factors turned out to be statistically insignificant as opposed to the results from previous studies. The factors that were determined to be statistically insignificant were the speculation variable, the US dollar index, and the percent of noncommercial traders. In their research the authors conclude that speculation is a significant variable in the determination of oil prices, but when a major financial event occurs it becomes insignificant.

Following the Great Recession, the global market has overcome other major events that due to their location, have greatly influenced the oil market supply, which has therefore influenced the oil price. In an article written by Garzón, A. J., & Hierro, L. Á. (2018), they argue that the wars that took place in Libya, Syria, and Ukraine after the Great Recession had a major impact in the oil market. In addition to the wars, the authors also determined that the discovery of the fracking method also affected the oil market. Due to this new method of extracting oil, US was able to become a great influence in the oil market, hence pushing back the influence from other major players like OPEC. To be able to test this hypothesis the authors created a VECM model in which they used some variables to be able to determine the price of oil. They took into account the effects from OECD stock of oil, OPEC oil production, the US price index (CPI), the production of oil in the US (to be able to reflect the impact of fracking), and a dummy variable to take into account the major events studies in this analysis. The authors concluded that the negative relationship between the OECD oil stock and oil prices, and these did maintain after the major events studied. There is a positive relationship between OPEC production and prices, which therefore means that OPEC acted as a price taker during this events. The uncertainty following the stock market crash also proved be a significant influence in the dramatic decrease of oil prices. Ultimately only the Great Recession had an impact on the oil prices, the wars that took place after the recession did not have any influence on fluctuations in the price of oil.

Methodology & Data

Since the price of oil is determined by the demand and supply of this resource, constructing a LSM will probably provide inappropriate results since all of the variables listed in the anchor paper, Garzón, A. J., & Hierro, L. Á. (2018), would create troublesome multicollinearity in the model. Therefore this research focuses on creating two models to observe if there is an equilibrium between the price of oil, OPEC Production and the US production. As previously mentioned, the US has become a strong player in the last few months in the oil market, and therefore, it would be expected that it has a greater influence in the price of oil in the last few years, but overall little less influence than OPEC in the model. For this research two models will be tested to be able to determine, if the structural break in the market that causes the US to become a higher influence in the market has anything to do with the implementation of fracking, and if this also caused a structural break in the model that relates OPEC to the price of oil.

Before running the tests, the data was examined to be able to see relationships throughout the years between this three variables. In table 1, shown below, it can be observed the correlation between this three variables. It can be concluded from this table that there is no troublesome multicollinearity between the variables. The table also demonstrates that there is a positive relationship between the US oil production and the price, and a negative relationship between the prices of oil and OPEC oil production. This correlation table also suggest that there is a greater relationship between prices of oil and OPEC oil production than with US oil production.

TABLE 3.1

	WTI	US_PROD	OPEC_PROD
WTI	1.0000		
US_PROD	0.0008	1.0000	
OPEC_PROD	-0.7550	-0.1869	1.0000

We also tested the variables to be able to determine if prices of oil are determined by production or if production is determined by the prices of oil. the results are shown below on Table 2. The table shows that OPEC *Granger Causes* the price of oil, since it is rejecting the null hypothesis at a 20% confidence level. Therefore our preliminary results suggest that the only variables that is causing changes in prices would be the OPEC oil production, which then complements the results from the correlation table above.

TABLE 3.2

Null Hypothesis	F-stat	Probability.
WTI does not Granger Cause US_PROD	12.7318	8.00E-06
US_PROD does not Granger Cause WTI	4.75795	0.01
OPEC_PROD does not Granger Cause WTI	1.6703	0.1942
WTI does not Granger Cause OPEC_PROD	13.5907	7.00E-06

As shown by the summary statistics stated above, it seems that OPEC is the bigger player in the oil market, and that the US oil production is still not a big influence in the equilibrium that determines the price of oil. Still, recent events, like the expansion of fracking in the oil production has helped the United States to become a major player in the market and therefore it should be today a bigger influence in this market. The question is whether it has become a bigger influence than OPEC or is the Organization of Petroleum Exporting Countries still the major player in this market. To be able to determine this two models will be constructed and tested to be able to determine if there are any structural breaks that proves that the US is a bigger player in the market. The two models are shown below.

$$eq.1 \qquad WTI = \beta_0 + \beta_1(LnOPEC_{Prod})$$

$$eq.2 \qquad WTI = \beta_0 + \beta_1(LnUS_{Prod})$$

Where WTI is the price of oil, determined by West Texas Institute, $LnOPEC_{Prod}$ is the log of OPEC oil production in millions of barrels per day, and LUS_{Prod} is the log of US oil production measured in the 2012=100 index. Since the oil production is given in two different measures, this variables will be logged for the purpose of this research. The US oil production data was obtained from the Federal Reserve Bank of St. Louis, and the OPEC oil Production was obtained from the US Energy Information Administration. The data set runs from the year 1980s to 2017 in quarters. Therefore there are 150 observations in this regression to prevent the data from having multicollinearity due to *micronumerocity*.

To first determine the equilibrium the data will be tested through a cointegration analysis, if the data is cointegrated it will be ran using an error correction model and then it will also be tested on whether there is a structural break or not by testing the regression on a Quandt-Andrews Breakpoint Test.

Results

The cointegration test resulted in the values in Table 4.1. The results show that price of oil and OPEC oil production are cointegrated therefore they can be regressed in a model, and they are not spurious. As for the second model, the cointegration test shows that price of oil and US oil production are not cointegrated and therefore they should be regressed using a trend variable.

TABLE 4.1

Dependent	tau-statistic	Prob.*
LOPEC_PROD	-6.076042	0
WTI	-4.830965	0.0008
WTI	-1.598414	0.7237
LUS_PROD	-0.835089	0.9278

The results of both of the regression models are given in Table 4.2. From the results it can be concluded that both variables, US oil production and OPEC oil production are individually significant to the determination of the price of oil as it was already stated in correlation table shown above. It is also important to point out that the regression output shows that there is a negative relationship between price of oil and the production of oil in OPEC countries, but still a positive relationship between the prices of oil and the oil production in the United States. Since the US oil production is not cointegrated with the WTI variable then model 2 has to be estimated using first differences and a trend variable. From the output we can conclude that in the short run both OPEC oil production and US oil production are both individually significant for the determination of the price of oil.

TABLE 4.2

Variable	Coefficient	Std. Error	Significance Level
Eq. 1			
C	69.39888	2.647578	*
LOPEC_PROD	-19.68983	1.771236	*
Eq. 2			
C	12.00993	3.29494	*
DLUS_PROD	331.3742	80.26747	*
@TREND	0.389572	0.038605	*

* significant at the 1% significance level

An Error Correcting Model can only be used when the variables are correlated. From our previous results then only the first model, that is the model that compares prices of oil with the production of oil in OPEC countries, can then be ran using a ECM to "capture the long run and short run dynamics of the relationship between the variables" (Stinespring, 2018). The results from the Error Correcting Model are shown in table 4.3. From the output shown below it can be then

concluded that on the long run the production of oil in OPEC countries will be insignificant to changes in the price of oil, since it is not even significant at a 10% level

TABLE 4.3

Variable	Coefficient	Std. Error	S. Level .
C	0.722637	1.002096	
ERROR(-1)	-0.064874	0.031662	**
LOPEC_PROD	-0.984346	1.239881	

**significant at the 5% level

As it has already been stated throughout the paper, there have been recent changes regarding the influence both of this producers have on the determination of the price of oil. to be able to observe if there is any structural break in the model, both models where tested using the Quandt-Andrews Breakpoint Test. The results are shown below in table 4.4 From the result shown below it can be determined that there is a structural break in the first model in the 3rd quarter of year 2008 and in the second model there is a structural break in the 2nd quarter of the year 2005. The structural break in 2008 may have been caused by the financial crisis in the United States that affected the economy throughout the world. Specifically in that quarter the price of oil started to decline after it was inflated for 3 consecutive quarters (Q4 2007- Q2 2008). Since the previous tests have proved that OPEC is a significant variable for the determination of oil prices, then a financial crisis that inflates the price of oil would cause a structural break in the model. As for the structural break during the second quarter of the year 2005 in the relationship between the price of oil and the oil production from the US, this can be accounted to the 2004 and 2005 hurricane seasons in the United states which cause billions of dollars in damages to the oil producing industry. Both of the years were listed as the worst hurricane seasons in history according to the Weather Channel.

TABLE 4.4

Statistic	Value	Prob.
Eq. 1		
Maximum LR F-statistic (2008Q3)	5.928573	*
Eq. 2		
Maximum LR F-statistic (2005Q2)	49.66936	*

* significant at the 1% significance level

Conclusion

Based on the results that were calculated for this research the hypothesis that there is a significant change in the influence of oil production from the United States to the prices of oil is rejected. According to the findings there is not sufficient influence that results in a statistically significant change in the influence of US oil production. Still, the results did confirm that there is a statistically significant structural break in the relationship between the price of oil and the OPEC oil production in the years the great recession peaked, as Garzón, A. J., & Hierro, L. Á. (2018) stated in their paper.

As already stated in the introduction though, and confirmed from the error correction model developed in this research, the influence of the OPEC oil production is insignificant in the long run, and thus showing that eventually other players, such as the US, have the opportunity to become greater influences for the determination of the price of oil.

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