Diesel, Conventional Gas, Jet Fuel, and Natural Gas Equity and Commodity Project Risk across the Oil and Gas Industry

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Abstract

Oil and gas company returns are compared between upstream, midstream, and down-stream sectors from 2000 through 2020. Crude oil, natural gas, and distillate returns reflect project risk, infrastructure, and conditions within the industry. Equity, commodity, and distillate markets positively price returns, and equity market risk and returns are higher than for commodity markets. Refining & marketing and equipment & service firms have the greatest equity market risk, while equipment & service and exploration & production firms have the greatest commodity market risk. Refining & marketing firm returns did not systematically vary with commodity market risk. Producer returns are positively related to crude distillates, and across the oil and gas industry, diesel has the greatest risk and distillate return. Equity, commodity, and distillate returns are collectively significant in individual risk and returns.

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I.   Introduction

Across various industries, a fundamental concern is output, commodity, and financial market interactions that reflect firm value and market performance. Until it is processed, oil has limited value, and well-informed market participants evaluate project risk, infrastructure, and market conditions. Crude oil's usefulness as an energy source is defined by its energy density, which is the amount of stored energy per volume unit, and despite wide-spread appeals for alternatives, no existing energy source has as high of energy density as crude oil and its distillates (EIA, 2012; EIA, 2013).[1] As an energy source, oil is processed into conventional gas, diesel, and aviation fuels, and evaluating the relationship between firm equity, commodity, and distillate returns reflect project risk, infrastructure, and conditions within the industry (Jaffe and Soligo, 2002, pp. 401-402; FTC, 1982, pp. 8-17). Moreover, to evaluate project risk at various stages of production, capital in the oil and gas industry is heterogeneous and segregated along production and service lines. Commodities are simultaneously priced in forward-looking commodity markets, and where firms are positioned within oil and gas production indicates much about access to capital, project risk, and government regulations.

Evaluating firm returns within equity, commodity, and distillate markets is important because conditions are constantly changing. Oil and gas producers used here are measured between January 2000 and August 2020. To assess risk, the oil and gas industry is segregated

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[1] Nuclear energy has greater energy density but as a mobile platform, nuclear is not a safe alternative to crude oil production. Electronic vehicles show promise to complement and eventually displace some crude-oil based platforms.

into five sections along production and services. Upstream exploration & production firms explore for and extract oil. To increase reserves, firms can merge to acquire or find new reserves through exploration & production (FTC, 1982, p. 72). Equipment & service firms are complements to exploration & production and recent fracking techniques with unconventional drilling are increasingly performed by equipment & service firms. Because their compensation varies directly with oil extraction, firm returns physically closer to crude extraction vary more with crude oil (Carson, 2022). Mid-stream transportation & pipeline firms transport and store crude-based products between upstream and downstream producers. Because it is more efficient, nearly all natural gas is transported through pipelines, while 70 percent of crude based-products are transported through pipelines. Downstream refiners and marketers process and distribute crude oil derivatives into conventional, natural gas, aviation fuels, and diesel to end-use consumers. Integrated firms were once classified as Super Majors, and their current operations include every stage of upstream, midstream, and downstream production, and technologies used in each production stage reflect different infrastructure, project risk, and labor supplies (Jaffe and Soligo, 2002, pp. 401-402; FTC, 1982, pp. 8-17). Subsequently, proximity to oil extraction reflects equity, commodity, and distillate project risk from when oil is extracted through its distribution to end use consumers.

Until it is processed into refined products, crude oil is of limited value, and processed distillates considered here are diesel, aviation fuel, conventional gas, and natural gas. Diesel fuel is a distillate used in freight, rail transportation, and manufacturing and is refined crude with less volatile fractions used in gasoline.[2] Aviation fuels are petroleum-based fuels that power aircraft

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[2] Red diesel is used as a heating oil and off-road agricultural uses, whereas green diesel refers to elements associated with plant and animal fats.

and account for about 10 percent of crude production.[3] Conventional gas is the primary fuel

used in automobile and ground transportation, and accounts for about half of refined oil

production (FTC, 1982, p. 12). Natural gas is the gaseous mixture of hydro-carbon compounds,

and its primary component is methane; natural gas is extracted at the same time as oil and is the

gaseous hydrocarbon used in many household and commercial energy applications.

The oil and gas industry is capital intensive, and high capital expenditures limit entry into

every sector of the industry. Innovation that increases industry productivity is facilitated by

skilled labor throughout production, and recent developments in horizontal drilling and

unconventional recovery techniques have improved project success, decreasing both risk and

returns (Zuckerman, 2013). Skilled innovators require access to capital, and Schumpeterian-

financiers allocate capital by assimilating relevant project-risk to evaluate profitability relative to

risk across oil and gas industry sectors (Bodenhorn, 1998, p. 106; Bodenhorn, 1999, pp. 279-280,

283-284; FTC, 1982, p. 73; Ackcigit et al., 2019). Well-informed Schumpeterian-financiers are

also active in commodity markets that combine information flows and the type of assets traded

on their respective exchanges. Commodity market valuations vary with commodity prices and

information from firm's regarding labor supplies and infrastructure in commodity markets.

Information regarding oil and gas credit conditions and project risk are provided by a well-

informed publication industry, and the *Oil & Gas Financial Journal, Oil & Gas Journal,* and

Offshore Magazine are publications that inform market participants of profit potential and project

risk. Whereas project risk and well completions are risky, Schumpeterian-financiers occupy

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[3] Naptha-type jet fuels ignite at lower temperatures and are primarily used in military turbojet and turboprop engines

that have lower freeze points.

important positions in oil production from their role in the production process and price information regarding equity, commodity, and distillate returns.

It is against this backdrop that this study considers three questions regarding the oil and gas industry between 2000 and 2020. First, how do equity markets assess risk across various sectors of the oil and gas industry? Equity markets positively price returns with the appropriate equity market index, and upstream equipment & service firms and downstream refiners & marketers have greater equity market risk than downstream producers. Second, how do different sectors of the oil and gas industry vary with commodity risk? Reflecting greater project risk, upstream exploration & production and equipment & service firm returns vary more with crude oil than midstream and downstream producers. Third, across the industry, how do firm returns vary with respect to fuel distillates? Oil and gas returns are positively related to crude oil distillates, and diesel is the leading derivative that contributes to firm returns, and firm returns are mostly unrelated to natural gas returns.

II.   Literature Review

Oil price variation and macroeconomic performance is a long-standing debate in industrial and macroeconomics. During the 1970s and 1980s, higher energy prices may have reduced US economic growth, and the US Department of Energy estimates that lost economic output from the two 1970s oil shocks was around $1.2 trillion in 1997-1998 dollars (US DOE, 1988, p. 6). Hamilton (1983) was among the first to find an inverse relationship between oil price changes and Gross National Product (GNP). However, this inverse relationship, while intuitive, has not received widespread support. Mork (1989, pp. 743-744) extends the results to

include the early 1980s and confirms an inverse relationship between energy prices but cannot affirm that energy price decreases increase output (Monk, Myson, and Olsen, 1994). Lee, Ni, and Retti (1995) find that large price increases are greater after unanticipated oil shocks compared to when price movements are erratic and frequent. Gao, Medlock, and Sickles (2001) show that oil price volatility is negatively related to productivity growth.

Across industries, firm valuation is related to industrial economic factors and risk, and Harry Markowitz (1952) was the first to formalize a mean-variance relationship between returns and risk in modern portfolio theory. Sharpe (1964), Litner (1965), and Moussin (1966) use single factor asset pricing models. However, early asset pricing models were not successful at pricing equity returns (Fama and French, 2004). To account for size and value effects, Fama and French (1992) and Fama and French (1993) add small-minus-big and high-minus-low variables. Carhart (1997) adds a momentum variable to account for how firm value is related to near-term performance and momentum. Titman, Wei, and Xei (2004) and Novy-Marx (2013) augment Fama-French models with profitability and investment strategy variables.

Equity return premiums are related across the oil and gas industry and are important when evaluating how markets evaluate risk. Faff and Brailsford (1999) show the effect that crude prices have with the Australian Stock Exchange. Mork et al. (1994) and Arouri (2011) partition the industry into sectors and use four factor Fama-French type asset pricing models to show return variation across the industry. US oil producer returns are related to equity market risk, size, book-to-market, and momentum factors, and risk exposure varies over time, across firms, and across the industry. Goodwin (1993) considers US oil price variation with equities around the 1973 oil price disruptions, and oil price changes have positive relationships with oil returns for refining & marketing firms. Mohanty and Nanda (2011) use Fama-French type

models to show that oil price changes are significant in producer returns, and oil price variation is related to the S&P 500, size, book-to-market, and momentum. Ramos et al (2014) show that upstream and downstream firms follow positive equity and commodity returns. Carson (2020) shows that both Major and Independent equity and firm returns are positively related to crude returns, while natural gas generally does not affect producer returns. Equity and commodity market risk varies across oil and gas extraction and have greater project risk as reflected by equity and commodity market variation (Carson, 2022). To assess project risk across the oil and gas industry, five sector Fama-French return variation models are used here to assess equity, commodity, and distillate market risk, and this study relies on well-informed Schumpeterian-financiers to assess information regarding equity market and infrastructure project risk across the oil and gas industry.

III.   Data

Table 1, Crude Oil, Natural and Conventional Gas, Diesel, and Jet Fuel Returns

and Correlations

Commodity Returns	*Returns*	*Standard Deviation*			
Brent Crude Oil	.0000613	.0326599			
Natural Gas	.0011192	.0535347			
Conventional Gas	.0001818	.0340214			
Diesel	-.0001725	.0234782			
Jet Fuel	-.000126	.0263762			
Price Correlation	Brent Crude Oil	Natural Gas	Conventional Gas	Diesel	Jet Fuel
Brent Crude Oil	1				
Natural Gas	.7716	1			
Conventional Gas	.9613	.7480	1		
Diesel	.9904	.7823	.9587	1	
Jet Fuel	.9882	.7741	.9564	.9974	1
ROR Correlations	Brent Crude Oil	Natural Gas	Conventional Gas	Diesel	Jet Fuel
Brent Crude Oil	1				
Natural Gas	.0108	1			
Conventional Gas	.6178	.0268	1		
Diesel	.5976	.0100	.5875	1	
Jet Fuel	.6471	.0099	.6437	.8860	1

Source: Brent Crude Oil Prices
        https://fred.stlouisfed.org/series/DCOILBRENTEU
Conventional Gas Prices
https://fred.stlouisfed.org/series/DGASUSGULF
Diesel Prices
https://fred.stlouisfed.org/series/DDFUELUSGULF
Jet Fuel Prices
https://fred.stlouisfed.org/series/DJFUELUSGULF
Natural Gas Prices
https://fred.stlouisfed.org/series/DHHNGSP

Table 1 presents commodity expected returns, standard deviations, return skewness, kurtosis, and Sharpe Ratios. Across brent, natural gas, conventional gas, diesel and jet fuel, natural gas has the highest daily rate of return, followed by conventional gas, crude oil, jet fuel, and diesel. Natural gas has the highest risk and standard deviation, followed by conventional gas, crude, oil, jet fuel, and diesel. Sharpe ratios measure average expected returns to risk and are standard measures for how markets value equity and project risk. Because they reflect returns to risk, Sharpe ratios are returns per unit of risk and are helpful in industry analysis. The highest commodity Sharpe ratios are for natural gas, conventional gas, crude oil, jet fuel, and diesel. Subsequently, the highest commodity and distillate returns coincide with project and distillate return per unit of risk, which are compensated with higher returns.

Figure 1, Crude Oil, Natural and Conventional Gas, Diesel, and Jet Fuel Returns and
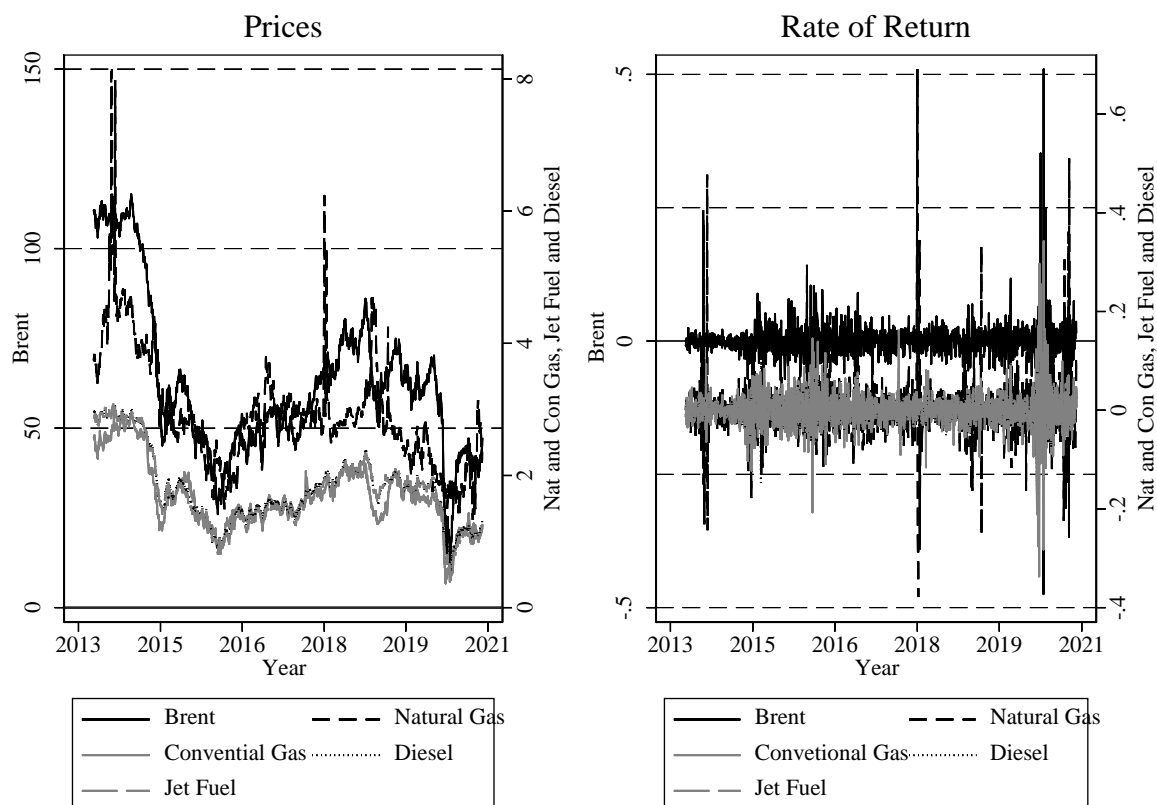
Correlations

Source: See Table 1.

Table 1 presents commodity prices, returns, risk, and correlations. Price and return variation over time signals information to market participants, and the fracking revolution decreased project risk with new engineering techniques in unconventional and horizontal drilling. The price of crude in highly correlated with diesel, jet fuel, and conventional gas prices (Table 1). Natural gas prices are the least correlated with crude oil and distillates. While related, crude, natural gas, and distillate rates of return are less correlated than prices. Crude, jet fuel, conventional gas, and diesel rates of return are highly correlated, whereas natural gas's rate of

return with crude and distillate returns are unrelated. Price and commodity risk decreased between 2013 and 2016 (Figure 1). Oil, gas, and derivative prices stabilized with modest upward drift between 2016 and 2019. However, in the Spring of 2020, the effects of Covid 19 decreased crude, natural gas, and distillate prices and returns. Crude oil's abrupt Spring 2020 collapse affected firm and commodity returns in general and exposed downstream refining & marketing firms that made contracts on higher crude oil upon delivery but were unable to recover returns after conventional gas, diesel, and jet fuel distillate prices decreased.

The oil and gas industry is partitioned into 57 exploration & production firms, 15 equipment & service firms, 13 integrated firms, nine transportation & pipeline firms, and six refining & marketing firms.[4] In international oil and gas markets, Brent North Sea is the crude grade that is light and sweet and is the leading global crude benchmark for Atlantic Basin oils used to price about two-thirds of international oil.[5] Henry Hub natural gas at Erath, Louisiana is the international benchmark for natural gas prices and returns and is the most heavily traded contract priced off the New York Mercantile Exchange. Conventional gas returns are measured with Gulf Coast conventional gas returns. Diesel returns are measured with ultra-low sulfur No. 2, Diesel Fuel Prices: US Gulf Coast. Jet fuel is the return on US Gulf Coast kerosene type jet-fuel prices. Commodity and fuel-blend excess returns are added for natural and conventional gas, diesel, and aviation fuel. Standard small-minus-big (SMB_t), high-minus-low (HML_t),

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[4] Downstream refining & marketing is highly concentrated in production and ownership. For example, Koch Industries devotes much of its industrial capacity to refining, along with Goodway Refining, and Kern Oil and Refining.

[5] Brent was originally priced on the International Petroleum Exchange in London but since 2005 has traded on the Intercontinental Exchange (ICE).

robust-minus-weak (RMW_t), and conservative-minus-aggressive (CMA_t) factors are included. Carhart's momentum factor, MOM_t, is included to account for the relationship between returns and momentum.

Tables 2 through 5 present firm return and risk descriptive statistics across upstream, midstream, and downstream sectors. Refining & marketing firms have the highest expected returns, followed by transportation & pipeline, integrated, exploration & production, and equipment & services (Tables 2 through 5). The uncertainty over project return is associated the greatest risk and standard deviations for upstream exploration & production and equipment & services firms. The asymmetric payment and delivery periods for midstream transportation & pipeline and downstream refining & marketing are associated with a high degree of risk, followed by integrated firms that are well-capitalized and are better able to withstand refining between when crude is purchased and when refined oil and gas products are sold to downstream consumers. Large integrated firms have the highest Sharpe Ratios, followed by transportation & pipeline, refining & marketing, equipment & services, and exploration & production.

Table 2, Exploration & Production Expected, Risk, and the Shape of Return Distribution

		N	Mean	Median	SD	Skewness	Kurtosis	Sharpe Ratio
Exploration & Production								
NYSE								
Amplify	AMPY	2,141	-.002251	-.001879	.073440	2.1095	38.933	-.03035
Antero	AR	1,776	-.000681	-.001188	.038870	1.1133	12.310	-.01752
Bonanza Creek	CIVI	2,164	-.000282	-.000543	.058370	.613812	22.330	-.00483
Cabot Oil & Gas		3,604	.000710	-.000040	.027770	.313591	9.3018	.02557
Callon Energy	CPE	3,543	.000577	0	.054093	1.0816	43.2826	.01067
Canadian Natural Resources	CNQ	3,543	.000412	.000232	.028918	-.468350	16.382	.01425
Cimarex	XEC	3,604	.000426	.000344	.029383	-.142524	16.983	.01450
CNX	CNX	3,543	.000393	-.000070	.037455	.236865	9.1688	.01049
Comstock	CRK	3,543	.000433	-.000200	.052731	2.1013	30.399	.00821
Concho	CXO	3,261	.000893	.000657	.030985	.164721	12.2460	.02882
Continental	CLR	3,378	.001055	.000370	.040028	-.107875	18.680	.02636
Crescent Point	CPG	3,543	-.000122	-.000010	.031528	-.306084	23.317	-.00387
Cross Timbers	CRT	3,543	.000073	0	.025188	-.324867	15.118	.00290
CRV	CVI	3,205	.000909	.000536	.039175	2.5721	49.761	.02320
Devon	DVN	3,543	-.000016	-.000001	.028719	-.237328	17.608	-.00056
EcoPetrol	EC	2,978	.000262	.000393	.026130	-.332254	14.070	.01003
Enerplus	ERF	3,541	-.000113	0	.031387	-.236135	14.316	-.00360
EOG	EOG	3,604	.000483	.000242	.026079	-.189532	14.982	.01852
EQT	EQT	3,543	.000330	.000234	.027019	1.1059	20.275	.01221
Equinor	EQNR	3,604	.000296	.000419	.023565	-.299874	9.7632	.01256
GeoPark	GPRK	2,456	.000466	0	.032277	-.316544	16.219	.01444
Kosmos	KOS	2,315	-.000254	-.000090	.038894	-1.00066	44.113	-.00653
Laredo Petroleum	LPI	2,164	-.000180	-.000090	.052856	5.0966	112.632	-.00341
Marathon Oil	MRO	3,543	.000105	.000488	.029983	-.71988	25.5578	.00350
Matador	MTDR	2,133	.000826	0	.041536	-.954749	41.6174	.01989
Noble	NE	3,542	-.000727	-.000580	.052172	8.4692	288.733	-.01394
Northern Oil & Gas	NOG	3,341	.000631	-.000160	.048679	.575691	10.055	.01296
Occidental	OXY	3,543	.000108	.000304	.026754	-1.3372	57.9213	.00404

Ovintiv	OVV	3,543	.000025	-.000100	.034083	-2.0261	65.3373	.00073
Permian Basin Trust	PBT	3,543	.000043	0	.022122	-.105646	10.8206	.00194
Pioneer	PXD	3,543	.000682	.000461	.029150	-.498363	16.1032	.02340
Range	RRC	3,543	.000218	-.000565	.033714	.621462	10.8361	.00647
Sandridge	SD	965	-.001492	-.002098	.051224	3.5226	56.918	-.02913
Silverbow	SBOW	904	-.001015	-.001298	.049687	2.7291	34.501	-.02043
SM Energy	SM	3,543	.000212	0	.044842	1.1343	41.523	.00473
Southwestern	SWN	3,543	.000126	-.000536	.035629	.530230	11.2382	.00354
Sun	SU	1,978	.000687	.000254	.024102	.344835	30.450	.02850
Talos Energy	TALO	569	-.001538	-.000070	.047494	.018034	9.9597	-.03238
Vaalco	EGY	3,543	.000293	-.000090	.042297	.594781	9.2799	.00693
W & T Offshore	WTI	3,543	.000203	-.000651	.043228	.609081	9.2999	.00470
WPX	WPX	2,172	.000390	-.000060	.38572	.206839	13.928	.00101
YPF	YPA	3,543	.000033	-.000281	.029945	-.596799	25.675	.00110
NYSE Averages		**3,017.05**	**.000086**	**-.00013**	**.045866**	**.611064**	**32.1892**	**.000452**
AMEX								
Barnwell	BRN	3,544	.000422	-.000010	.054650	4.5966	76.339	.00772
Camber Energy	CEI	3,361	.000501	-.000080	.056076	4.2800	81.362	.00893
Contango	CTGO	3,543	.000283	-.000453	.041507	.913251	15.273	.00682
Evolution Petroleum	EPM	3.544	.000592	-.000025	.033086	.171190	14.032	.01789
Evolve Transition Infrastructure	SNMP	3,435	-.000724	-.000090	.048855	-.013512	27.304	-.01482
Goodrich Petroleum	GDP	919	.000405	-.000030	.039693	.279880	10.666	.01020
Houston America Energy	HUSA	3,543	.000935	-.000050	.063088	1.02655	13.599	.01482
Riley Exploration Permian	REPX	3,542	.000667	-.000050	.059669	2.3804	32.3009	.01112
AMEX Averages		**2,736.32**	**.000385**	**-.000100**	**.049578**	**1.70430**	**33.8595**	**.007835**
NASDAQ								
Abraxas	AXAS	3,361	.000501	-.000080	.056076	4.2800	81.362	.00893
APA	APA	3,544	.000136	.000474	.031012	-1.1191	42.227	.00439
Centenial	CDEV	1,085	-.000681	-.000010	.056708	.057441	30.970	-.01201
DiamondBack	FANG	2,036	.001124	.001760	.032129	-.90946	30.549	.03498
Epsilon	EPSN	3,179	.000421	0	.046230	-.96926	72.778	.00911
PDC	PDCE	3,568	.000715	.000293	.046718	8.5815	306.872	.01531

Penn Virginia	ROEC	934	.001408	-.000553	.081150	7.4252	130.565	.01735
NASDAQ Averages		**2,529.57**	**.000518**	**.000269**	**.050003**	**2.47805**	**99.3319**	**.01115**
Total Average		**2,917.78**	**.000181**	**-.000080**	**.046910**	**.993778**	**40.6692**	**.005796**

Source: https://finance.yahoo.com/

Table 3, Equipment & Services Expected Returns, Risk, Sharpe Ratios, and the Shape of Return Distribution

Equipment & Services		N	Mean	Median	SD	Skewness	Kurtosis	Sharpe Ratio
NYSE								
Fluor	FLR	3,543	.000086	.000441	.032221	2.9988	100.011	.00267
Halliburton	HAL	3,543	.000192	.000146	.028117	-.680614	21.7503	.00683
Helmerich & Payne	HP	3,543	.000441	.000823	.030700	-.232013	14.3210	.01437
Nabors Drilling	NBR	3,543	-.000096	-.000501	.043162	.646594	20.2003	-.00222
National Oilwell Varco	NOV	3,543	.000252	.000507	.030689	-.227100	13.5455	.00821
Newpark	NR	3,544	.000496	-.000020	.039706	.016860	15.071	.01249
Nextier Oilfield	NEX	892	-.00108	-.001432	.049816	.793824	18.5875	-.02168
Precision Drilling	PDS	3,543	-.000283	-.00009	.037536	-.305900	12.0733	-.00754
Schlumberger	SLB	3,543	.000034	-.000180	.024358	-.508566	14.1663	.00140
TechniFMC	FTI	3,543	.000279	.000333	.028341	-.229772	11.6050	.00984
Tidewater	TDW	3,543	-.000758	.000217	.037474	-.401174	17.0553	-.02023
NYSE Averages		**3,302.09**	**-3.98^{-5}**	**2.22^{-5}**	**.034738**	**.170085**	**23.4897**	**-.00114**
NASDAQ								
Baker Hughes	BKR	3,543	.000060	.000052	.027115	-.018553	13.1985	.00221
Patterson Drilling	PTEN	3,543	.000104	0	.035395	-.318079	16.0630	.00294
		3543	**8.20^{-5}**	**2.60^{-5}**	**.031255**	**-.16832**	**14.6308**	**.002624**
		3,339.15	**-.000021**	**-2.28^{-5}**	**.034202**	**.118024**	**22.1268**	**-.000610**

Source:https://finance.yahoo.com/

Table 4, Integrated Expected Returns, Risk, Sharpe Ratios, and the Shape of Return Distribution

Integrated		*N*	*Mean*	*Median*	*SD*	*Skewness*	*Kurtosis*	*Sharpe Ratio*
BP	BP	3,543	.000048	.000245	.019839	-.182945	19.0837	.00242
Chevron	CVX	3,543	.000383	.000852	.018547	.087754	27.9742	.02065
ConocoPhillips	COP	3,533	.000255	.000355	.022039	-.066675	18.9175	.01157
ENI	E	3,543	.000160	.000820	.020810	-.485032	13.7681	.00769
Enlink	ENLC	3,543	.000452	-.000050	.043905	2.56066	56.0172	.01029
Exxon	XOM	3,545	.000159	.000151	.016452	.179705	17.0156	.00967
Hess	HES	3,543	.000486	.000800	.029072	-.494450	14.4078	.01672
Murphy Oil	MUR	3,543	.000283	.000390	.030038	.306754	9.1918	.00642
Petrobras	PBR	3,543	.000475	.000812	.034974	.052305	11.5059	.01358
Petro China	PTR	3,543	.000074	-.000317	.023298	.306754	9.19184	.00318
Royal Dutch Shell	RDS	3,568	.000136	.000719	.019704	-.085433	20.3876	.00690
Sinopec	SNP	3,543	.000460	.000381	.024014	.569700	10.2945	.01916
Total, SA	TTE	3,543	.000241	.000702	.019394	-.253300	13.7427	.01243
Integrated Averages		**3,544.31**	**.000278**	**.000451**	**.024776**	**.191984**	**18.5768**	**.01082**

Source:
https://finance.yahoo.com/

Table 5, Refining & Marketing and Transportation & Pipeline Expected, Risk, and Shape of Return Distribution

Refining & Marketing		N	Mean	Median	SD	Skewness	Kurtosis	Sharpe Ratio
Dalek	DK	3,543	.000735	.000334	.034278	.354704	10.184	.021443
Holly Frontier	HEP	3,543	.000628	.001031	.029857	.105311	8.9380	.021034
Marathon Petroleum	MPC	2,285	.000807	.001343	.026535	-.373685	15.547	.030413
PBF	PBF	1,922	.000369	.001330	.036424	.707620	28.256	.010131
Par Pacific	PARR	1,987	.001615	0	.050838	18.0815	539.034	.031768
Phillips 66	PSX	2,087	.000542	.000925	.020079	-.148747	12.9628	.026993
Targa Resources	TRPG	2,420	.000631	.000852	.032273	-2.1535	49.2675	.019552
Valero	VLO	3,543	.000424	.000864	.026700	-.302505	10.6340	.015880
Refining & Marketing Averages		**2,666.25**	**.000719**	**.000835**	**.032123**	**2.03387**	**84.3529**	**.022253**
Transportation & Pipeline								
Cheniere (AMEX)	LNG	3,543	.001060	-.000070	.045358	2.2396	37.6602	.023370
HES Midstream	HESM	840	.000337	.000435	.032941	-.921411	37.806	.010230
Kinder Morgan	KMI	2,435	.000053	-.000040	.019740	-.321324	18.9889	.002685
Prime Energy (NASDAQ)	PNRG	3,543	.000641	-.000010	.038485	1.51889	29.4211	.016656
One OK	OKE	3,543	.000643	.000965	.024814	-.376207	47.2708	.025913
TC Energy	TRP	3,543	.000464	.000704	.016752	-.111406	20.4700	.027698
Western Midstream	WES	1,925	.000175	0	.032384	-1.6086	65.9035	.005404
Whiting	WLL	3,543	.000303	.000160	.061787	8.1223	179.52	.004904
Transportation & Pipeline Averages		**2,864.38**	**.000460**	**.000268**	**.034033**	**1.06773**	**54.6300**	**.014608**

Source: https://finance.yahoo.com/

IV.   Research Design

To triangulate information regarding firm risk and returns from equity, commodity, and distillate markets, equity and commodity market Fama-French type models are now augmented with distillate returns. Oil and gas firm returns are now regressed on appropriate equity market indices, oil, gas, and distillate returns.

$$R_{it} - R_{ft} = \theta_0 + \theta_1 \left(R_{mt} - R_{ft} \right) + \theta_2 \left(R_{ot} - R_{ft} \right) + \theta_3 \left(R_{gt} - R_{ft} \right) + \theta_4 \left(R_{cg} - R_{ft} \right) + \theta_5 \left(R_d - R_{ft} \right)$$

$$+ \theta_6 \left(R_j - R_{ft} \right) + \theta_7 SMB_t + \theta_8 HML_t + \theta_9 RMW_t + \theta_{10} CMA_t + \theta_{11} MOM_t + \varepsilon_t$$

R_{it} is each firm's daily adjusted return. R_{ft} is the daily US three-month Treasury Bill rate. Market returns vary with respect to project risk and exchange listing requirements. R_{mt} is the Standard & Poor's daily rate of return for firms on the New York Exchange; R_{mt} is the NYSE—American index for firms on the American Exchange; R_{mt} is the NASDAQ index for firms on the National Association Securities Automated Quotations. θ_1 is the appropriate index excess return for market systematic risk. R_{ot} is the daily return on North Sea Brent. θ_2 is the North Sea returns sensitivity parameter. R_{gt} is the Henry-Hub daily rate of return on natural gas, and θ_3 is firm excess return variation with Henry Hub natural gas excess returns and θ_2 and θ_3 represents oil systematic risk. R_c is the conventional gas daily returns, and θ_4 is firm excess return variation with conventional gas excess returns. R_d is the diesel fuel daily returns, and θ_5 is firm excess return variation with diesel excess return variation. R_j is jet fuel daily returns, and θ_6 is firm excess return variation with jet fuel. SMB_t, HML_t, RMW_t, and CMA_t are small-minus-big,

high-minus-low, robust-minus-weak, and conservative-minus-aggressive.[6] θ_7, θ_8, θ_9, and θ_{10} are firms' sensitivities for excess returns with respect to SMB_t, HML_t, RMW_t, and CMA_t. MOM_t is a daily momentum factor, and θ_{11} is how firm returns vary with momentum. Returns are estimated with GARCH (1, 1) models, which is common in the return's literature.

Three paths of inquiry are considered when evaluating firm equity, commodity, and distillate returns. First, individual equity betas are positively related to broader equity market indices, and financial markets positively price oil producer equity returns with the appropriate equity market index. Equity markets measure project risks, which are informed by financiers across exchanges, and refining & marketing firms have the highest equity market risk, followed by equipment & services, integrated, exploration & production, and transportation & pipeline (Table 13; Kim and Choi, 2019, p. 361). Although upstream exploration & production and equipment firms assume capital market project risk, downstream refining & marketing firms assume considerable project risk because risk depends on price asymmetries between when refiners take physical possession of crude oil and when it is delivered to downstream consumers. For example, in 2008 and 2020, smaller refiners contracted and took delivery of oil at high crude

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[6] Fama-French factors are constructed using the six value-weighted portfolios that represent size and book-to-market values. Small-minus-big is the daily average on small equity portfolios, less the average nine big stock average returns, the size effect for an equity. High-minus-low is the average return on two value portfolios, less the average return on two growth portfolios, the value effect. Robust-minus-weak is the average returns on two operating profitability portfolios, less average returns on the two weak operating portfolios, a profitability effect. Conservative-minus-weak is two average returns on conservative investment portfolios, less the average returns on two aggressive investment portfolios.

prices. However, downstream gas and distillate prices decreased before refiners delivered refined products as fuel and other distillates (Rueters, 2008; Edelhart, 2010; Morenne, 2022). Refining & marketing equity market returns are further complicated by fewer downstream refineries, and around 50 percent of refining capacity is controlled by Chevron, ExxonMobil, ConocoPhillips, Marathon Petroleum, and Valero. Larger integrated firms also have greater market power to determine refinery margins. Subsequently, downstream refining & marketing equity returns have greater equity market return variation, and risk is related to their physical position in the oil and gas industry (Kim and Choi, 2019).

Table 6, Exploration & Production GARCH Return Models, New York Stock Exchange

	Amplify	Antero	Bonanza Creek	Cabot	Callon	Canadian Natural	Cimarex	CNX	Comstock	Concho
Intercept	-.002***	-.001***	.001	2.32^{-4}	.001**	-6.46^{-5}	6.54^{-4}	-2.15^{-4}	-3.15^{-4}	.001
	(.001)	(.001)	(.001)	(3.42^{-4})	(.001)	(2.46^{-5})	(2.77^{-4})	(3.81^{-4})	(.001)	(3.27^{-4})
S & P 500	1.18***	.920***	1.02***	.959***	1.23***	.936***	.937***	1.22***	1.07***	.967***
	(.045)	(.055)	(.062)	(.029)	(.040)	(.023)	(.028)	(.043)	(.048)	(.027)
Brent	.052	-.036	.063**	-.024	.112***	.106***	.085***	.003	.023	.120***
	(.032)	(.032)	(.032)	(.019)	(.020)	(.012)	(.016)	(.023)	(.020)	(.016)
Natural Gas	-.032***	.037***	.012	.034***	.022**	.007	.014**	.032***	.045***	.008
	(.006)	(.010)	(.018)	(.007)	(.009)	(.006)	(.007)	(.008)	(.011)	(.009)
Conventional Gas	.116***	.065**	.092***	.070***	.028	.069***	.054***	.058***	.062**	.077***
	(.033)	(.026)	(.032)	(.002)	(.027)	(.013)	(.016)	(.021)	(.025)	(.016)
Diesel	.034	.178**	.406***	.213***	.334***	.166***	.187***	.160***	.199***	.278***
	(.060)	(.070)	(.063)	(.031)	(.046)	(.024)	(.028)	(.033)	(.050)	(.041)
Jet Fuel	.261***	-.025	.004	.013	.156***	.132***	.071**	.078**	.115**	-.021
	(.032)	(.053)	(.007)	(.033)	(.046)	(.023)	(.025)	(.039)	(.051)	(.040)
SMB	.006***	.005***	.008***	.003***	.014***	.002***	.004***	.005***	.006***	.003***
	(.001)	(.001)	(.001)	(.001)	(.001)	(4.32^{-4})	(.001)	(.001)	(.001)	(.001)
HML	.002	.002**	.003**	.002***	.011***	.002***	.003***	.003***	.002**	.001
	(.002)	(.001)	(.002)	(.001)	(.001)	(.001)	(.001)	(.001)	(.001)	(.001)
RMW	-.007***	-.010***	-.008***	.003***	-.002	-.001	-.001	-.001	.002	-.002**
	(.002)	(.002)	(.001)	(.001)	(.001)	(.001)	(.001)	(.001)	(.001)	(.001)
CMA	.002	.002	-.002	-.003***	-.002	1.10^{-4}	1.99^{-4}	-.003**	-.010***	.001
	(.003)	(.002)	(.002)	(.001)	(.002)	(.001)	(.001)	(.001)	(.002)	(.001)
MOM	-.010***	-.009***	-.006***	-3.03^{-4}	-3.77^{-4}	-.003***	-.002***	-.004***	-.001	-.003***

	(.001)	(.001)	(.001)	(4.04^{-4})	(.001)	(3.08^{-4})	(3.51^{-4})	(.001)	(.001)	(4.44^{-4})
N	2,141	1,776	2,164	3,604	3,543	3,543	3,604	3,543	3,543	3,261
Log Likelihood	3,649.15	4,096.49	4,088.44	8,858.82	6,899.98	9,465.79	9,285.80	7,947.25	6,863.25	8,081.77
Wald	2,157.59	1,174.11	1,262.06	2,203.50	5,725.18	13,834.38	3,923.91	2,531.02	1,817.64	3,748.36

Source: See Table 2.

Notes: *** Significant at .01; ** Significant at .05; * Significant at .10.

Table 6, Exploration & Production GARCH Return Models, New York Stock Exchange

	Continental	Crescent Point	Cross Timbers	CRV	Devon	EcoPetrol	Enerplus	EOG	EQT
Intercept	.001**	-9.66^{-5}	-6.20^{-5}	.001***	-2.40^{-4}	-6.25^{-5}	-3.80^{-4}	1.14^{-4}	-8.42^{-4}
	(3.50^{-4})	(2.71^{-4})	(2.81^{-4})	(3.84^{-4})	(2.52^{-4})	(2.89^{-4})	(2.70^{-4})	(2.53^{-4})	(2.57^{-4})
S & P 500	1.05***	.617***	.286***	1.12***	.962***	.690***	.671***	.951***	.983***
	(.032)	(.028)	(.028)	(.038)	(.025)	(.029)	(.026)	(.024)	(.027)
Brent	.169***	.189***	.129***	.013	.061***	.101***	.095***	.077***	.035**
	(.022)	(.012)	(.015)	(.021)	(.013)	(.014)	(.019)	(.014)	(.017)
Natural Gas	.007	-.006	.012**	-.012	.015***	-.002	.008	.006	.038***
	(.009)	(.005)	(.006)	(.010)	(.005)	(.006)	(.007)	(.006)	(.006)
Conventional Gas	.046**	.028*	-.004	.085***	.043***	.047***	.008	.048***	.033**
	(.022)	(.014)	(.012)	(.019)	(.013)	(.015)	(.016)	(.013)	(.016)
Diesel	.375***	.179***	.056***	.136***	.200***	.195***	.181***	.216***	.126***
	(.040)	(.026)	(.021)	(.041)	(.024)	(.035)	(.027)	(.024)	(.025)
Jet Fuel	.095***	.118***	.103***	.047	.084***	.050	.081***	.056***	.014
	(.031)	(.026)	(.017)	(.037)	(.024)	(.032)	(.025)	(.020)	(.024)
SMB	.005***	.001**	.003***	.008***	.002***	-.001*	.001**	.002***	.002***
	(.001)	(.001)	(.001)	(.001)	(.001)	(.001)	(.001)	(4.32^{-4})	(.001)
HML	.003***	-2.38^{-4}	.003***	.004	.003***	-.002***	.002***	.002***	.001*
	(.001)	(.001)	(.001)	(.001)	(.001)	(.001)	(.001)	(.001)	(.001)
RMW	-.002**	-.001	.003***	1.25^{-4}	.001*	-.002**	-.001	-3.84^{-4}	.003***
	(.001)	(.001)	(.001)	(.001)	(.001)	(.001)	(.001)	(.001)	(.001)
CMA	-.001	-2.32^{-4}	-.003***	-2.13^{-4}	-.002**	.007***	-.004***	-.002*	-.001
	(.001)	(.001)	(.001)	(.001)	(.001)	(.001)	(.001)	(.001)	(.001)
MOM	-.004***	-.002***	2.96^{-4}	3.97^{-5}	-.003***	-.004***	-.001***	-.002***	-1.63^{-4}
	(.001)	(4.30^{-4})	(3.99^{-4})	(.001)	(3.49^{-4})	(3.57^{-4})	(4.15^{-4})	(3.16^{-4})	(3.26^{-4})
N	3,378	3,543	3,543	3,205	3,543	2,978	3,541	3,604	3,543
Log Likelihood	7,852.58	8,786.68	9,061.52	7,255.50	9,475.85	7,785.23	8,537.16	9,724.10	9,248.00

| Wald | 4,681.88 | 3,909.02 | 1,148.23 | 2,611.08 | 4,801.22 | 3,345.17 | 2,521.97 | 5,990.50 | 2,733.16 |

Source: See Table 2.

Notes: *** Significant at .01; ** Significant at .05; * Significant at .10.

Table 6, Exploration & Production GARCH Return Models, New York Stock Exchange

	Equinor	GeoPark	Kosmos	Laredo Petroleum	Marathon Oil	Matador	Noble	Northern Oil & Gas	Occidental
Intercept	-2.05^{-4}	.001	4.47^{-6}	-3.37^{-4}	-7.11^{-5}	2.25^{-4}	-6.07^{-4}*	.001	-2.71^{-4}
	(2.12^{-4})	(.001)	(.001)	(.001)	(2.36^{-4})	(.001)	(3.26^{-4})	(.001)	(1.98^{-4})
S & P 500	.972***	.329***	.848***	1.07***	1.08***	1.16***	1.08***	1.10***	.978***
	(.022)	(.050)	(.051)	(.066)	(.024)	(.061)	(.034)	(.046)	(.021)
Brent	.129***	.041**	.013	.135***	.097***	.048**	.114***	.106***	.046***
	(.011)	(.018)	(.026)	(.029)	(.016)	(.020)	(.019)	(.026)	(.012)
Natural Gas	.003	.011	.003	.029**	-.005	.011	-.012*	-.008	.004
	(.004)	(.018)	(.013)	(.015)	(.006)	(.013)	(.007)	(.011)	(.004)
Conventional Gas	.038***	.026	.084***	.075**	.081***	.094***	.087***	.012	.046***
	(.010)	(.021)	(.028)	(.032)	(.014)	(.027)	(.018)	(.013)	(.011)
Diesel	.135***	.097**	.268***	.262***	.189***	.317***	.213***	.350***	.175***
	(.023)	(.048)	(.032)	(.072)	(.029)	(.050)	(.035)	(.046)	(.019)
Jet Fuel	.080***	.069	.035	.112*	.056*	.047	.054	.081*	.037**
	(.021)	(.047)	(.033)	(.058)	(.029*)	(.049)	(.036)	(.044)	(.018)
SMB	2.37^{-4}	.002**	.003***	.008***	8.88^{-5}	.010***	.001	.011***	2.97^{-4}
	(3.97^{-4})	(.001)	(.001)	(.001)	(.001)	(.001)	(.001)	(.001)	(3.68^{-4})
HML	.001**	.001	.001	2.75^{-4}	.001*	.004***	-2.19^{-4}	.003***	.001*
	(4.43^{-4})	(.001)	(.001)	(.001)	(.001)	(.001)	(.001)	(.001)	(4.03^{-4})
RMW	1.69^{-4}	1.81^{-4}	-.006***	-.011***	3.50^{-4}	-.011***	.001	-.002	.001
	(6.11^{-4})	(.001)	(.001)	(.002)	(.001)	(.001)	(.001)	(.002)	(.001)
CMA	.004***	.002	.001	.014***	.001	.002	-.003**	-.006***	.001*
	(.001)	(.002)	(.001)	(.002)	(.001)	(.002)	(.001)	(.002)	(.001)
MOM	-.002***	-.002**	-.009***	-.009***	-.003***	-.008***	-.001***	-.003***	-.002***
	(2.88^{-4})	(.001)	(.001)	(.001)	(3.47^{-4})	(.001)	(3.94^{-4})	(.001)	(2.63^{-4})

N	3,604	2,456	2,315	2,164	3,543	2,133	3,542	3,339	3,543
Log Likelihood	10,398.07	5,225.61	5,239.09	4,406.87	9,377.15	4,829.04	7,883.77	6,434.94	10,265.63
Wald	7,519.40	308.91	1,755.86	3,027.63	5,756.14	3,199.05	3,662.20	3,780.30	5,139.56

Source: See Table 2.

Notes: *** Significant at .01; ** Significant at .05; * Significant at .10.

Table 6, Exploration & Production GARCH Return Models, New York Stock Exchange

	Ovintiv	Permian Basin Trust	Pioneer	Range	Sandridge	Silverbow	SM Energy	Southwestern	Sun
Intercept	-3.18^{-4}	-6.71^{-5}	4.78^{-5}	-2.29^{-4}	-.002*	-.001	1.30^{-4}	-.001	.001***
	(2.99^{-4})	(2.44^{-4})	(2.88^{-4})	(3.56^{-4})	(.001)	(.001)	(3.71^{-4})	(3.62^{-4})	(4.12^{-4})
S & P 500	.778***	.401***	1.09***	.924***	1.12***	.700***	.954***	.946***	.571***
	(.030)	(.024)	(.026)	(.037)	(.115)	(.120)	(.039)	(.037)	(.051)
Brent	.104***	.100***	.067***	.040*	.245***	-.062	.187***	.006	.009
	(.013)	(.014)	(.010)	(.022)	(.037)	(.042)	(.021)	(.022)	(.019)
Natural Gas	.033***	.009	.010	.047***	.049***	.014	.040***	.072***	.015
	(.006)	(.006)	(.007)	(.007)	(.016)	(.022)	(.006)	(.007)	(.010)
Conventional Gas	.083***	.049***	.060***	.066***	.104***	.056	.082***	.072***	.036
	(.016)	(.013)	(.014)	(.020)	(.040)	(.049)	(.023)	(.020)	(.022)
Diesel	.194***	.158***	.247***	.216***	.365***	.413**	.254***	.170***	-.013
	(.025)	(.024)	(.026)	(.038)	(.121)	(.162)	(.035)	(.034)	(.048)
Jet Fuel	.120***	.012	.043*	.065*	-.214*	-.153	.107***	.087**	.022
	(.023)	(.024)	(.025)	(.035)	(.120)	(.155)	(.035)	(.037)	(.046)
SMB	.003***	.003***	.003**	.006***	.010***	.008***	.006***	.005***	-.001
	(.001)	(4.17^{-4})	(.005)	(6.64^{-4})	(.002)	(.002)	(.001)	(.001)	(.001)
HML	.001	.003***	.004***	.003***	.004***	.001	.002***	.002***	-.003***
	(.001)	(.001)	(.001)	(.001)	(.001)	(.001)	(.001)	(.001)	(.001)
RMW	.001	.002***	-2.54^{-4}	.005***	-.011***	-.002	-.002*	.004***	-.001
	(.001)	(.001)	(.001)	(.001)	(.002)	(.003)	(.001)	(.001)	(.001)
CMA	.002*	-.001	-.003***	-.006***	.002	.007**	-.001	-.006***	.005***
	(.001)	(.001)	(.001)	(.001)	(.003)	(.003)	(.001)	(.001)	(.001)
MOM	-.003***	.001***	-.001***	-4.02^{-4}	-.007***	-.007***	-.002***	-.002***	-.004***
	(3.68^{-4})	(3.21^{-4})	(3.36^{-4})	(.001)	(.001)	(.002)	(.001)	(.001)	(.001)
N	3,543	3,543	3,543	3,543	965	904	3,543	3,543	1,978
Log Likelihood	8,748.48	9,503.77	9,165.60	8,267.09	1,997.70	1,783.73	7,797.13	8,094.03	5,126.18
Wald	5,292.69	2,268.35	10,161.91	2,067.29	4,705.68	299.01	2,907.25	2,280.29	315.67

Table 6, Exploration & Production GARCH Return Models, New York Stock Exchange

	Talos	Vaalco	W&T Offshore	WPX	YPF	Total
Intercept	-.001	-2.59^{-4}	-1.93^{-4}	.001	1.79^{-4}	-4.93^{-4}
	(.001)	(.001)	(4.28^{-4})	(.001)	(3.24^{-4})	(.001)
S & P 500	.828***	1.06***	1.08***	.565***	.522***	.903***
	(.095)	(.042)	(.034)	(.062)	(.033)	(.039)
Brent	.249***	.018	.156***	.279***	.104***	.086***
	(.048)	(.027)	(.022)	(.036)	(.015)	(.021)
Natural Gas	-.022	.011	.011	.020*	-.008	.014
	(.027)	(.012)	(.010)	(.010)	(.008)	(.009)
Conventional Gas	.026	.090***	.061**	.026	.028*	.057***
	(.051)	(.026)	(.024)	(.030)	(.015)	(.021)
Diesel	.240***	.234***	.341***	.201***	.171***	.215***
	(.082)	(.043)	(.040)	(.071)	(.028)	(.044)
Jet Fuel	.071	.079*	.063*	.096	-.029	.057
	(.061)	(.041)	(.035)	(.070)	(.029)	(.040)
SMB	.011***	.011***	.013***	.003**	.002***	.005***
	(.002)	(.001)	(.001)	(.001)	(.001)	(.001)
HML	.004*	.001	.003***	-9.01^{-5}	-.001**	.002*
	(.002)	(.001)	(.001)	(.001)	(.001)	(.001)
RMW	-.007**	-.001	-1.85^{-4}	-.009***	-.001	-.001
	(.003)	(.001)	(.001)	(.002)	(.001)	(.001)
CMA	-.005	-.008***	-.008***	.010***	.003**	-1.93^{-4}
	(.004)	(.002)	(.001)	(.002)	(.001)	(.001)
MOM	-.007***	-.001	-.003***	-.006***	1.83^{-4}	-.003***
	(.002)	(.001)	(.001)	(.001)	(.001)	(.001)
N	569	3,543	3,543	2,170	3,543	
Log Likelihood	1,196.51	6,674.60	7,340.23	4,606.09	8,197.51	
Wald	1,706.92	2,052.24	4,757.48	1,625.82	839.55	

Source: See Table 2.

Table 7, Exploration & Production GARCH Return Models, National Association of Securities Dealers Automated Quotations

	Abraxas	APA	Centennial	Diamond Back	Epsilon	PDC	Penn Virginia	Total
Intercept	-1.66^{-4}	-.001**	-2.67^{-4}	.001	-.001**	.001	$-.2.78^{-4}$	-1.02^{-4}
	(.001)	(2.67^{-4})	(.001)	(4.33^{-4})	(.001)	(4.19^{-4})	(.001)	.001
NASDAQ	1.04***	.852***	.889***	1.02***	.511***	1.05***	.756***	.874***
	(.044)	(.023)	(.103)	(.046)	(.045)	(.037)	(.074)	.053
Brent	.285***	.106***	.009	.004	.013	.006	.129***	.079***
	(.016)	(.015)	(.039)	(.012)	(.011)	(.007)	(.049)	.017
Natural Gas	.017	.013**	.005	-.003	.088***	.011	-.044*	.012
	(.013)	(.001)	(.024)	(.008)	(.007)	(.009)	(.023)	.008
Conventional Gas	.070***	.066***	.154***	.032***	.012	.008	-.010	.047***
	(.016)	(.014)	(.043)	(.012)	(.028)	(.009)	(.050)	.020
Diesel	.090***	.152***	.312***	.147***	.016	.381***	.333***	.204***
	(.026)	(.028)	(.118)	(.046)	(.067)	(.024)	(.125)	.055
Jet Fuel	.298***	.105***	-.033	.112***	.035	-.003	.059	.082*
	(.028)	(.027)	(.100)	(.039)	(.069)	(.018)	(.113)	.048
SMB	.009***	-.001**	.006***	.003***	.004***	.006***	.005***	.005***
	(.001)	(.001)	(.002)	(.001)	(.001)	(.001)	(.002)	.001
HML	.004***	.003***	.001	.006***	.003**	.005***	.004**	.004***
	(.001)	(.001)	(.002)	(.001)	(.001)	(.001)	(.002)	.001
RMW	-.008***	.001	-.007***	-.010***	.007***	-.005***	-.008***	-.004***
	(.002)	(.001)	(.002)	(.001)	(.001)	(.001)	(.003)	.001
CMA	.009***	.003***	.011***	.010***	-.006**	.003**	-.010***	.003**
	(.002)	(.001)	(.003)	(.002)	(.002)	(.001)	(.003)	.001
MOM	-.003***	-.003***	-.007***	-.006***	2.67^{-4}	-.003***	-.014***	-.005***
	(.001)	(3.36^{-4})	(.001)	(.001)	(3.95^{-4})	(.001)	(.002)	.001
N	3,361	3,544	1,085	2,023	3,179	3,543	934	
Log Likelihood	6,089.89	9,212.69	2.187.91	4,925.77	5,545.30	7,698.83	1,800.91	
Wald	5,310.35	5,114.40	935.86	2,217.54	1,175.91	3,803.24	1,044.00	

See Table 2.

Table 8, Exploration & Production GARCH Return Models, American Stock Exchange

	Barnwell	Camber	Contango	Evolution Petroleum	Evolve Transition	Goodrich Petroleum	Houston American	Riley Exploration	Total
Intercept	-.001*	3.06^{-4}	-4.22^{-4}	.001	-3.07^{-4}	.001	.001	5.65^{-5}	2.04^{-4}
	(.001)	(.001)	(4.16^{-4})	(3.79^{-4})	(.001)	(.001)	(.001)	(6.32^{-4})	(.001)
AMEX	.312***	1.13***	.830***	.671***	.496***	.785***	.899***	.466***	.699***
	(.048)	(.050)	(.043)	(.038)	(.058)	(.136)	(.069)	(.064)	(.054)
Brent	-.070***	.304***	-.046**	.106***	-.017	-.003	.050	.113***	.055***
	(.027)	(.016)	(.020)	(.019)	(.023)	(.004)	(.046)	(.033)	(.024)
Natural Gas	.025**	.013	.017**	-.009	.029***	.005	-.042	.017	.007
	(.013)	(.012)	(.008)	(.009)	(.011)	(.020)	(.025)	(.015)	(.014)
Conventional Gas	-.003	.082***	.058***	.004	.040	.129***	-.008	-1.21^{-4}	.038
	(.027)	(.016)	(.022)	(.018)	(.024)	(.044)	(.044)	(.037)	(.029)
Diesel	.391***	.075***	.526***	.153***	-.050	.106	.045	.190***	.180***
	(.036)	(.024)	(.024)	(.039)	(.048)	(.091)	(.082)	(.055)	(.050)
Jet Fuel	-.182***	.184***	-.216***	-.004	.138***	-.133**	.082	.096*	-.004
	(.044)	(.028)	(.038)	(.034)	(.048)	(.061)	(.081)	(.049)	(.048)
SMB	1.81^{-4}*	.011***	.007***	.010***	3.70^{-4}	.004**	.002	-.002	.004
	(.001)	(.001)	(.001)	(.001)	(.001)	(.002)	(.002)	(.001)	(.025)
HML	-.002	.003***	.003***	.003***	.001	-.001	.006***	.002**	.002
	(.001)	(.001)	(.001)	(.001)	(.001)	(.002)	(.002)	(.001)	(.002)
RMW	-.001	-.011***	-4.43^{-4}	-.002**	-.004***	-.004	-.010***	-.007***	-.002
	(.001)	(.001)	(.001)	(.001)	(.002)	(.003)	(.003)	(.002)	(.002)
CMA	.001	.002	-.004**	-.003**	-.006***	-2.72^{-6}	-.007**	-.007***	-.003
	(.002)	(.002)	(.002)	(.001)	(.002)	(.003)	(.003)	(.002)	(.002)
MOM	-.003	-.003***	-.001	.001	-.001	-.003*	1.20^{-4}	1.67^{-4}	-.001
	(.001)	(.001)	(.001)	(.001)	(.001)	(.002)	(.001)	(.001)	(.001)

N	3,544	3,361	3,543	3,544	3,435	919	3,543	3,542
Log Likelihood	6,288.35	6,103.03	7,380.07	7,974.99	6,127.60	1,863.26	4,996.25	5,578.96
Wald	4323.72	5,662.85	3,250.14	1,903.24	296.11	155.84	435.95	624.82

Table 9, Equipment and Service GARCH Return Models, New York Stock Exchange

	Fluor	Halliburton	Helmerich & Payne	Nabors Drilling	National Oilwell Varco	New Park	Nextier	Precision Drilling	Schlumberger
Intercept	-1.02^{-4}	6.46^{-5}	.011***	-1.90^{-4}	-1.12^{-4}	.001	-.001	-1.92^{-4}	-2.94^{-4}
	(2.08^{-4})	(2.51^{-4})	(.004)	(3.80^{-4})	(2.87^{-4})	(3.99^{-4})	(.001)	(4.08^{-4})	(2.01^{-4})
S & P 500	1.24***	1.06***	.620**	1.13***	1.09***	1.18***	1.37***	.979***	1.04***
	(.027)	(.024)	(.027)	(.037)	(.030)	(.037)	(.093)	(.041)	(.019)
Brent	.120***	.094***	.052	.130***	.082***	.134***	.228	.181***	.083***
	(.015)	(.015)	(.140)	(.024)	(.015)	(.016)	(.030)	(.025)	(.013)
Natural Gas	.012***	.003	.009	.022***	.010	.009	.003	.010	.005
	(.004)	(.007)	(.102)	(.008)	(.007)	(.009)	(.018)	(.010)	(.004)
Conventional Gas	-.031***	.060***	-.073	.050**	.051***	.058***	-.087**	.055**	.070***
	(.012)	(.013)	(.177)	(.021)	(.016)	(.019)	(.044)	(.022)	(.010)
Diesel	.032	.191***	-.160	.261***	.173***	.184***	.420***	.297***	.133***
	(.029)	(.026)	(.392)	(.033)	(.032)	(.034)	(.105)	(.041)	(.022)
Jet Fuel	.035	.044**	.411	.132***	.046	.001	.038	.106***	.026
	(.027)	(.023)	(.332)	(.032)	(.030)	(.029)	(.109)	(.039)	(.020)
SMB	.004***	.003***	3.09^{-4}	.005***	.003***	.015***	.014***	.006***	.002***
	(4.19^{-4})	(.001)	(.007)	(.001)	(.001)	(.001)	(.002)	(.001)	(4.09^{-4})
HML	.001	.002***	-.005	.002***	.004***	.005***	.002	.001	.003***
	(.001)	(.001)	(.008)	(.001)	(.001)	(.001)	(.002)	(.001)	(4.42^{-4})
RMW	-.005***	-1.11^{-4}	.007	-.004***	3.24^{-4}	.003***	-.013***	-.004***	3.73^{-4}
	(.001)	(.001)	(.011)	(.001)	(.001)	(.001)	(.003)	(.001)	(.001)
CMA	-.002***	.001*	.035**	.002*	-.001	.002	.007**	.003*	.001
	(.001)	(.001)	(.015)	(.001)	(.001)	(.001)	(.004)	(.001)	(.001)

MOM	-2.27^{-4}	-.002***	-.004	-.003***	-.002***	-.002***	-.009***	-.005***	-.002***
	(3.03^{-4})	(3.21^{-4})	(.005)	(.001)	(3.72^{-4})	(.001)	(.001)	(.001)	(2.94^{-4})
N	3,543	3,543	1,919	3,543	3,543	3,544	892	3,543	3,543
Log Likelihood	9,104.04	9,515.86	840.03	8,012.75	9,108.01	7,695.87	1,871.92	7,870.76	10,222.60
Wald	6,368.55	5,927.24	35.99	3,049.43	4,637.42	5,665.72	1,448.58	4,119.13	9,520.39

Source: See Table 3.

Notes: *** Significant at .01; ** Significant at .05; * Significant at .10.

Table 9, Equipment and Services GARCH Return Models, New York Stock Exchange

	TechnipFMC	Tidewaters	Total	NASDAQ	Baker Hughes	Patterson Drilling	Total
Intercept	7.67^{-5}	-4.82^{-4}*	.001		-1.19^{-4}	-2.50^{-7}	-5.96^{-5}
	(2.81^{-4})	(2.71^{-4})	(.001)		(2.70^{-4})	(3.68^{-4})	(3.19^{-4})
S & P 500	1.07***	.855***	1.66****		1.03***	1.11***	1.07***
	(.030)	(.029)	(.035)		(.026)	(.035)	(.031)
Brent	.080***	.032*	.104***		.038***	.113***	.076***
	(.016)	(.019)	(.018)		(.011)	(.020)	(.016)
Natural Gas	.001	.031*	.011		.009	.007	.008
	(.006)	(.019)	(.018)		(.008)	(.009)	(.009)
Conventional Gas	.067***	-.011*	.033		.059***	.059***	.059***
	(.015)	(.001)	(.033)		(.012)	(.021)	(.017)
Diesel	.134***	.079***	.145**		.151***	.253***	.202***
	(.030)	(.016)	(.072)		(.024)	(.039)	(.032)
Jet Fuel	.061**	.179***	.097***		.063***	.091**	.077***
	(.030)	(.038)	(.037)		(.021)	(.036)	(.029)
SMB	.005***	.005***	.006***		.003***	.005***	.004
	(.001)	(.001)	(.002)		(.005)	(.001)	(.003)
HML	.003***	.001*	.002		.003***	.004***	.004
	(.001)	(.001)	(.002)		(.001)	(.001)	(.002)
RMW	.001	.002**	-8.41^{-4}		.002**	4.22^{-4}	.001
	(.001)	(.001)	(.002)		(.001)	(.001)	(.001)
CMA	2.30^{-4}	-.003***	.004		.013***	-.001	.006***
	(.001)	(.001)	(.003)		(.001)	(.001)	(.001)
MOM	-.001**	-.002***	-.003***		-.001***	-.003***	-.002***
	(3.74^{-4})	(3.79^{-4})	(.001)		(3.51^{-4})	(.001)	(.001)
N	3,543	3,543			3,543	3,543	
Log Likelihood	9,262.51	8,333.19			9,298.55	8,365.18	
Wald	4,458.97	2,743.08			5,973.83	3,455.76	

Source: See Table 3.

Notes: *** Significant at .01; ** Significant at .05; * Significant at .10.

Table 10, Integrated GARCH Return Models, New York Stock Exchange

	British Petroleum	Chevron	Conoco Phillips	ENI	Enlink	Exxon
Intercept	-7.26^{-5}	-1.11^{-5}	4.54^{-5}	-2.40^{-4}	.003***	-2.15^{-4}*
	(1.81^{-4})	(1.49^{-4})	(1.82^{-4})	(1.84^{-4})	(2.86^{-4})	(1.24^{-4})
S & P 500	.824***	.912***	.897***	.977***	1.03***	.867***
	(.015)	(.014)	(.019)	(.016)	(.032)	(.013)
Brent	.095***	.035***	.089***	.077***	.019	.025***
	(.010)	(.008)	(.010)	(.008)	(.018)	(.001)
Natural Gas	-.009***	.003	-.005	-.002	-.003	.005*
	(.003)	(.004)	(.005)	(.004)	(.008)	(.003)
Conventional Gas	.028***	.031***	.051***	.022**	-.002	.018***
	(.009)	(.007)	(.010)	(.001)	(.016)	(.006)
Diesel	.125***	.110***	.125***	.082***	.149***	.082***
	(.016)	(.014)	(.020)	(.017)	(.019)	(.013)
Jet Fuel	.014	.014	.046**	.034**	.199***	.018
	(.017)	(.013)	(.019)	(.015)	(.016)	(.011)
SMB	-2.94^{-4}	-.001***	-4.43^{-4}	3.62^{-4}	.009***	-.001***
	(3.20^{-4})	(2.55^{-4})	(3.37^{-4})	(3.34^{-4})	(.001)	(2.36^{-4})
HML	1.49^{-4}	.001***	.003***	.001***	.009	2.37^{-4}
	(3.38^{-4})	(2.85^{-4})	(3.98^{-4})	(3.95^{-4})	(.001)	(2.42^{-4})
RMW	-4.27^{-4}	.002***	.002***	-.001	-.003***	.003***
	(4.18^{-4})	(3.67^{-4})	(.001)	(.001)	(.001)	(3.49^{-4})
CMA	.004***	.004***	.013***	.016***	-.017***	.014***
	(.001)	(.001)	(.001)	(.001)	(.001)	(.001)
MOM	-.001***	-.001**	-.001**	-.001**	.002***	-.001***
	(2.21^{-4})	(1.86^{-6})	(2.46^{-4})	(2.57^{-4})	(4.22^{-4})	(1.72^{-4})
N	3,543	3,543	3,515	3,543	3,544	3,544
Log Likelihood	10,798.96	11,580.14	10,582.58	10,624.37	7,538.26	11,889.31
Wald	15,663.62	11,472.56	7,876.22	9,193.38	6,718.87	8,323.45

Source: See Table 4.

Notes: *** Significant at .01; ** Significant at .05; * Significant at .10.

Table 10, Integrated GARCH Return Models, New York Stock Exchange

	Hess	*Murphy Oil*	*Petrobras*	*Petro China*	*Royal Dutch Shell*	*Sinopec*	*Total SA*	*Total*
Intercept	1.03^{-4}	4.26^{-4}	-2.80^{-4}	-4.49^{-4}**	-1.03^{-4}	-2.94^{-5}	-6.00^{-5}	1.63^{-4}
	(2.37^{-4})	(.001)	(3.06^{-4})	(2.26^{-4})	(1.63^{-4})	(2.43^{-4})	(1.70^{-4})	(2.65^{-4})
S & P 500	1.11***	.945***	1.20***	.998***	.841***	.996***	.976***	.967***
	(.024)	(.022)	(.030)	(.022)	(.016)	(.020)	(.014)	(.020)
Brent	.087***	.105***	.092***	.052***	.037	-.001	.078***	.061***
	(.014)	(.015)	(.020)	(.012)	(.004)	(.011)	(.009)	(.011)
Natural Gas	.004	.002	-.013*	-.001	-.001	-.003	-.003	-.002
	(.006)	(.006)	(.007)	(.001)	(.004)	(.005)	(.003)	(.004)
Conventional Gas	.071***	.062***	.063***	.009	.008	.015	.024***	.031***
	(.013)	(.015)	(.017)	(.011)	(.006)	(.012)	(.008)	(.010)
Diesel	.212***	.152***	.104**	.110***	.205***	.085***	.103***	.127***
	(.024)	(.024)	(.041)	(.015)	(.012)	(.018)	(.016)	(.019)
Jet Fuel	.050**	.113***	.113***	.043***	-.007	.021	.027*	.053***
	(.024)	(.024)	(.040)	(.011)	(.010)	(.015)	(.015)	(.018)
SMB	.001**	.002***	.001	2.61^{-5}	-2.87^{-4}	1.15^{-4}	-1.56^{-4}	.001
	(.001)	(4.04^{-4})	(.001)	(3.96^{-4})	(3.21^{-4})	(4.30^{-4})	(3.04^{-4})	(.001)
HML	.002***	.003***	.001	.001	.001*	2.58^{-4}	.001***	.002***
	(.001)	(3.92^{-4})	(.001)	(.001)	(3.64^{-4})	(4.79^{-4})	(3.44^{-4})	(.001)
RMW	-.001	.001**	.003***	-1.34^{-5}	.001	-.002***	.001**	4.28^{-4}
	(.001)	(.001)	(.001)	(.001)	(.001)	(.001)	(.001)	(.001)
CMA	.017***	.016***	1.67^{-5}	.001	.005***	.001	.003***	.006***
	(.001)	(2.55^{-7})	(.001)	(.001)	(.001)	(.001)	(.001)	(.001)
MOM	-.003***	-2.41^{-7}	-.003***	-.002***	-.001***	-.002	-.001***	-.001***
	(3.39^{-4})	(2.55^{-7})	(4.33^{-4})	(2.80^{-4})	(2.37^{-4})	(.001)	(2.30^{-4})	(3.10^{-4})
N	3,543	3,543	3,604	3,543	3,543	3,544	3,543	
Log Likelihood	9,502.25	9,314.49	8,497.81	9,909.62	10,918.11	9,665.63	11,033.58	
Wald	6,881.94	7,908.50	5,141.71	5,942.00	7,376.27	4,113.52	13,249.01	

Table 11, Transportation & Pipeline GARCH Return Models, New York Stock Exchange

	Transportation & Pipeline									
	Cheniere (AMEX)	HES Midstream	Kinder Morgan	One OK	Prime Energy (NASDAQ)	TC Energy	TransGlobe Enegy	Western Midstream	Whiting	Total
Intercept	.001**	2.52^{-4}	-5.84^{-5}	.001***	.001	2.64^{-4*}	-4.41^{-4}	2.39^{-4}	4.24^{-4}	4.09^{-4}
	(3.30^{-4})	(.001)	(2.38^{-4})	(1.70^{-4})	(.001)	(.002)	(.001)	(3.50^{-4})	(3.00^{-4})	(.001)
S & P 500	.944***	.794***	.811***	.877***	.327***	.619***	.487***	.677***	1.26***	.755***
	(.035)	(.062)	(.022)	(.013)	(.011)	(.016)	(.022)	(.047)	(.027)	(.029)
Brent	-.015	.009	.020*	.044***	.100***	.042***	.207***	.030	.181***	.069***
	(.021)	(.026)	(.012)	(.010)	(.027)	(.008)	(.019)	(.022)	(.016)	(.018)
Natural Gas	-.002	.020*	.008	.015***	-.038***	.001	-.005	.019**	.002	.002
	(.007)	(.011)	(.005)	(.005)	(.012)	(.004)	(.011)	(.008)	(.008)	(.008)
Conventional Gas	.040**	-.032	.018	.057***	-.051**	.015*	.071***	-.005	.105***	.024
	(.019)	(.025)	(.015)	(.008)	(.024)	(.008)	(.021)	(.018)	(.019)	(.017)
Diesel	.116***	.014	.073***	.056***	-.058	.071***	.304***	.069	.270***	.102***
	(.039)	(.064)	(.026)	(.014)	(.041)	(.015)	(.044)	(.042)	(.038)	(.036)
Jet Fuel	.053	.099**	-.004	.028*	.175***	.009	-.064	.069*	.070**	.048
	(.040)	(.047)	(.030)	(.015)	(.026)	(.014)	(.042)	(.042)	(.035)	(.032)
SMB	.004***	.002*	.001	.002***	.001	-3.88^{-4}	.002***	.001	.006***	.002***
	(.001)	(.001)	(.001)	(3.05^{-4})	(.001)	(3.06^{-4})	(3.59^{-4})	(.001)	(.001)	(.001)
HML	.001	-.002*	.001*	-3.35^{-5}	.005***	-.001***	.003***	.002*	.001	.001
	(.001)	(.001)	(.001)	(3.57^{-4})	(.001)	(3.11^{-4})	(.001)	(.001)	(.001)	(.001)

RMW	-.009***	-.003**	-.005***	.004***	.001	.001	.004***	-.003***	.001*	-.001
	(.001)	(.002)	(.001)	(4.25^{-4})	(.001)	(4.40^{-4})	(.001)	(.001)	(.001)	(.001)
CMA	.001	.006***	.004***	.006***	-1.23^{-4}	.004***	-.005***	-1.12^{-4}	-.008***	.001
	(.001)	(.002)	(.001)	(.001)	(.002)	(.001)	(.001)	(.001)	(.001)	(.001)
MOM	-.001**	-.003**	-.002***	4.09^{-4}*	-.002***	-2.14^{-4}	.019	-.004***	-.002***	.001
	(.001)	(.001)	(2.93^{-4})	(2.28^{-4})	(.001)	(2.16^{-4})	(.076)	(.001)	(.001)	(.001)
		840							1,925		
N	3,543	2,097.12	2,435	3,543	3,543	3,543	3,543	4,897.10	3,543	
Log Likelihood	7,820.07	493.50	7,189.15	10,134.75	7,022.36	11,125.55	7,512.46	840.01	7,374.51	
Wald	1,714.72		6,677.78	10,901.31	806.00	4,735.79	6.11^{6}		7,138.30	

Source: See Table 3.

Notes: *** Significant at .01; ** Significant at .05; * Significant at .10.

Table 12, Refining & Marketing GARCH Return Models, New York Stock Exchange

	Refining & Marketing						
	Delek	Holly Frontier	Marathon Petroleum	PBF	Phillips 66	Valero	Total
Intercept	2.42^{-4}	.001	2.97^{-4}	1.45^{-4}	2.60^{-5}	3.77^{-4}	3.49^{-4}
	(4.04^{-4})	(3.49^{-4})	(3.76^{-4})	(.001)	(2.59^{-4})	(2.74^{-4})	(4.44^{-4})
S & P 500	1.08***	.955***	1.05***	1.40***	1.06***	1.08***	1.10***
	(.038)	(.032)	(.034)	(.056)	(.025)	(.025)	(.035)
Brent	.026	.006	.044**	-.064**	.031**	.006	.008
	(.021)	(.020)	(.022)	(.031)	(.015)	(.026)	(.023)
Natural Gas	.004	-.007	-.017*	-.019	-.008	-.002	-.008
	(.010)	(.009)	(.009)	(.013)	(.006)	(.007)	(.009)
Conventional Gas	.094***	.124***	.068***	.114***	.039***	.105***	.091***
	(.019)	(.017)	(.015)	(.025)	(.011)	(.013)	(.017)
Diesel	.133**	.144***	.043	.172***	.066**	.090***	.108***
	(.034)	(.035)	(.041)	(.061)	(.027)	(.030)	(.038)
Jet Fuel	-.026	-.002	.020	-.020	-3.14^{-4}	-.011	-.007
	(.032)	(.033)	(.040)	(.061)	(.023)	(.027)	(.036)
SMB	.008***	.005***	.003***	.006***	.002***	.004***	.005***
	(.001)	(.001)	(.001)	(.001)	(.001)	(.001)	(.001)
HML	.003***	.003***	.005***	.005***	.002***	.004***	.004***
	(.001)	(.001)	(.001)	(.001)	(.001)	(.001)	(.001)
RMW	-.001	.002*	-.001	.003*	-.001	.002**	.001
	(.001)	(.001)	(.001)	(.002)	(.001)	(.001)	(.001)
CMA	-.002	-.003**	-.003*	.013***	.004***	-.005***	.001
	(.001)	(.001)	(.002)	(.002)	(.001)	(.001)	(.001)
MOM	-2.04^{-4}	1.79^{-4}	-.001**	-.002**	-.001***	.001	-.001

	(.001)	(.001)	(.001)	(.001)	(4.03^{-4})	(3.91^{-4})	(.001)
	3,543						
N	7,981.78	3,543	2,285	1,922	2,088	3,543	
Log Likelihood	2,406.29	8,505.70	5,885.42	4,317.49	6,129.65	9,291.37	
Wald		2,593.60	2,583.44	1,542.43	3,459.27	3,836.38	

Source: See Table 3.

Notes: *** Significant at .01; ** Significant at .05; * Significant at .10.

Second, commodity markets also reflect project risk and are positively related to oil and gas excess commodity returns that are smaller than equity risk. The physically closer firms are to resource extraction, the greater their commodity risk and returns are associated with firm value (Table 13). Across sectors, Brent North Sea crude risk is highest for equipment & services, followed by exploration & production, transportation & pipelines, integrated, and refining & marketing, indicating that markets assess the greatest project risk to upstream producers (Carson, 2022). Commodity market risk is related to how frequently new oil production equipment is updated and replaced, and commodity market risk is highest for equipment & service firms that must continuously update new oil and gas equipment to remain competitive, and closer proximity to oil extraction is associated with equipment & service firms. Competition between exploration & production and integrated firms to maintain the most recent technologies and continuous equipment upgrading is risky with each new extraction technology. Integrated firms also bear less project risk because they are more liquid, with greater access to credit to survive during down markets. Downstream firms are not as exposed to commodity project risk. For example, refineries & marketers are furthest removed from oil and gas extraction, however, still have high return variation with equity markets, which is related to their position in the supply chain. Transportation & pipelines and refining & marketing firm returns vary less because their compensation is based on units transported and refined, which are not as directly tied to oil and gas prices. As is well-known in the oil and gas industry, natural gas is mostly a by-product of crude production and does not drive firm returns (Carson, 2020; Carson, 2022). Failing to account for statistically significant commodity risk with single factor model may also lead to biased and inconsistent single-price oil and gas asset models.

The ratio of equity to commodity coefficients illustrates how equity and commodity markets allocate risk across sectors. The ratio of equity to commodity project risk is highest for downstream refining & marketing, followed by integrated, transportation & pipeline, exploration & production, and equipment & service. Similar to the ratio of equity to crude risk, equity and distillate markets price the greatest diesel to crude risk for refining & marketing, exploration & production, and integrated; however, the ratio of diesel to oil risk is highest for equipment & services compared to transportation & pipeline. Consequently, refining & marketing has the highest ratio of equity to commodity risk, while firms physically closer to oil and gas production have lower yet still significant return ratios.

Third, oil and gas producer returns are positively related to distillates refined from crude, and across the oil and gas industry, diesel is the leading fuel derivative for individual firm returns. As a fuel, diesel has the lowest relative risk (Table 1). Most of crude oil is refined into conventional gas used in the transportation sector. While at the margins, diesel remains a smaller portion of the oil and gas industry, the relatively small proportion has a larger marginal effect between fuel distillates and firm returns. Furthermore, diesel commodity market risk is greatest for upstream exploration & production and equipment & service firms. Integrated firm returns are related to diesel commodity risk, while transportation & pipeline firms are less exposed to diesel risk. Downstream refining & marketing is more sensitivity to conventional gas returns than upstream firms, and refining & marketing firm returns and risk are more sensitive to conventional gas. After controlling for equity, crude oil, and diesel return variation, only equipment & services and integrated firms are related to jet fuel. Refining & marketing firms' isks are greater because they purchase crude to be refined into gasoline and other distillates that

are asymmetrically delivered to consumer markets, and downstream refining & marketing have greater project risk and higher returns associated with refined conventual gas.

Other patterns are consistent with expectations. A firm's size effect measures investment returns on market value, and resource allocation to smaller firms may provide higher risk adjusted returns. While the size effect is positively related to firm size, equity markets positively price oil and gas returns with equipment & service, exploration & production, and refining & marketing, while transportation & pipelines, and the overall size effect for integrated firms do not affect firm returns. However, while positive across the industry, the size effect is small compared to equity, commodity, and distillate market risk. High-minus-low, the value premium in oil and gas firm return variation with book-to-market, does not affect all firms across the industry. Refining & marketing are the most affected by the value effect, while transportation & pipeline and equipment & services are not related to the value effect. Like the size effect, the value effect is small across the oil and gas industry.

Oil and gas producer returns are not related to robust-minus-weak, indicating that oil and gas returns are not systematically related to the difference in returns with firm profitability. Integrated and equipment & service firms are the only oil and gas sectors related to conservative-minus-aggressive and the only sector of the oil and gas industry systematically related to the difference between firms with low and high investment policies. Conservative firms have low investment policies, while aggressive firms show a higher degree of investment policies, and integrated firms are the only sector where low investment policies consistently exceed that of higher degrees of investment policies.

Jenson's alpha is a portfolio's average return above that predicted by a pricing model and is a measure for market efficiency and Jensen's alpha is the most widely used measure of fund

performance (BKM, 2018, p. 819). Superior performance requires a positive alpha. Markets are more efficient the closer Jensen's alpha is to zero (Fama and French, 2015, p. 3). Around 80.1 percent of exploration & production intercepts were zero and insignificant, 86.7 percent of equipment & services; 76.9 percent of Integrated intercepts are zero and insignificant. 100 percent of refining & marketing have zero Jenson's alpha, while 77.8 percent of transportation & pipeline are zero. Nonetheless, in the equity market, the further a firm's operation is from production, transportation & pipeline and integrated, the less efficient the sector, while refining & marketing firms are efficiently priced (Carson, 2022). Subsequently, equity markets may more efficiently price upstream exploration & production and equipment & service firms that are closest to oil extraction, whereas further downstream transportation & pipeline and refining & marketing firms may be less efficiently priced.[7]

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[7] While the relationship between firm returns and natural gas are small across sectors, markets price firm returns according to process and infrastructure specialization between crude and natural gas. For example, Cabot historically specializes in natural gas and has a higher rate of return from natural gas, whereas Cimirex specializes in crude has a higher return from Brent. Firms merge for market power or infrastructure (FTC, 1982, p. 72), and Cabot and Cimirex, recognizing their comparative infrastructure and technological advantages in natural gas and crude, announced a merge in May 2021 to form the new company Coterra Energy to combine assets in supply chain activities to increase returns and diversification.[7]

Table 13, Oil and Gas Industry Sector Comparison

	Exploration & Production	Equipment & Services	Transportation & Pipeline	Refining & Marketing	Integrated
Intercept	-1.04^{-5}	.001	4.09^{-4}	3.49^{-4}	1.63^{-4}
	(.001)	(.001)	(.001)	(4.44^{-4})	(2.65^{-4})
Equity Index	.871***	1.07***	.755***	1.10***	.967***
	(.042)	(.035)	(.029)	(.035)	(.020)
Brent	.081***	.090***	.069***	.008	.061***
	(.021)	(.018)	(.018)	(.023)	(.011)
Natural Gas	.014	.009	.002	-.008	-.002
	(.009)	(.017)	(.008)	(.009)	(.004)
Conventional Gas	.053***	.046*	.024	.091***	.031***
	(.025)	(.025)	(.017)	(.017)	(.010)
Diesel	.215***	.173***	.102***	.108***	.127***
	(.043)	(.052)	(.036)	(.038)	(.019)
Jet Fuel	.051	.087***	.048	-.007	.053***
	(.043)	(.033)	(.032)	(.036)	(.018)
SMB	.005***	.005**	.002	.005***	.001
	(.001)	(.002)	(.001)	(.001)	(.001)
HML	.002*	.003*	.001	.004***	.002***
	(.001)	(.001)	(.001)	(.001)	(.001)
RMW	-.002	1.85^{-4}	-.001	.001	4.28^{-4}
	(.001)	(.002)	(.001)	(.001)	(.001)
CMA	1.13^{-6}	.005***	.001	.001	.006***
	(.002)	(.002)	(.001)	(.001)	(.001)
MOM	-.003***	-.002***	.001	-.001	-.001***
	(.001)	(.001)	(.001)	(.001)	(3.10^{-4})

Source: See Tables 2 through 12.

Notes: *** Significant at .01; ** Significant at .05; * Significant at .10.

Table 14, Summary of Oil and Gas Industry Structure and Returns

	Exploration & Production	Equipment & Services	Integrated	Transportation & Pipeline	Refining & Marketing
Number of Firms	57	15	13	9	6
Average Days in Operation	2,917.78	3,33.15	3,434.27	2,997.80	2,315.00
Average Daily Expected Returns	.000181	-.000021	.000373	.000475	.000173
Average Return Standard Deviation	.04691	.034202	.025234	.036682	.039147
Sharpe Ratio	.005796	-.000610	.0152	.0133	.0100
Average $\hat{\alpha}$	-1.04^{-4}	.001	1.63^{-4}	4.09^{-4}	3.5^{-4}
Average $\hat{\beta}_{S\&P}$	.871***	1.07***	.967***	.755***	1.10***
Average $\hat{\beta}_{Oil}$	.081***	.090***	.061***	.069***	.008
Average $\hat{\beta}_{Natural\,Gas}$	.001	.009	-.002	.002	-.008
Average $\hat{\beta}_{Conventional\,Gas}$	.053**	.046*	.031***	.024	.091***
Average $\hat{\beta}_{Diesel}$	.209***	.173**	.127***	.102***	.108***
Average $\hat{\beta}_{Jet\,Fuel}$	.051	.087	.053***	.048	-.007

Source: See Table 2-12.

Notes: *** Significant at .01; ** Significant at .05; * Significant at .10.

Tables 13 and 14 summarize the US oil and gas industry and market risk assessment across the industry. There are more publicly traded upstream exploration & production firms, with less time in the industry. Integrated firms have the greatest time in the industry, while firms in the concentrated transportation & pipeline and refining & marketing have shorter industry

duration; however, this is influenced by Marathon Petroleum and PBF. Marathon Petroleum is a subsidiary of Marathon Oil, and PBF is a combination between ExxonMobil and Royal Dutch Shell refineries.

Markets measure project risk, and upstream firms have greater average equity returns than downstream transportation & pipeline and refining & marketing firms (Tables 13 and 14). Upstream producers are also closer to commodity market risk, and exploration & production and equipment & service commodity market risk is greater than downstream transportation & pipeline and refining & marketing. For the most part, conventional gas refining is related to downstream refining & marketing. Across the industry, firm returns are highly related to refined diesel, followed by jet fuels, and average natural gas return variation does not affect firm return variation. Subsequently, oil and gas return variation are highly related to proximity to upstream midstream, and downstream production, and diesel is the leading distillate in oil and gas return variation.

V.   Collective Equity and Commodity Risks across the Oil and Gas Industry

Oil and gas returns independently vary with respect to equity and commodity market risk. However, firm returns also collectivity vary with respect to equity and commodity market risk. Tables 15 and 16 present firm restrictions and returns for both collective equity and commodity market restriction returns. Oil and gas excess returns are individually and collectively related to both equity and commodity market returns.

Table 15, Equity Market Multiple Restriction Tests

Exploration & Production				*Equipment & Services*			
NYSE						TC Energy	1,766.20
Amplify	838.63	Pioneer	2,596.51	Fluor	3,408.05	Western Midstream	363.60
Antero	800.47	Range	974.48	Halliburton	2,520.13	Whiting	2,704.98
		Sandridge	392.80	Helmerich & Payne	2,213.50		
Bonanza Creek	467.82	Silverbow	134.24	Nabors Drilling	1,352.92	**Refining & Marketing**	
Cabot		SM Energy	943.76	National Oilwell Varco	1,999.34	Delek	1,434.59
Callon	2,332.71	Southwestern	1,080.51	New Park	3,683.91	Holly Frontier	1,161.67
Canadian Natural Resources	2,668.76	Sun	198.03	Nextier	527.02	Marathon Petroleum	1,517.42
Cimarex	1,843.43	Talos	310.58	Precision Drilling	1,166.23	PBF	852.34
Cimarex	1,843.43	Vaalco	1,094.89	Schlumberger	3,920.81	Par Pacific	282.78
Comstock	852.01	Vermillion	1,342.79	TechnipFMC	1,899.88	Phillips 66	2,056.49
Concho	1,754.83	W &T Offshore	2,233.63	Tidewater	1,346.10	Targa Resources	638.49
Continental	1,491.58	WPX	253.09	Baker Hughes	2,435.05	Valero	2,423.47
Crescent Point	665.39	YPF	349.88	Patterson Drilling (NASD)	1,603.18		
Cross Timbers	223.26	*NASDAQ*		**Integrated**			
CVR	1,305.16	Abraxas	1,489.61	BP	3,526.99		

Delek		APA	1,903.26	Chevron	6,076.49
Devon	2,318.30	Centennial	257.57	ConocoPhillips	3,202.55
EcoPetrol	848.32	Diamond Back	1,216.06	ENI	4,552.93
Enerplus	1,276.58	Epsilon	401.42	Exxon	5,536.86
EOG	2,146.13	PDC	2,317.67	Hess	2,627.96
EQT	1,650.24	Penn Virginia	341.61	Murphy Oil	2,454.40
Equinor	2,464.60	*AMEX*		Petrobras	2,020.08
Geopark	137.31	Barnwell		Petro China	2,988.97
		Camber	1,865.01	Royal Dutch Shell	3,551.50
Kosmos	684.81	Contango	718.22	Sinopec	2,738.82
Laredo Petroleum	609.64	Evolution Petroleum	1,023.51	Total	5,217.57
Marathon Oil	2,602.17	Evolve Transition	143.44	**Transportation & Pipelines**	
Matador	1,074.00	Goodrich Petroleum	76.06	Cheniere	1,100.66
Northern Oil & Gas	1,410.31	Houston American	290.24	HES Midstream	176.89
Nobel	1,603.36	Riley Exploration	108.08		
Occidental	2,660.94			Kinder Morgan	2,092.55
Ovintiv	1,167.53			Prime Energy	145.04
Permian Basin Trust	540.21			One OK	7,768.92
Permian Basin Trust	540.21			TransGlobe	793.11

Source: See Tables 2 through 12.

Table 16, Commodity Market Multiple Restriction Tests

Exploration & Production				*Equipment & Services*			
NYSE						TC Energy	1,766.20
Amplify	838.63	Pioneer	2,596.51	Fluor	3,408.05	Western Midstream	363.60
Antero	800.47	Range	974.48	Halliburton	2,520.13	Whiting	2,704.98
		Sandridge	392.80	Helmerich & Payne	2,213.50		
Bonanza Creek	467.82	Silverbow	134.24	Nabors Drilling	1,352.92	**Refining & Marketing**	
Cabot		SM Energy	943.76	National Oilwell Varco	1,999.34	Delek	1,434.59
Callon	2,332.71	Southwestern	1,080.51	New Park	3,683.91	Holly Frontier	1,161.67
Canadian Natural Resources	2,668.76	Sun	198.03	Nextier	527.02	Marathon Petroleum	1,517.42
Cimarex	1,843.43	Talos	310.58	Precision Drilling	1,166.23	PBF	852.34
Cimarex	1,843.43	Vaalco	1,094.89	Schlumberger	3,920.81	Par Pacific	282.78
Comstock	852.01	Vermillion	1,342.79	TechnipFMC	1,899.88	Phillips 66	2,056.49
Concho	1,754.83	W &T Offshore	2,233.63	Tidewater	1,346.10	Targa Resources	638.49
Continental	1,491.58	WPX	253.09	Baker Hughes	2,435.05	Valero	2,423.47
Crescent Point	665.39	YPF	349.88	Patterson Drilling (NASD)	1,603.18		
Cross Timbers	223.26	*NASDAQ*		**Integrated**			
CVR	1,305.16	Abraxas	1,489.61	BP	3,526.99		

Delek		APA	1,903.26	Chevron	6,076.49
Devon	2,318.30	Centennial	257.57	ConocoPhillips	3,202.55
EcoPetrol	848.32	Diamond Back	1,216.06	ENI	4,552.93
Enerplus	1,276.58	Epsilon	401.42	Exxon	5,536.86
EOG	2,146.13	PDC	2,317.67	Hess	2,627.96
EQT	1,650.24	Penn Virginia	341.61	Murphy Oil	2,454.40
Equinor	2,464.60	*AMEX*		Petrobras	2,020.08
Geopark	137.31	Barnwell		Petro China	2,988.97
		Camber	1,865.01	Royal Dutch Shell	3,551.50
Kosmos	684.81	Contango	718.22	Sinopec	2,738.82
Laredo Petroleum	609.64	Evolution Petroleum	1,023.51	Total	5,217.57
Marathon Oil	2,602.17	Evolve Transition	143.44	**Transportation & Pipelines**	
Matador	1,074.00	Goodrich Petroleum	76.06	Cheniere	1,100.66
Northern Oil & Gas	1,410.31	Houston American	290.24	HES Midstream	176.89
Nobel	1,603.36	Riley Exploration	108.08		
Occidental	2,660.94			Kinder Morgan	2,092.55
Ovintiv	1,167.53			Prime Energy	145.04
Permian Basin Trust	540.21			One OK	7,768.92
Permian Basin Trust	540.21			TransGlobe	793.11

Source: See Tables 2 through 12.

VI.   Conclusion

Across various oil and gas sectors, a primary concern is equity, commodity, and distillate market interaction to price risk. This study compares oil and gas firm returns by upstream, midstream, and downstream producers between 2000 and 2020. Equity, commodity, and distillate markets positively price firm return, and equity market risk is greater than commodity market risk. Moreover, equity and commodity markets price greater risk for upstream compared to mid and downstream producers. Across sectors, oil and gas producer returns positively price returns with distillates, and diesel is the leading distillate associated with firm returns across the oil and gas industry. The small proportion of oil and gas production devoted to diesel has a greater marginal effect on firm returns, and diesel has the greatest firm return coefficients, second only to equity market coefficients. Failing to account for commodity market risk also creates biased and inconsistent single-price oil and gas models. Firm returns across sectors are not related to natural gas, and equity and commodity markets may be more efficiently priced the closer they are to production. In sum, firm value is sensitive to physical infrastructure, project risk, and proximity to oil and gas production, and risk and market conditions vary throughout the oil and gas industry.

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