

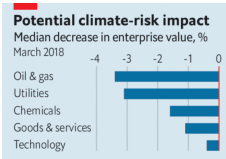
The systemic risk of US Oil and Natural Gas companies

M.Caporin, F. Fontini and R. Panzica

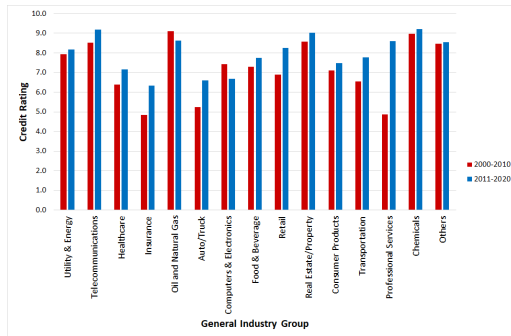
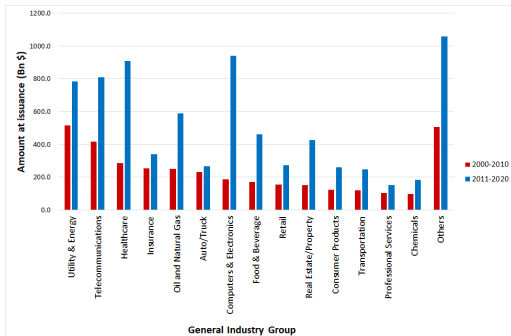
Disclaimer: The content of the paper and this presentation does not necessarily reflect the official opinion of the European Commission , July, 2022

Motivation

- ▶ The US oil and gas upstream production sector soared from 2000 to 2021:
 - ▶ US crude oil yearly production doubled, from 2.13 to 4.08 Gigabarrels
 - ▶ The natural gas production moved from 19.18 to 33.49 trillion cubic feet
- ▶ The shale oil share spurred from 8% to 65% from 2011 to 2021
- ▶ The shale gas share increased from 30% to 86% from 2011 to 2021
- ▶ Bond issuances to finance drilling activities with low credit rating
- ▶ Oil and gas companies could be more affected by climate risk



Background



- ▶ The Oil and Natural Gas companies raised the issuances by 134%, reaching 589 Bn\$ from 251 Bn\$
- ▶ It was less creditworthy in 2000-2010 with 9.1 of weighted averaged score, which decreased to 8.6 in 2011-2021
- ▶ According to Moody's \$123 Billion in debt will expire between 2020-2024

Research questions and preview of the results

- ▶ *Could the US Oil and Natural Gas sector turmoil threaten the stability of financial system?*

We show that the company's losses, as summarized by the VaR at 95% and 99%, have contributed to the systemic risk

- ▶ *Is the systemic impact of this sector increased with the development of the shale extraction technology(2011-2021)?*

The results show the role played by the shale extraction in changing the risk structure of the oil and gas companies. We observe that the impact in the most recent decade is sensibly increasing compared to 2000-2010.

Literature

► Drivers of US Oil and Gas sector

Exchange rates, crude oil prices and interest rates have large and significant impact on stock price returns Sadorsky (2001). El-Sharif et al. (2005) introduced the gas price, Apergis et al.(2021) the number of rigs. Howard and Harp Jr (2009) added companies characteristic as ratios, debt with the drivers mentioned before.

► Decarbonisation and transition risk

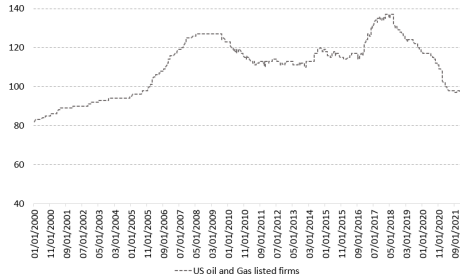
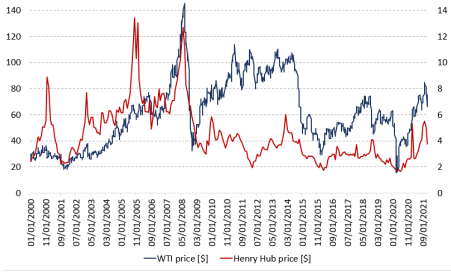
The sign of the Paris Agreement (PA) had a large negative impact for the Oil and Gas sector Diaz-Rainey et al. (2021). After PA the high carbon stocks became less appealing for the investors Monasterolo and De Angelis (2020).

► Systemic risk and Oil and Natural Gas companies

Lupu et al.(2021) found that the European energy companies enhanced the systemic risk. Tiwari et al.(2020) using $\Delta CoVaR$ and MES show that oil price dynamics contributes to the G7 stock market returns during volatile times. Al-Jarrah et al. (2021) show that traditional models fails to capture the systemic risk of small-middle size banks operating in the Gulf Cooperation Council

US Oil and Gas companies

- ▶ We considered all companies that are characterized by the presence of non-missing values for at least two years
- ▶ The evolution of the number of companies can be associated with the margin that Oil and Natural Gas firms have on their cost (dependence on the oil and gas prices)
- ▶ Analysis of two sub-samples 2000-2010 and 2011-2021 according to Caporin et al. (2019) who found a structural break in the oil price time series, located at the beginning of 2011 (the start of shale oil and gas boom)



Methodology

The first step in the $\Delta CoVaR$ estimation is the estimation of quantile regression (Koenker, 2005) of the two linear models.

$$X_t^i = \alpha_q^i + \gamma_q^i M_{t-1} + \epsilon_{q,t}^i$$

$$X_t^{system} = \alpha_q^{system|i} + \gamma_q^{system|i} M_{t-1} + \beta_q^{system|i} X_t^i + \epsilon_{q,t}^{system|i}$$

- ▶ X_t^i and X_t^{system} are the losses at time t for company i and the system loss at time t
- ▶ M_{t-1} a vector of state variables at time $t - 1$.

Variables

- ▶ X_t^i : Stock returns of US Oil and Natural gas companies multiplied by (-1).
- ▶ X_t^{system} : S&P 500 market returns multiplied by (-1).

State Variable M_{t-1}

- ▶ Rates: Treasury Bill, Term spread, Ted spread, Credit spread, Inflation rate
- ▶ Market indicators: S&P 500 market returns
- ▶ Volatility Index: Russell Volatility index changes
- ▶ Oil and Gas indicators: WTI return, Henry Hub spot return, difference between WTI price and Brent price.

Time horizon: 2000-2021, weekly based

Source: Refinitiv

$\Delta CoVaR$

Application of Adrian and Brunnermeier (2016) methodology on $\Delta CoVaR$. It measures the impact of each oil and gas company on a proxy of the financial market (the system) conditional to the distress in the company.

$$\Delta CoVaR_{q,t}^{system|i} = (CoVaR_{q,t}^{system|i,q} - CoVaR_{q,t}^{system|i,0.5}) = \hat{\beta}_q^{system|i} (VaR_{q,t}^i - VaR_{0.50,t}^i)$$

$$CoVaR_{q,t}^{system|i,\tau} = \hat{\alpha}_q^{system|i} + \hat{\gamma}_q^{system|i} M_{t-1} + \hat{\beta}_q^{system|i} VaR_{\tau,t}^i$$
$$\{q, \tau\} = \{(0.99, 0.99), (0.95, 0.95), (0.99, 0.50), (0.95, 0.50)\}.$$

$$VaR_{q,t}^i = \hat{\alpha}_q^i + \hat{\gamma}_q^i M_{t-1}, \quad q = 0.5, 0.95, 0.99,$$

$\Delta CoVaR$ and its predictors over time

$$\Delta CoVaR_{q,t}^{system|i} = a + b_1 VaR_{q,t-1} + cM_{t-1} + bZ_{t-1} + \mu_i + \eta_t$$

- ▶ $\Delta CoVaR_{q,t}^{system|i}$: $\Delta CoVaR$ aggregated at the quarterly level within the quarter
- ▶ $VaR_{q,t}$: the time series of quarterly losses at the $q\%$ quantile, obtained by averaging the weekly observation within the quarter.
- ▶ M_{t-1} : state variables
- ▶ Z_{t-1} includes :
 - ▶ *Size*: computed as the logarithm of the market capitalization;
 - ▶ *Debt*: computed as the logarithm of the total debt;
 - ▶ *ROA*: the ratio between *operating income* and *total asset income*;
 - ▶ *ROE*: the ratio between *operating income* and *common equity*;
 - ▶ $\Delta NRIG\%$: the percentage variation in the number of active oil rigs.
- ▶ μ_i : Firm FE

Results: baseline

VARIABLES	Δ_CoVaR_{99} Q12000-Q42010	Δ_CoVaR_{95} Q12000-Q42010	Δ_CoVaR_{99} Q12011-Q42021	Δ_CoVaR_{95} Q12011-Q42021
Panel A	Baseline			
$VaR_{q,QPYYYY-QPYYYY}$	0.0253* (0.014)	0.0405*** (0.011)	0.0494*** (0.006)	0.0422*** (0.004)
Size	-0.0004 (0.000)	-0.0000 (0.000)	0.0004* (0.000)	0.0001 (0.000)
Controls and Constant	YES	YES	YES	YES
Observations	3,580	3,540	3,320	3,325
Number of firms	105	104	123	123
Adj R2	0.563	0.603	0.360	0.375

- VaR at 99% and 95% levels have lower impact on $\Delta CoVaR$ in the first period than in the second one.

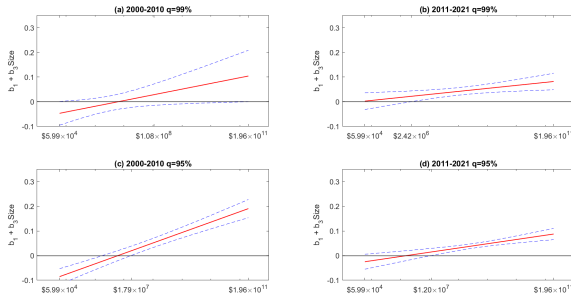
Alternative specifications

We also test two alternative specifications to spot possible non-linearities that could affect the dependent variables.

1. We add to the baseline model the interaction between VaR and $Size$
2. We add to the point 1 $Size^2$ and $VaR \times Size^2$

Size effect

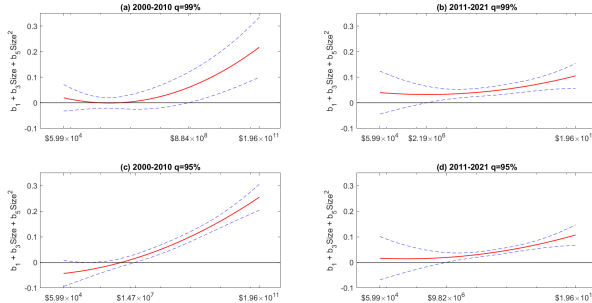
$$\Delta CoVaR_{q,t}^{system|i} = a + \mathbf{b}_1 VaR_{q,t-1} + b_2 Size_{t-1} + \mathbf{b}_3 VaR_{q,t-1} \times Size_{t-1} + b'_Z Z_{t-1} + c'_M M_{t-1} + \eta_t$$



- ▶ We test the overall effect of the coefficient $b_1 + b_3 Size_{t-1}$, for different levels of *Size*
- ▶ The coefficient is significant only in the first period when q=95% and the company size greater than M\$17.9.
- ▶ In the second period, the overall impact is smaller, but significant for smaller companies (M\$2.4(b) and M\$12.0 (d))

Size effect: quadratic interaction

$$\Delta CoVaR_{q,t}^{system|i} = a + \mathbf{b}_1 VaR_{q,t-1} + b_2 Size_{t-1} + \mathbf{b}_3 VaR_{q,t-1} \times Size_{t-1} + b_4 Size_{t-1}^2 + \mathbf{b}_5 VaR_{q,t-1} \times Size_{t-1}^2 + b'_Z Z_{t-1} + c'_M M_{t-1} + \eta_t$$



- In the first period the coefficient $b_1 + b_3 Size_{t-1} + b_5 Size_{t-1}^2$ is non significant only for the small size firms (M\$884 (a) and M\$14.7 (c))
- In the second period, the effect is significant for small size firms (M\$2.1 (b) (b) M\$9.82 (d))

Robustness

- ▶ *Effect on $\Delta CoVaR$ among the three subsectors*

VaR of firms belonging to "extraction of natural gas and "support activities", is economically and statistically significant only in the second period

- ▶ *An alternative measure of $\Delta CoVaR$ ($\Delta CoVaR^{\$}$)*

The coefficients of VaR are positive and significant only in the second period

- ▶ *Balanced Panel* The results hold when we include firms having available observations more than 80% in the time horizon

- ▶ *Removing COVID-19 outbreak* VaR has a significant and stronger effect on $\Delta CoVaR$ w.r.t 2000-2010

Conclusions

- ▶ We show that the company's losses, as summarized by the VaR at 95% and 99%, contribute to the systemic risk
- ▶ This effect has been higher in the second period, when oil and gas supply has been mostly driven by shale technology
- ▶ Company's size has played a role on the systemic risk and has been reducing after the booming of the shale production, showing that also small sized companies started contributing to the systemic risk
- ▶ Robustness checks confirm that the effect is stronger in the second period when we:
 - ▶ express $\Delta CoVaR$ in monetary term
 - ▶ look at the extraction of natural Gas and support activities subgroup
 - ▶ consider a balanced sub-panel of firms (available observations more than 80% of the time)
 - ▶ we exclude the COVID-19 period from the analysis

NACE 4-digit breakdown

07-01-2000 31-12-2010							
NACE code 4-digits	Nfirms	%	Mean	Std	Median	Q10	Q90
			Market cap [M\$]				
Extraction of crude petroleum (NACE) (06.10)	71	56.69	3363	9298	471	49	8381
Extraction of natural gas (NACE) (06.20)	21	16.54	4347	5474	2125	74	14079
Support activities for petroleum and natural gas extraction (NACE) (09.10)	34	26.77	3636	10241	992	73	6735
07-01-2011 31-12-2021							
NACE code 4-digits	Nfirms	%	Mean	Std	Median	Q10	Q90
			Market cap [M\$]				
Extraction of crude petroleum (NACE) (06.10)	90	54.55	5087	11857	1005	82	15693
Extraction of natural gas (NACE) (06.20)	34	20.61	5132	5496	3711	319	10791
Support activities for petroleum and natural gas extraction (NACE) (09.10)	41	24.85	4304	14224	995	92	5087

- ▶ The 57% of the firms belongs to the extraction of crude oil, followed by firms involved in support activities, 27% in 2000-2010
- ▶ The number of firms belonging to the extraction of natural gas increased more than those active in the extraction of crude oil and support activities in the second period

Variables definitions

N	Code	Description	Source
1	Tbill3M	Three-month Treasury bill rate Changes	Refinitiv
2	Term_spread_10Y3M	Difference between the composite 10 year bond yield and the three-month bill rate	Refinitiv
3	Ted_spread	Difference between the three-month LIBOR rate and the three-month secondary market Treasury bill rate.	Refinitiv
4	Credit_spread	Difference between ICE bank of america BBB US Corporate Index and treasury 10 year bond yield	Refinitiv
5	Ret_{MKT}	Standard and Poor 500 Market Index return	Refinitiv
6	Ret_{WTI}	Crude Oil-West Texas Intermediate return	Refinitiv
7	$Ret_{HenryHub}$	United States, Natural Gas, Prices, Henry Hub Spot, USD	Refinitiv
8	$Price_{WTI} - Price_{BRE}$	Difference between the Crude Oil-West Texas Intermediate price and European Brent oil	Refinitiv
9	ΔVIX	Russel volatility index change	Refinitiv
10	Inflation Rate	Changes of all Urban Consumers, United States City Average	Refinitiv
11	Oil	Petroleum and Natural Gas industry portfolio return	French library
12	Debt	Natural logarithm of all interest bearing and capitalized lease obligations.	Refinitiv
13	Size	Natural logarithm of market capitalization	Refinitiv
14	ROA	Ratio between Operating Income and Total Asset	Refinitiv
15	ROE	Ratio between Operating Income and Total Asset	Refinitiv
16	$\Delta NRIGS_5\%$	Weekly census change in percentage of the number of Oil drilling rigs actively exploring for or developing oil or natural gas in the U.S.	Baker Hughes North American Rotary

Descriptives: predictor of $\Delta CoVaR$

Panel A					Q1 2000 – Q4 2010					
VARIABLES	N	mean	sd	skewness	kurtosis	p25	p50	p75	min	max
$\Delta CoVaR_{99}$	4,470	0.034	0.024	2.034	11.130	0.019	0.030	0.044	0.000	0.276
$\Delta CoVaR_{95}$	4,472	0.018	0.012	1.867	9.119	0.009	0.016	0.023	0.000	0.106
$\Delta CoVaR^{\Delta}_{99}$	4,470	0.041	0.125	10.960	203.100	0.001	0.005	0.028	0.000	3.478
$\Delta CoVaR^{\Delta}_{95}$	4,472	0.025	0.079	8.645	111.900	0.000	0.003	0.016	0.000	1.641
var99	4,529	0.213	0.160	3.463	25.920	0.118	0.168	0.255	0.019	2.544
var95	4,529	0.120	0.077	2.563	14.470	0.072	0.099	0.142	0.005	0.959
Tbill3M	9,416	-0.001	0.005	-1.119	3.658	-0.002	0.000	0.002	-0.014	0.006
Ted_spread	9,416	0.005	0.005	2.128	8.150	0.002	0.004	0.006	0.002	0.025
Credit_spread	9,416	0.020	0.012	2.146	8.116	0.013	0.017	0.024	0.007	0.063
Oil	9,416	0.006	0.022	2.237	10.970	-0.005	0.002	0.012	-0.031	0.106
Ret_WTI	9,416	0.029	0.187	-1.947	10.330	-0.031	0.052	0.121	-0.814	0.342
Inflation Rate	9,416	1.165	1.322	-2.379	11.750	0.833	1.349	1.835	-5.012	3.323
Henry Hub_ret	9,416	0.010	0.224	-0.243	2.282	-0.155	0.041	0.190	-0.465	0.391
size	4,675	20.090	2.291	-0.195	2.719	18.460	20.230	21.700	11.780	25.690
debt	4,428	10.430	4.746	-1.232	3.411	9.089	12.050	13.650	0.000	17.170
ROA	4,432	0.055	3.048	-36.400	1376.000	0.038	0.089	0.148	-115.000	7.724
ROE	4,432	5.051	55.820	13.070	195.400	0.077	0.203	0.331	-300.000	976.300
$\Delta NRI_{GS\%}$	9,416	0.010	0.119	-1.379	4.960	-0.028	0.035	0.083	-0.368	0.184

Panel B					Q1 2011 – Q4 2021					
VARIABLES	N	mean	sd	skewness	kurtosis	p25	p50	p75	min	max
$\Delta CoVaR_{99}$	4,853	0.025	0.014	1.439	10.630	0.016	0.025	0.033	0.000	0.162
$\Delta CoVaR_{95}$	4,840	0.014	0.007	0.793	4.799	0.009	0.014	0.018	0.001	0.059
$\Delta CoVaR^{\Delta}_{99}$	4,845	0.034	0.075	3.704	19.610	0.001	0.006	0.024	0.000	0.730
$\Delta CoVaR^{\Delta}_{95}$	4,832	0.022	0.053	4.215	24.660	0.001	0.003	0.014	0.000	0.557
var99	4,991	0.225	0.124	3.739	38.970	0.149	0.197	0.272	0.033	2.428
var95	4,991	0.129	0.059	1.949	13.390	0.089	0.117	0.156	0.018	0.833
Tbill3M	9,416	0.000	0.002	-2.317	11.380	0.000	0.000	0.001	-0.010	0.004
Ted_spread	9,416	0.003	0.001	0.402	2.237	0.002	0.003	0.004	0.001	0.005
Credit_spread	9,416	0.016	0.004	0.634	2.951	0.012	0.015	0.018	0.009	0.027
Oil	9,416	0.005	0.024	-0.371	3.405	-0.011	0.007	0.022	-0.066	0.053
Ret_WTI	9,416	-0.004	0.256	-1.639	9.285	-0.085	0.026	0.127	-1.093	0.651
Inflation Rate	9,416	1.334	1.385	0.611	5.097	0.848	1.253	1.803	-2.200	5.250
Henry Hub_ret	9,416	0.005	0.171	0.299	2.567	-0.115	-0.003	0.094	-0.307	0.394
size	5,131	20.660	2.190	-0.227	2.605	19.240	20.760	22.220	12.770	25.750
debt	4,501	11.710	4.670	-1.598	4.522	10.860	13.350	14.660	0.000	17.470
ROA	4,545	0.136	1.946	30.600	993.800	-0.017	0.043	0.095	-2.123	63.570
ROE	4,545	1.484	18.020	17.940	374.100	-0.030	0.096	0.231	-6.340	438.500
$\Delta NRI_{GS\%}$	9,416	-0.017	0.216	-1.519	5.638	-0.046	0.021	0.110	-0.779	0.328

Results

VARIABLES	$\Delta_CoVaR99$ Q12000-Q42010	$\Delta_CoVaR95$ Q12000-Q42010	$\Delta_CoVaR99$ Q12011-Q42021	$\Delta_CoVaR95$ Q12011-Q42021
Panel A				
Baseline				
$Var_{q,OPVYYY-QPVYY}$	0.0253* (0.014)	0.0405*** (0.011)	0.0494*** (0.006)	0.0422*** (0.004)
Size	-0.0004 (0.000)	-0.0000 (0.000)	0.0004* (0.000)	0.0001 (0.000)
Adj R2	0.563	0.603	0.360	0.375
Panel B				
Baseline + interaction				
$Var_{q,OPVYYY-QPVYY}$	-0.1577*** (0.055)	-0.2879*** (0.028)	-0.0558* (0.029)	-0.1073*** (0.026)
$Var_{q,OPVYYY-QPVYY} * Size$	0.0100*** (0.004)	0.0184*** (0.002)	0.0053*** (0.002)	0.0075*** (0.001)
Size	-0.0036*** (0.001)	-0.0029*** (0.000)	-0.0010** (0.000)	-0.0010*** (0.000)
Adj R2	0.588	0.674	0.368	0.394
Panel C				
Baseline + interaction + quadratic interaction				
$Var_{q,OPVYYY-QPVYY}$	0.3465** (0.135)	0.0127 (0.120)	0.1532 (0.161)	0.1077 (0.159)
$Var_{q,OPVYYY-QPVYY} * Size$	-0.0479*** (0.015)	-0.0156 (0.013)	-0.0165 (0.016)	-0.0144 (0.016)
$Var_{q,OPVYYY-QPVYY} * Size^2$	0.0016*** (0.000)	0.0010*** (0.000)	0.0006 (0.000)	0.0006 (0.000)
Size	-0.0067 (0.006)	-0.0102*** (0.002)	0.0011 (0.004)	0.0009 (0.002)
$Size^2$	0.0001 (0.000)	0.0002*** (0.000)	-0.0001 (0.000)	-0.0000 (0.000)
Controls and Constant	YES	YES	YES	YES
Observations	3,580	3,540	3,320	3,325
Number of firms	105	104	123	123
Adj R2	0.609	0.694	0.369	0.395

Results baseline: complete

VARIABLES	$\Delta_CoVaR99$ Q12000-Q42010	$\Delta_CoVaR95$ Q12000-Q42010	$\Delta_CoVaR99$ Q12011-Q42021	$\Delta_CoVaR95$ Q12011-Q42021
$VaR_{q, QPYYYY-QPYYYY}$	0.0253* (0.014)	0.0405*** (0.011)	0.0494*** (0.006)	0.0422*** (0.004)
Ted_spread	1.0060*** (0.142)	0.5004*** (0.073)	1.0903*** (0.143)	0.5630*** (0.076)
Credit_spread	0.4473*** (0.064)	0.1829*** (0.027)	0.0894* (0.052)	0.0604** (0.024)
Tbill3M	-0.0500* (0.028)	-0.0036 (0.014)	-0.4471*** (0.077)	-0.4483*** (0.051)
Oil sector return	0.2197*** (0.015)	0.1322*** (0.008)	-0.0444*** (0.004)	-0.0280*** (0.002)
Inflation rate	0.0021*** (0.000)	0.0014*** (0.000)	0.0015*** (0.000)	0.0010*** (0.000)
Size	-0.0004 (0.000)	-0.0000 (0.000)	0.0004* (0.000)	0.0001 (0.000)
Debt	0.0002* (0.000)	0.0002* (0.000)	0.0000 (0.000)	-0.0000 (0.000)
ROA	0.2156* (0.126)	0.0184 (0.108)	0.0412 (0.064)	0.1042** (0.040)
ROE	-0.0002* (0.000)	0.0004*** (0.000)	-0.0025** (0.001)	0.0002*** (0.000)
RET_WTI	-0.0011 (0.001)	0.0001 (0.000)	-0.0061*** (0.001)	-0.0031*** (0.000)
Henry Hub_ret	-0.0035*** (0.001)	-0.0023*** (0.000)	-0.0059*** (0.001)	-0.0038*** (0.000)
$\Delta NRI\%_S$	0.0146*** (0.001)	0.0086*** (0.001)	-0.0005 (0.000)	-0.0003 (0.000)
Constant	0.0157** (0.007)	0.0026 (0.004)	0.0020 (0.005)	0.0039 (0.002)
Observations	3,580	3,540	3,320	3,325
Number of firms	105	104	123	123
R2	0.565	0.605	0.362	0.378
Adj R2	0.563	0.603	0.360	0.375

Oil, Gas and Supporting activities

Panel A				
Extraction of Oil				
VARIABLES	$\Delta_CoVaR99$ Q12000-Q42010	$\Delta_CoVaR95$ Q12000-Q42010	$\Delta_CoVaR99$ Q12011-Q42021	$\Delta_CoVaR95$ Q12011-Q42021
$VaR_{q,QPYYYY-QPYYYY}$	0.0318* (0.016)	0.0446*** (0.013)	0.0467*** (0.009)	0.0329*** (0.005)
Size	-0.0006 (0.000)	0.0001 (0.000)	0.0002 (0.000)	-0.0000 (0.000)
Controls and Constant	YES	YES	YES	YES
Observations	1,961	1,961	1,872	1,877
Number of firms	57	57	67	67
Adj R2	0.546	0.564	0.317	0.352
Panel B				
Extraction of gas				
VARIABLES	$\Delta_CoVaR99$ Q12000-Q42010	$\Delta_CoVaR95$ Q12000-Q42010	$\Delta_CoVaR99$ Q12011-Q42021	$\Delta_CoVaR95$ Q12011-Q42021
$VaR_{q,QPYYYY-QPYYYY}$	0.0105 (0.018)	0.0191 (0.024)	0.0719*** (0.005)	0.0571*** (0.006)
Size	-0.0008 (0.001)	0.0000 (0.000)	0.0008 (0.001)	0.0004 (0.000)
Controls and Constant	YES	YES	YES	YES
Observations	526	526	546	546
Number of firms	16	16	23	23
Adj R2	0.658	0.638	0.389	0.333
Panel C				
Support activities				
VARIABLES	$\Delta_CoVaR99$ Q12000-Q42010	$\Delta_CoVaR95$ Q12000-Q42010	$\Delta_CoVaR99$ Q12011-Q42021	$\Delta_CoVaR95$ Q12011-Q42021
$VaR_{q,QPYYYY-QPYYYY}$	0.0121 (0.024)	0.0375 (0.028)	0.0401*** (0.007)	0.0532*** (0.008)
Size	0.0006 (0.001)	0.0000 (0.000)	0.0008** (0.000)	0.0004* (0.000)
Controls and Constant	YES	YES	YES	YES
Observations	1,093	1,053	902	902
Number of firms	32	31	33	33
Adj R2	0.581	0.673	0.465	0.456

Dollar-valued systemic risk

VARIABLES	$\Delta_CoVaR99^{\$}$ Q12000-Q42010	$\Delta_CoVaR95^{\$}$ Q12000-Q42010	$\Delta_CoVaR99^{\$}$ Q12011-Q42021	$\Delta_CoVaR95^{\$}$ Q12011-Q42021
$VaR_{q,QPYYYY-QPYYYY}$	-0.0187 (0.026)	-0.0078 (0.034)	0.0504** (0.023)	0.0692** (0.026)
Ted_spread	1.8695** (0.921)	1.2029** (0.516)	1.3127* (0.744)	0.5011 (0.452)
Credit_spread	0.9207*** (0.309)	0.5070*** (0.182)	0.4093 (0.299)	0.2853 (0.190)
Tbill3M	-0.4173*** (0.115)	-0.2176*** (0.079)	-0.5097 (0.545)	-0.5745 (0.437)
Oil sector return	0.3370*** (0.104)	0.1992*** (0.058)	-0.0307* (0.017)	-0.0257** (0.011)
Inflation rate	0.0031* (0.002)	0.0020** (0.001)	0.0026*** (0.001)	0.0020*** (0.001)
Size	0.0107*** (0.004)	0.0063*** (0.002)	0.0114*** (0.003)	0.0072*** (0.002)
Debt	-0.0007 (0.001)	-0.0005 (0.000)	0.0000 (0.000)	-0.0000 (0.000)
ROA	-0.3388 (0.356)	-0.2073 (0.222)	-0.2948 (0.459)	0.0420 (0.246)
ROE	-0.0011 (0.001)	-0.0007 (0.000)	-0.0229 (0.026)	-0.0030*** (0.001)
RET_WTI	-0.0015 (0.003)	-0.0002 (0.002)	-0.0084*** (0.003)	-0.0039** (0.002)
Henry Hub_ret	-0.0083 (0.006)	-0.0047 (0.003)	-0.0042 (0.003)	-0.0046** (0.002)
$\Delta NRI\%_{\$}$	0.0182*** (0.005)	0.0107*** (0.004)	-0.0044 (0.003)	-0.0016 (0.002)
Constant	-0.1972** (0.083)	-0.1161** (0.049)	-0.2223*** (0.063)	-0.1408*** (0.041)
Observations	3,580	3,540	3,320	3,325
Number of firms	105	104	123	123
R2	0.0654	0.0703	0.0638	0.0548
Adj R2	0.0620	0.0669	0.0601	0.0511

Balanced panel

VARIABLES	$\Delta_CoVaR99$ Q12000-Q42010	$\Delta_CoVaR95$ Q12000-Q42010	$\Delta_CoVaR99$ Q12011-Q42021	$\Delta_CoVaR95$ Q12011-Q42021	$\Delta_CoVaR99$ Q12000-Q42010	$\Delta_CoVaR95$ Q12000-Q42010	$\Delta_CoVaR99$ Q12011-Q42021	$\Delta_CoVaR95$ Q12011-Q42021
	Balanced				Strong Balanced			
$Var_{q,QPYYYY-QPYYY}$	0.0237 (0.016)	0.0404*** (0.013)	0.0471*** (0.006)	0.0467*** (0.005)	0.0604** (0.027)	0.0661*** (0.019)	0.0507*** (0.007)	0.0512*** (0.006)
Size	-0.0006** (0.000)	-0.0001 (0.000)	0.0003 (0.000)	0.0001 (0.000)	-0.0002 (0.001)	0.0001 (0.000)	0.0002 (0.000)	-0.0001 (0.000)
Controls and Constant	YES	YES	YES	YES	YES	YES	YES	YES
Observations	3,117	3,077	2,240	2,245	1,651	1,651	1,608	1,639
Number of firms	75	74	56	56	39	39	39	40
R2	0.553	0.589	0.380	0.352	0.594	0.635	0.417	0.373
Adj R2	0.551	0.587	0.377	0.348	0.590	0.632	0.413	0.368

Removing COVID outbreak

VARIABLES	Q12011-Q42019					
	$\Delta_CoVaR99$			$\Delta_CoVaR95$		
	I	II	III	IV	V	VI
$VaR_{99,QPYYYY-QPYYYY}$	0.0614*** (0.007)	-0.0824** (0.035)	0.6517*** (0.195)			
$VaR_{99,QPYYYY-QPYYYY} * Size$		0.0074*** (0.002)	-0.0686*** (0.021)			
$VaR_{99,QPYYYY-QPYYYY} * Size^2$			0.0019*** (0.001)			
$VaR_{95,QPYYYY-QPYYYY}$				0.0565*** (0.005)	-0.0785** (0.031)	0.1605 (0.160)
$VaR_{95,QPYYYY-QPYYYY} * Size$					0.0067*** (0.002)	-0.0177 (0.017)
$VaR_{95,QPYYYY-QPYYYY} * Size^2$						0.0006 (0.000)
Size	-0.0001 (0.000)	-0.0019*** (0.001)	0.0151*** (0.005)	0.0001 (0.000)	-0.0008*** (0.000)	0.0017 (0.002)
Size ²			-0.0004*** (0.000)			-0.0001 (0.000)
Controls and Constant	YES	YES	YES	YES	YES	YES
Observations	2,782	2,782	2,782	2,782	2,782	2,782
Number of firms	118	118	118	118	118	118
R2	0.340	0.361	0.372	0.347	0.362	0.363
Adj R2	0.337	0.357	0.369	0.344	0.358	0.359

