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The Price Impact of Strategic Petroleum Reserve Releases on Oil Industry Firms

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Abstract

The U.S. Strategic Petroleum Reserve was initiated in response to the Arab oil embargo as a means to buffer supply shocks. Since its inception, stocks have been released in response to disruptive events such as war or natural disaster. In this paper, we document the market's response to these releases through the market adjusted returns of oil and gas industry stocks in the days surrounding release. We find an average decline in price of 0.32% across all firms and events; however, exchange only releases elicit a positive response of 0.71%. The effect also varies with industry sector.

Introduction

On March 31st, 2022, The Wall Street Journal reported "President Biden is preparing to announce the release of up to 1 million barrels of oil a day from the U.S. Strategic Petroleum Reserve" (Parti & Restuccia, 2022). This news followed an announcement earlier in the month that the U.S. was coordinating with the International Energy Agency to release 60 million barrels (MMbbl) of oil in an effort to tamp down prices that had risen in response to the Russian invasion of Ukraine. These moves followed a pre-invasion release of 50 MMbbl in November 2021 that was also aimed at countering high prices at the gas pump (Stevens, 2021). Clearly, the administration believed that releases from the Strategic Petroleum Reserve (SPR) could be used to influence oil (and therefore gasoline) prices. In this paper, we seek to explore the impact of these releases on the share prices of firms in the oil and gas industry.

To investigate the link between SPR releases and the price of oil industry stocks, we create a sample consisting of 40 SPR release events and 36 oil industry firms yielding a sample of 1105 firm-events. We then analyze this sample using the event study methodology on daily stock price data to determine the impact of reserve releases on firm value. We document a statistically significant average loss of 0.32% in the 5 days surrounding release. However, as we also show, the magnitude and even the sign of the share price reaction to an SPR varies by event type and industry sector.

The paper proceeds as follows: We first give a brief history of the SPR, the impetus for its creation, and a brief background on previous releases. We then review the relevant literature and develop our hypotheses. Next, we detail the construction of our sample and our test methodology. We present and discuss results then conclude.

Strategic Petroleum Reserve and Drawdown Background

In late 1975, President Ford signed the Energy Policy and Conservation Act (ECPA), which began the formal process of creating the U.S. Strategic Petroleum reserve; however, actual implementation of the SPR did not begin until 1977 following the preparation and submission of a series of plans by the Federal Energy Administration. The legislation requiring the creation of such a reserve followed a 1973 report from the National Petroleum council that recommended the creation of a reserve containing 540 MMbbl, which would be sufficient to buffer a 3 MMbbl per day supply disruption for a period of 6 months. The Arab oil embargo of 1973-1974 provided a clear demonstration of U.S. vulnerability to an oil supply disruption and spurred passage of the ECPA.

The process of filling the reserve was not without its own complications. Reserve oil purchases were paused in 1979 in response to threats from Saudi Arabia to cut production by 1 MMbbl per day. The following year repurchases began again with Congress urging a fill rate of at least 100 thousand barrels per day. This requested rate was revised upward to 300 thousand barrels per day in 1981 then cut to 200 thousand barrels per day in 1982 to reduce expenditures. The reserve contained 450 MMbbl in 1985 (Hubbard & Weiner, 1985). The Energy Policy Act of 2005 would direct an expansion of SPR capacity to 1 billion barrels (Andrews & Pirog, 2017).

A variety of conditions exist under which oil may be released from the SPR. The International Energy Agency (IEA), of which the U.S. is a member, was also created in response to the Arab oil embargo. This organization requires the stockpiling of oil supplies both privately and governmentally to be used by members in coordinated responses to disruptions in oil supplies. If the IEA coordinates a response, U.S. participation is obligatory. The U.S. President is empowered to release oil in whatever amount deemed necessary in response to a “severe energy supply interruption.” Following the Exxon Valdez oil spill, the President was authorized to conduct a more limited drawdown[i] to meet domestic shortages under less rigorous standards than required by the ECPA and in the absence of an IEA coordinated program. Additionally, the Secretary of Energy is required to periodically conduct test sales of up to 5 MMbbl. The ECPA also allows for exchanges of oil. These exchanges amount to short term loans that are repaid in oil. Essentially, the loaned oil is returned along with additional barrels paid as “interest” for the loan. Finally, Congress has authorized the periodic sale of oil from the reserve for budgetary purposes beginning in 1996 with the sale of 5.1 MMbbl to cover the costs of decommissioning the Weeks Island storage site (Andrews & Pirog, 2017).

Literature Review and Hypothesis Development

Given the difficulties in filling the SPR early in its life, it should not be a surprise that an early strand of the literature (Oren & Wan, 1986; Teisberg, 1981) focused on optimizing reserve fill rate and sale policies. Hubbard and Weiner (1985) model the world oil market and conclude that SPR releases during a simulated supply shock lead to lower oil prices and improved US GNP.

More recently, Considine (2006) finds that a 30MMbbl release during a supply shock could lower prices by 3.5%. Stevens (2014) uses a vector autoregression (VAR) approach and finds no link between releases and crude oil prices. On the other hand,

Newell and Prest (2017) develop a VAR model that suggests that a 10MMbbl release would result in a 2-3% decline in oil prices albeit temporarily. Kilian & Zhou (2019) find that the Desert Storm releases (events 2 & 3) lowered prices by $2 per barrel as did the sale and exchange due to hurricane Katrina. They found a substantial $13 per barrel price reduction as a result of the IEA releases in 2011 in response to the Libyan conflict.

Degiannakis et al. (2018) reviews the literature regarding oil prices and stock market activity. According to their analysis, while the literature often finds a negative relationship between oil prices and stock prices generally, there is "strong evidence" of a positive relationship between oil prices and the performance of the oil and gas (O&G) sector. A couple of papers explore the market's reaction to specific oil related catastrophes. Patten & Nance (1998) examine the Exxon Valdez oil spill in Alaska while Humphrey et al. (2016) focus on the 2010 BP oil spill in the Gulf of Mexico. In both papers, the authors document the perverse relationship between environmentally damaging oil spills and positive returns to oil and gas firms. Both studies also document the market's ability to differentiate the impact among various firms based on their differing exposures to the consequences of these events.

Based on the relationships between SPR releases and oil prices and between oil prices and O&G firms, we propose the following hypothesis:

H1: Strategic oil releases should negatively impact the stock price of O&G firms.

As discussed above, exchanges are essentially short-term loans that are expected to be repaid with a premium of additional barrels of oil serving as interest, which leads to our second hypothesis.

H2: We would expect SPR exchange release to have a negligible impact, if any, on O&G firm share prices.

As noted by The Library of Congress research guide for the O&G industry (Burclaff, 2005a), the O&G industry is often divided into three segments: upstream firms focus on exploration and production; midstream firms deal with the transportation of oil and gas whether by pipeline or tanker; while downstream firms specialize in the refining and marketing of O&G products. Additionally, there are integrated firms, also known as the majors, that operate across these segments. We develop our final hypotheses based on these segments and the pricing relationships noted by the guide. Per the Library of Congress guide (Burclaff, 2005b), "Upstream companies benefit from high oil and gas prices."

H3: SPR releases should lower stock prices for upstream firms.

For midstream firms, oil prices are important as they relate to volume (Burclaff, 2005b). As such, lower oil prices would be detrimental to midstream firms to the extent that they depress volumes. However, if the SPR release offsets lost volume, we would not expect an impact on midstream firms.

H4a: SPR releases should reduce midstream sector share prices.

H4b: To the extent that releases replace volume lost to lower share prices, we would expect no impact on midstream firms.

Downstream company performance is driven by margin and not simply price. As a result, the impact of SPR releases on downstream firms is an empirical question.

Sample Construction and Methodology

To construct our sample, we begin by collecting relevant event dates for SPR oil releases. The Department of Energy's "History of SPR Releases" serves as our starting point. This resource lists all releases through the year 2020. We supplement this data in several ways. When a specific date for an event is not provided, we search for news sources to determine the specific date to be used. (Ellis, 2005; Gardner, 2017). We comb the Department of Energy's newsroom[ii] for dates related to mandatory sales[iii] and for events subsequent to 2020. This process yields 44 SPR releases; however, we are only able to determine a year and month of announcement for 4 of the dates resulting in 40 event dates for our study. Table 1 presents the release dates we identified, the type of release, along with volume figures for the release. We try to note, where applicable, whether the volume was the volume announced or offered upon the event date or the amount delivered as these numbers can differ. In some cases, the amount on offer is not fully subscribed. In the event of an exchange, the number of firms to which oil is lent may grow following the initially announced contract. We also list the number of firms for which we have the necessary stock price information for that event as the firm count.

TABLE 1: SPR Release Dates, Description, and Firm Count

Event Number	Event Date	Drawdown Name	Drawdown Type	Volume Announced/Offered (MMbbl)	Volume Delivered (MMbbl)	Firm Count
1	11/18/85	1985 Test Sale	Test Sale	5	0.967	11
2	9/27/90	1990 Desert Shield Test Sale	Test Sale	5	3.9	13
3	1/16/91	Operation Desert Storm Sale	Emergency Drawdown	33.75	17.3	13
4	1/29/96	1996 Weeks Island Sale	Non-Emergency Sale	7	5.1	14
5	4/26/96	1996 Sale to Reduce Deficit	Non-Emergency Sale		12.8	14
6	5/3/96	1996 Pipeline Blockage Exchange	Exchange	1	0.901	14
7	9/30/97	1997 Sale to Reduce Deficit	Non-Emergency Sale		10.2	14
8	8/13/99	1999 Maya Exchange	Exchange	11	11	16
9	6/15/00	2000 Ship Channel Closure	Exchange	1	1	16

10	7/10/00	Establish NEHHOR	Exchange	2	2.84	16
11	9/22/00	2000 Heating Oil Exchange	Exchange	30	30	16
12	10/1/02	2002 Hurricane Lili Exchange	Exchange	0.296	0.98	20
13	9/16/04	2004 Hurricane Ivan Exchange	Exchange	5.4	5.4	21
14	8/31/05	IEA - Hurricane Katrina[iv] Sale/Exchange	Emergency Drawdown	30	20.8	21
15	1/17/06	2006 Barge Accident Exchange	Exchange	0.767	0.767	22
16	6/21/06	2006 Ship Channel Closure	Exchange	0.75	0.75	23
17	9/2/08	2008 Hurricanes Gustav and Ike	Exchange		5.39	26
18	6/23/11	IEA Coordinated Release - Libya	Emergency Drawdown	30	30.64	29
19	8/31/12	2012 Hurricane Isaac Exchange	Exchange	1	1.02	31
20	3/12/14	2014 Test Sale	Test Sale	5	5	35
21	8/31/17	2017 Hurricane Harvey Exchange	Exchange	1	5.2	36
22	Feb - 2001 7	FY 2017 SPR Modernization Sale	Non-Emergency Sale		6.28	
23	May - 2017	FY 2017 Mandatory Sale	Non-Emergency Sale		9.894	
24	Oct - 2017	FY 2018 Mandatory Sale	Non-Emergency Sale		13.717	
25	2/9/18	FY 2018 SPR Modernization Sale	Non-Emergency Sale		4.74	36
26	Oct - 2018	FY 2019 Mandatory Sale	Non-Emergency Sale		10.87	
27	2/28/19	FY 2019 SPR Modernization Sale	Non-Emergency Sale	6		36

28	8/21/19	FY 2020 Mandatory Sale	Non-Emergency Sale	10	9.85	36
29	2/28/20	FY 2020 SPR Modernization Sale	Non-Emergency Sale	12		36
30	2/11/21	FY 2021 Mandatory Sale	Non-Emergency Sale	10.1	10.1	36
31	4/16/21	FY 2021 SPR Modernization Sale	Non-Emergency Sale	9		36
32	8/23/21	FY 2022 Mandatory Sale	Non-Emergency Sale	20	20	36
33	9/2/21	2021 Hurricane Ida Exchange	Exchange	1.8		36
34	11/23/21	High Gas Prices[v]	Exchange/Accelerated Sale	50		36
35	12/10/21	High Gas Prices	Accelerated Sale	18		36
36	3/1/22	IEA Coordinated Release/Russian Invasion	Emergency Sale	30		36
37	3/31/22	War in Ukraine	Emergency Sale	180[vi]	180	36
38	4/1/22	War in Ukraine	Emergency Sale	30	30	36
39	5/24/22	War in Ukraine	Emergency Sale	40	40	36
40	6/14/22	War in Ukraine	Emergency Sale	45	45	36
41	7/26/22	War in Ukraine	Emergency Sale	20	20	36
42	9/19/22	War in Ukraine	Emergency Sale	10	10	36
43	10/18/22	War in Ukraine	Emergency Sale	15	15	36
44	2/13/23	FY 2023 Mandatory Sale	Non-Emergency Sale	26		36

Table 1: This table contains a list of SPR release event dates, type of release, volumes offered and delivered when available and a count of firms for which data was available for the event.

We next compile a selection of firms. The list of firms selected are all traded on the New York Stock Exchange. Our selection is not intended to be exhaustive but to be representative of the oil and gas industry. We select a number of integrated, upstream, midstream, and downstream firms. We include only firms that have some exposure to crude oil. Firms that deal exclusively with natural gas were not considered. We gather historical daily stock price information for the firms from Yahoo! Finance and calculate daily returns using the closing price adjusted for splits and dividends. We use returns on the S&P 500, also taken from Yahoo! Finance, as our market proxy.

Table 2 lists our sample firms, their standard industry classification code (SIC) according to the Securities and Exchange Commission's (SEC) EDGAR database, their sector classification, the date for which we first have price data for the firm, and a count of the number of events for each firm. Our sample contains 7 integrated, 7 upstream, 14 midstream, and 8 downstream firms. The combination of 36 firms and 40 event dates yields our sample of 1105 firm-events.

TABLE 2: Sample Firms, Their Industry Sector, and Event Count

Ticker	SIC Code	Company Name	Integrated	Upstream	Midstream	Downstream	Date of First Price	Event Count
BP	2911	BP Plc	ü				1/2/62	40
CEQP	4923	Crestwood Equity Partners LP			ü		7/26/01	29
COP	2911	ConocoPhillips		ü			12/31/81	40
CTRA	1311	Coterra Energy		ü			2/8/90	39
CVE	1311	Cenovus Energy	ü				11/17/09	23
CVI	2911	CVR Energy				ü	10/23/07	24
CVX	2911	Chevron Corp	ü				1/2/62	40
DHT	4412	DHT Holdings			ü		10/13/05	26
DINO	4610	HF Sinclair				ü	3/17/80	40
DK	2911	Delek US Holdings, Inc				ü	5/4/06	24
DVN	1311	Devon Energy Corp		ü			7/22/85	40
ENB	4610	Enbridge Inc			ü		3/15/84	40
ENLC	4922	EnLink Midstream			ü		1/13/04	28

EOG	1311	EOG Resources		ü			10/4/89	39
EPD	4922	Enterprise Products Partners			ü		7/28/98	33
EQNR	2911	Equinor ASA	ü				6/18/01	29
ET	4922	Energy Transfer			ü		2/3/06	25
EURN	4412	Euronav NV			ü		1/26/15	20
KMI	4922	Kinder Morgan, Inc			ü		2/11/11	23
MMP	4610	Magellan Midstream Partners			ü		3/19/01	29
MPC	2911	Marathon Petroleum Corp				ü	6/24/11	22
MPLX	4610	MPLX			ü		10/26/12	21
OVV	1311	Ovintiv Inc		ü			4/8/02	29
OXY	1311	Occidental Petroleum Corp		ü			12/31/81	40
PBA	1382	Pembina Pipeline Corp			ü		10/6/10	23
PBF	2911	PBF Energy Inc				ü	12/13/12	21
PSX	2911	Phillips 66				ü	4/12/12	22
PXD	1311	Pioneer Natural Resources		ü			8/8/97	33
SHEL	1311	Shell plc	ü				10/31/94	37
SU	2911	Suncor Energy	ü				3/17/80	40
SUN	2911	Sunoco LP				ü	9/20/12	21
TNK	4400	Teekay Tankers LTD			ü		12/13/07	24
TRP	4922	TC Energy Corp			ü		9/20/82	40
VLO	2911	Valero Energy Corp				ü	1/4/82	40

WES	4922	Western Midstream Partners			ü		12/10/12	21
XOM	2911	Exxon Mobil Corp	ü				1/2/62	40

Table 2: This table contains a list of sample firms and their ticker along with an indicator for the firm's sector, the firm SIC code as listed in the Securities and Exchange Commission's EDGAR database, the date at which pricing data is first available, and a count of the number of events for which we have the requisite firm data.

To investigate the relationship between SPR releases and the price impact of these releases on oil industry stock prices, we employ the event study methodology[vii] using the market model as in Brown and Warner (1985). For each firm event, we utilize a 5-day window centered about the event date. In other words, our event window includes the event date as well as two days before and two days after to be sure that we capture the effect of the event. For each day of the event window, we calculate an abnormal return:

$$AR_{i,t} = R_{i,t} - E(R_{i,t})$$

Where $R_{i,t}$ is the daily return for firm *i* on day *t*, and $E(R_{i,t})$ is the expected return for firm *i* on day *t* according to the market model:

$$E(R_{i,t}) = \alpha_i + \beta_i * R_{m,t}$$

$R_{m,t}$ is the market return for day *t*. We use returns on the S&P 500 as our market proxy. Parameters α_i and β_i are determined by the following regression equation using data from the 30 to 60 trading days prior to the event day (days -30 through -60).

$$R_{i,t} = \alpha_i + \beta_i * R_{m,t} + e_{i,t}$$

Our primary variable of interest is the 5-day cumulative abnormal return for firm *i* for the event occurring at time *t=0*.

$$CAR_{i,t} = \sum_{t=-2}^{t=2} AR_{i,t}$$

Results and Discussion

We present our main results in Table 3. We find that, when viewing all firm-events, an SPR release results in a 0.32% drop in oil industry firm prices. This result is statistically significant at the 5% level and supports our hypothesis 1. If we exclude releases that consist solely of an exchange, we find an even stronger result, both economically and statistically. For non-exchange releases, stock prices decline by 0.69%. Interestingly, when we view exchange releases by themselves, we find a result that is nearly the

mirror of the non-exchange result. In this case, prices jump by 0.71%. According to our second hypothesis, we would expect a negligible response to what is essentially a short-term loan. These exchanges are frequently associated with natural disasters. Perhaps the willingness of the government to intervene in such circumstances is viewed by the market as a positive sign for the oil industry resulting in the statistically significant price increase that we observe.

TABLE 3: Market Reaction (Cumulative Abnormal Return) to SPR Release Events

Panel A: All Firms			
	All Events	Excluding Exchange Only	Exchange Only
Average CAR	-0.315454**	-0.6863382***	0.7123891***
t-stat	-1.99	-3.61	2.61
observations	1105	812	293
Panel B: Integrated Firms			
	All Events	Excluding Exchange Only	Exchange Only
Average CAR	-0.6408689**	-0.9529455***	0.0695159
t-stat	-2.34	-2.91	0.14
observations	249	173	76
Panel C: Upstream Firms			
	All Events	Excluding Exchange Only	Exchange Only
Average CAR	-0.6338908*	-1.289288***	0.7154562
t-stat	-1.82	-3.09	1.19
observations	260	175	85
Panel D: Midstream Firms			
	All Events	Excluding Exchange Only	Exchange Only
Average CAR	0.2635634	0.1127394	0.7674527*
t-stat	1.05	0.37	1.85
observations	382	294	88
Panel E: Downstream Firms			
	All Events	Excluding Exchange Only	Exchange Only
Average CAR	-0.5835041	-1.176277**	1.706754**
t-stat	-1.36	-2.36	2.32
observations	214	170	44

*Table 3 contains average cumulative abnormal returns for the 5 day window surrounding the event date determined using the market model. t-statistics are calculated using heteroskedasticity robust standard errors. *, **, and *** indicate significant at the 10%, 5%, and 1% levels respectively. The numbers of observations for each average are also given.*

For the various sectors of the industry, we see that the integrated, upstream, and downstream firms generally behave in the same manner as the overall sample. They

exhibit a negative reaction to release overall that is more strongly negative when excluding exchange only releases, and a positive response to exchange only releases. The overall negative response for upstream firms and especially the highly significantly negative response when excluding exchange only releases for upstream firms is broadly supportive of H3.

For midstream firms, responses are positive but not statistically so, except in the case of exchange only releases where the result is marginally significant. These findings are somewhat consistent with our hypothesis 4b in that the reaction for midstream firms is not significant. For downstream firms, we find a significantly negative reaction when excluding exchange only releases and a significantly positive response when only considering these types of release.

Table 4 reports results for each event broken down by sector. The results are primarily interesting to the extent that they show the variability in responses. For instance, the Hurricane Katrina release elicits a strongly positive response for integrated and upstream firms, but the response to the Hurricanes Gustav and Ike are large and negative. The response for downstream firms is often of the opposite direction from integrated and upstream firms, but not consistently so.

TABLE 4: Results by Sector

Event Number	Event Date	Drawdown Name		All Firms	Integrated	Upstream	Midstream	Downstream
1	11/18/85	1985 Test Sale	Average CAR	-2.486	-7.170	-2.903	0.582	4.441
			t-stat	-1.13	-1.48	-2.32	0.56	1.09
			Observations	11	4	3	2	2
2	9/27/90	1990 Desert Shield Test Sale	Average CAR	-3.154	-1.755	-5.017*	0.461	-4.912*
			t-stat	-1.75	-0.32	-2.47	0.4	-10.7
			Observations	13	4	5	2	2
3	1/16/91	Operation Desert Storm Sale	Average CAR	-1.300	-3.856	-0.754	-2.568**	3.716
			t-stat	-1.32	-2.2	-0.71	-39.14	1.56
			Observations	13	4	5	2	2
4	1/29/96	1996 Weeks Island Sale	Average CAR	1.896	-1.081	4.862	1.493	2.325
			t-stat	1.6	-1.54	1.87	1.12	0.78
			Observations	14	5	5	2	2

5	4/26/96	1996 Sale to Reduce Deficit	Average CAR	0.331	-0.192	-0.249	0.077	3.341*
			t-stat	0.31	-0.78	-0.08	0.1	14.61
			Observations	14	5	5	2	2
6	5/3/96	1996 Pipeline Blockage Exchange	Average CAR	-1.348	-1.922*	-1.258	0.010	-1.493
			t-stat	-1.45	-2.24	-0.5	0.03	-0.73
			Observations	14	5	5	2	2
7	9/30/97	1997 Sale to Reduce Deficit	Average CAR	0.363	1.124	0.678	0.756	-2.722
			t-stat	0.3	0.71	0.2	0.46	-2.46
			Observations	14	5	5	2	2
8	8/13/99	1999 Maya Exchange	Average CAR	0.052	-1.235	1.350	-0.113	-0.379
			t-stat	0.07	-1.08	1.22	-0.26	-0.09
			Observations	16	5	6	3	2
9	6/15/00	2000 Ship Channel Closure	Average CAR	-1.695*	-2.485	-3.437***	0.165	2.717
			t-stat	-1.91	-1.59	-7.41	0.1	0.57
			Observations	16	5	6	3	2
10	7/10/00	Establish NEHHOR	Average CAR	0.565	0.657	-0.587	2.911	0.274
			t-stat	0.45	1.24	-0.2	0.78	0.12
			Observations	16	5	6	3	2
11	9/22/00	2000 Heating Oil Exchange	Average CAR	-1.311	-3.750*	-0.901	-1.278**	3.503
			t-stat	-1.34	-2.13	-0.65	-4.53	0.88
			Observations	16	5	6	3	2
12	10/1/02	2002 Hurricane Lili Exchange	Average CAR	2.382*	3.317**	5.631***	-0.525	-4.530
			t-stat	2.06	3.01	5.15	-0.19	-0.88
			Observations	20	6	7	5	2

13	9/16/04	2004 Hurricane Ivan Exchange	Average CAR	0.719*	0.819	1.332**	-0.395	1.610
			t-stat	2.07	1.3	2.69	-0.56	1.67
			Observations	21	6	7	6	2
14	8/31/05	IEA - Hurricane Katrina Sale/Exchange	Average CAR	4.354***	3.406***	5.397***	1.305	12.697
			t-stat	4.9	7.65	5.97	1.1	2.82
			Observations	21	6	7	6	2
15	1/17/06	2006 Barge Accident Exchange	Average CAR	4.184***	4.255***	6.970***	0.338	7.680
			t-stat	4.83	5.21	5.48	0.26	5.6
			Observations	22	6	7	7	2
16	6/21/06	2006 Ship Channel Closure	Average CAR	0.335	-0.378*	1.861*	-1.149	3.072*
			t-stat	0.67	-2.2	2.13	-1.32	9.65
			Observations	23	6	7	8	2
17	9/2/08	2008 Hurricanes Gustav and Ike	Average CAR	-3.675**	-7.291***	-10.400***	-0.999	7.498
			t-stat	-2.56	-4.08	-11.78	-0.81	2.17
			Observations	26	6	7	9	4
18	6/23/11	IEA Coordinated Release - Libya	Average CAR	0.742	0.714	0.562	1.009	0.374
			t-stat	1.78	1.24	0.7	1.23	0.26
			Observations	29	7	7	11	4
19	8/31/12	2012 Hurricane Isaac Exchange	Average CAR	-0.824**	-1.180	-1.706	0.011	-0.909
			t-stat	-2.17	-1.74	-1.93	0.02	-0.78
			Observations	31	7	7	11	6
20	3/12/14	2014 Test Sale	Average CAR	1.536**	1.312*	0.162	0.195	5.114**
			t-stat	2.49	2.28	0.19	0.23	3.05
			Observations	35	7	7	13	8

21	8/31/17	2017 Hurricane Harvey Exchange	Average CAR	1.052*	3.318*	3.300***	0.222	-1.447
			t-stat	1.91	1.96	5.76	0.38	-1.46
			Observations	36	7	7	14	8
25	2/9/18	FY 2018 SPR Modernization Sale	Average CAR	-1.292	-2.295	-4.388	1.329	-2.290
			t-stat	-1.89	-2.38	-4.11	1.13	-2.07
			Observations	36	7	7	14	8
27	2/28/19	FY 2019 SPR Modernization Sale	Average CAR	-0.871	-0.390	0.832*	-0.696	-3.090***
			t-stat	-1.62	-0.31	1.99	-0.65	-5.47
			Observations	36	7	7	14	8
28	8/21/19	FY 2020 Mandatory Sale	Average CAR	0.317	0.926	-0.477	1.007	-0.728
			t-stat	0.63	1.73	-0.42	1.05	-0.67
			Observations	36	7	7	14	8
29	2/28/20	FY 2020 SPR Modernization Sale	Average CAR	-3.426**	-1.820	-4.932**	-0.253	-9.068***
			t-stat	-2.62	-1.06	-2.71	-0.09	-5.54
			Observations	36	7	7	14	8
30	2/11/21	FY 2021 Mandatory Sale	Average CAR	3.205***	2.144**	3.472*	3.149	3.997**
			t-stat	3.82	2.92	2.42	1.71	2.48
			Observations	36	7	7	14	8
31	4/16/21	FY 2021 SPR Modernization Sale	Average CAR	-2.878***	-2.411*	-5.834***	0.540	-6.683**
			t-stat	-3.63	-2.43	-4.24	0.73	-3.3
			Observations	36	7	7	14	8
32	8/23/21	FY 2022 Mandatory Sale	Average CAR	1.713**	0.041	2.365	-0.517	6.506**
			t-stat	2.31	0.04	1.5	-1.53	3.04
			Observations	36	7	7	14	8

33	9/2/21	2021 Hurricane Ida Exchange	Average CAR	5.182***	4.238**	5.662**	5.717***	4.653**
			t-stat	7.63	3.03	3.17	4.63	4.05
			Observations	36	7	7	14	8
34	11/23/21	High Gas Prices	Average CAR	-4.059***	-4.872***	-3.356***	-2.77***	-6.210**
			t-stat	-6.67	-4.33	-4.31	-3.24	-3.41
			Observations	36	7	7	14	8
35	12/10/21	High Gas Prices	Average CAR	-5.930***	-5.572***	-7.745***	-4.395***	-7.343***
			t-stat	-9.88	-4.71	-5.9	-6.53	-4.25
			Observations	36	7	7	14	8
36	3/1/22	IEA Coordinated Release/Russian Invasion	Average CAR	2.224*	0.965	7.536***	4.814***	-5.855**
			t-stat	1.99	0.42	3.77	5.68	-2.88
			Observations	36	7	7	14	8
37	3/31/22	War in Ukraine	Average CAR	0.061	-0.936	-4.072***	1.427	2.160*
			t-stat	0.09	-1.06	-4.05	1.29	2.27
			Observations	36	7	7	14	8
38	4/1/22	War in Ukraine	Average CAR	-0.386	-1.182**	-4.971***	0.824	2.204
			t-stat	-0.49	-2.5	-23.31	0.54	1.58
			Observations	36	7	7	14	8
39	5/24/22	War in Ukraine	Average CAR	2.842***	4.092***	5.435**	1.906**	1.118
			t-stat	5.47	6.17	3.62	2.49	1.61
			Observations	36	7	7	14	8
40	6/14/22	War in Ukraine	Average CAR	-10.525***	-8.759***	-11.429***	-9.477***	-13.112***
			t-stat	-14.15	-11.55	-8.7	-6.64	-8.49

			Observations	36	7	7	14	8
41	7/26/22	War in Ukraine	Average CAR	0.031	0.694	-1.099	0.383	-0.177
			t-stat	0.07	0.65	-1.39	0.63	-0.13
			Observations	36	7	7	14	8
42	9/19/22	War in Ukraine	Average CAR	-2.273***	-2.033	-4.480***	-1.845*	-1.301
			t-stat	-4.06	-1.67	-3.67	-1.99	-1.17
			Observations	36	7	7	14	8
43	10/18/22	War in Ukraine	Average CAR	-0.306	-1.516	-3.604**	1.621*	0.266
			t-stat	-0.52	-1.73	-3.13	1.83	0.24
			Observations	36	7	7	14	8
44	2/13/23	FY 2023 Mandatory Sale	Average CAR	2.802***	1.836*	-0.019	3.67**	4.586***
			t-stat	3.64	2.15	-0.02	2.16	5.73
			Observations	36	7	7	14	8

*Table 4 contains average cumulative abnormal returns for the 5 day window surrounding the event date determined using the market model. t-statistics are calculated using heteroskedasticity robust standard errors. *, **, and *** indicate significant at the 10%, 5%, and 1% levels respectively. The numbers of observations for each average are also given.*

Conclusion

In this paper, we examine the market's response as it relates to firms in the oil and gas industry to releases of oil from the U.S. Strategic Petroleum Reserve. Utilizing a sample of 1105 firm-events derived from 40 event dates and 36 firms in the integrated, upstream, midstream, and downstream sectors, we find that a release is associated with a 0.32% decline, on average, across all firms. When excluding short-term loans (exchanges), this effect strengthens to a 0.69% decline in prices. When examined alone, the exchanges result in an average 0.71% increase in price. Results are mixed across segments. Integrated, upstream, and downstream firms roughly mimic the overall group; however, midstream firms react independently. For midstream firms, the average CAR is positive though not significant.

We can postulate implications for policy makers by considering the results presented. As the market reaction to releases of reserves is negative, policy makers may want to include consideration of the lost value when weighing their decisions. The positive reaction to exchange announcements suggests that exchanges may be a better vehicle for responding to oil supply disruptions as the market seems to look more favorable on what could be termed a loan of oil to deal with supply shocks rather than a simple

release of extra supply without the obligation to pull from future supplies. From the perspective of the financial markets, the significant reactions to the announcement of SPR releases indicates that the markets are not able to fully anticipate whether reserves will be released, the amount released, or the form of the release. By shining some light on this topic and providing some data on previous releases, the markets may be more capable of anticipating and efficiently responding to future events.

We also examine the returns to individual events by industry sector and discover a more complicated story. Future research that delves more fully into the determinants of the market reaction would no doubt shine some light into the underlying economic phenomena.

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[i] Not more than 30 MMbbl over a 60-day period contingent upon an SPR inventory exceeding 500 MMbbl
[ii] https://www.energy.gov/newsroom
[iii] Unfortunately, we were unable to locate specific dates for mandatory sales prior to FY 2020 or for the FY 2017 SPR modernization sale.
[iv] The Hurricane Katrina response consisted of an offer of 30MMbbl from the SPR as part of an IEA coordinated effort along with an exchange release. 9.8 MMbbl were loaned as part of the exchange and 11MMbbl were ultimately sold of the 30MMbbl offered.
[v] The 50MMbbl barrels consist of an exchange of 32MMbbl along with an acceleration of the congressionally mandated sale of 18MMbbl. The notice of sale was issued on December 10th, and is the next event.
[vi] 180MMbbl is the total announced. Only 20MMbbl were made available initially. The remaining barrels were released through the 6 subsequent notices of sale.
[vii] See Kothari and Warner (2007) for an overview of event study methodology.