FRE 502 Final Paper

An Analysis of OPEC Diminishing Influence on World Crude Oil Prices

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Introduction

The Organization of Oil Producing Countries (OPEC) consists of a group of countries that coordinate oil production targets to collectively influence the world price of crude oil (Ayub,2004). This study aims to investigate the influence of OPEC countries' crude oil export volume on the world crude oil price. The estimating regression model of this study is established on time-series data from 1979 to 2019. To fulfill the investigation's purpose, we employed a Log-Log regression model to estimate the elasticity of world crude oil price with respect to OPEC's crude oil exports volume. The regression results show that a 1% increase in the OPEC countries crude oil exports can lead to approximately 1.276% reduction in the world crude oil price. Besides, the RESET test, Breusch-Pagan test, and Durbin Watson test are conducted to check for our regression model's validity.

Additionally, we explore potential factors that might hinder OPEC's ability to raise crude oil's world price. Nevertheless, our model still has considerable limitations because the model fails to capture the bi-directional effects of variables on both sides of the regression equation. The issue of simultaneity bias may cause inaccurate coefficient estimation in the Log-Log regression model.

Price Levels Overview

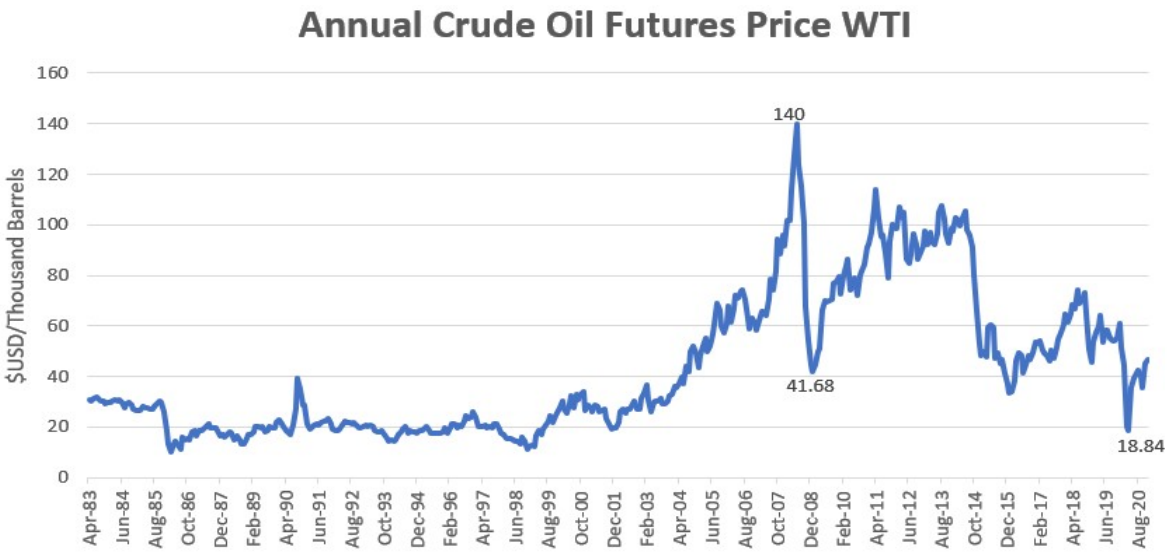

Figure 1, Data from Investing.com

Like all commodities, crude oil prices fluctuate with supply and demand and have a history of high volatility. For instance, the price of crude oil from around 2011 to 2014 maintained a sustained peak, as seen in Figure 1. It resulted from the rapid industrialization of China and India, which increased the demand for crude oil, both from the increased use of automobiles by a growing middle class and an increase in industrial and manufacturing activity (Mieles, 2020). Besides, political instability in many of the leading producers of petroleum products during this time, like the Middle East and North Africa, and sanctions imposed against Iran reduced supplies and kept prices high (Mieles, 2020).

Furthermore, due to the importance of crude oil, factors like economic events and geopolitics also play a significant role in determining prices. An example of an economic event would be the 2008 financial crisis, where a global economic recession reduced worldwide crude oil consumption due to less economic activity. This resulted in a huge dip in oil prices, as seen

from 2008 to 2009, where prices dropped from $140 to $41.68 per thousand barrels. In terms of geopolitics, one event can be seen as recently as March 2020. Where Saudi Arabia, the largest exporter of crude oil and OPEC member, and Russia, the second largest exporter, failed to reach an agreement to reduce oil production in order to stabilize oil prices (Cohen, 2020). In response, Saudi Arabia initiated an oil price war by increasing its oil production. This also occurred during the COVID-19 pandemic, where there were fewer economic activities due to lockdowns. The increased supply and decreased demand led to oil prices plummeting to an all-time low of $18.84 per thousand barrels, as seen in Figure 1.

Production Output

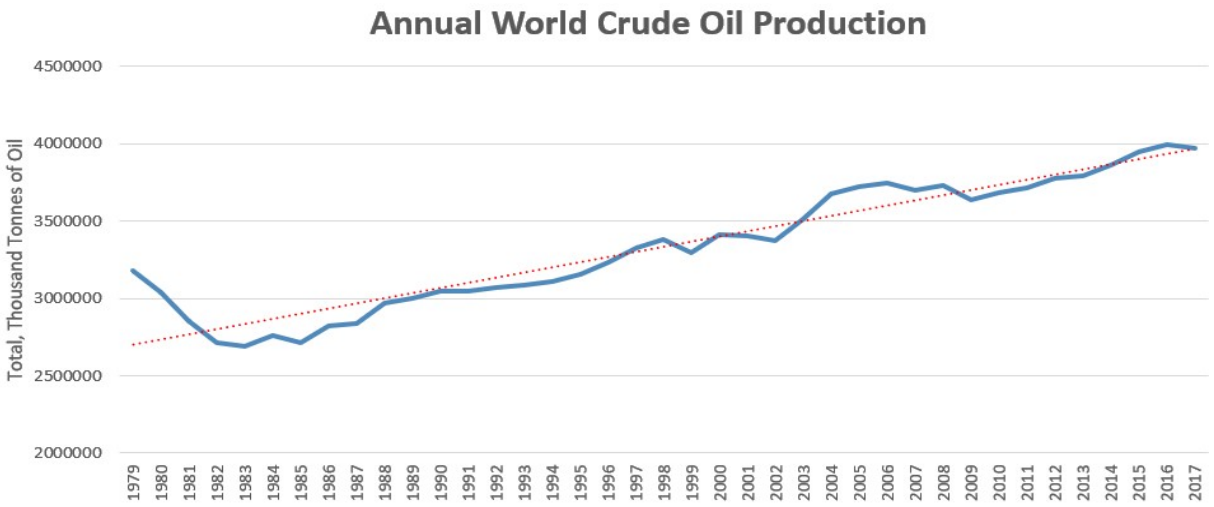

Figure 2, Data from OECD Data

Figure 2 reveals that since 1983 world crude oil production has been steadily increasing. This could be due to various reasons, such as keeping up with global demand due to growing populations and economic activities or threats of substitutes. For example, emerging economies typically consume less petroleum products than developed economies with the same population

levels due to less industrial activity (Mieles, 2020). However, as developing nations start to grow rapidly so does their demand for crude oil, in contrast to the stable demand seen from developed economies. The reason is that emerging markets have minor shares of global reserves and must import from countries that produce far more than they need. These emerging markets come from countries in Africa, Southeast Asia and the BRIC (Brazil, Russia, India, and China) nations, particularly India and China, all of which are rapidly industrializing countries with massive populations (Mieles, 2020).

Likewise, due to increasing economic activities, demand for road and air transport has also become a critical, demanding factor. This increases the demand for crude oil as it is used to create transport fuel products like diesel and petroleum. Other products made from crude oil also include asphalt, jet fuel, and fuel oil, all major components in industrializing areas (Mieles, 2020). However, transportation driven demand for crude oil has begun to differentiate between emerging and developed economies. For example, as automobile markets in emerging economies continue to grow, they are expected to be some of the largest energy consumers in the world over the next five years (Mieles, 2020). In contrast to developed economies like the United States, renewable energy technology developments are expected to reduce gasoline consumption in vehicles slowly.

Another reason for the growth in crude oil production is the result of competition from natural gas. Natural gas and crude oil are heavily used worldwide to power electricity generators and activities in the industrial sector. There are two main reasons why people are switching to natural gas. Firstly, due to the growth in natural gas production in recent years, it has become a far cheaper alternative to crude oil (Ross, 2020). Secondly, its advantage of producing less C02 and other harmful particulates makes it easier for users to meet emission standards. Due to this

increasing competition from natural gas, crude oil producers must further increase production to compete in price.

As of 2019, it is estimated that 73.5% of the total volume of crude oil produced worldwide is traded internationally (Mieles, 2020). It was making crude oil a thickly traded commodity.

Major Exporting and Importing Countries

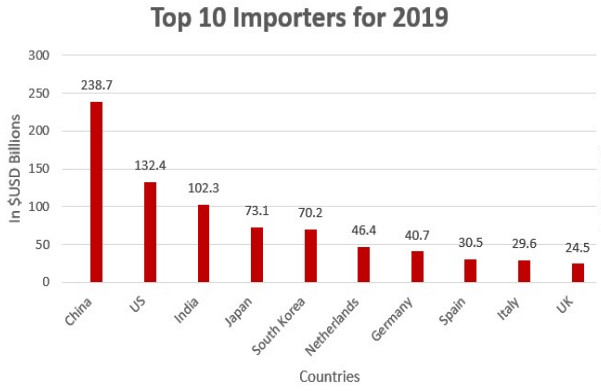

Figure 3

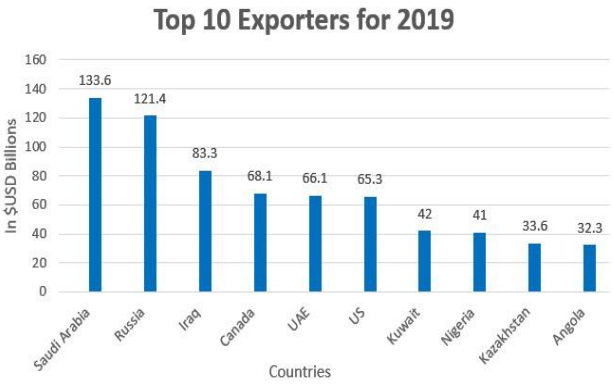

Figure 4

***Data is from WorldsTopExports.com and UAE stands for the United Arab Emirates**

Literature Review

The issue of OPEC's influence on oil prices has been widely studied. A significant number of existing literature establishes OPEC's influence over oil prices by the members' ability to act as a cartel. However, researchers have contrasting views on the ability of OPEC to coordinate the behavior of members. Therefore, the differing conclusions give rise to the scope for further analysis.

On the one hand, researchers attribute OPEC's strong cartel behavior to its ability to influence oil prices. Earlier studies, Griffin (1985), conclude that OPEC members were able to act as a unified cartel and effectively influence oil prices for the period up to the early 1980s. Griffin ran an OLS regression on OPEC members' behavior to determine if the organization's structure followed a Cartel, Competitive, Target Revenue, or Property Rights model. Griffin determined that OPEC members behaved in a manner that was aligned with a collusive cartel. Therefore, OPEC could influence the world price of oil by collectively adjusting their supply of oil.

Literature by Quint and Venditti (2020) indicates that OPEC has partial influence over crude oil prices. The authors utilized a counterfactual analysis to assess the impact of OPEC's production cuts on increasing oil prices from 2016 to the beginning of 2020. In the end, the authors concluded that OPEC was responsible for 6% of the total price increase over that period.

On the other hand, studies found insignificant evidence to support the claim that OPEC acted as a market sharing cartel. Kisswani (2016) utilized monthly data from 1994 to 2004 to test if OPEC acted as a cartel and could influence oil prices through the coordinated efforts of its members. However, Kisswani found no evidence of cartel behavior between OPEC members as there was insignificant cointegration between OPEC members' oil production.

Additional literature also presents the idea that factors beyond OPEC's cartel behavior primarily determine oil prices. MacAvoy (1982) concluded that the long-run oil price pattern is determined more by competitive forces and market fundamentals than by OPEC's cartel

behavior. MacAvoy argues that broader supply disruptions, such as the 1979 Iranian revolution, have a more significant bearing on the world price for crude oil.

Furthermore, the rise of oil production from non-OPEC producing countries has dampened OPEC's ability to influence oil prices. Ansari (2017) found significant evidence to support increasing global competition levels in the oil market, brought about by the growth in US shale oil fracking.

Through this literature review, we observe that the influence of OPEC's production limits on crude oil prices has changed over time. Through our paper, we aim to analyze the impact of OPEC exports on world crude oil prices. Ultimately, we hope to identify reasons why OPEC might not be able to raise oil prices effectively.

Data

We obtained our data from several different sources. To be more specific, the average crude oil price ($/bbl) and annual natural gas price, US ($/mmbtu), are extracted from the World Bank Commodity Annual Price Data (The Pink Sheet). The yearly price data about crude oil and natural gas are denominated in real 2010 US dollars. We use the natural gas US price data because the United States is the world’s largest natural gas producer. The natural gas US price can exert a considerable impact on the world's natural gas price. The world GDP data ($US) are obtained from the World Development Indicators dataset. The world population data is extracted from the United Nations population Data Query.

Furthermore, the world jet fuel consumption (mb/day), world motor oil consumption (mb/day), and world crude oil consumption (mb/d) data are obtained from the U.S. Energy Information Administration (EIA). Lastly, world oil demand by country (1000 b/d), world crude

oil exports (1000 b/d), and OPEC crude oil exports (1000 b/d) data are all extracted from the OPEC data. All the data described above are the time-series data from the year 1979 to the year 2019. We combined these data to a single dataset called "Master Data," and we will use this time series dataset for our regression analysis.

Econometric Model Development

The process of deriving our final regression model involved an iterative process of testing different model specifications. Firstly, we attempted a first differences model to deal with stationarity in time series data; however, it generated insignificant results. Secondly, we attempted a regression with five-year interval dummy variables and interaction terms between quantitative variables and the time dummies. Through this second method, we wanted to examine the price effects of different period quantities. In other words, we wanted to investigate how the influence of OPEC's export quantities on oil prices might have changed across the period of 1979 to 2019; however, the second model had issues of multicollinearity and completely insignificant results. Therefore, we settled on our final regression model as it was the only model that produced significant results.

This study aims to investigate the changing influence of OPEC on the world crude oil price. It is useful to understand the effect that OPEC countries crude oil exports have on the world crude oil price in the percentage change term. Because the percentage change can be interpreted as elasticity and using elasticity can help us better understand OPEC countries' crude oil export volume on the world crude oil price. Specifically, the main variables of interest in this study are the world crude oil price and OPEC crude oil exports. We use the world crude oil price as the dependent variable and OPEC crude oil exports as one of the independent variables to find the impact of OPEC crude oil exports on the world crude oil price. If we can estimate the

elasticity of crude oil price with respect to OPEC export volume, we can get a reasonable estimation of OPEC's impact on the world crude oil price.

Given this study's purpose, we employed the Log-Log model in our estimating regression equation because the Log-Log model's interpretation is convenient. The dependent variable and the independent variables in our model are transformed by the natural logarithm. This estimating model allows us to assess the constant elasticity directly as the slope coefficients showing the dependent variable's elasticity with respect to the independent variables in our regression equation. Besides, we divide our time-series data into seven 5-year intervals and one 6-year interval from 1979 to 2019. Specifically, we create eight dummy variables to control for time-specific fixed effects. For instance, a temporary price shock restricted to a given specific time-period can distort our model's estimation because it can impact our independent variables' slope coefficients. The time dummy variables control for the independent variables that are constant across different entities but vary over the period from 1979 to 2019. With time dummy variables, the regression model can eliminate some potential omitted variable bias resulting from excluding some unobservable independent variables that vary over time but are consistent across different entities in our regression model. Since our data type is time-series, controlling for time-specific fixed effects can help us get a more accurate estimation of OPEC's impact on the world crude oil price. One example of the time dummy variables in our model is called “First_5years". It represents the period from the year 1979 to 1983. The “First_5years” is also the reference category among all the dummy variables. The other dummies are “Second_5years”, “Third_5years”, “Fourth_5years”, “Fifth_5years”, “Sixth_5years”, “Seventh_5years”, and “Last_6years”.

To keep the time dummy variables' simplicity, we use "Last_6years" to represent the last time interval from 2014 to 2019. We didn't include the variable "world crude oil exports" in our regression equation because including this variable may result in multicollinearity, distorting our estimating results. The world crude oil exports and OPEC crude oil exports have similar measures, so we exclude the world crude oil exports to avoid multicollinearity and focus our study mainly on the impact of OPEC crude oil exports.

The estimating regression equation is shown below:

$$LogCrudeP = \beta_1 + \beta_2 * LogJet + \beta_3 * LogMotor + \beta_4 * LogNatural + \beta_5 * LogOPEC + \beta_6 * LogPop + \beta_7 * LogGDP + \beta_8 * LogOilDemand + \beta_9 * Second5yrs + \beta_{10} * Third5yrs + \beta_{11} * Fourth5yrs + \beta_{12} * Fifth5yrs + \beta_{13} * Sixth5yrs + \beta_{14} * Seventh5yrs + \beta_{15} * Last6yrs$$

In detail, the variable "$LogCrudeP$" represents the log of the world crude oil price ($/bbl); "$LogJet$" is the log of the world jet fuel consumption (mb/day); "$LogMotor$" stands for log of the world motor oil consumption (mb/day); "$LogNatural$" is the log of the annual US natural gas price ($/mmbtu); "$LogOPEC$" represents the log of OPEC crude oil exports volume (1000b/d); "$LogPop$" is the log of the total world population; "$LogGDP$" stands for the log of world GDP measured in US dollars; "$LogOilDemand$" is the log of world crude oil demand (1000 b/d); "$Second5yrs$", "$Third5yrs$", "$Fourth5yrs$", "$Fifth5yrs$", "$Sixth5yrs$", "$Seventh5yrs$", and "$Last6yrs$" all represent time dummy variables to control for the for time-specific fixed effects in our regression model. We did not include the dummy variable for the first 5-year interval because it is used as the reference category for these indicator variables.

The main variables of interest are the log of world crude oil price and the log of OPEC crude oil exports volume. Our goal is to estimate the elasticity of the world crude oil price with

respect to the crude oil exports volume in the regression model. Besides this, we also add the log of natural gas US price because we believe that natural gas is an essential substitute for crude oil. According to economic theory, the prices of two substitutes closely move together in the same direction. Our model's independent variables include the log of motor oil consumption, the log of jet fuel consumption, and the log of world crude oil demand. These three independent variables account for the consumption and demand-side factors that can impact the world crude oil price. Crude oil is an essential raw input for producing fuel for jet and motor oil consumption. The consumption combined with the world crude oil demand can have a considerable impact on the crude oil price for the short term and long term. So, adding these variables into our estimating regression equation can improve the accuracy of estimating OPEC's changing influence on the world crude oil price. The log of the world population and log of world GDP is used as two independent variables because these two factors are two critical contributors to changing the world crude oil price. Controlling these two variables allows us to estimate the impact of the OPEC countries' crude oil exports volume on the world crude oil price accurately. As previously mentioned, the time dummy variables serve as a tool to control the time-specific fixed effects. Our regression analysis is based on the time-series dataset with 41 observations for all the dependent and independent variables from 1979 to 2019.

Results

Given the Regression Results Table in the Appendix section. Our Log-Log regression model passed the overall significance test. The F test statistics is 46.26, and the p-value at the 46.26 test statistics is equal to 0.0000. It supports the alternative hypothesis that at least one of our independent variables is a significant predictor of the dependent variable – log of world crude oil price. The slope coefficient on the variable log of the OPEC crude oil exports is -1.276,

and it is statistically significant at the 5% level of significance. This coefficient indicates the elasticity of world crude oil price with respect to OPEC countries' crude oil exports volume. Given this slope coefficient -1.276, if the OPEC countries' crude oil exports volume (1000b/d) increases by 1 percent, we would expect the world crude oil price ($/bbl) to decrease by 1.276 percent on average. The sign of this slope coefficient is as expected, given the underlying Demand-Supply economic theory in the world crude oil market. As OPEC countries increase their crude oil exports volume, there is more crude oil supply in the world market. This increased the excess supply of crude oil and reduces the world price for crude oil.

On the demand side, the coefficient on the variable log of world crude oil demand is 12.29, and it is statistically significant at a 0.1% level of significance. This result shows that as the world demand for crude oil rises by 1%, we expect the world crude oil price to increase by 12.29% on average. Besides, the coefficient on the variable log of natural gas price aligns with our underlying assumption that natural gas is a substitute for crude oil. The positive slope coefficient of 0.473 is statistically significant at a 1% significance level. It implies that the price of crude oil and natural gas move together in the same direction. One thing to note is that the world GDP can considerably affect the world price of crude oil. The slope coefficient on the log of world GDP is 2.625, and it is statistically significant at a 0.1% level of significance. As the world GDP increases by 1%, we expect that the world crude oil price will rise by 2.625% on average. One possible explanation for this positive coefficient is that the rise in GDP implies an increase in economic activity. This raised economic activity increased the demand for crude oil as well as the crude oil price accordingly.

Interpreting the regression results, we find that the demand factors play a more influential role in determining the world price of crude oil. In other words, OPEC exports' ability to impact world prices is relatively small compared to the combined impact of the demand factors.

Model Evaluation and Diagnostic Tests

We conducted three diagnostic tests for our model: First, the RESET test for the potential model misspecification; Second, the Breusch-Pagan test for heteroscedasticity; Third, the Durbin Watson test for autocorrelation. To be more specific, the RESET test is employed to detect if our regression model has an incorrect functional form. Given the Diagnostic Test Results Table 1 in Appendix 2 section, we fail to reject the null hypothesis that this regression model has no misspecification because the p-value is almost 60%. The large p-value supports that our Log-Log model has no misspecification and is adequate in the context of our study.

On the other hand, Diagnostic Test Results Table 2 in Appendix 3 illustrates the Breusch-Pagan test results. Since the p-value in the Chi-square distribution is very large, approximately 81%, we fail to reject the null hypothesis of the Breusch-Pagan test that our regression model has constant variance of the error terms. So, we can conclude that our Log-Log regression model does not have heteroscedasticity.

Lastly, the Durbin Watson test is used to check for autocorrelation in our time-series data. The critical d statistic is 2.557 for the upper bound and 0.678 for the lower bound at a 5% level of significance. Given the Diagnostic Test Results Table 3 in Appendix 4, the d statistic (15, 41) for the Durbin Watson test is 2.06. This d statistic locates in the zone of indecision for indecision. Therefore, it is still ambiguous whether our regression model has autocorrelation.

Combining the RESET test result and the Breusch-Pagan test result gives us more certainty that our Log-Log regression model is adequate in measuring the impact of the OPEC countries' crude oil exports volume on the world crude oil price.

Further Discussion: Analyzing OPEC's Ability to Increase Oil Prices

While our regression results show a significant but relatively limited relationship between OPEC exports and the world price of crude oil, further analysis should be carried out to assess how this influence might have changed over time.

Firstly, OPEC's ability to affect oil prices could be decreasing due to the rise of alternative fuels. The rise of substitute fuel sources, like natural gas, increases the price elasticity of demand for crude oil. As identified in our regression results (Appendix 1), the natural gas variable is statistically significant and plays an influential role in affecting crude oil prices as a substitute fuel. Moreover, the emergence of renewable fuel sources that appeal to consumer preferences for sustainability has also negatively affected the demand and elasticity of demand for crude oil (Adelman, 2001). Furthermore, OPEC's efforts to raise oil prices have facilitated the research and development of these alternative energy sources; thus, increasing the viability of crude oil substitutes (Chatzky & Siripurapu, 2020). Therefore, as the OPEC countries face a more elastic demand curve, this reduces the ability for OPEC to affect the world crude oil prices (Godson, 2009).

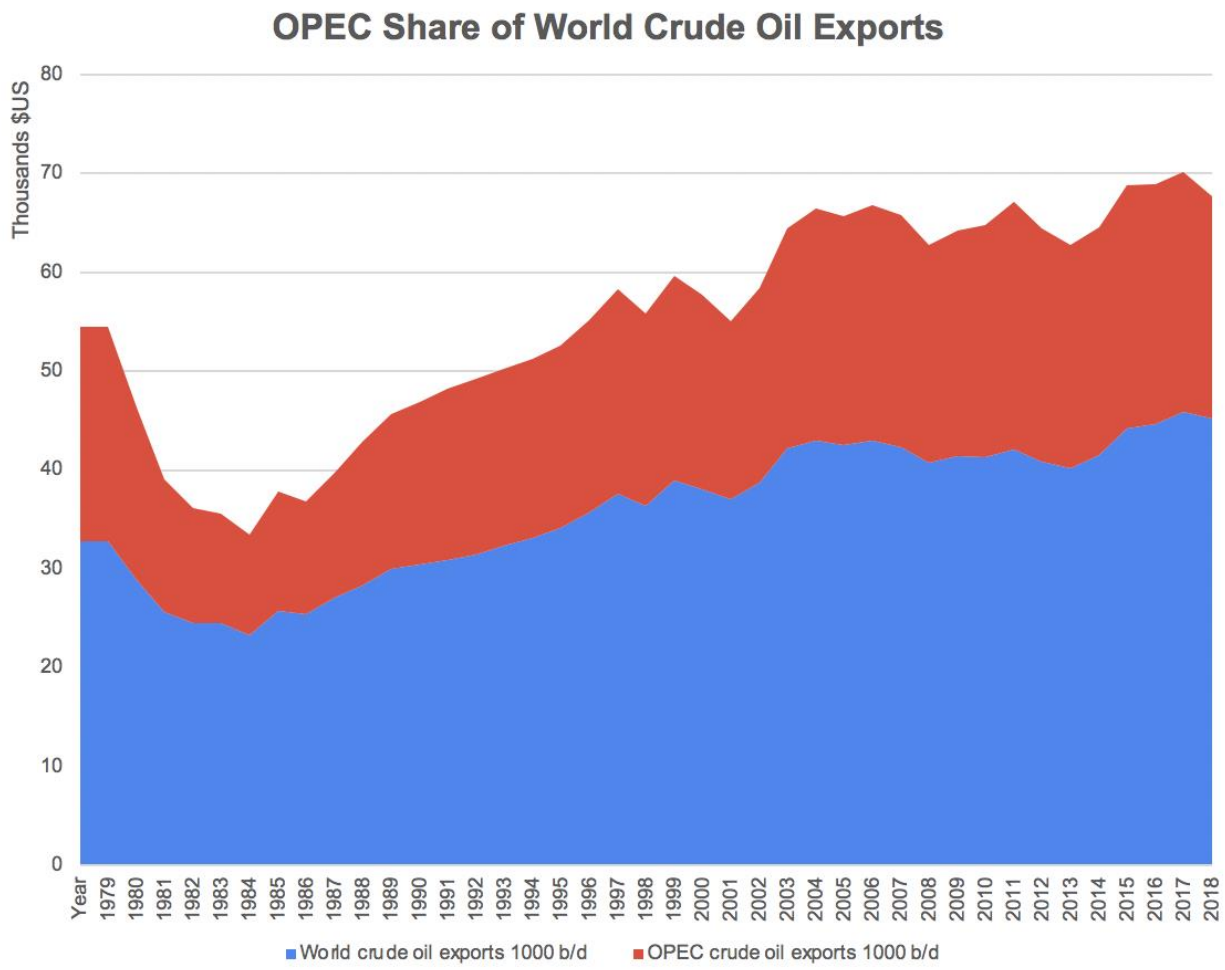

Figure 5: World Crude Oil Exports and OPEC Crude Oil Exports from 1979 to 2018 (Data from OPEC)

Secondly, OPEC's decreasing share of world crude oil exports has reduced the organization's ability to affect crude oil's world price. From Figure 5, we observe that OPEC's share of export in 1979 was approximately 58%. However, this proportion decreased over time to around 36% in 2018. This decreasing share of world exports due to the emergence of other oil-producing nations. In particular, the US has increased its supply of crude oil from shale fracking

(Ansari, 2017). It should be noted that OPEC members form a significant portion of top crude oil exporters (Figure 4) and therefore have clout in determining world prices. However, the organization's efforts to raise prices with production cuts will become less effective due to non-OPEC producers taking advantage of the prevailing high prices to export more (Chatzky & Siripurapu, 2020). Consequently, the increase in the supply of oil has depressed crude oil prices. Therefore, the increasing supply of oil from non-OPEC countries has proven to be an important factor in minimizing OPEC's ability to raise crude oil prices.

Lastly, OPEC's ability to influence oil prices has been hindered by coordination issues within the organization. When OPEC decides to restrict the supply of oil, this drives world prices up. To maintain the higher price level, this requires members to cut back on individual production collectively. However, the behavior between OPEC members can be modeled by game theory as one of a prisoners' dilemma. Evidence suggests that OPEC members have been producing more than their allocated quota (Ayub, 2004). OPEC members are incentivized to cheat and produce over their production limits to take advantage of the prevailing higher prices. However, the lack of collective restraint and coordination would result in declining oil prices (Ayub, 2004). Therefore, OPEC's inability to coordinate its members' individual actions leads to a reduction in OPEC's influence in raising crude oil prices.

Limitations

Our simple regression model utilized five-year dummy variable groups to control time-specific characteristics that evolve over time but are constant across entities. The choice of five-year intervals was not based on economic theory. There is no economic intuition to suggest that characteristics within the oil markets change every five years. The use of the five-year interval

groups was done solely for the purposes of developing a working regression model. Disaggregating the time dummies into smaller interval groups led to insignificant regression results. Therefore, the application of five-year dummy variable groups was chosen as it was the only model iteration that produced significant results. Compared to existing literature that analyzes OPEC's influence over oil prices, our methodology is not a common method to deal with time-series data. The published methodology (Kissawani, 2016) involves running an Engle and Granger test. The data series are tested for stationarity using a Dicky Fuller unit root test, as the presence of non-stationary data leads to spurious results. Next, each series's first difference is tested for stationarity to determine if the non-stationary data series are integrated of the same order. A test for cointegration can be performed. Subsequently, the residuals are tested for stationarity using a Dickey-Fuller test. If the residuals are concluded to be stationary, then the variables are said to be cointegrated, and the coefficients provide an estimate for the long run relationship between the variables.

The second limitation involves only using annual data. The exclusion of a more frequent data series, such as daily data, prevents us from analyzing OPEC's short run influence on crude oil prices. Utilizing daily spot prices would facilitate an assessment of the short-run reaction of oil prices to announcements on OPEC production targets Loutia et al. (2015).

Thirdly, there exists an issue of simultaneity bias in our model. Our model fails to capture the bi-directional effects of variables on both sides of the regression equation. Currently, our regression equation only captures the influence of the right-hand side variables on the left-hand side variables. We assumed that only a change in the explanatory variables could change crude oil's Log price. However, there is a possibility that a difference in the independent variable (Log crude oil prices) can also affect the explanatory variables. For example, high exports would

decrease prices as the influx of oil supply would reduce oil prices in the world market. However, high prices could also increase exports, as high prices incentivize exporters to export more to have a higher profit. Therefore, the bi-directional channel of influence can lead to biased coefficient estimates (Merton, 1968). To deal with the issue of simultaneity bias, an instrumental variable regression should be used (Merton, 1968); however, the use of advanced statistical methodology is beyond the scope of this paper.

Conclusion and Policy Implications

In conclusion, we found evidence that shows the elasticity of the world crude oil price with respect to OPEC countries' crude oil exports volume is negative. This result supports that the increase in OPEC's exports can reduce the world crude oil price. On the other hand, there is still an issue of simultaneity bias that may lead to imprecise estimation in our model. Regarding the policy implications, the negative coefficient on the variable log of OPEC's crude oil exports implies that OPEC countries crude oil exports create an excess supply on the world crude oil market. This excess supply leads to a price reduction in the global crude oil market.

While this coefficient is less than 0, meaning OPEC exports continue to have an effect on global oil prices, we can see hints of a weakening influence. This is because the magnitude of Log World Oil Demand is far larger than Log OPEC Crude Oil Exports. Meaning demand forces outweigh OPEC supply forces and thus raise and decrease world crude oil prices. The reduced influence implies that OPEC, as a cartel, suffers a reduction of market power in the world market.

OPEC can mitigate its dwindling influence by adding more members to the organization. This strategy is aligned with OPEC's formation of OPEC Plus (Quint & Venditti, 2020). The

corporation with large oil producers, such as Russia, boosts OPEC's share of world supply and, therefore, increases its clout in influencing oil prices.

However, OPEC should take caution in its strategy of expanding its partners. Coordination between members remains a problem, as represented by the recent fallout between Russia and OPEC on production cuts (Cohen, 2020). Ultimately, OPEC's influence on world crude oil prices will depend on its ability to attract new members and effectively coordinate production across the organization. Whereby the lack of collective restraint will drive prices back to a more competitive level.

The decreased market power of this cartel makes the pricing mechanism of the crude oil market more competitive. In turn, the competitive market implies an opportunity for intermediate crude oil producers to enter the world market and capture profits. Besides, as the crude oil market becomes more competitive-based, the total social welfare will increase, and it is a positive indicator for the world crude oil market.

Appendix

Appendix1: Regression Results Table

	(1) Log_Crude_oil_price
Log_Jet_consumption	-8.717
	(0.097)
Log_Motor_consumption	-1.895*
	(0.028)
Log_Natural_gas_price	0.473**
	(0.004)
Log_OPEC_crudeoil_exports	-1.276*
	(0.010)
Log_Population	-7.116
	(0.118)
Log_World_GDP	2.625***
	(0.000)
Log_World_oil_demand	12.29***
	(0.001)
Second_5years	-0.358
	(0.128)
Third_5years	-0.0807
	(0.809)
Fourth_5years	-0.206
	(0.624)
Fifth_5years	0.00268
	(0.996)
Sixth_5years	-0.0745
	(0.890)

	(1)
Seventh_5years	0.403
	(0.484)
Last_6years	0.457
	(0.471)
Constant	8.728
	(0.820)
Observations	41
R^2	0.962
Adjusted R^2	0.942
F	47.26

p-values in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Appendix 2: Diagnostic Test Results Table 1

```
Ramsey RESET test using powers of the fitted values of Log_Crude_oil_price
       Ho:  model has no omitted variables
                  F(3, 23) =      0.66
                  Prob > F =      0.5822
```

Appendix 3: Diagnostic Test Results Table 2

```
      Breusch-Pagan / Cook-Weisberg test for heteroskedasticity
               Ho: Constant variance
               Variables: fitted values of Log_Crude_oil_price

               chi2(1)      =     0.06
               Prob > chi2  =   0.8119
```

Appendix 4: Diagnostic Test Results Table 3

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     Durbin-Watson d-statistic( 15,    41) =  2.060337
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