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COVID-19 and Energy

COVID-19: The reaction of US oil and gas producers to the pandemic

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In this paper, we examine the reaction of US oil and gas producers to the COVID-19 pandemic. We find that firms react to COVID-19 heterogeneously. The pandemic significantly explains 28% of returns and 27% of return volatility. These findings are qualitatively consistent when using competing COVID-19 indicators.

I. INTRODUCTION

The COVID-19 pandemic—which is caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2)—has halted economic activities globally (Iyke & Ho, 2020; Narayan, 2020; Phan & Narayan, 2020).[1] In this paper, we examine how oil and gas firms reacted to the COVID-19 pandemic. In theory, the impact of the COVID-19 pandemic on the oil and gas industry seems obvious. The disruption in demand vis-à-vis excess supply will lead, *inter alia*, to declines in oil and gas prices, supply, and firm revenues.[2] Consistent with this possibility, Qin et al. (2020) show that the COVID-19 pandemic caused a reduction in oil demand leading to a decline in oil prices. Similarly, Gil-Alana and Monge (2020) find that the COVID-19 outbreak made the oil market inefficient, and, in turn, oil prices difficult to forecast. An alternative credible explanation is that the rate of COVID-19 infections and deaths created fear among investors, and this had implications for stock valuation. Pessimism about the future of the economy (or a negative investor sentiment) leads to a significant decline in trading activities, and stock prices. Chen, Chen, and Lee (2013) find that optimism causes overvaluation while pessimism causes undervaluation of industry returns. They note that the impact of sentiments may vary across stocks, consistent with theory.[3] Liu, Wang, and Lee (2020), on the other hand, find that the COVID-19 pandemic had a positive impact on crude oil and stock returns.

What remains unclear is how individual firms in the oil and gas industry reacted to the COVID-19 pandemic, which we proxy using deaths per million (*TDM*). In this regard, we provide novel evidence on the firm-specific impact of the pandemic on returns of oil and gas firms. Our empirical analysis focuses on 90 US oil and gas firms for two reasons. First, these firms have consistent data as compared with oil and gas firms of other countries. Second, for several years now, the US consistently emerged as the top producer of oil and gas and based on the most current ranking, the country produced 19% share of world total oil and gas (or 19.51 million barrels per day) in 2019.[4]

Using daily data over the period of 21 January 2020 to 5 May 2020, we unravel the following findings. First, the influence of COVID-19 on returns is statistically significant in 25/90 firms (or 28% of the firms). Second, COVID-19 can significantly explain return volatility in 24/90 firms (or 27% of the firms). Third, firms return and volatility react to COVID-19 heterogeneously. The effect varies from negative to positive, suggesting that the reaction of the oil and gas stocks to the pandemic is firm-specific. In fact, some stocks do not show a statistically significant reaction to the pandemic at all. Our results are qualitatively consistent when using alternative measures of COVID-19 and controlling for the Russia–Saudi Arabia oil price war of May to April 2020. Narayan and Sharma (2011) show that turnover rate and size dictate firms' reaction to oil prices. They show, for instance, that larger firms tend to react negatively to oil price increase, while smaller firms tend to react positively. Our finding could be driven by the turnover rate and size effects, which we do not explore. We leave this aspect of research to future studies.

Our contribution relates to the effect of COVID-19 on returns and volatility—this aspect is less understood given that the pandemic-based research is at a nascent stage. Ali et al. (2020), Phan and Narayan (2020) and Liu, Wang, and Lee (2020), for instance, study this issue but focus on aggregate stock market reaction to COVID-19. Studies, such as Gil-Alana and Monge (2020), Narayan (2020), and Qin et al. (2020), examine the effect of the pandemic on oil prices, while others, such as Iyke (2020), examine the effect of the pandemic on foreign exchange markets. We add to these studies on COVID-19 and the financial system by showing how the pandemic has influenced firm returns and return volatility for a representative sample of 90 US oil and gas firms.

The paper proceeds as follows. Section II presents the data and results. Section III concludes the paper.

II. DATA AND RESULTS

We collect daily COVID-19 data on the total number of

1 See https://www.who.int/emergencies/diseases/novel-coronavirus-2019/technical-guidance/naming-the-coronavirus-disease-(covid-2019)-and-the-virus-that-causes-it for the naming of the disease.

2 See also Iyke (2019), for a related explanation.

3 See Baker and Wurgler (2006) for the theoretical exposition.

4 This information is available at the Energy Information Administration's website at https://www.eia.gov/todayinenergy/detail.php?id=40973 and https://www.eia.gov/tools/faqs/faq.php?id=709&t=6.

deaths per million (*TDM*) from *Our World in Data*.[5] We retrieve the stock data for each of the 90 US oil and gas producers from https://finance.yahoo.com/. The 90 US oil and gas producers are chosen following the guidance provided by https://money.usnews.com/investing/stocks/oil-gas-production; the complete list can be found at this link and is available upon request. Using the daily closing price (CP), we calculate stock returns as $SR_t = [ln(CP_t) - ln(CP_{t-1})] * 100$, where *ln* is the logarithm operator. The sample period is from 21 January 2020 to 5 May 2020.

Our preliminary analysis suggests that seven out of the 90 oil and gas firms (or 8% of the firms) recorded positive stock returns, while the remaining 83 firms (or 92% of the firms) recorded negative stock returns during the COVID-19 outbreak.[6] Those seven firms recorded an average stock return of 0.30% whereas the other 83 firms recorded an average return of -0.97%. Based on the skewness, kurtosis, and Jarque–Bera statistics, we find that stock returns and the COVID-19 indicators are non-normally distributed. We find evidence of unit roots for the COVID-19 indicators but not for stock returns. This does not rule out persistency in stock returns. In fact, the autoregressive coefficient of order one (AR(1)) indicates that 22/90 stock returns are persistent. Both the ADF and the AR(1) test results show that the COVID-19 indicators are highly persistent. Finally, the AR conditional heteroskedasticity (ARCH) effect test results suggest evidence of "ARCH" effects in 7/90 returns.

In theory, several factors can predict stock returns and return volatility. The external habit formation theories, for instance, emphasize that stock returns and volatility are determined by the surplus consumption ratio (Corradi et al., 2013). Consistent with theory, the commonly utilized determinants of stock returns and return volatility are interest rates, dividend yields, and consumption–wealth ratio (see Iyke & Ho, 2020). From the sentiment literature (see Baker & Wurgler, 2006), we learn that waves of sentiment influence cross-sectional returns. Consistent with this view, Narayan (2019) demonstrates that positive and negative oil news predict stock returns in 12 countries via the discount rate channel. Similarly, Narayan (2020) shows that positive and negative oil news and COVID-19 information can predict oil prices. Our argument is that the negative sentiments around the COVID-19 pandemic—the fear and panic it created—should have affected stock returns and volatility. Our argument is in line with the sentiment theory and evidence of stock price discovery. However, the role of pandemics in shaping stock returns and volatility is not yet analysed by the literature. In response, a growing literature now focuses on pandemics as a competing determinant of stock returns and volatility (Ali et al., 2020; Liu et al., 2020).

Our framework is motivated by the sentiment—stock return literature. We control for persistency and heteroskedasticity of returns, consistent with Iyke and Ho (2020). Financial markets are known to react to news asymmetrically (Iyke, 2020). For example, Iyke and Ho (2019) show that negative news induces higher volatility as compared with positive news. To model this attribute of financial markets, as well as the features of our data, we use the exponential generalised ARCH (EGARCH) model. Specifically, we fit the following EGARCH(1,1) model:

$$SR_t = \gamma_0 + \gamma_1 SR_{t-1} + \gamma_2 \Delta TDM_t + \epsilon_t \qquad (1)$$

where ΔTDM is the first difference of TDM, to remove unit roots in this variable; γ_i are parameters of the mean equation; and ϵ_t is the error term whose conditional variance, σ_t^2, takes the following form

$$\ln \sigma_t^2 = \overline{\rho} + \alpha_1 \ln \sigma_{t-1}^2 + \beta_1 \left| \frac{\varepsilon_{t-1}}{\sigma_{t-1}} \right| + \tau_1 \frac{\varepsilon_{t-1}}{\sigma_{t-1}} + \delta \Delta TDM_t \qquad (2)$$

where $\overline{\rho}$, α_1, β_1, τ_1, and δ are parameters; ln and || are the natural logarithm and absolute value operators, respectively.

Table 1, which reports estimates from Eqs. (1) and (2), shows that COVID-19 influences stock returns of oil and gas firms. In 25/90 firms (or 28% of the firms) the effect on returns is statistically significant. Similarly, the estimates show that COVID-19 significantly explains return volatility in 24/90 firms (or 27% of the firms). A careful look at the estimates suggests that the impact of COVID-19 on return and its volatility are heterogenous across the oil and gas firms, varying from negative to positive. That is, the oil and gas stocks react differently to the pandemic. Some stocks do not show a statistically significant reaction to the pandemic. In their study, Narayan and Sharma (2011) find that size and turnover rate explain the different responses of firms to changes in oil prices. For example, they find that smaller firms respond positively to oil price increases whereas larger firms respond negatively. In our framework, firm turnover rate and size may be driving the heterogenous reaction of returns and volatility to the COVID-19 pandemic, which we do not explore. Future studies should explore these effects.

We perform three sets of robustness tests and withhold the test results to conserve space. First, we control for the Russia–Saudi Arabia oil price war of 8 March 2020—which crashed oil prices by 30% and remains the biggest one-day decline in oil prices since the Gulf war (Raval & Sheppard, 2020). To capture this, we introduce in Equations (1) and (2) a dummy variable, which equals one from 8 March to 12 April 2020 and zero otherwise.[7] The estimates suggest that COVID-19 can explain 30/90 (or 33%) and 47/90 (or 52%) of firm returns and return volatility, respectively. Thus, the pandemic explains returns and volatility better when the relation between returns and COVID-19 is modelled by controlling the oil price war.

Second, we replicate the analysis by measuring the COVID-19 pandemic using the total number of daily deaths, *TD*. The estimates suggest that COVID-19 can explain 20/90 (or 22%) and 30/90 (or 33%) of firm returns and return volatility, respectively. Third, we repeat the estimation using the total daily number of deaths per million population for the entire world from COVID-19. These estimates suggest that the impact of COVID-19 is statistically significant for 24/90 (or 27%) firm returns and for 24/90 (or 27%) return volatility. Overall, these results are qualitatively consistent when using the two competing COVID-19 indicators.

III. CONCLUSION

In this study, we examine the reaction of US oil and gas firms to the COVID-19 pandemic. We found a heterogenous reaction of firms to COVID-19. The pandemic significantly explains 28% of returns and 27% of return volatility. We

5 The data is available here https://ourworldindata.org/coronavirus-source-data.

6 The summary statistics are withheld due to space consideration and are available upon request.

7 The Russia–Saudi Arabia oil price war ended on 12 April 2020 (Raval & Sheppard, 2020).

Table 1: Stock return and volatility reaction to total deaths per million from COVID-19

Company (Stock)	Mean equation	*p*-value	Variance equation	*p*-value
USEG	0.050	0.490	-0.008	0.161
CEI	0.003	0.975	-0.049	0.199
CHK	-0.055	0.835	0.009	0.222
MCEP	-0.166	0.092	0.000	0.993
OVV	0.456	0.054	0.073	0.343
MCF	0.195	0.319	0.015	0.269
CRK	0.250	0.003	-0.110	0.026
HES	0.170	0.127	0.000	0.983
CEO	0.093	0.034	-0.008	0.412
SWN	0.209	0.237	-0.027	0.698
MXC	0.102	0.452	-0.008	0.263
CNQ	-0.008	0.906	0.019	0.130
COP	0.008	0.921	0.028	0.062
BCEI	-0.008	0.927	0.006	0.674
DMLP	0.129	0.239	0.019	0.460
EPSN	0.037	0.021	-0.018	0.000
RRC	0.438	0.002	-0.008	0.333
NRT	0.206	0.153	-0.010	0.056
EQT	0.215	0.045	-0.004	0.896
ZN	0.121	0.101	-0.110	0.035
PXD	0.185	0.017	0.123	0.003
SBR	0.029	0.714	0.001	0.937
HUSA	0.119	0.496	0.075	0.085
CRT	0.197	0.078	-0.012	0.153
EOG	-0.095	0.000	0.059	0.045
PNRG	-0.059	0.589	-0.002	0.859
WTI	0.246	0.002	-0.003	0.838
TGC	0.038	0.632	-0.011	0.196
CVE	0.035	0.797	0.012	0.149
CXO	0.021	0.807	0.022	0.259
GPRK	-0.050	0.472	-0.003	0.850
EGY	0.049	0.575	0.003	0.741
MR	0.465	0.030	0.062	0.375
MUR	0.175	0.086	0.012	0.366
MGY	0.240	0.211	0.007	0.662
WPX	0.069	0.614	0.019	0.679
MTR	-0.059	0.613	-0.012	0.453
PE	-0.061	0.509	0.032	0.093
EPM	0.130	0.237	0.005	0.787
GBR	-0.045	0.825	-0.025	0.000
DVN	0.100	0.509	0.012	0.394
BSM	0.077	0.594	-0.008	0.384
NOG	0.107	0.218	-0.003	0.789
VOC	0.039	0.767	0.150	0.042
BRY	0.238	0.177	0.007	0.663
CPG	0.113	0.397	0.020	0.126
NBL	0.060	0.647	0.020	0.179

Company (Stock)	Mean equation	*p*-value	Variance equation	*p*-value
BRN	0.111	0.226	-0.203	0.000
MTDR	0.227	0.083	0.027	0.083
APA	0.060	0.622	0.019	0.350
XEC	0.140	0.243	0.002	0.882
FANG	0.150	0.295	-0.005	0.590
MRO	0.144	0.362	0.126	0.010
AR	0.749	0.009	0.035	0.605
ENSV	-0.091	0.490	0.026	0.000
CLR	0.422	0.005	0.062	0.443
PDCE	0.007	0.955	0.006	0.778
ERF	0.206	0.024	0.010	0.418
OXY	0.087	0.222	0.005	0.727
FLNG	0.172	0.119	-0.010	0.242
ECT	0.206	0.045	0.019	0.075
PHX	0.043	0.753	0.009	0.602
PER	-0.055	0.580	-0.001	0.940
TGA	0.021	0.838	0.011	0.602
VET	0.080	0.593	0.009	0.402
KOS	0.295	0.121	-0.005	0.433
SBOW	0.250	0.226	0.029	0.505
LPI	0.651	0.000	0.109	0.061
NEXT	0.045	0.492	-0.011	0.448
SM	0.469	0.023	-0.005	0.654
GPOR	0.678	0.002	0.011	0.677
REI	0.596	0.001	0.155	0.035
ROYT	0.072	0.554	-0.020	0.415
LLEX	-0.036	0.728	-0.063	0.421
SD	0.395	0.000	0.214	0.000
PVAC	0.528	0.007	0.032	0.415
LONE	0.106	0.504	-0.003	0.908
DNR	-0.174	0.305	0.033	0.014
BTE	-0.042	0.658	0.026	0.134
HPR	0.274	0.113	0.008	0.493
GTE	0.157	0.425	-0.002	0.766
QEP	-0.095	0.542	0.052	0.000
OAS	0.001	0.996	0.065	0.187
CPE	-0.102	0.249	-0.080	0.162
CDEV	1.058	0.000	-0.029	0.000
XOG	0.140	0.497	-0.003	0.849
CRC	0.053	0.462	0.063	0.000
WLL	0.106	0.315	-0.080	0.043
CHAP	0.164	0.558	-0.002	0.909
UNT	0.079	0.687	-0.001	0.988

The table shows estimates of the EGARCH(1,1) model: $SR_t = \gamma_0 + \gamma_1 SR_{t-1} + \gamma_2 \Delta TDM_t + \epsilon_t$, where ΔTDM is the first difference of TDM; γ_i are parameters of the mean equation; and ϵ_t is the error term whose conditional variance, σ_t^2, takes the form $\ln \sigma_t^2 = \overline{\rho} + \alpha_1 \ln \sigma_{t-1}^2 + \beta_1 \left| \frac{\epsilon_{t-1}}{\sigma_{t-1}} \right| + \tau_1 \frac{\epsilon_{t-1}}{\sigma_{t-1}} + \delta \Delta TDM_t$, where $\overline{\rho}$, α_1, β_1, τ_1, and δ are parameters; $\ln$ and $\|$ are the natural logarithm and absolute value operators, respectively. In the mean and variance equations, we report the coefficients, γ_2 and δ, and their *p*-values. The sample is from 21 January 2020 to 5 May 2020.

demonstrate that our findings survive robustness tests. The heterogeneous reaction of firms could be driven by firm-specific attributes, such as size and turnover rate, which we did not model. Future studies could extend our study by analysing the role of these attributes in explaining the heterogeneous reaction of firms to COVID-19.

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FIGURES, TABLES, AND SUPPLEMENTARY MATERIALS

Dataset

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