Are Oil and Gas Prices Immune to COVID-19?

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Coronavirus and global society/economy

COVID-19 pandemic has far reaching consequences for our day-to-day activities. The spread of social distancing which was introduced as a measure to fight the virus influenced our families, work and lifestyles. A survey carried out by Statista (2020) between 26 March and 1 April 2020 on a sample of 2900 respondents from China, Germany, the United Kingdom and the United States supports such impact. It turns out that the majority of respondents (ranging from 73% to 84%) stayed at home after the spread of the coronavirus. By doing so, they have avoided public places (61%-73%), public transport (33%-61%) and worked more from home (28%-39%). A lot has also changed in the shopping patterns. People have either changed shopping hours (30%-37%) or even gave up on standard shopping (61%-76%) by choosing its online form (30%-61%), and additionally as a precautionary measure, decided to use less cash (29%-53%).

World economy seems to be also heavily affected by the COVID-19 pandemic especially in terms of capital and tourists flows. As UNCTAD (2020) forecasts, FDI will suffer from downward pressure between -30% to -40% between 2020-2021. Travel restrictions that were introduced all around the world affected firstly and mostly the airline industry. The world number of commercial flights covering commercial passenger flights, cargo flights, charter flights, and some business jet flights, decreased between January 2020 and beginning of April 2020 from 117,000 to 37,000 (Flightradar24, 2020).

SARS-Cov-2 pandemic is an extraordinary case for the world economy for many reasons. The most important one is the fact that for many years the global economy has not experienced external supply shocks. We have rather been used to negative demand shocks that affected business conditions. The COVID-19 pandemic started with a supply shock on global markets as China was forced to reduce its exports. As a consequence, Chinese exports dropped year to year by 17% between January and February 2020 (Market watch, 2020). However, spread of the virus infected other economies as well. With administratively imposed social distancing measures in many countries, demand weakened and number of companies have been temporarily shut down. In this sense COVID-19 started with a negative supply shock and evoked negative demand response.

Coronavirus and energy sector

Similar supply-demand shock mix can be also observed in the energy markets. The situation we are dealing right now is different from any circumstances we have experienced so far. Firstly, because of the shale gas fever that had transformed the energy markets, both oil and gas, and secondly as this is, one of those critical moments – when the global oil demand in 2020 is forecasted to contract for the first time since the global recession of 2009 (IEA, 2020). This dramatic energy landscape is built upon an on-going dispute between OPEC+ countries and Russia on crude oil supply.

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The goal of this study is to check how global COVID-19 pandemic influenced oil and gas prices in the short term. This research is of topic-similarity to the paper of Kelley and Osterholm (2008) who investigated the impact of the influenza pandemic on energy markets. They specifically looked at the U.S. market and the effects for coal supply chains and electricity production. It is understandable that during pandemics electricity production usually plays a role as it is vital to meet the energy needs of society. In this sense country and its inhabitants enjoy reliable and undisrupted energy supplies. At the same time, it is also true that one of the most severe pandemics such as Spanish flu (1918) occurred when hydrocarbons were not that widespread in use. Contemporary disease outbreaks such as SARS (2002) and MERS (2012) were mainly regionally limited, respectively to Asian and Persian Gulf countries. Notable difference was A/H1N1, which spread across the globe in 2009. But swine flu, manifested lower than SARS and MERS mortality rates. The COVID-19 situation could be different because even though the mortality rates are lower than SARS and MERS, it is highly infectious and the virus spread is global.

A closer look at the oil and gas markets between Jan. 23 and March 30 brings the picture of hydrocarbon prices within the COVID-pandemics. In this period, prices of Brent and West Texas Intermediate (WTI) were slumping. The former recorded a drop from 61.26 USD/bbl to 19.07 USD/bbl and the latter from 55.51 USD/bbl to 14.10 USD/bbl (CEIC, 2020). At the same time the reference OPEC basket price decreased from 63.26 USD/bbl to 21.66 USD/bbl (OPEC, 2020). However, the natural gas price did not drop that much. As U.S. Energy Information Agency reports, Henry Hub spot price in the respective period changed from 1.95 USD/million Btu to 1.65 USD/million Btu (EIA, 2020). Therefore, it is substantive to check whether oil and gas prices were affected by COVID-19 outbreak.

Methods and data

To identify if the increasing COVID-19 cases in the U.S. have an influence on the crude oil and natural gas prices, we applied the Auto-Regressive Distributive Lags (ARDL) approach proposed by Pesaran et al. (2001) on number of U.S. and world COVID-19 cases and energy prices. The period investigated in this study is from 21 Jan. 2020 to 30 March 2020. 21 Jan. 2020 is the initial time period when the COVID-19 case became apparent in the U.S..

	Level				First differences			
	PP	KPSS	LS1	LS2	PP	KPSS	LS1	LS2
LnWTI	-1.289	0.217 ***	-4.901	-5.092	-9.262 ***	0.100	-9.573 ***	-10.158 ***
LnBrent	-1.181	0.209 **	-2.896	-4.105	-7.755 ***	0.071	-7.985 ***	-9.384 ***
LnNatural gas	-2.855	0.102	-3.880	-4.778	-6.294 ***	0.047	-6.684 ***	-7.018 **
LnCOVID-US	-0.469	0.218 ***	-2.493	-3.678	-6.690 ***	0.107	-3.310	-6.655 **
LnCOVID-World	-3.612 **	0.179 **	-1.245	-2.712	-4.292 ***	0.232 ***	-5.464 ***	-5.649
LnDJUSAU	-1.935	0.192 **	-3.744	-6.222 *	-6.896 ***	0.081	-7.380 ***	-8.250 ***
LnDWCELC	-2.157	0.178 **	-3.827	-6.010 *	-8.257 ***	0.086	-10.190 ***	-10.190 ***

Table 1 Unit root tests
*Note: PP, and KPSS unit root tests include only a constant and trend ***, **, and * denote significance at 1%, 5%, and 10% respectively. LS1 and LS2 represent the Lee-Strazicich t-statistics with one and two structural breaks.*

The reason of choosing the ARDL method is because this method can be used to identify both short-run and long-run relationships between time series variables when their order of integration is different. For example, the conventional cointegration methods require the variables of interest to be all integrated of order one I(1)), but in the ARDL method the variables can be either I(1) or I(0). Furthermore, ARDL method has its strength in omitted variables and auto-correlation issue in time series data and can provide valid results even when the sample size is small (Ifa and Guetat, 2018). We applied the PP and KPSS tests, and the Lee-Strazicich tests with one and two structural breaks to identify the order of integration of all our test variables.

To investigate the relationship between the energy price and COVID-19 cases, we created the following two log-linear models for crude oil and natural gas:

Model 1

$$\text{Ln(Oil price)}=c+\beta_1\,\text{COVID19}+\beta_2\,\text{Ln(gas price)}+\beta_3\,\text{LnDJUSAU}+e_t \quad (1),$$

Model 2

$$\text{Ln(Gas price)}=c+\beta_1\,\text{COVID19}+\beta_2\,\text{Ln(WTI price)}+\beta_3\,\text{LnDWCLEC}+e_t \quad (2),$$

where is either the U..S. and World total number of COVID-19 cases, DJUSAU is the Dow Jones U.S. Automobiles Index, DWCLEC is the Dow Jones U.S. Electricity Total Stock Market Index, and is the white noise error term. For the crude oil model, we tested the model for both cases for WTI and Brent crude oil prices. For the natural gas model, we investigated the model with the NYMEX Henry Hub futures price. The gas price and the DJUSAU in equation (1) and the WTI crude oil price and the DWCLEC in equation (2) are included in the models as fixed variables to capture the effects of factors other than the COVID-19 cases that could influence the oil and gas prices. In both Models 1 and 2, we tested the effects of the COVID-19 cases for the U.S. and global total numbers.

First, we estimated the simple ARDL, and second, we performed the ARDL bounds F-test for cointegration. Finally, we evaluated the conditional error correction ARDL models for the oil and gas price models. All models have been tested for the serial correlation test with the Breusch-Godfrey test and the parameter stability is tested with the CUSUM test.

The WTI and Brent crude oil prices are the daily USD per Barrel prices and the Henry Hub natural gas price is the daily USD per 1 million British thermal unit (MMBtu) price. All these daily prices are obtained from the Markets Insider site. The data for the U.S. daily COVID-19 case (COVID-U.S.) and the global daily COVID-19 case (COVID-World) are from the World Health Organization (WHO) and the European Centre for Disease Prevention and Control (ECDC). Finally, DJUSAU and the DWCLEC are quoted from the ADVFN website.

Results

To confirm the level of integration of the variables of our interest, we performed the PP, KPSS, and the Lee-Strazicich unit root tests. The stationarity tests presented in Table 1 indicate that all the variables

	WTI and COVID-US		WTI and COVID-world	
Variables	Coef.	t-stat	Coef.	t-stat
Intercept	0.525	1.311	-0.999 ***	-3.338
LnWTI(-1)	0.263 **	2.330	0.367 **	2.671
LnWTI(-2)	na		0.227 *	1.830
LnCOVID-US	-0.047 ***	-5.107	na	
LnCOVID-World	na		-0.030 ***	-2.856
Lngas	0.090	0.417	0.104	0.416
LnDJUSAU	0.436 ***	5.431	0.506 ***	4.610
	Brent and COVID-US		Brent and COVID-world	
	Coef.	t-stat	Coef.	t-stat
Intercept	0.759 *	1.974	-0.507 *	-1.823
LnBrent(-1)	0.408 ***	3.560	0.687 ***	7.468
LnCOVID-US	-0.041 ***	-4.506	na	
LnCOVID-World	na		-0.061	-1.132
LnCOVID-World(-1)	na		0.033	0.686
Lngas	-0.148	-0.753	-0.014	-0.062
LnDJUSAU	0.325 ***	4.327	0.367 ***	3.401
	Gas and COVID-US		Gas and COVID-world	
	Coef.	t-stat	Coef.	t-stat
Intercept	-0.820	-1.345	-0.588	-1.032
Lngas(-1)	0.773 ***	5.217	0.763 ***	5.016
Lngas(-2)	-0.227	-1.519	-0.231	-1.586
LnCOVID-US	0.013	0.911	na	
LnCOVID-US(-1)	0.015	0.799	na	
LnCOVID-US(-2)	-0.028 **	-2.103	na	
LnCOVID-World	na		-0.002	-0.509
LnCOVID-World(-1)	na		na	
LnWTI	0.031	0.588	0.021	0.581
LnDWCELC	0.119	1.459	0.100	1.195

Table 2 ARDL estimations
*Note: *** and ** denote significance at 1% and 5% respectively.*

Model	F-stat.
WTI vs COVID-US	16.21 ***
WTI vs COVID-World	8.60 ***
Brent vs COVID-US	10.12 ***
Brent vs COVID-World	4.69 **
Gas vs COVID-US	5.91 ***
Gas vs COVID-World	5.35 **

Table 3 Bounds F-test for cointegration
*Note: *** and ** denote significance at 1% and 5% respectively*

except the world total COVID-19 (COVID-World) cases are I(1). The Lee-Strazicich with one structural break and the PP test suggests that COVID-World is either I(1) or I(0). Hence, all our test variables satisfy the precondition of ARDL.

Table 2 depicts the results of the ARDL estimation. The optimal number of lag length of the ARDL models is determined with the AIC by setting the maximum lag length to four. The two models in the top of the table illustrate the results of the effects of the U.S. and world total COVID-19 cases on the WTI crude oil prices. It is discernible from the table that increased COVID-19 cases in the U.S. and World both had negative impacts on the WTI crude oil price. Similarly, the result of the first model in the middle of the table suggests that the U.S. COVID-19 cases negatively affected the Brent crude oil. Finally, the natural gas models in the bottom of the table indicate that both the U.S. and World COVID-19 cases did not have a statistically significant influence on the gas price.

These contrastive result between the crude oil and natural gas markets might be reflecting the difference in their use. Since crude oil is more used for automobile or jet fuels compared to natural gas, it could be that the decreased number of people using automobile and airplanes after the increase in the COVID-19 cases had some impacts on the crude oil prices.

Table 3 shows our results of the ARDL bounds test for cointegration. The results indicated that in all our models the F-statistics were higher than the upper-bound critical values at the 5% level. This indicates that both the crude oil and natural gas prices are cointegrated with the U.S. and World COVID-19 cases. Finally, Table 4 illustrates the results of the conditional error correction ARDL estimations. It is observable that the same distinctions on the effects of the COVID-19 cases on the prices hold between the crude oil and natural gas models. The COVID-19 cases have negative impacts in the crude oil models, but such effects are not apparent in the natural gas models.

	WTI and COVID-US		WTI and COVID-world	
Variables	Coef.	t-stat	Coef.	t-stat
Intercept	0.525	1.311	-0.999 ***	-3.338
LnWTI(-1)	-0.737 ***	-6.535	-0.405 ***	-4.377
D(LnWTI(-1))	na		-0.227 *	1.830
LnCOVID-US	-0.047 ***	-5.107	na	
LnCOVID-World	na		-0.030 ***	-2.856
Lngas	0.090	0.417	0.104	0.416
LnDJUSAU	0.436 ***	5.431	0.506 ***	4.610
	Brent and COVID-US		Brent and COVID-world	
	Coef.	t-stat	Coef.	t-stat
Intercept	0.759 *	1.974	-0.507 *	-1.823
LnBrent(-1)	-0.592 ***	-5.160	-0.313 ***	-3.408
LnCOVID-US	-0.041 ***	-4.506	na	
LnCOVID-World(-1)	na		-0.028 **	-2.588
D(LnCOVID-World)	na		-0.061	-1.132
Lngas	-0.148	-0.753	-0.014	-0.062
LnDJUSAU	0.325 ***	4.327	0.367 ***	3.401
	Gas and COVID-US		Gas and COVID-world	
	Coef.	t-stat	Coef.	t-stat
Intercept	-0.820	-1.345	-0.588	-1.032
Lngas(-1)	-0.454 ***	-3.719	-0.469 ***	-3.855
LnCOVID-US(-1)	0.000	-0.008	na	
D(Lngas(-1))	0.227	1.519	0.231	1.586
D(LnCOVID-US)	0.013	0.911	na	
D(LnCOVID-US(-1))	0.028 **	2.103	na	
LnCOVID-World	na		-0.002	-0.509
LnCOVID-World(-1)	na		na	
LnWTI	0.031	0.588	0.021	0.581
LnDWCELC	0.12	1.46	0.10	1.20

Table 4 Conditional error correction ARDL estimations
*Note: ***, **, and * denote significance at 1%, 5%, and 10% respectively.*

The Breusch-Godfrey test performed to identify the serial correlation in the model suggested that except for the WTI crude oil model with the world COVID-19 cases, the models did not contain the serial correlation issue. The CUSUM diagnostic test for parameter stability confirmed that all our estimated coefficients satisfy the stability condition at the 5% significance level.

Conclusions

COVID-19 will transform energy markets, and it already seems to be causing effects on the oil market. Our study proves that increased COVID-19 cases in the U.S. and world both had negative impacts not only on the WTI but also on the Brent crude oil price. Finally, our natural gas models indicated that both the U.S. and World COVID-19 cases did not have a statistically significant influence on the gas price.

Possible explanations of this relationship include a number of reasons. Firstly, when it comes to the U.S., due to the beginning of the covid-19 outbreak in March 2020, precise influence over gas prices might have been not recognized at the moment this study was prepared. Secondly, world natural gas prices have already been low enough due to market fundamentals. Mild winter, huge expansion of world LNG capacity and

increased storage levels pushed prices to its record low tracks. In January 2020, the Henry Hub spot price remained below $2 per mmbtu reflecting its worst levels of $1.6 per mmbtu in 1995 (Dewar, Vazquez and Bori, 2020). Another possible explanation for the lack of COVID-19 influence over gas prices might be the fact that natural gas prices react differently in various time horizons. As Brown and Yücel (2007) prove natural gas prices are anchored in a long-term relationship with crude oil prices, but the short-run dynamics can result in considerable variation in relative natural gas and crude oil prices. It might be that natural gas prices within our model (which depicts short term relationship) did not have enough "time" to adjust to market changes. It is probable, that COVID-19 footprint over the gas prices will be revealed in the coming months as demand for LNG in Europe will further decrease and will lead to oversupply of gas.

But there are also forecasts (Bakx, 2020) that natural gas will take advantage of plummeting oil prices as mainly in the U.S., since in the U.S., most of its natural gas is produced from oil wells. Contrary to gas prices, the COVID-19 influence over the oil market was visible in the last months. People stopped travelling using planes as Pew Research Center (2020) claims 93% of the world's population (7 bln people) as of March 31, 2020 lived in countries with travel restrictions and 39% (3 billion people) lived in countries with borders completely closed. Social distancing in many countries changed work-life patterns leaving cars idle and decreasing frequency of public transport and thus decreasing demand for refined crude oil products. In summary, the energy sector will change due to COVID-19, apart from short term shock consequences, and there will be some long-term changes in the demand patterns (UAEE, 2020). That will not only affect hydrocarbon markets, but also renewables, as global supply chains have already been disrupted.

Our study as any other research has its limitations. Firstly, due to sample size and scope, our results provide information on aggregated world and disaggregated U.S. level. We have not carried out the analysis for separate European countries, such as Italy, Spain or even UK (in the first days of April), that at the time of article writing have been heavily infected with coronavirus. The situation has been changing within days during article preparation. Secondly, since we have not included in our research any variable reflecting Russia-OPEC+ dispute as we believe that this phenomenon might have been captured by fixed variables other than COVID-19 cases. In ARDL oil price model these were: gas price and the DJUSAU and the respective gas price model: the WTI crude oil price and the DWCLEC. Allowing for time horizon, geographical scope, dispute specific variable extension, might be the next research step.

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