Investment Dynamics and Market Power In the U.S. Oil and Gas Industry

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Abstract

This paper examines how ownership structure shapes investment in the U.S. oil and gas exploration and production industry. Using more than 356,000 well-level drilling decisions from 2010 to 2023, I compare how public and private firms adjust drilling in response to oil price changes. I find that public firms have become substantially less responsive to oil price increases than private firms. From 2016 onward, private firms' drilling decisions were roughly twice as sensitive to oil prices as those of public firms, with the gap concentrated in high-price periods. This divergence is not explained by mechanisms emphasized in prior work on ownership structure and investment, including differences in financing frictions, scale, or technology. I interpret these patterns through a stylized framework in which firms with greater influence over input markets restrain drilling when prices are high in order to avoid bidding up the costs of rigs, labor, and completion services. I also provide evidence that financial market pressure helps sustain this restraint. Using 15,000 analyst reports on U.S. oil and gas firms, I show that analyst attention to investment rose sharply after the 2014–2015 oil price collapse and that analysts have since become increasingly supportive of capital discipline and less favorable toward higher capital spending. Stock price reactions also vary systematically with the tone of analyst commentary. The findings show that financial markets can discourage expansion even in favorable market conditions, with implications for competition, energy supply, and regulatory oversight.

1 Introduction

A central question in corporate finance is how financial markets shape firms' real investment decisions (Modigliani & Miller, 1958). Financial markets can improve efficiency by disciplining managers and curbing wasteful spending (Jensen, 1986), yet they can also distort investment by pressuring firms to prioritize short-term returns over long-term growth (Stein, 2003). Understanding when markets play a disciplining role and when they create distortions is crucial, as the consequences extend beyond firm value to broader outcomes such as competition and resource allocation. This paper speaks directly to this tension by studying the U.S. oil and gas exploration and production (E&P) industry, where public firms, subject to investor and analyst oversight, have increasingly diverged from private firms in their investment responses to changing oil prices.

The E&P industry provides an ideal setting for studying ownership and investment behavior for several reasons. First, public and private firms are highly comparable in this sector, as their main objective is to extract hydrocarbons through contracted drilling services and sell them at prevailing market prices. Second, the availability of detailed project-level data enables a comprehensive analysis of investment decisions: I assemble more than 356,000 well-level drilling observations from 2010 onward, covering virtually all onshore activity in the United States. Third, the industry has undergone major shifts over the past decade that underscore the influence of financial markets. The shale boom of the early 2010s fueled rapid expansion, but the sharp oil price collapse of 2014-2015 marked a turning point: investors and analysts began pressing public firms to adopt "capital discipline," prioritizing shareholder returns over production growth.[1] Fourth, consolidation among major E&P firms has heightened regulatory scrutiny, as policymakers worry that fewer dominant players could reshape competitive dynamics in the industry.[2] Together, these shifts make the U.S. E&P industry industry a particularly revealing setting for studying how ownership structure shapes

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[1] For example, Scott Sheffield, former CEO of Pioneer Natural Resources, publicly urged peer firms in 2021 to be disciplined about capacity growth, warning that shareholders would punish companies that pursued aggressive expansion.

[2] For example, in 2023 the Federal Trade Commission launched an investigation into Pioneer Natural Resources that raised concerns about potential coordination to limit investment.

investment behavior.

I begin by comparing how public and private firms adjust drilling activity in response to oil price changes over time. Analyzing more than a decade of well-level drilling data, I show that public firms have become significantly less responsive to oil prices than private firms operating under the same conditions. While public and private firms behaved similarly before the 2014-2015 oil price collapse, their behavior diverged sharply thereafter: from 2016 onward, private firms' drilling decisions were roughly twice as sensitive to price changes as those of public firms. A $1 increase in oil prices during this period is associated with a 1.5% increase in drilling by public firms, compared to a 2.9% increase by private firms. This muted responsiveness among public firms is especially pronounced during high-price periods, in contrast to low-price periods where drilling remains sensitive to changes in oil prices.

I then consider alternative explanations for the public-private gap in investment responsiveness. I show that this divergence is not simply the result of differences in financial constraints, size, or drilling technology. Public firms remain less price-sensitive even when compared to private equity-backed firms, which are unlikely to face financing frictions. The gap also persists after controlling for firm size and measures of drilling efficiency. These results suggest that the decline in public firms' investment responsiveness reflects forces beyond firm characteristics or technological capacity.

The muted responsiveness of public firms to price changes raises the question of what mechanisms could explain such restraint. To shed light on this pattern, I develop a stylized model in which public firms' behavior can be understood as the exercise of market power in input markets. Rather than expanding aggressively when prices rise, a firm with input market power internalizes that additional drilling bids up the cost of rigs, crews, and completion services, and therefore limits investment. By contrast, competitive private firms face no such incentives and continue to adjust drilling in response to price changes. The model predicts that firms with input market power remain responsive to prices at low levels, but their sensitivity diminishes in high-price environments as they hold back to avoid escalating input costs. This framework helps interpret the muted responsiveness of public firms observed in the data.[3]

Public firms' investment restraint is not self-sustaining; it is reinforced by external pressures that shape managerial choices. Financial analysts play an important role by setting investor expectations and emphasizing "capital discipline," thereby discouraging firms from pursuing aggressive capital expenditures.[4] To investigate this mechanism, I analyze the sentiment of analyst reports on U.S. oil and gas E&P firms, classifying their commentary using GPT-4o, a large language model (LLM). The analysis shows that discussions of investment—particularly capital expenditures—rose sharply after the 2014-2015 oil price collapse. Since the late 2010s, analysts have become less likely to respond favorably to increases in capital spending and more likely to endorse reductions relative to expectations. Moreover, stock price reactions move with the sentiment of analyst commentary, suggesting that managers—mindful of stock market responses—face strong incentives to limit investment in order to avoid negative analyst assessments.

I contribute to research on how ownership structure shapes investment decisions. Asker et al. (2014) show that public firms invest less and respond less to opportunities than private firms, attributing this to short-term market pressures. Similarly, in the chemical industry, Sheen (2019) finds that public firms are less likely to make investments and are less responsive to changes in investment opportunities compared to their private counterparts. On the other hand, Gilje and Taillard (2016) find that public firms are more sensitive than private firms in making drilling decisions in response to changes in investment opportunities in the U.S. gas industry during 2000–2012.[5] They

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[3] Several executives of public oil and gas firms stated that disciplined investment by public firms benefits the entire industry, while "bad actors" could spoil the rally with excessive drilling (See McCormick, Myles, and Derek Brower, Jan 26, 2021, Shale operators fear urge to keep drilling will spoil good times: Oil & gas, Financial Times).

[4] For instance, Devin McDemott, an analyst at Morgan Stanley, commented in 2022 that "Independent producers are focused on cleaning up balance sheets, lowering break even prices and returning cash back to investors, not looking for growth" (See Crowley, Kevin, and David Wethe, Feb 17, 2022, Not Even $200 a Barrel: Shale Giants Swear They Won't Drill More, Bloomberg). In February 2024, Morningstar analyst Katherine Olexa described Pioneer Natural Resources' plan to cap growth at the 5% level as "a remarkable achievement for a company in the oft-demonized shale industry, which historically relied on capital markets to support its profligacy and is commonly expected to keep destroying value".

[5] Liu et al. (2024) also study the U.S oil and gas industry and find that private firms mitigate their financial disad-

attribute this difference to capital access, as public firms can access capital more easily compared to private firms.[6] In contrast to these previous studies, which attribute differences in public firms' investment behavior to short-term considerations or financing advantages, my evidence points to a structural shift in responsiveness. Public firms once behaved similarly to private peers, but since the mid-2010s they have become far less sensitive to rising oil prices, indicating a change in how ownership structure interacts with market pressures.

My research contributes to several strands of work on investment behavior in the oil and gas industry. Existing studies emphasize the role of uncertainty, real options, and learning, showing that drilling decisions evolve as firms update beliefs based on their own experience, peer activity, and relationship-specific interactions with drilling contractors (Covert, 2015; Decaire et al., 2019; Decaire & Wittry, 2024; Kellogg, 2011, 2014). Other research documents structural frictions, including geological and technological constraints, market power, and price environments that shape supply responses (Anderson et al., 2018; Asker et al., 2019; Gilje et al., 2023; Newell & Prest, 2019). Financial frictions also shape investment behavior: debt overhang can distort the timing of project execution, and limited access to credit can dampen supply responses to shocks (Gilje et al., 2020; Seleznev & Selezneva, 2025). My study builds on these insights by examining how financial market pressure shapes investment decisions in this sector.

My research is also related to the literature on financial market pressures and investment in the oil and gas sector. Studies of international supermajors during the 1990s-2000s find that shareholder demands for short-term profitability reduced exploration spending, contributing to supply constraints and heightened price volatility (Aune et al., 2010; Osmundsen et al., 2007). I extend this literature by focusing on U.S. E&P firms in the post-2010 period and by combining granular project-level drilling data with sentiment analysis of analyst reports. This approach provides a

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vantages by focusing on investment opportunities that entail higher levels of uncertainty, specifically focusing on North Dakota.

[6] This advantage allows public firms to experience fewer financial constraints, enhancing their real activities including mergers and acquisitions (Maksimovic et al. (2013)), innovation (Bernstein (2015) and Acharya and Xu (2017)), and product launching (Phillips and Sertsios (2016)).

more detailed account of how investor pressure shapes investment decisions and sheds light on the mechanisms through which financial markets influence firms' responses to commodity prices.

My work also connects to studies on capital market access and competition. Some show public disclosures can facilitate coordination (Bourveu et al., 2020; Igor & Caspar David, 2019; Kepler, 2021), while others discuss anticompetitive incentives from common ownership (Azar et al., 2018; Backus et al., 2020, 2021; Dennis et al., 2022; He & Huang, 2017; Koch et al., 2021; Lewellen & Lowry, 2021). I add a perspective on how being publicly listed—and subject to investor pressure—affects strategic decision-making and competitive conduct.

Lastly, I contribute to the literature on the determinants of analyst outputs. Previous research has largely focused on the quantitative dimensions of analyst activity-such as EPS forecasts, recommendations, and price targets.[7] In contrast, I offer a context-specific analysis of how analysts issue qualitative assessments, particularly regarding corporate investment strategy.[8]

2 Background and Data

2.1 US Oil and Gas Exploration and Production Industry

I focus on the U.S. onshore oil and gas exploration and production (E&P) industry. E&P companies extract oil and gas reserves located beneath the Earth's surface.[9] These reserves are typically trapped beneath multiple layers of rock. To access them, specialized equipment known as drilling rigs is used to penetrate these overlying rock formations. E&P firms typically do not

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[7] Jegadeesh et al. (2004) show that stocks with higher projected growth tend to receive favorable recommendations from analysts and suggest that analyst activity may reflect new information about a firm's competitive position within its industry.

[8] Several papers have investigated how information contained in analyst reports provides incremental value to investors. Asquith et al. (2005) find that the market reacts to the justification provided in reports for forecast revisions. Using a Bayesian textual analysis of analyst reports, Huang et al. (2014) find that textual information helps investors interpret quantitative signals, especially when the report contains more negative news and is written more assertively.

[9] The vast majority of oil and gas in the U.S. is produced onshore rather than offshore. According to the U.S. Energy Information Administration (EIA), in 2022, oil and natural gas production in the Federal Offshore Gulf of Mexico accounted for only about 15% of total U.S. crude oil production and about 2% of total U.S. dry natural gas production.

conduct drilling operations themselves[10], nor do they own transportation infrastructure. Instead, they outsource drilling operations to specialized companies known as “oilfield service" companies, such as Baker Hughes, Halliburton, or Schlumberger, that own drilling rigs and employ workers. E&P firms also rely on midstream companies for pipelines and other infrastructure necessary to transport resources to downstream firms.

As a result, the success of oil and natural gas development activities depends not only on the prices received by E&P operators but also on oilfield service costs associated with well development (Energy Information Administration (2016)). The major components of well development costs include drilling and completion costs, the latter being the process of bringing the resources into production. Additionally, E&P operators incur various other expenses, such as land acquisition, field facilities, and transportation. Figure A1 presents an example of the items included in drilling costs for a well drilled in North Dakota in 2019.[11]

2.2 Oil and Gas Exploration and Production Industry

Following the widespread adoption of fracking technologies from the mid-2000s through the early 2010s, many U.S. E&P firms pursued aggressive growth strategies in response to high oil prices. With easy access to capital markets, public firms expanded production substantially. Figure A2 illustrates the share of U.S. petroleum and other liquids production[12] in global output. The United States became the world’s largest producer of natural gas in 2011 and of oil in 2013, and by 2022 accounted for 21% of global petroleum output.

However, this production boom came at a cost. Aggressive capacity expansion often generated

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[10] Kellogg (2011) argues that the industry’s vertical separation exists due to variability in drilling activity. Producers share rigs across firms to manage fluctuations, reducing overall rig capacity needs and lowering transportation and mobilization costs without requiring direct contracts between producers.

[11] The AFE filing typically does not discuss the cost of transportation of the resources, as it focuses primarily on drilling and completion expenditures.

[12] The EIA defines “petroleum supply” to include crude oil production, natural gas plant liquids, other liquids, and refinery processing gains. “Other liquids” encompasses biodiesel, ethanol, liquids from coal, gas, and oil shale, as well as blending components and other hydrocarbons.

significant negative cash flows, as collective increases in production contributed to oversupply, driving down prices and raising costs. Because oilfield drilling rigs and transportation infrastructure cannot adjust perfectly in the short run, the surge in investment strained capacity, pushed up service costs, and further pressured prices. Energy Information Administration (2016) notes that the US E&P industry expanded faster than the oilfield service sectors could keep up with from 2010 to 2012, leading to sharp increases in drilling costs. As a result, the stock prices of public E&P firms declined sharply alongside the drop in oil prices in 2015. As shown in Figure 1, a $1 investment in the E&P sector at the start of 2010 grew to only $1.19 by the end of 2019, compared with $3.01 for the S&P 500. Persistent underperformance heightened investor scrutiny and prompted a strategic shift from growth to profitability.

This shift — often referred to as "capital discipline"—emphasized free cash flow generation, cost control, and restrained capital spending. Public firms adopted more cautious investment policies, prioritizing financial stability over expansion. Industry observers have noted that shareholder pressure has played a key role in this restraint. For instance, Robert Kaplan, then President of the Federal Reserve Bank of Dallas, identified investor pressure as a key constraint on oil production growth in 2018. Similarly, the 2022 Dallas Fed survey of oil and gas firm executives found that a majority of respondents viewed shareholder pressure as the primary reason public firms were reluctant to invest, despite favorable market conditions (see Figure 2).[13]

At the same time, the oil and gas E&P industry has undergone significant consolidation, through mergers and acquisitions (M&A). Figure A3 indicates that public firms have engaged in larger and more frequent M&A transactions since 2016. This trend has coincided with a marked decline in the number of active public operators, as shown in Figure A4. The number of active public firms fell from 110 at the peak of drilling activity in 2014 to 59 by the end of 2022.

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[13] For instance, Devon Energy's management committed to capping production growth at 5%. Likewise, Occidental Petroleum CEO Vicki Hollub stated in a 2023 Bloomberg interview that the company would avoid significant expansion.

2.3 Data Construction

Well-level Data

I assemble data from Enverus on 723,486 onshore wells drilled in the United States between 2000Q1 and 2023Q2.[14] Enverus collects detailed information on well location, productivity, and characteristics in North America, primarily from state regulatory filings.[15] I fuzzy-match the initial operator names in Enverus to public firm names from CRSP and Compustat. Among the matched firms, I retain only those that drilled at least 30 onshore wells over their lifespan and fall within SIC 1311 (Crude Petroleum and Natural Gas) or 2911 (Petroleum Refining).[16] I then construct a quarterly firm-level panel spanning each firm's active drilling period.

I focus on oil wells when measuring investment responses to prices, using them as the main dependent variable in the main analysis.[17] This choice avoids complications from the highly segmented U.S. natural gas market, where regional prices vary substantially due to infrastructure and local supply-demand imbalances.[18]

The final drilling sample covers well-level drilling data from 2010Q1 to 2023Q2, encompassing approximately 356,000 newly drilled onshore wells in the United States. This period is selected to capture the increasing shareholder pressure on E&P firms during the late 2010s and into the

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[14] A "well" is identified using Enverus' WellID, a unique code derived from the first 10 digits of the American Petroleum Institute (API) number.

[15] One limitation of the data is that tracking well ownership over time is challenging because Enverus' records are not standardized and are mostly limited to the "initial operator" and the current owner. Due to this limitation, I do not track production levels for wells owned by each firm. However, since firms typically respond to prices by adjusting drilling activity rather than production levels (Anderson et al., 2018), the number of wells drilled is the most appropriate measure of investment expected to respond to changes in commodity prices.

[16] A firm is classified as public with a 90-day delay after its GVKEY first appears in Compustat, and as private with a 90-day delay after its GVKEY disappears, to reflect the timing of drilling decisions.

[17] A well is classified as oil-producing if its gas-oil ratio is 6,000 cubic feet of natural gas per barrel (cf/b) or lower during the first 12 months of production. If no production information is available in the Enverus data, I follow Enverus' well type classification, categorizing a well as gas-producing if it is classified as either coalbed methane (CBM) or gas. A similar approach is used by the EIA. The results are robust to different classification choices.

[18] For example, Preonas (2023) documents the existence of 104 distinct local trading hubs for natural gas prices based on SNL Energy data. Given this high degree of market segmentation, it is empirically challenging to identify the specific regional gas prices that individual operators face when making drilling decisions.

2020s. The dataset contains quarterly firm-level observations for both public and private firms.

Table 1 presents summary statistics for firm-quarter drilling activity across ownership types from 2010Q1 to 2023Q2. Public firms are generally larger than private firms: on average, they drilled 30.71 wells per quarter, compared with just 1.21 wells for private firms. I proxy for firm size using both (i) the cumulative number of wells drilled since 2000Q1 and (ii) the number of wells drilled in the trailing 12 quarters.[19] Based on cumulative well counts, public firms are roughly 28 times larger than private firms; based on the trailing 12-quarter measure, they are about 26 times larger. Additional summary statistics for public firms — including profitability and analyst coverage — are reported in Panel A of Table A1.[20]

Drilling Cost Data

For a subset of wells in New Mexico and North Dakota, I hand-collect ex-ante drilling cost estimates from authorization for expenditure (AFE) filings.[21] I assemble about 700 filings (PDFs) for wells drilled between 2004 and 2022, matching roughly 520 to Enverus records via the American Petroleum Institute (API) number.[22] Table 2 presents the summary statistics for the AFE sample. On average, firms spend $7.94 million on total well development costs, yielding 0.12 million barrels of oil equivalent (BOE) in the first 12 months, resulting in an average cost of $115.68 per BOE.

Oil and Gas Prices

Oil and gas spot price data come from the Energy Information Administration (EIA). I collect 3-, 6-, 12-, and 18-month futures prices from Bloomberg, and the CBOE crude oil ETF volatility

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[19] Similar approaches are used by Liu et al. (2024) and Gilje and Taillard (2016). The full 2000Q1-2023Q2 sample is used to construct these proxies.

[20] In Figure A5, I also validate the Enverus drilling data for public firms by comparing drilling-derived capital investment to Compustat-reported capital expenditures. Trends in the two measures closely align, supporting the use of drilling activity as a reliable investment proxy.

[21] An authorization for expenditure (AFE) in the oil and gas industry provides an estimated budget for drilling, completion, equipping, or plugging a well. Operators prepare AFE filings and distribute them to stakeholders for approval. An example is shown in Figure A1.

[22] Some wells could not be matched because they were either not drilled or had unreadable filings.

index from the St. Louis Fed. Figure 3 plots quarterly spot and futures prices along with volatility; Table A2 reports summary statistics. For the main analysis, I use 18-month futures prices to estimate the investment elasticity of drilling in response to price changes. I choose this horizon for two main reasons. First, it captures the typical well production cycle, making it an appropriate measure for evaluating drilling prospects. Second, following Kellogg (2014), 18-month futures prices provide a better fit for the Black (1976) commodity option model than front-month futures when estimating implied volatility.

Analyst Data

I manually download analyst reports from InvesText on the Mergent Online platform, which provides both contemporary and archival research reports in PDF format from a wide range of brokerage houses, investment banks, and independent research firms.[23]

I focus on analyst reports covering firms with SIC code 1311, headquartered in the United States, and with at least 30 drilling records in the Enverus data.[24] Due to the time and cost involved in manually downloading and analyzing these reports, I concentrate on the largest brokerage houses based on their report volume from 2010 to 2023.[25] Specifically, I identify the top 70 brokerage houses by entries in the IBES recommendation dataset. I then download equity reports from brokerage houses with at least 3,000 reports[26] in InvesText from 2010 to 2023. The final brokerage houses included in the analysis are JP Morgan, RBC Capital Markets, and Wells Fargo Securities. Following Huang et al. (2014), I exclude multi-firm reports and limit analysis to the first page,

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[23] Quantitative outputs, such as recommendations, price targets, and CAPEX/EPS forecasts, are obtained from Refinitiv's Institutional Brokers Estimate (IBES) detail file for the period 2010-2023, covering a sample of U.S. public oil and gas firms.

[24] I include only firms with SIC code 1311 in the analyst report sample, as I focus on capital spending for each firm in the analysis. Vertically integrated oil and gas firms are excluded to avoid interpreting capital spending that may include activities beyond drilling.

[25] InvesText does not include reports from all brokerage houses listed in the IBES database. Some brokerage houses do not contribute equity reports to InvesText.

[26] I restrict the reports to those categorized as "Company (Equity) Reports" under the "Oil & Gas Exploration and Production" sector.

where analysts summarize key views.

The final analyst sample includes 94 unique public firms from 2010 to 2023, covering approximately 80-90% of the market capitalization of public firms in the Enverus drilling firm sample. Summary statistics for the InvesText-Enverus-Compustat sample are reported in Panel B of Table A1.

Other data

I use Compustat for public firm accounting data, CRSP for stock return data, the Compustat Industrial File for annual production and reserve data, and the Refinitiv/Thomson Reuters S34 dataset for institutional investor holdings to measure ownership concentration.

3 Empirical Analysis

Empirical Patterns in Drilling Activity

I begin by comparing how public and private firms adjust drilling in response to oil prices. Figure 4 plots aggregate drilling activity by ownership type from 2010Q1 to 2023Q2. In the early 2010s, both ownership groups expanded drilling alongside rising oil prices, followed by a sharp pullback during the 2014-2015 price collapse. Since then, however, their trajectories have diverged. Public firms have maintained relatively low drilling activity, with 2023 levels comparable to the lows during the collapse, whereas private firms have expanded drilling more aggressively in recent high-price periods—particularly after the onset of the Russian-Ukrainian war in 2022.

To formally quantify these differences, I estimate the sensitivity of drilling to oil prices over time for each ownership type. Specifically, I run the following Poisson regression for each ownership type using a rolling window of ± 12 quarters around each sample point from 2010Q1 to 2023Q2:

$$\log(E(Y_{it}|X_{it})) = \beta_1 Price_{t-1} + FirmFE_i \tag{1}$$

where i denotes the firm and t denotes the year-quarter. Y represents the number of oil wells drilled, while $Price$ is the log of the lagged quarterly price of the 18-month WTI future. The Poisson model allows for zero counts, controls for firm fixed effects, and provides a semi-elasticity interpretation of β_1.[27] The coefficient β_1 measures the percentage change in the number of wells drilled in response to a \$1 increase in $Price$.

Figure 5 plots the coefficient β_1 from Equation (1), separately for public and private firms. Before 2016, drilling elasticities were statistically indistinguishable between public and private firms. However, as oil prices began rising again around 2018, the elasticity gap between public and private firms widened and remained pronounced throughout the period.

The widening gap in drilling-price sensitivity in the late 2010s suggests that public and private firms have responded differently to price changes in recent years. I define the post-2016 period as the focus for firm-level analysis. This choice is motivated by industry developments following the 2014-2015 oil price collapse, after which investment practices and investor expectations shifted.[28] To quantify this divergence at the firm level, I estimate the following Poisson regression:

$$\log(Y_{it}|X_{it}) = \beta_1 Price_{t-1} + \beta_2 Price_{t-1} \times Private_{it} + \beta_3 Private_{it} + FirmFE_i \tag{2}$$

where i denotes the firm and t denotes the year-quarter. Y represents the number of oil wells drilled, and $Price$ is the quarterly average price of the 18-month WTI futures contract in the previous quarter. $Private$ is a dummy variable equal to one if the firm is private (in a given year-quarter) and zero otherwise. $Private \times Price$ is the interaction term between $Private$ and $Price$. $FirmFE_i$ controls for firm-specific effects. In these specifications, public firm elasticity is captured by the coefficient β_1, while private firm elasticity is calculated as the sum $\beta_1 + \beta_2$.

Table 3 presents regression results that confirm the patterns illustrated in the previous figures.

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[27] Both Cohn et al. (2022) and Chen and Roth (2023) advocate using Poisson regression for count data due to its ability to yield meaningful percentage-based interpretations while accommodating zero outcomes.

[28] Importantly, the results are robust to alternative break points, including 2018Q1.

Column (1) reports a univariate regression in which the number of oil wells drilled is regressed on $Price$. The coefficient for $Price$ suggests that a \$1 increase results in a 2.2% rise in the total number of wells drilled per quarter. Column (2) presents results for Equation (2), where the dependent variable is the number of oil wells drilled per quarter. The coefficient on $Price$ indicates that public firms increase drilling by only 1.4% in response to a \$1 increase in $Price$. However, the positive and statistically significant coefficient on $Private \times Price$ suggests that private firms are more responsive to price changes. The coefficient for $Private \times Price$ is 0.014, implying that private firms increase drilling by 2.9% (i.e., $\beta_1 + \beta_2$ = 0.015 + 0.014).[29] Column (3) presents the log specification of Equation (2), where the independent variable is $\log(Price)$. The coefficients for $\log(Price)$ and $Private \times \log(Price)$ suggest that public firms increase drilling by 0.988% in response to a 1% rise in $Price$, while private firms increase investment by 1.85% (i.e., 0.988 + 0.862) for the same percentage increase in $Price$. Overall, the results indicate that, after 2016, public firms have been nearly twice as unresponsive to commodity price changes compared to private firms.[30]

Heterogeneity Analysis by High and Low Price Periods

The results in the previous table show that public firms are significantly less responsive to oil price changes than private firms. However, it remains unclear whether this inelastic behavior holds uniformly across all price levels. In particular, do public firms respond similarly when prices fall below break-even thresholds, or is their muted responsiveness concentrated in high-price environments?

To explore this question, I divide the post-2016 sample into high- and low-price periods and re-estimate the regressions separately for each. I split the sample from 2016Q1 to 2023Q2 into

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[29] Note that the coefficient on the $Private$ dummy is identified using firms that switch ownership status during the sample period, since firm fixed effects absorb time-invariant firm characteristics. The results remain robust when these ownership-changing firms are excluded from the sample.

[30] These estimates are comparable to prior literature on the elasticity of aggregate drilling in response to prices. For instance, Newell and Prest (2019) estimates the elasticity of aggregate onshore drilling activity to prices from 2005Q1 to 2017Q2 and finds that the oil price elasticity of aggregate drilling ranges from 1.23 to 1.82.

high- and low-price periods, using price cutoffs of \$50, \$55, and \$60 as benchmarks, based on the break-even price for profitable drilling. These cutoffs are derived from the 2022Q1 Dallas Fed Energy Survey, which reports an average break-even price of \$56.[31]

Using these thresholds, I re-estimate the regression specification in Equation (2) separately for high- and low-price periods. Table 4 reports elasticity estimates for public and private firms across various price cutoffs. Comparing the coefficients on $Public \times Price$ between high- and low-price periods suggests that public firms are generally less responsive to price changes when prices are high. The results in Columns (1), (3), and (6) suggest that public firms may be more responsive than private firms during low-price periods. The elasticity estimates for public firms are consistently positive, while those for private firms are generally lower or statistically indistinguishable from public firms in low-price periods. In contrast, Columns (2), (4), and (5) indicate that public firms exhibit minimal elasticity in drilling activity when prices are high. This contrasts sharply with the consistently significant positive elasticity estimates observed for private firms.[32]

Heterogeneity Across Different Regions

The previous analysis shows that public firms exhibit weaker investment responsiveness to price changes, particularly in high-price periods. However, these findings could be influenced by regional differences in oil field quality, as some regions may offer better drilling prospects than others. To account for this, I examine whether the observed differences in investment behavior persist across geographic regions.

To account for unobserved changes in land quality over time, I construct a firm-quarter-region panel dataset.[33] Table 5 presents the results. Column (1) reports the benchmark specification,

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[31] The 2016 Dallas Fed Energy Survey also reported a break-even price of \$54.

[32] The results in Table 4 help rule out firm size as the main explanation for the investment differences between public and private firms. If slower adjustment by public firms were solely due to their larger organizational size, their elasticity should be similarly low across price levels. Instead, Table 4 shows that public firms respond more strongly during low-price periods, inconsistent with a pure size-based explanation.

[33] Regions are grouped into seven main areas based on Enverus' classifications: Permian (West Texas and New Mexico), Mid-Continent (North/Central Texas, Oklahoma, and Kansas), Rockies (North Dakota, Wyoming, and Col-

including only firm and region fixed effects. Column (2) adds year fixed effects, and Column (3) introduces firm and region-quarter fixed effects to account for regional variation over time. Across Columns (1)-(3), the semi-elasticity of drilling to price is consistently higher for private firms by 1.3-1.5%, aligning with previous findings.[34] Columns (4) and (5) divide the sample into low- and high-price periods using $55 as the price cutoff. I estimate elasticity differences between public and private firms, controlling for firm, region, and year fixed effects. Consistent with the previous results, public firms respond to prices much like private firms when prices are low, but their drilling elasticity falls to nearly zero in high-price periods. The results in Table 5 suggest that the higher drilling-to-price elasticity observed in private firms is unlikely to be driven by differences in land quality over time.

I further examine whether firms with different ownership types exhibit varying sensitivity to prices across major U.S. oilfields. Specifically, I estimate the drilling-to-price elasticity for firms in the Permian, Rockies, Mid-Continent, and Gulf regions.[35] Within each of the four major regions, I further divide the sample into high- and low-price periods using a $55 threshold, yielding eight region-price subsamples. For each subsample, I estimate drilling-to-price elasticity by regressing the quarterly number of oil wells drilled on prices separately for public and private firms:

$$\log(E(WellsDrilled_{it}|X_{it})) = \beta Price_{t-1} + FirmFE_i \tag{3}$$

Figure 6 presents the semi-elasticity estimates β for public and private firms across these subsamples. The results are consistent with the earlier findings. In low-price periods, both public and private firms display strong sensitivity to oil prices. In the Permian and Gulf regions, public firms behave similarly to private firms, while in the Mid-Continent and Rockies, they appear even more

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orado), Gulf (East Texas and Louisiana), U.S. West (California), U.S. East (Pennsylvania, Ohio, and West Virginia), and Alaska. The findings remain consistent when using more granular oilfield play classifications.

[34] The relative drilling-to-price ratio (i.e., $\frac{\beta_1+\beta_2}{\beta_1}$) between public and private firms ranges from 1.68 to 2.

[35] I exclude U.S. West, U.S. East, and Alaska from the analysis due to the limited presence of publicly traded oil-producing firms. However, public firms in these regions exhibit qualitatively similar behavior.

responsive. By contrast, in high-price environments, public firms are consistently less responsive than private firms across all major oil-producing regions. Overall, these results suggest that private firms maintain greater flexibility to scale investment in response to price changes, whereas public firms appear more constrained—particularly when prices are high.

Possible Explanations

I next consider alternative explanations for the observed differences in investment responsiveness between public and private firms, beyond ownership structure itself.

Financial Constraints

First, I examine whether differences in investment elasticity between public and private firms are driven by varying access to external capital. Private firms may respond more aggressively to rising commodity prices because higher oil prices can relax their financial constraints (see Fazzari et al. (1988) and Lamont (1997)).

Assessing the financial status of private firms is difficult because they do not provide detailed financial reporting. Prior studies have therefore relied on proxies, such as shale discoveries (Gilje and Taillard (2016)) or the presence of collateralizable reserves (Liu et al. (2024)), to capture financial constraints during the fracking boom of the mid-2000s through the mid-2010s. However, since most shale discoveries occurred earlier and this study focuses on a later period, I adopt a different strategy to test whether financial constraints drive the results. Specifically, I exploit the entry of private equity (PE) funds into the oil and gas industry during the 2010s to compare the price sensitivity of investments between PE-backed and public firms. Because PE-backed firms receive financial support from PE funds, they are less likely to face financial constraints, as suggested in prior literature.[36]

To test this, I compare the price sensitivity of public firms and PE-backed private firms, which

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[36] See Boucly et al. (2011), Cohn et al. (2021), and Howell et al. (2022).

are less likely to be financially constrained. Table 6 shows that PE-backed firms have a higher drilling-to-price elasticity than public firms. The coefficient on $Price \times Private$ in Column (1) indicates that PE-backed firms increase drilling activity by 3.2% (0.015 + 0.017) for a $1 increase in oil prices, compared to just 1.5% for public firms. Column (2) presents results for non-PE-backed private firms, showing a similar pattern. These firms respond to a $1 increase in price by increasing drilling activity by 2.9% (0.015 + 0.014), comparable to PE-backed firms. In Column (3), I include both PE-backed and non-PE-backed private firms. The similar elasticity estimates for both PE-backed and non-PE-backed private firms suggest that the greater investment responsiveness of private firms is unlikely due to financial constraints.

Size Effect

Another possible explanation for public firms' reduced sensitivity to commodity price changes is their larger size. Due to their size, public firms may adjust investments more slowly in response to oil price fluctuations. Operational constraints may prevent larger firms from responding as quickly as smaller firms to market conditions.

To assess whether size differences between public and private firms influence investment responsiveness, I use two firm size proxies. The first measure, $Log(Cum.Drilling)$, represents the log of the cumulative number of wells drilled. The second measure, $Log(DrillingPrior12Q)$, captures the log of the number of wells drilled over the prior 12 quarters. Similar size proxies have been used in prior literature (see Gilje and Taillard (2016) and Liu et al. (2024)).

Table 7 presents regression results with explicit size controls. Even after controlling for firm size, public firms remain significantly less responsive to price changes than private firms. When $Log(Cum.Drilling)$ is used as a size proxy in Column (1), the coefficient on $Price$ is 0.012, while the coefficient on $Private \times Price$ is 0.010, indicating that private firms are approximately 1.83 times more elastic in drilling decisions than public firms (i.e., $\frac{0.012+0.010}{0.012}$). Similarly, when $Log(DrillingPrior12Q)$ is used in Column (2), the coefficient on $Price$ is 0.016, while the coefficient on $Private \times Price$ is 0.011, suggesting that private firms are approximately 1.69 times more elastic than public firms (i.e., $\frac{0.016+0.011}{0.016}$).

As an alternative approach, I apply a size-based sample cutoff, using thresholds similar to those in Gilje and Taillard (2016). Table 8 reports the results. In Column (1), I restrict the sample to firms with at least 10 cumulative wells drilled. In Column (2), I increase this threshold to 30 wells.[37] Similarly, in Column (3), I impose a minimum drilling activity threshold of at least 10 wells drilled in the previous 12 quarters, and in Column (4), I raise this threshold to 30 wells. The results in Table 8 confirm that public firms remain less responsive to price changes than private firms, even after implementing strict size thresholds. The relative drilling-to-price ratio (i.e., $\frac{\beta_1+\beta_2}{\beta_1}$) between public and private firms ranges from 1.67 to 1.80, supporting the finding that private firms consistently exhibit greater investment sensitivity to oil prices than public firms, even when controlling for size.

Efficiency Comparison Across Ownership Types

I examine whether efficiency differences between public and private oil and gas firms can explain the lower investment responsiveness of public firms to oil price fluctuations. If public firms have become less efficient in drilling, they may reduce direct drilling investments and instead acquire already drilled wells from private firms.

Using ex-ante cost estimates from AFE filings for a subset of wells in New Mexico and North Dakota, I compare efficiency metrics between public and private firms. These metrics include total drilling costs, productivity levels, and average drilling costs. Total drilling costs encompass both drilling and completion expenses. Productivity is measured by the first 12 months of well production, expressed in millions of barrels of oil equivalent (MBOE). Average drilling cost per well is calculated by dividing total cost by production over the first 12 months, providing the total cost per barrel of oil equivalent (BOE).

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[37] This threshold is close to the median number of cumulative wells drilled across firms in the sample, which is 27.

Figure 7 presents year-over-year efficiency comparisons for public and private firms across these three metrics. The results yield two key findings. First, both public and private firms have improved efficiency over time, as shown by declining average drilling costs. Second, there are no systematic efficiency differences between public and private firms across these metrics, suggesting that efficiency differences are unlikely to explain the lower investment responsiveness of public firms.[38]

Robustness Analysis

To ensure that the findings are not driven by modeling choices, I examine a variety of alternative specifications.

Other Prices

I re-estimate the difference in drilling sensitivity to prices between public and private firms using different oil futures and spot prices. The results are reported in Table 9. In Column (1), I use WTI spot prices as the relevant oil price. Columns (2) to (4) extend the analysis by incorporating WTI 3-month, 6-month, and 12-month futures prices, while Column (5) reproduces the 18-month futures price benchmark from Table 3, Column (2).

The results in Table 9 indicate that investment responsiveness increases consistently from spot prices to longer-maturity futures. This finding aligns with the notion that firms base investment decisions on a longer forecast horizon rather than immediate price fluctuations. Across all columns, the estimated $Private \times Price$ coefficient remains consistent, confirming that private firms are nearly twice as responsive to oil price changes as public firms.

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[38] This analysis focuses on per-well drilling efficiency rather than scalability. While public firms may have advantages in scaling operations, these do not necessarily translate into greater efficiency on a per-well basis.

Adjusting for Technological Differences

I next examine whether differences in technology adoption explain the gap in price responsiveness between public and private firms. Specifically, I re-estimate Equation (2) focusing on horizontal wells—now the dominant drilling method in the United States—and compare responses over 2016Q1-2023Q2.

The results in Table B1 closely mirror those in Table 3 and Table 4. Private firms remain significantly more responsive to prices, particularly in high-price periods, while public firms' responsiveness is muted even after accounting for technology. These findings indicate that technological differences do not explain the public-private gap in investment sensitivity. Instead, the muted responsiveness of public firms is most pronounced precisely when price signals are strongest, suggesting that other forces beyond technology or geology may be shaping investment decisions.

4 Conceptual Framework

The empirical analysis shows that public E&P firms are significantly less responsive to price increases than private firms, particularly during high-price periods. Commentators often attribute this restraint to shifting investor expectations rather than to changes in market fundamentals such as price signals. At the same time, industry observers emphasize that investment restraint among public firms has had a meaningful impact on input markets, suggesting that investment restraint could function as a form of market power, where firms may limit activity to avoid driving up drilling costs.[39]

Building on these observations, I develop a stylized model—described in Appendix: Model of Public Firm—that interprets public firms' restraint as the exercise of market power in input markets (monopsony). The framework focuses on oilfield services, which are local and inelastic in the short

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[39] For instance, David Lagasse, associate director for oil and gas at S&P Global Ratings, noted that "While capital discipline has been good for E&P firms, it has negatively impacted oilfield service companies. It has led to reduced rig counts and lower spending on oilfield services." (See Whitfield, Stephen, August 11, 2019, Capital Discipline Drives E&P Sector as Investors Look for Better Returns, The Journal of Petroleum Technology.)

run, making them especially susceptible to strategic behavior by firms with market power. Rather than expanding aggressively when prices rise, such firms internalize that higher drilling activity bids up the cost of rigs, crews, and completion services, and therefore limit investment strategically. In Appendix: Model of Public and Private Firm, I extend the framework by introducing a competitive fringe of private firms that take input prices as given. This extension shows that a monopsonistic public firm may restrict investment to keep input costs low, allowing competitive private firms to expand as long as their cost structures do not fully overlap.

5 Investor Pressure: Analyst Channel

The evidence so far shows that public E&P firms are far less responsive to oil prices than private firms, especially in high-price periods. This pattern is unlikely to be explained by fundamentals such as technology or geology, and the conceptual framework suggests that restraining investment may also reflect strategic considerations in input markets. Yet such restraint is difficult to sustain without external pressure. One prominent channel is the influence of financial analysts. Serving as intermediaries between investors and management, analysts play a key role in shaping corporate behavior by framing shareholder expectations and promoting “capital discipline”—a strategy that prioritizes free cash flow and shareholder payouts over production growth.

Analyst pressure has become a recurring theme in the oil and gas sector. For example, Scott Sheffield, former CEO of Pioneer Natural Resources, stated that shareholders and analysts began pressuring firms to scale back growth initiatives around 2017-2018.[40] Similarly, Harold Hamm, CEO of Continental Resources, said in a 2022 Bloomberg interview that taking the company private allowed it to escape analyst pressure on investment decisions. Analysts themselves have also been explicit in discouraging expansion.[41]

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[40] He made this argument in response to a 2024 FTC allegation that he had attempted to organize collusion among U.S. oil producers.

[41] For instance, Brian Youngberg, an analyst at Edward Jones & Co, remarked that “increasing spending and pushing prices back down is like shooting yourself in the foot.” (See Gilblom and Crowley, July 24, 2018, Big Oil Is Raking in Cash So Investors Are Asking: Now What?, Bloomberg.)

To examine this mechanism systematically, I analyze the content of analyst reports, focusing on how sentiment toward capital expenditures aligns with the restrained investment behavior documented among public firms. This approach highlights how financial market pressures—channeled through analyst commentary and investor expectations—can help explain why public E&P firms limit investment even in periods of strong price signals.

Parsing Analyst Commentary

Using a corpus of more than 15,000 analyst reports from InvesText, I classify each report by analyzing parsed text with the GPT-4o. Each report is evaluated along three dimensions: whether it discusses the firm's investment strategy (e.g., capital expenditures), whether it indicates a change in investment relative to a benchmark, and whether it conveys a positive, neutral, or negative sentiment toward that investment change.[42]

The full set of instructions provided to GPT-4o is displayed in Figure 8.[43] To illustrate how the classification process works, Figure 9 presents an excerpt from a May 2023 analyst report on PDC Energy, alongside GPT-4o's corresponding output. The analyst notes that PDC reduced its FY23 CAPEX guidance by $25 million to $1.40 billion—below both JP Morgan's estimate (JPMe) and the consensus estimate (STe) of $1.45 billion—and interprets this reduction as a positive signal, potentially supporting a favorable stock market reaction.

To evaluate how analysts respond to changes in investment activity, I classify each report along two dimensions: the change in capital expenditures (CAPEX) and the analyst's opinion. For each report s discussing CAPEX for company i, written by an analyst at brokerage firm j on date d, I define $Opinion_{isjd}$, which takes a value of 1 if the report views the company's CAPEX positively,

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[42] Analysts frequently compare a company's capital spending to their own estimates or to consensus benchmarks. Figure F1 illustrates the distribution of benchmarks used by analysts. Most reports discussing capital expenditures (approximately 60%) compare the company's spending to either the analyst's own estimates or broader consensus estimates. In contrast, less than 5% of reports benchmark capital spending against the company's own guidance. The remaining reports are classified as "Others," which includes alternative references such as the prior year's capital spending or internal performance metrics.

[43] The results remain consistent across alternative versions of the instruction prompt.

0 if neutrally, and -1 if negatively. Similarly, I define $Change_{isjd}$, which takes a value of 1 if the report indicates an increase in CAPEX (relative to a benchmark), 0 if there was no change, and -1 if it indicates a decrease. Table 10 provides summary statistics. Over half of the reports address capital expenditures, and the mean of $Opinion_{isjd}$ (0.18) indicates that analysts are, on average, more likely to express favorable than neutral or negative views on CAPEX. The mean of $Change_{isjd}$ (0.06) suggests that analysts slightly more often report increases than decreases. Finally, $Word\ Count_{isjd}$ shows that the average report summary contains just over 3,000 words.

I begin by examining whether analysts disproportionately emphasize the investment activities of oil and gas E&P firms. Figure 10 shows that the share of reports mentioning capital expenditures rose sharply after the 2014-2015 oil price collapse—from under 50% before 2015 to more than 80% by 2023. To assess whether this emphasis is industry-specific, I compare these trends to analyst reports from the same brokerage (JP Morgan) covering mining and manufacturing firms, applying parallel keyword filters.[44] For each industry, I compute the annual share of reports containing investment-related terms such as "capex," "capital expenditure," or "capital spending." As shown in Figure 11, such terms appear far more frequently in oil and gas reports and show a sustained upward trend absent in the other sectors. These results suggest that analysts not only devote greater attention to capital spending in oil and gas, but have increasingly prioritized it over time.[45]

Sentiment Analysis of Analyst Report

Table 11 presents a two-way classification of analyst opinions ($Opinion_{isjd}$) and changes in capital expenditure ($Change_{isjd}$). Across the full sample, analysts generally maintain a neutral stance when no change in capital expenditure is observed. However, when firms' capital expenditures fall short of benchmark expectations, analysts respond positively in nearly half of the cases.

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[44] For mining, I use the "Coal," "Steel," and "Aluminum" filters, match firms to CRSP, and retain SIC codes beginning with 12 or 33. For manufacturing, I use the "Industrial Machinery & Equipment" filter and retain SIC codes 20-39.

[45] A comparison with environmental topics in Figure F3 shows they appear much less frequently, underscoring that capital spending receives greater emphasis than ESG issues.

By contrast, when firms exceed benchmark expectations for capital spending, analyst opinions are more mixed, with a substantial share remaining neutral.

To further analyze how analysts' reactions to changes in capital expenditure (CAPEX) have evolved over time, I plot the proportion of reports with positive, neutral, and negative opinions, conditional on whether CAPEX increased or decreased relative to a benchmark. Specifically, for each year t, I calculate the conditional distribution of analyst opinions as follows. For reports indicating an increase in CAPEX, I compute the following proportions:

$$\frac{\sum_s \text{Positive}_{isjd}|\text{CAPEX Inc}_{isjd}}{\sum_s \text{CAPEX Inc}_{isjd}}, \frac{\sum_s \text{Neutral}_{isjd}|\text{CAPEX Inc}_{isjd}}{\sum_s \text{CAPEX Inc}_{isjd}}, \frac{\sum_s \text{Negative}_{isjd}|\text{CAPEX Inc}_{isjd}}{\sum_s \text{CAPEX Inc}_{isjd}}$$

The same computation is performed for reports noting a decrease in CAPEX.

The results provided in Figure 12 reveal a growing tendency for analysts to respond favorably to reductions in capital expenditures, with the share of positive reports on CAPEX cuts rising steadily since the late 2010s. Negative responses to CAPEX cuts are rare, occurring in fewer than 20% of cases on average. In contrast, positive opinions on CAPEX increases have declined substantially over the same period, while neutral reactions to increases have risen sharply, indicating that analysts have become important enforcers of capital discipline in the oil and gas sector.

Building on the descriptive evidence, I next estimate a regression to test whether analyst sentiment is correlated with firms' capital spending decisions. Specifically, I interact a year dummy with $Change_{isjd}$ to capture how analysts' reactions to investment decisions have evolved over time:

$$Opinion_{isjd} = \alpha + \sum_t \theta_t Change_{isjd} \times Year_t + FE + \epsilon_{isjd} \tag{4}$$

where i denotes a firm, s a report, j a brokerage firm, d a date, and t a year. The specification includes firm, brokerage firm, and year fixed effects, and standard errors are clustered at the firm level. Figure 13 plots the estimated θ_t coefficients, which show that the correlation between a firm's capital investment and analysts' opinions became significantly negative around 2018. This timing is consistent with both empirical evidence and anecdotal accounts that analysts have grown increasingly critical of firms expanding their capital expenditures.

To examine this shift more directly, I re-estimate the relationship between analysts' opinions and firms' capital expenditures (CAPEX) focusing on the post-2015 period, when investor pressure became most salient. Specifically, in Table 12, I restrict the sample to 2016-2023 and estimate the following specification:

$$Opinion_{isjd} = \alpha + \theta Change_{isjd} + FE + \epsilon_{isjd} \tag{5}$$

where i denotes a firm, s a report, j a brokerage firm, d a date, and t a year. The regression includes firm, brokerage firm, and year fixed effects, with standard errors clustered at the firm level. Across all specifications, the estimated coefficients on $Change_{isjd}$ are negative, indicating that analysts systematically express less favorable opinions when firms increase capital expenditures. These results complement the time-series evidence in Figure 13, confirming that analysts became more critical of investment growth beginning in the late 2010s.

In the Appendix F: Analyst Report section, I further separate capital expenditures into two categories: projected and realized.[46] Projected CAPEX refers to expected future spending, whereas realized CAPEX reflects the firm's actual past spending. Figure F4 shows that analysts predominantly focus on projected capital spending. To quantify the sentiment patterns, Figure F6 reports the conditional proportions of positive, neutral, and negative opinions for both projected and realized CAPEX, conditional on whether spending increased or decreased relative to a benchmark. The results confirm that analysts are significantly more likely to react positively to reductions in both projected and realized capital expenditure. Moreover, the share of positive reactions to increased capital spending has declined steadily since the late 2010s, with the decline in realized CAPEX reactions becoming especially pronounced after 2020. Overall, these patterns reinforce the broader finding that analysts increasingly favor capital discipline among public firms.

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[46] See Figure F5 for the instructions provided to ChatGPT-4o for classifying projected and realized capital expenditure.

Stock Market Reaction to Analyst Opinion on Investment

The preceding analysis shows that analysts generally discourage investment, responding negatively to increases in capital expenditures while favoring reductions. If these opinions influence firm behavior, one plausible channel is through their effect on stock prices: managers may adjust investment policies if negative analyst assessments trigger unfavorable market reactions.

To examine this channel, I test whether analysts' opinions on capital expenditure are associated with stock market responses to their reports. Using $Opinion_{isjd}$ from analyst reports issued between 2010 and 2023, I classify each report into three categories: positive, neutral, or negative. For each category, I then compute cumulative abnormal returns (CAR) over event windows [0,1], [0,2], and [0,3] relative to the report issuance date.[47]

Table 13 presents the CAR estimates for different event windows. The results show that abnormal returns increase monotonically with analyst opinion, indicating that investors respond systematically to analysts' assessments of capital expenditures. Specifically, favorable opinions are associated with positive and statistically significant stock price reactions, with a three-day CAR of 1.26%. Neutral opinions generate a mild negative response that dissipates quickly, while unfavorable opinions trigger a sharp decline, with a two-day CAR of –3.35%. These asymmetries suggest that investors react more strongly to negative assessments, perhaps because they are less frequent but signal greater concern. Moreover, the differences in CAR between positive and negative opinions are both statistically and economically significant across all event windows.

Overall, the evidence demonstrates that analyst opinions materially shape investor reactions. Positive assessments of capital expenditures are rewarded with higher abnormal returns, while negative assessments are penalized with significant price declines. This pattern highlights how analysts transmit investor expectations into market outcomes, thereby amplifying the pressures on public

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[47] Abnormal returns are calculated as the difference between actual returns and expected returns based on the CAPM. Expected returns are estimated using a 100-day estimation window, requiring at least 70 non-missing return observations. To mitigate potential biases, I impose a 50-trading-day gap between the end of the estimation window and the start of the event window. The results are qualitatively similar across alternative expected return models.

firms to exercise "capital discipline" by limiting investment growth.

Investor Pressure and Subsequent Investment Behavior

I next examine whether analyst sentiment toward capital expenditures is associated with subsequent changes in public firms' investment behavior. While the analysis is descriptive rather than causal, it provides suggestive evidence on how analysts' views may shape capital spending. Specifically, I estimate regressions of quarterly CAPEX growth on indicators of analyst opinion, including firm, brokerage, and quarter fixed effects, with standard errors clustered at the firm level.

Table F1 shows that CAPEX growth is systematically higher after favorable analyst reports and lower after negative ones. On average, spending grows about 5.4% more following positive commentary and 7.5% less following negative commentary, with neutral opinions showing no statistically significant effect. These results suggest that analyst sentiment toward capital expenditures is meaningfully associated with firms' subsequent investment decisions.[48]

Discussion

Investor Concentration

I explore potential incentives behind investor demands for restrained investment growth among public oil and gas firms, even in favorable market conditions. A possible contributing factor is the rise of concentrated ownership, which may increase investor pressure by enabling institutions to indirectly encourage coordinated restraint in investment—especially when they hold stakes across multiple competitors. To measure ownership concentration in the oil and gas E&P sector, I construct several metrics following an approach similar to He and Huang (2017).[49] As an alternative

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[48] In Table F2, I repeat the analysis at the company level by aggregating analyst opinions on capital expenditures. While this approach introduces some noise—since I do not collect all analyst reports for each E&P company due to data limitations—the results remain broadly consistent with the prior findings.

[49] Using Thomson Financial's 13F database, I define firm i as block-held by institution s if s holds more than 5% of outstanding shares in year-quarter t. The measures are: (1) $CrossDummy_{it}$, an indicator equal to one if firm i

measure, I also employ the modified Herfindahl-Hirschman Index (MHHI), a widely used measure of ownership concentration.[50]

Figure D1 plots the quarterly average of cross-ownership measures from 2002 to 2023. All measures indicate a steady increase in ownership concentration within the oil and gas industry. While I do not directly test a causal relationship between concentrated ownership and investment behavior, the observed increase in ownership concentration coincides with the investment patterns documented in the previous analyses, suggesting a potential connection worth further exploration.

Cost of Investor Pressure

Public firms' muted response to oil prices—especially when prices are high—may help contain input costs but also means forgoing potential revenue from additional drilling. To gauge the magnitude of this trade-off, I estimate a lower bound on the revenue lost due to reduced drilling sensitivity attributed to shareholder pressure.

In Appendix E: Cost of Investor Pressure, I estimate how much revenue public firms may have missed by comparing their actual drilling to what it would have been if they had matched private firms' stroner price responsiveness. While this estimate excludes potential cost-side gains (e.g., avoided input inflation), it provides a lower bound on the revenue foregone. The results suggest that public firms may have forgone approximately \$501.65 million in discounted revenues—just over 21% of their average annual revenue during this period.[51] This underscores the economic cost of investor-driven capital discipline and the trade-offs involved in strategic underinvestment.

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is block-held by any institution; (2) $NumConnected_{it}$, the number of same-industry peers sharing a common cross-holding institution, where peers are public U.S. E&P firms (SIC 1311) with at least 30 drilling records in the Enverus dataset; (3) $NumCross_{it}$, the number of unique cross-holding institutions for firm i; (4) $AvgNum_{it}$, the average number of cross-held peers per cross-holding institution; and (5) $TotalCrossOwn_{it}$, the total ownership stake held by cross-holding institutions.

[50] See Appendix D: Construction of HHI Delta for details. The MHHI formula follows Azar et al. (2018); see also Backus et al. (2020, 2021), Dennis et al. (2022), and Lewellen and Lowry (2021) for related discussions.

[51] The average annual revenue of public U.S. firms with SIC 1311 during 2016-2023 is \$2.391 billion.

Conclusion

In recent years, commentators have noted that public oil and gas exlproation and production (E&P) firms appear more cautious in expanding investment despite elevated prices. This paper provides systematic evidence on this phenomenon, showing that public E&P firms have become far less responsive to oil price increases than private firms operating under similar conditions. Using a comprehensive well-level dataset spanning more than a decade, I document that the divergence is most pronounced during high-price environments, when public firms exhibit muted investment responses while private firms continue to expand drilling activity.

A key mechanism behind this shift is the growing role of financial market pressures, particularly through equity analysts. Since the late 2010s, analyst commentary has increasingly discouraged capital expenditure growth, favoring restraint over expansion. Event-study evidence shows that analyst sentiment is closely associated with stock price movements, indicating that commentary on capital expenditures coincides with meaningful market reactions. This helps explain why public firms' investment strategies have diverged from both private peers and traditional price-driven behavior, and it aligns with the idea that public firms may exercise market power in input markets by strategically limiting investment to contain the rising costs of rigs, crews, and completion services.

These findings carry broader implications for corporate finance and energy policy. They highlight how financial markets can shape real activity in capital-intensive industries, not only by disciplining managers but also by inducing underinvestment relative to market fundamentals. In the oil and gas sector, such dynamics may influence not only firm strategies but also aggregate investment cycles, with consequences for price volatility, resource development, and the global energy transition.

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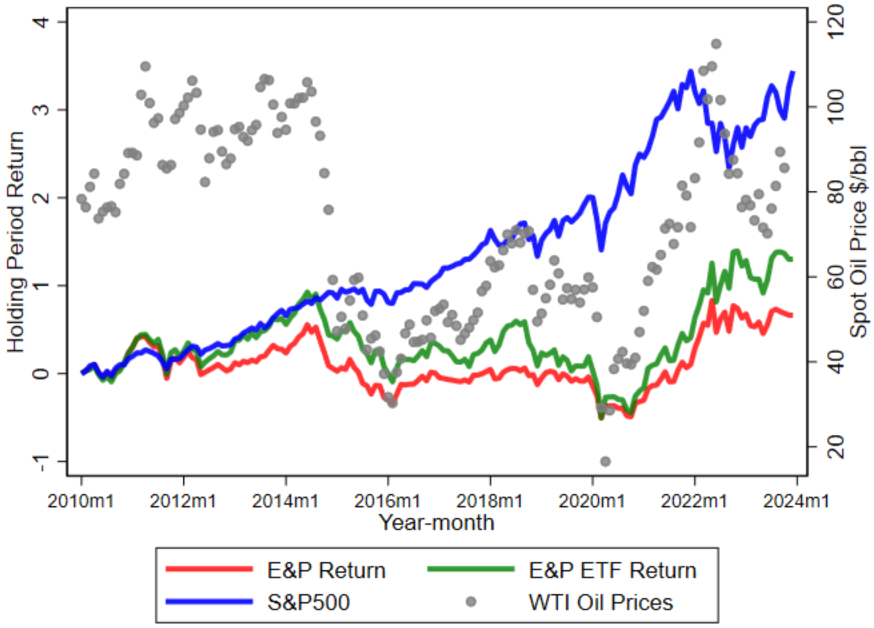
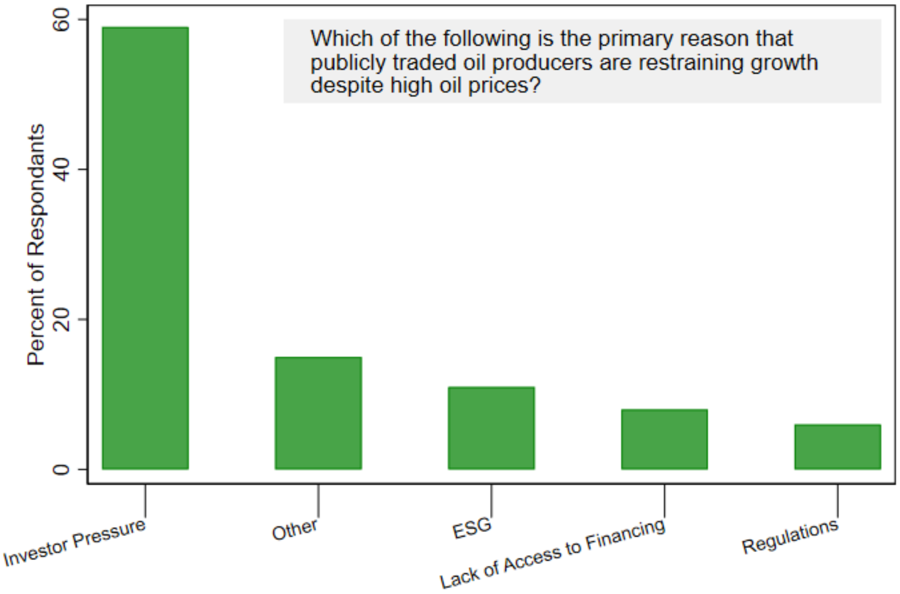
Figures

Figure 1: Stock Price Performance of Oil and Gas Exploration and Production Industry



This figure compares the holding period return of the oil and gas exploration and production (E&P) industry with that of the S&P 500 from 2010 to 2019. The red line represents the holding period return of the entire CRSP oil and gas extraction industry (SIC 1311). The green line shows the holding period return of the iShares U.S. Oil & Gas Exploration & Production ETF, which tracks the performance of the U.S. equities in the oil and gas E&P sector. The blue line serves as a benchmark, indicating the holding period return of the S&P 500. The grey dot indicates the WTI monthly spot prices.

Figure 2: 2022 Q1 Dallas Energy Survey

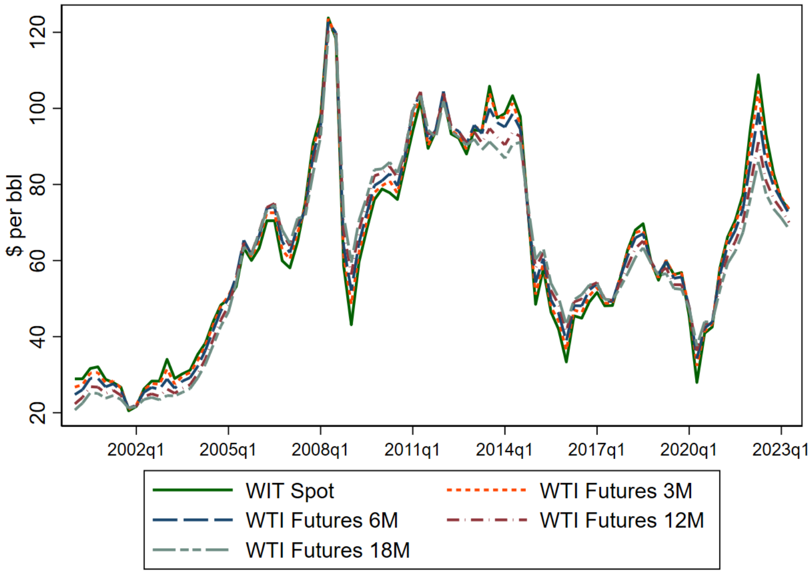


Source: Federal Reserve Bank of Dallas Energy Survey 2022Q1

This figure replicates responses from the Dallas Energy Survey conducted in the first quarter of 2022. The survey took place from March 9 to 17, with 141 energy firms participating. Of these, 91 were exploration and production firms, and 50 were oilfield services firms. The replicated figure shows the 131 respondents' answers to the question: "Which of the following is the primary reason that publicly traded oil producers are restraining growth despite high oil prices?"

Figure 3: WTI Crude Oil Prices and Oil Volatility Index

(a) WTI Crude Oil Prices



(b) CBOE Crude Oil ETF Volatility Index

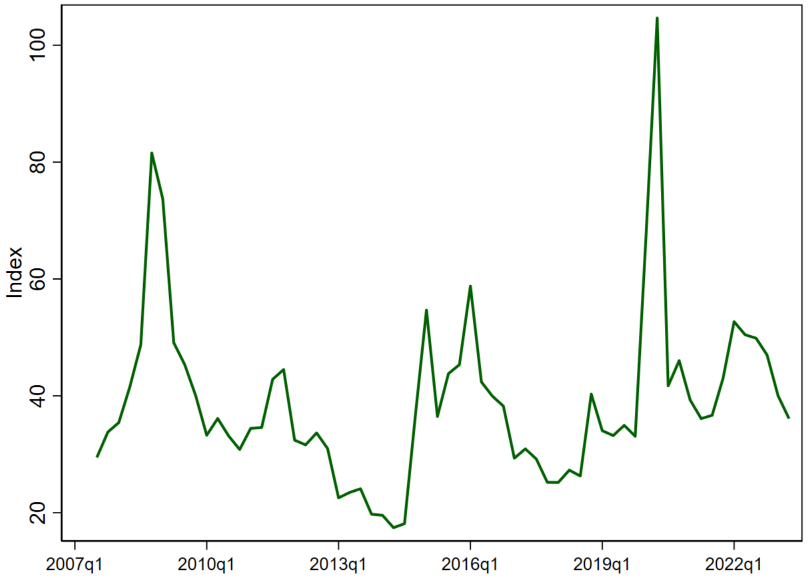
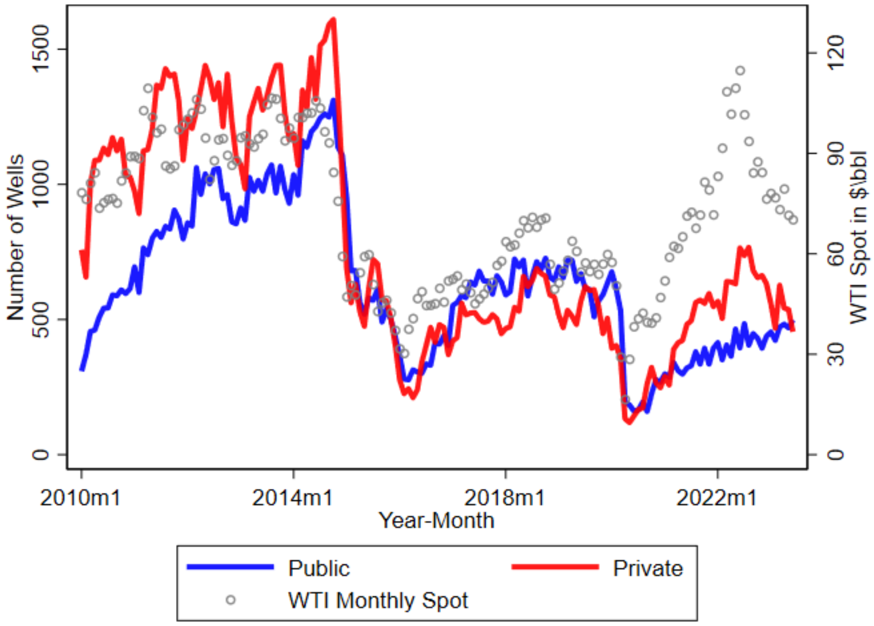


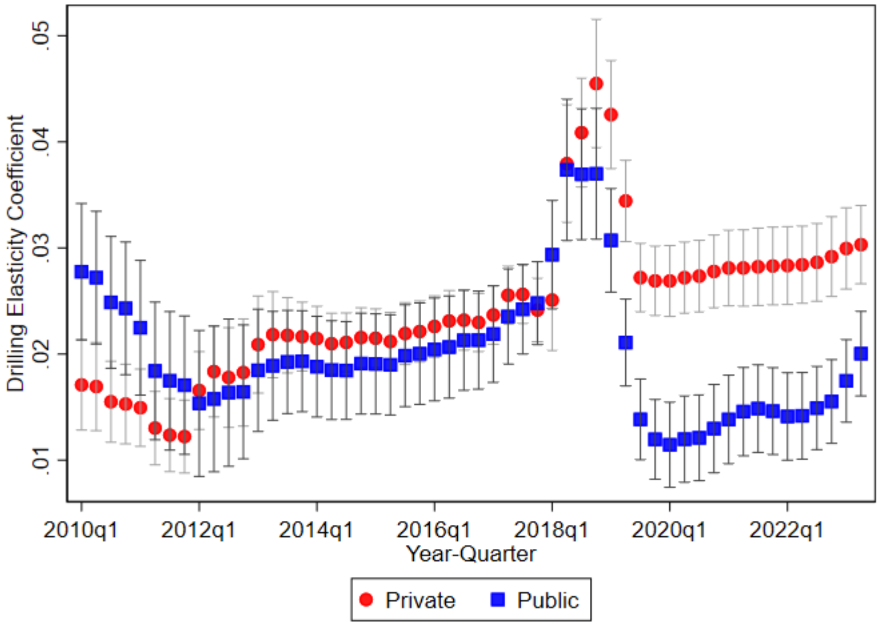
Figure (a) plots the quarterly WTI crude oil prices, including both spot and futures prices with varying maturities, from 2000Q1 to 2023Q2. Spot prices (per barrel for WTI crude oil) are obtained from the Energy Information Administration, while futures prices for the 3-month, 6-month, 12-month, and 18-month maturities are sourced from Bloomberg. Figure (b) plots the quarterly CBOE Crude Oil ETF Volatility Index (OVX) from 2007Q3 to 2023Q2, retrieved from the St. Louis Federal Reserve Bank.

Figure 4: US Onshore Drilling Activities and Oil Prices



This figure plots the aggregate monthly drilling activities for the oil wells during the period 2010m1-2023m6. The red line represents the aggregate number of oil wells drilled by private firms, while the blue line represents the aggregate number of oil wells drilled by public firms for each month. A well is classified as oil well if the gas-oil ratio is less or equal to 6,000 cubic feet of natural gas to 1 cubic foot per barrel (cf/b) of the first 12 month production. If no production information is available in the Enverus data, I rely on Enverus' well type classification, designating wells as gas-producing if they are classified as either coalbed methane (CBM) or gas. The grey dots in the figure represent monthly WTI spot prices.

Figure 5: Drilling Elasticity to Commodity Price



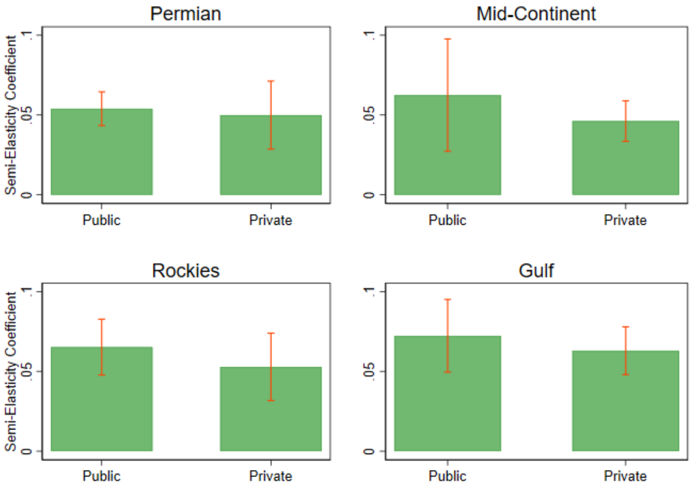
This figure plots the semi-elasticity of drilling to price coefficient in a +/- 12 rolling quarters around each sample point during the 2010Q1-2023Q2 period based on the following Poisson regression specification:

$$\log(E(Y_{it}|X_{it})) = \beta_1 Log(Price)_{t-1} + FirmFE_i$$

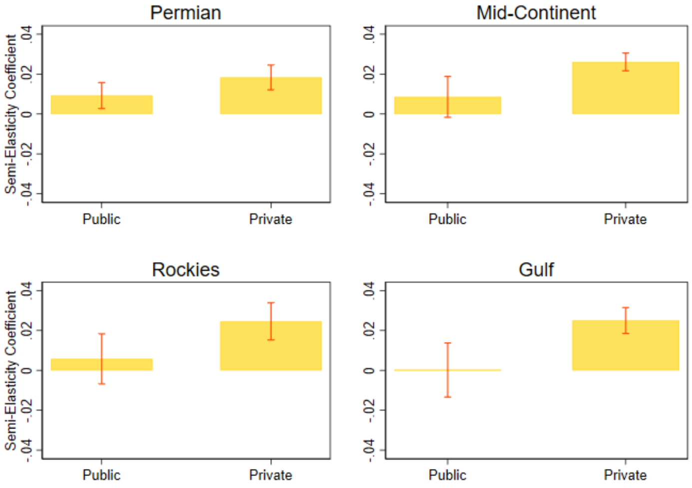
The data are a quarterly panel spanning from 2010Q1 to 2023Q2. The dependent variable is the number of oil wells drilled in each year-quarter. Log(Price) denotes the logarithm of the lagged 18-month WTI futures price. The standard errors are clustered at the firm level.

Figure 6: Drilling Elasticity to Commodity Price Across Different Regions

(a) Low Price



(b) High Price



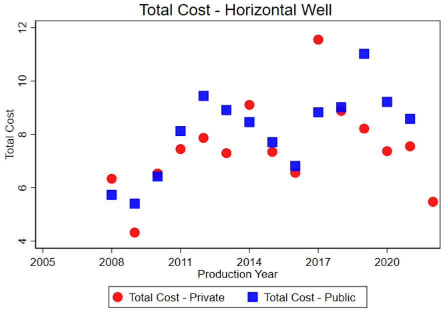
These figures plot the semi-elasticity coefficient for the public and private firms for low and high prices periods across major US oil-producing regions based on the following Poisson regression:

$$\log(E(Y_{it}|X_{it})) = \beta Price_{t-1} + FirmFE_i$$

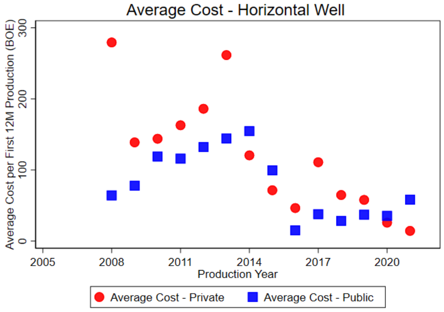
The data are a quarterly panel spanning from 2016Q1 to 2023Q2. The US oilfields include the Permian (West Texas and New Mexico), Rockies (North Dakota, Wyoming, and Colorado), Mid-continent (North/Central Texas, Oklahoma, and Kansas), and Gulf (East Texas and Louisiana). The high and low price threshold is $55. The dependent variable is the number of oil wells drilled in each year-quarter. Standard errors are clustered at the firm level. *Price* is the lagged 18-month WTI futures price.

Figure 7: Efficiency Across Ownership

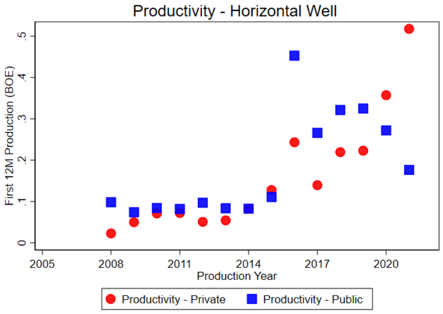
(a) Total Cost



(b) Average Cost



(c) First 12M Production



These figures plot the mean of different drilling efficiency measures based on the subset of horizontal wells located in New Mexico and North Dakota with the authorized for expenditure (AFE) filings. *Total cost* reflects the sum of drilling and completion expenses. *Productivity* is measured by the first 12-month production output from each well, expressed in barrels of oil equivalent (MBOE). *Average cost* is calculated by dividing the total cost by the first 12-month production (i.e., total cost per barrel of oil equivalent).

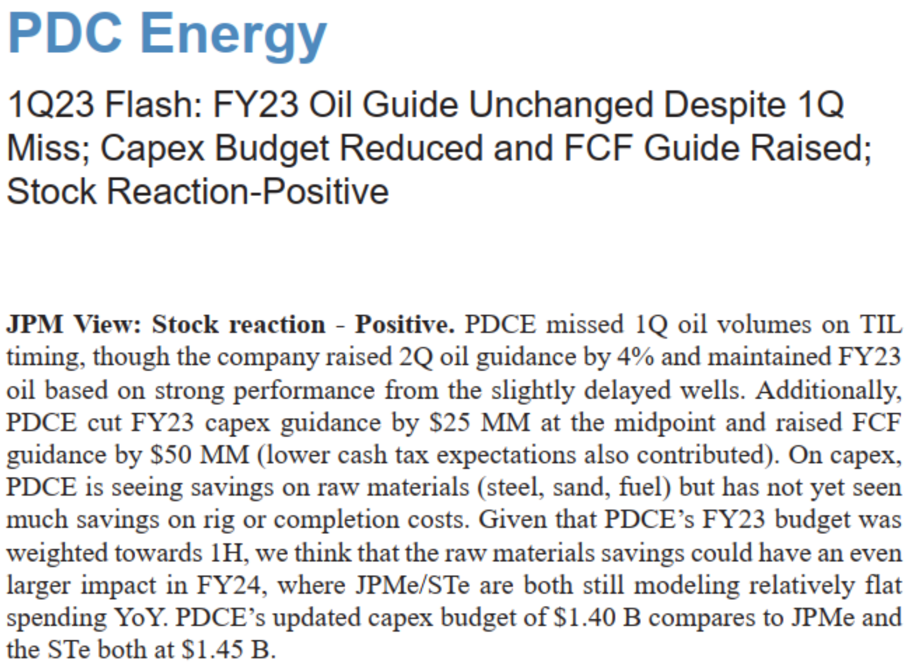
Figure 8: Instruction for GPT-4

```
"You are analyzing financial analyst reports."
"Q1. Can you tell me whether the report discusses the company's CAPEX (i.e
   . capital expenditure or capital spending)?"
"If the company's CAPEX is discussed in the report, please answer all of
   the following questions."
"Focus on the most significant CAPEX information presented."

"Q2. Did the company being analyzed increase, decrease, or keep its CAPEX
   ?"
"Q2a1. How much is the reported CAPEX?"
"Q2a2. If the report discusses the CAPEX, does the report also discusses
   the benchmark for the CAPEX? (i.e. increase/decrease/unchange the CAPEX
    relative to the benchmark)?"
"Q2a2. If no benchmark is mentioned, specify 'NA' and state that no
   benchmark was found in the report."
"Q2b. Does the report view the firm's CAPEX positively, negatively, or
   neutrally?"

"Use 'MM' to indicate millions and 'BN' to indicate billions when
   specifying amounts."
"Separate each of your answers using a comma."
"Report the midpoint of the range if the estimate is reported as a range.
   For example, if the CAPEX is reported as $100-$200 million, report $150
    million."

"Format your response for each question exactly like this:\n"
    "Q1. **CAPEX_Discussion: [yes/no]**, \n"
    "Q2. **CAPEX_updown: [up/down/unchanged/NA]**, \n"
    "Q2a1. **CAPEX_amount: [$ Amount MM/BN/NA]**, \n"
    "Q2a2. **CAPEX_benchmark1: [$ Amount MM/BN/NA]**, \n"
    "Q2a2. **CAPEX_benchmark1_explnation: [Analyst's Estimate/Other
   Analyst's Estimate/Consensus Estimate/Others/NA]**, \n"
    "Q2a2. **CAPEX_benchmark2: [$ Amount MM/BN/NA]**, \n"
    "Q2a2. **CAPEX_benchmark2_explnation: [Analyst's Estimate/Other
   Analyst's Estimate/Consensus Estimate/Others/NA]**, \n"
    "Q2b. **opinion: [positive/negative/neutral/NA]**, \n"
    "**Text**: [Your comment].\n"
```

This figure provides the instruction to GPT-4o to classify each analyst report.

Figure 9: Analyst Report Example

(a) Analyst Report Excerpt



PDC Energy

1Q23 Flash: FY23 Oil Guide Unchanged Despite 1Q Miss; Capex Budget Reduced and FCF Guide Raised; Stock Reaction-Positive

JPM View: Stock reaction - Positive. PDCE missed 1Q oil volumes on TIL timing, though the company raised 2Q oil guidance by 4% and maintained FY23 oil based on strong performance from the slightly delayed wells. Additionally, PDCE cut FY23 capex guidance by $25 MM at the midpoint and raised FCF guidance by $50 MM (lower cash tax expectations also contributed). On capex, PDCE is seeing savings on raw materials (steel, sand, fuel) but has not yet seen much savings on rig or completion costs. Given that PDCE's FY23 budget was weighted towards 1H, we think that the raw materials savings could have an even larger impact in FY24, where JPMe/STe are both still modeling relatively flat spending YoY. PDCE's updated capex budget of $1.40 B compares to JPMe and the STe both at $1.45 B.

(b) GPT-4o Output

CAPEX Discussion: Yes

CAPEX Updown: Down

CAPEX Amount: $1.40 BN

CAPEX Benchmark1: $1.45 BN

CAPEX Benchmark1 Explanation: Analyst's Estimate

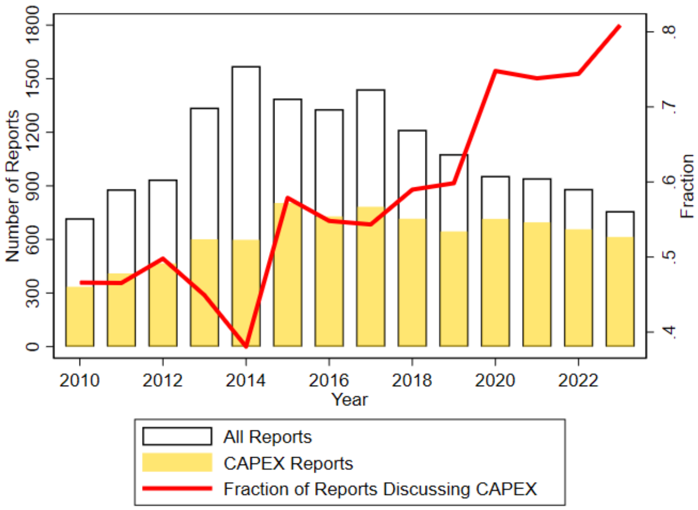
CAPEX Benchmark2: $1.45 BN

CAPEX Benchmark2 Explanation: Consensus Estimate

CAPEX Opinion: Positive

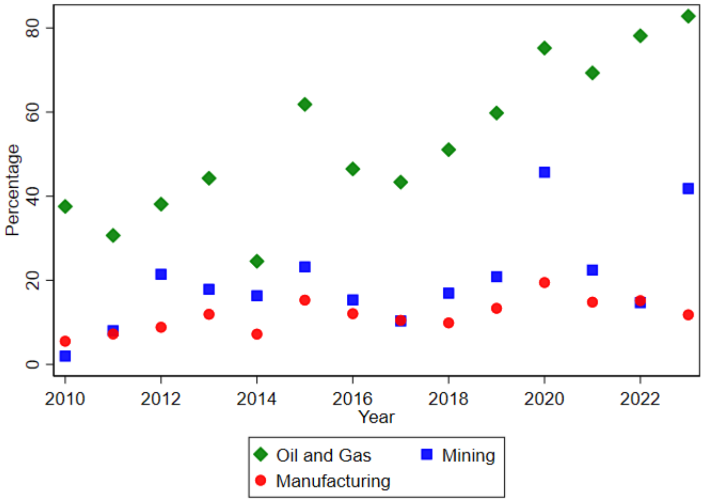
Figure (a) provides an example excerpt of analyst report. The report is prepared by JP Morgan for PDC Energy in May 2023. Figure (b) provides the corresponding GPT-4o output, generated by applying the instruction prompt to the text in Panel (a).

Figure 10: Analyst Report Distribution



This figure plots both the number and the fraction of analyst reports that discuss capital expenditures. The sample is drawn from InvesText (2010-2023) and restricted to U.S. oil and gas exploration and production firms (SIC 1311) with at least 30 wells in the Enverus dataset. Reports come from the three largest brokerage houses in InvesText that cover U.S. oil and gas exploration and production firms (SIC 1311) during 2010-2023: JP Morgan, RBC Capital Markets, and Wells Fargo Securities, after excluding multi-firm reports and retaining only the first page of each report.

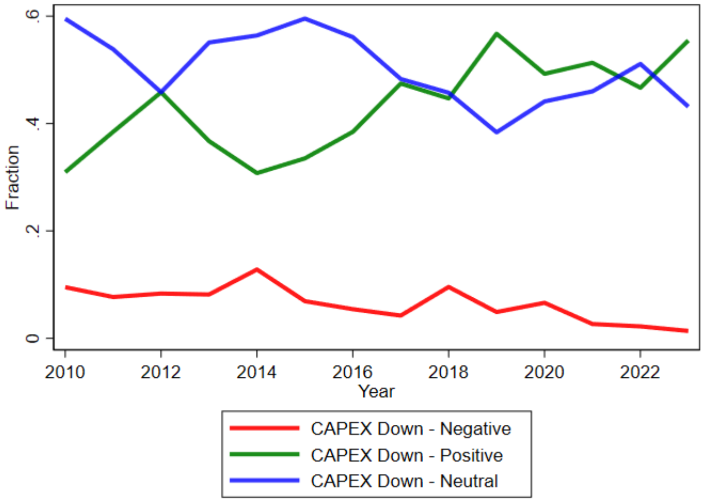
Figure 11: Proportion of Reports Discussing Capital Expenditure



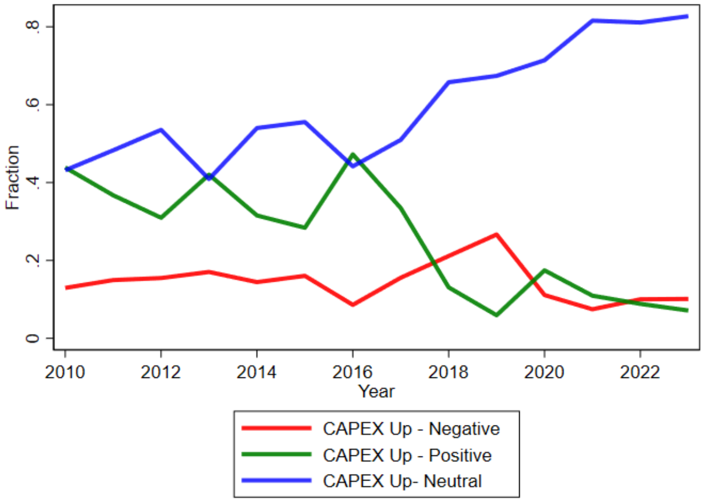
This figure compares the average proportion of analyst reports discussing capital expenditures across industries from 2010 to 2023. All reports are sourced from the InvesText Online Platform and are covered by JP Morgan. The sample includes oil and gas, mining, and manufacturing firms. For oil and gas, I include reports in the "Oil & Gas Exploration and Production" sector, matched to CRSP firms with SIC code 1311. For mining, I use the "Coal," "Steel," and "Aluminum" filters in InvesText, match firm names to CRSP, and retain firms with SIC codes beginning with 12 or 33. For manufacturing, I use the "Industrial Machinery & Equipment" filter, again matching to CRSP and keeping firms with SIC codes 20–39. A report is classified as investment-related if it contains terms such as "capex," "capital expenditure," or "capital spending."

Figure 12: Analyst Sentiment Conditional on CAPEX

(a) Conditional on CAPEX Down

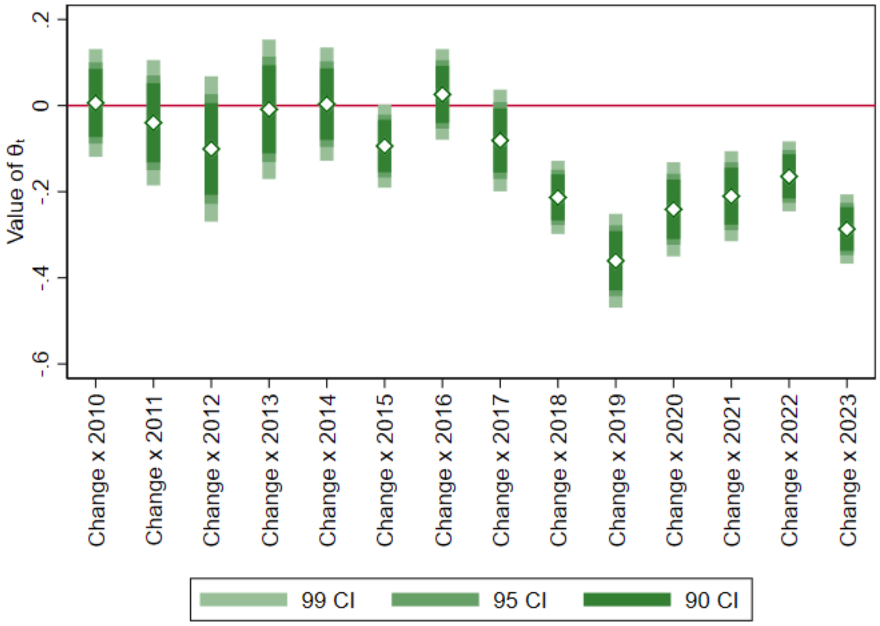


(b) Conditional on CAPEX Up



This figure plots the share of analyst reports expressing positive (green), neutral (blue), and negative (red) opinions on capital expenditures, conditional on CAPEX changes from 2010 to 2023. Panel A shows the distribution when CAPEX decreases (labeled $CAPEX\ Down$), while Panel B shows the distribution when CAPEX increases (labeled $CAPEX\ Up$). Accordingly, $CAPEX\ Down - Negative$ ($Neutral$, $Positive$) refers to the fraction of reports in which analysts express a negative (neutral, positive) opinion when CAPEX decreases relative to a benchmark. Similarly, $CAPEX\ Up - Negative$ ($Neutral$, $Positive$) refers to the fraction of reports in which analysts express a negative (neutral, positive) opinion when CAPEX increases relative to a benchmark.

Figure 13: Analyst Report Sentiment and Investment Over Time



This figure illustrates the regression result based on the following specification:

$$Opinion_{isjd} = \alpha + \sum_t \theta_t Change_{isjd} \times Year_t + FirmFE + YearFE + BrokerageFE + \epsilon_{isjd}$$

where i denotes a firm, s a report, j a brokerage firm, d a date, and t a year, with firm, brokerage firm, and year fixed effects included. The dependent variable is $Opinion_{isjd}$ which takes a value of 1 if the analyst report indicates that the company increased its CAPEX, 0 if there was no change, and -1 if the company decreased its CAPEX. $Change_{isjd}$ takes a value of 1 if the report views the company's CAPEX positively, 0 if it views it neutrally, and -1 if it views it negatively. $Year_t$ is an indicator variable that equals 1 if the report was written in year t and 0 otherwise. The standard errors are clustered at the firm level.

Tables

Table 1: Summary Statistics

	Mean	SD	N	p25	p50	p75
Public						
Wells Drilled	30.75	53.00	5,049	2.00	11.00	34.00
Oil Wells Drilled	20.31	36.39	5,049	0.00	6.00	23.00
Gas Wells Drilled	10.44	26.43	5,049	0.00	1.00	10.00
Investment Rate	0.11	0.25	4,533	0.03	0.07	0.12
Wells Drilled Prior 36M	406.65	645.60	4,772	39.00	178.00	450.00
Cum. Wells Drilled	1,908.58	3,218.03	5,049	94.00	564.00	2,003.00
Private						
Wells Drilled	1.21	4.19	132,828	0.00	0.00	1.00
Oil Wells Drilled	0.94	3.53	132,828	0.00	0.00	1.00
Gas Wells Drilled	0.27	1.89	132,828	0.00	0.00	0.00
Investment Rate	0.11	0.31	83,521	0.00	0.00	0.11
Wells Drilled Prior 36M	15.42	48.25	109,966	1.00	4.00	12.00
Cum. Wells Drilled	69.39	329.43	132,828	4.00	15.00	53.00
Total						
Wells Drilled	2.29	12.27	137,877	0.00	0.00	1.00
Oil Wells Drilled	1.65	8.59	137,877	0.00	0.00	1.00
Gas Wells Drilled	0.64	5.72	137,877	0.00	0.00	0.00
Investment Rate	0.11	0.31	88,054	0.00	0.00	0.11
Wells Drilled Prior 36M	31.69	160.20	114,738	1.00	4.00	14.00
Cum. Wells Drilled	136.74	776.55	137,877	4.00	17.00	59.00
Observations	137892					

This table provides the summary statistics for the sample at the firm-quarter level by different ownership types during the period 201Q1 to 2023Q2. *Wells Drilled* is the number of wells drilled by a firm in each quarter. *Oil Wells Drilled* is the number of oil wells drilled, and *Gas Wells Drilled* is the number of gas wells drilled. A well is classified as oil well if the gas-oil ratio is less or equal to 6,000 cubic feet of natural gas to 1 cubic foot per barrel (cf/b) of the first 12 month production. If no production information is available in the Enverus data, I rely on Enverus' well type classification, designating wells as gas-producing if they are classified as either coalbed methane (CBM) or gas. *Cum. Wells Drilled* is the cumulative number of wells drilled. *Wells Drilled Prior 12Q* is the number of wells drilled in the last 12 quarters. A firm must have at least 12 quarters of drilling history for this measure to be calculated. *Investment Rate* is the number of wells drilled in the current quarter divided by the number of wells drilled in the last 12 quarters by a firm.

Table 2: Summary Statistics for AFE Cost Data

	Mean	SD	Count	p25	p50	p75
Total						
Total Cost	7.94	2.36	521	6.73	8.02	9.05
Average Cost	115.68	105.40	488	55.13	88.95	142.63
First 12M Production (in Millions of BOE)	0.12	0.11	490	0.05	0.09	0.14
Private						
Total Cost	7.21	2.46	166	5.99	7.40	8.69
Average Cost	109.73	113.10	138	31.21	68.01	147.12
First 12M Production (in Millions of BOE)	0.15	0.14	139	0.04	0.10	0.24
Public						
Total Cost	8.28	2.24	355	7.03	8.27	9.55
Average Cost	118.02	102.27	350	63.11	93.40	138.58
First 12M Production (in Millions of BOE)	0.11	0.09	351	0.06	0.08	0.13
Observations	524					

This table reports the summary statistics of the subset of the wells with the authorized for expenditure (AFE) filings in New Mexico and North Dakota from 1999 to 2022. *Total Cost* refers to the total cost of well development (in millions of $). *First 12M Production* represents the total production from the well in the first 12 months, measured in millions of barrels of oil equivalent. *Average Cost* is calculated by dividing *Total Cost* by *First 12M Production*.

Table 3: Elasticity of Drilling Activity Between Public and Private Firms

	Dep. Variable: # Oil Wells Drilled		
	(1) Univariate	(2) Interaction	(3) Log Specification
Price	0.022***	0.015***	
	(0.002)	(0.002)	
Private × Price		0.014***	
		(0.003)	
Log(Price)			0.988***
			(0.123)
Private × Log(Price)			0.862***
			(0.164)
Private		-1.899***	-4.540***
		(0.271)	(0.701)
# Obs	46,613	46,613	46,613
Pseudo R-squared	0.722	0.725	0.726
Firm FE	Y	Y	Y

This table estimates the elasticity of investment across ownership types. The regression results are based on the following Poisson regression specification:

$$\log(E(Y_{it}|X_{it})) = \beta_1 Price_{t-1} + \beta_2 Price_{t-1} \times Private_{it} + \beta_3 Private_{it} + FirmFE_i$$

The data are a quarterly panel spanning from 2016Q1 to 2023Q2. The dependent variable is the number of oil wells drilled in each year-quarter. Standard errors are clustered at the firm level. *Price* is the lagged 18-month WTI futures price, while *Log(Price)* denotes the logarithm of the lagged 18-month WTI futures price. *Private* is a binary indicator equal to 1 if the company is private, and 0 otherwise. Statistical significance is denoted by *, **, and *** at the 10%, 5%, and 1% levels, respectively.

Table 4: Elasticity of Drilling Activity Between Public and Private Firms During High and Low Periods

	High/Low Price Threshold = \$50		High/Low Price Threshold = \$55		High/Low Price Threshold = \$60	
	Low	High	Low	High	Low	High
	(1)	(2)	(3)	(4)	(5)	(6)
	Oil Wells Drilled	Oil Wells Drilled	Oil Wells Drilled	Oil Wells Drilled	Oil Wells Drilled	Oil Wells Drilled
Price	0.079***	0.005*	0.067***	-0.002	0.049***	-0.001
	(0.010)	(0.003)	(0.006)	(0.004)	(0.004)	(0.004)
Private × Price	-0.024*	0.020***	-0.013	0.021***	0.003	0.019***
	(0.014)	(0.004)	(0.009)	(0.005)	(0.005)	(0.005)
Private	0.410	-2.271***	-0.060	-2.843***	-0.749**	-2.951***
	(0.747)	(0.320)	(0.504)	(0.492)	(0.381)	(0.497)
# Obs	8,754	32,004	22,802	17,403	32,735	9,093
Pseudo R-squared	0.686	0.736	0.712	0.745	0.724	0.741

This table estimates the elasticity of investment across ownership types separately for low and high price environments. The regression results are based on the following Poisson regression specification:

$$\log(E(Y_{it}|X_{it})) = \beta_1 \text{Price}_{t-1} + \beta_2(\text{Price}_{t-1} \times \text{Private}_{it}) + \beta_3 \text{Private}_{it} + \text{FirmFE}_i$$

The data are a quarterly panel spanning from 2016Q1 to 2023Q2. The low/high price cutoffs are \$50 for Columns (1) and (2), \$55 for Columns (3) and (4), and \$60 for Columns (5) and (6). The dependent variable is the number of oil wells drilled in each year-quarter. Standard errors are clustered at the firm level. *Price* is the lagged 18-month WTI futures price, while Log(Price) denotes the logarithm of the lagged 18-month WTI futures price. *Private* is a binary indicator equal to 1 if the company is private, and 0 otherwise. Statistical significance is denoted by *, **, and *** at the 10%, 5%, and 1% levels, respectively.

Table 5: Drilling Sensitivity: Variation in Land Quality

	Dep. Variable: # Oil Wells Drilled				
	(1) Firm, Region FE	(2) Firm, Region, Yr FE	(3) Firm, Region-Qtr FE	(4) Low Price	(5) High Price
Price	0.019***	0.015***	Subsumed	0.044***	0.001
	(0.002)	(0.002)	(.)	(0.006)	(0.003)
Private × Price	0.013***	0.015***	0.013***	-0.010	0.020***
	(0.003)	(0.003)	(0.004)	(0.008)	(0.005)
Private	-1.738***	-1.722***	-1.593***	0.061	-2.688***
	(0.251)	(0.272)	(0.289)	(0.510)	(0.481)
# Obs	52,398	52,398	52,395	26,541	19,683
Pseudo R-squared	0.607	0.612	0.620	0.580	0.635
Firm FE	Y	Y	Y	Y	Y
Region FE	Y	Y	N	Y	Y
Year FE	N	Y	Y	Y	Y
Region-Quarter FE	N	N	Y	N	N

This table estimates the elasticity of investment across ownership types including various geography and time fixed effects. The regression results are based on the following Poisson regression specification:

$$\log(E(Y_{it}|X_{it})) = \beta_1 Price_{t-1} + \beta_2 Price_{t-1} \times Private_{it} + \beta_3 Private_{it} + FE$$

The data are a quarterly panel spanning from 2016Q1 to 2023Q2. The dependent variable is the number of wells drilled in each year-quarter. The unit of observation is firm-region-quarter. Regions are defined based on Enverus' regional category Envregion), which includes Permian, Mid-continent, Rockies, Gulf Coast, US East, US West, and Alaska. *Price* is the lagged 18-month WTI futures price. *Private* is a binary indicator equal to 1 if the company is private, and 0 otherwise. In Column (1), firm and region fixed effects are used. In Column (2), firm, region, and year fixed effects are included. In Column (3), firm and region-quarter fixed effects are applied. For Columns (4) and (5), a $55 price cutoff is used to classify each period as either a low-price period (Column (4)) or a high-price period (Column (5)). The standard errors are clustered at the firm level. Statistical significance is denoted by *, **, and *** at the 10%, 5%, and 1% levels, respectively.

Table 6: Drilling Sensitivity: Private Equity Subsample

	(1)	(2)	
	Dep. Variable: # Oil Wells Drilled		
	PE-backed	Non PE-backed	Both
Price	0.015***	0.015***	0.015***
	(0.002)	(0.002)	(0.002)
PE × Price	0.017***		0.017***
	(0.004)		(0.004)
Non-PE-Private × Price		0.014***	0.013***
		(0.003)	(0.003)
Non-PE-Private		-2.019***	-2.019***
		(0.352)	(0.355)
PE	-1.711***		-1.697***
	(0.533)		(0.543)
# Obs	7,797	41,115	46,613
Pseudo R-squared	0.758	0.748	0.725
Firm FE	Y	Y	Y

This table reports the Poisson regression results based on subsamples of private firms. The dependant variable is the number of wells drilled in each year-quarter. *Price* is the lagged 18-month WTI futures price. *PE* is an indicator that equals 1 if the firm is private-equity backed, and 0 otherwise. *Non-PE-private* is an indicator that equals 1 if the firm is private but not backed by private equity firms, and 0 otherwise. The standard errors are clustered at the firm level. Statistical significance is denoted by *, **, and *** at the 10%, 5%, and 1% levels, respectively.

Table 7: Elasticity of Drilling Activity Between Public and Private Firms: Size Control

	Dep. Variable: # Oil Wells Drilled	
	(1) Proxy: Log(Cum. Drilling)	(2) Proxy: Log(Drilling Prior 12Q)
Price	0.012***	0.016***
	(0.002)	(0.002)
Private × Price	0.010***	0.011***
	(0.003)	(0.003)
ln(Cumulative Wells Drilled)	0.357***	
	(0.037)	
ln(Wells Drilled Prior 12Q)		0.150***
		(0.032)
Private	-1.394***	-1.369***
	(0.266)	(0.249)
# Obs	46,307	31,375
Pseudo R-squared	0.728	0.735
Firm FE	Y	Y

This table estimates the elasticity of investment across ownership types including different size proxies. The regression results are based on the following Poisson regression specification:

$$\log(E(Y_{it}|X_{it})) = \beta_1 Price_{t-1} + \beta_2 Price_{t-1} \times Private_{it} + \beta_3 Private_{it} + FirmFE_i$$

The data are a quarterly panel spanning from 2016Q1 to 2023Q2. The dependent variable is the number of oil wells drilled in each year-quarter. Standard errors are clustered at the firm level. *Price* is the lagged 18-month WTI futures price, while *Log(Price)* denotes the logarithm of the lagged 18-month WTI futures price. *Private* is a binary indicator equal to 1 if the company is private, and 0 otherwise. *Log(Cumulative Wells Drilled)* is the log of cumulative number of wells drilled. *Log(Wells Drilled Prior 12Q)* is the log of the number of wells drilled in the prior 12 quarters. A firm must have at least 12 quarters of drilling history for this measure to be calculated. Statistical significance is denoted by *, **, and *** at the 10%, 5%, and 1% levels, respectively.

Table 8: Elasticity of Drilling Activity Between Public and Private Firms: Size Threshold

	Dep. Variable: # Oil Wells Drilled			
	(1) Cum. Drilling $\geq$ 10	(2) Cum. Drilling $\geq$ 30	(3) Drilling Prior 12Q $\geq$ 10	(4) Drilling Prior 12Q $\geq$ 30
Price	0.015***	0.015***	0.015***	0.015***
	(0.002)	(0.002)	(0.002)	(0.002)
Private × Price	0.012***	0.010***	0.011***	0.010***
	(0.003)	(0.003)	(0.003)	(0.003)
Private	-1.570***	-1.429***	-1.592***	-1.547***
	(0.246)	(0.263)	(0.249)	(0.270)
# Obs	33,895	23,968	18,065	10,739
Pseudo R-squared	0.731	0.739	0.715	0.740
Firm FE	Y	Y	Y	Y

This table estimates the elasticity of investment across ownership types for different size proxy thresholds. The regression results are based on the following Poisson regression specification:

$$\log(E(Y_{it}|X_{it})) = \beta_1 \text{Price}_{t-1} + \beta_2(\text{Price}_{t-1} \times \text{Private}_{it}) + \beta_3 \text{Private}_{it} + \text{FirmFE}_i$$

The data are a quarterly panel spanning from 2016Q1 to 2023Q2. The dependent variable is the number of oil wells drilled in each year-quarter. Standard errors are clustered at the firm level. Column (1) restricts the sample to firms with more than 10 wells drilled in the prior 12 quarters. Column (2) increases this threshold to 30 wells. Column (3) restricts the sample to firms with more than 10 cumulative wells drilled. Column (4) increases this threshold to 30 wells. *Price* is the lagged 18-month WTI futures price, while *Log(Price)* denotes the logarithm of the lagged 18-month WTI futures price. *Private* is a binary indicator equal to 1 if the company is private, and 0 otherwise. Statistical significance is denoted by *, **, and *** at the 10%, 5%, and 1% levels, respectively.

Table 9: Drilling Sensitivity: Other Commodity Prices

	Dep. Variable: # Oil Wells Drilled				
	(1) Spot	(2) 3M Futures	(3) 6M Futures	(4) 12M Futures	(5) 18M Futures
Oil Spot Price	0.009***				
	(0.001)				
Private× Oil Spot Price	0.009***				
	(0.002)				
Oil Future Price (3M)		0.010***			
		(0.001)			
Private × Oil Future Price (3M)		0.010***			
		(0.002)			
Oil Future Price (6M)			0.011***		
			(0.002)		
Private × Oil Future Price (6M)			0.011***		
			(0.002)		
Oil Future Price (12M)				0.013***	
				(0.002)	
Private × Oil Future Price (12M)				0.013***	
				(0.002)	
Price					0.015***
					(0.002)
Private × Price					0.014***
					(0.003)
Private	-1.593***	-1.656***	-1.723***	-1.820***	-1.899***
	(0.253)	(0.257)	(0.261)	(0.266)	(0.271)
# Obs	46,613	46,613	46,613	46,613	46,613
Pseudo R-squared	0.725	0.725	0.725	0.725	0.725
Firm FE	Y	Y	Y	Y	Y

This table estimates the elasticity of investment across ownership types for different oil prices. The regression results are based on the following Poisson regression specification:

$$\log(E(Y_{it}|X_{it})) = \beta_1 \text{Price}_{t-1} + \beta_2(\text{Price}_{t-1} \times \text{Private}_{it}) + \beta_3 \text{Private}_{it} + \text{FirmFE}_i$$

The data are a quarterly panel spanning from 2016Q1 to 2023Q2. The dependent variable is the number of oil wells drilled in each year-quarter. Standard errors are clustered at the firm level. *Price* includes the WTI spot price for Column (1), the 3-month WTI futures price for Column (2), the 6-month WTI futures price for Column (3), the 12-month WTI futures price for Column (4), and the 18-month WTI futures price for Column (5). All of *Price* variables are lagged by one quarter. *Private* is a binary indicator equal to 1 if the company is private, and 0 otherwise. Statistical significance is denoted by *, **, and *** at the 10%, 5%, and 1% levels, respectively.

Table 10: Analyst Report Summary Statistics

	Level	Mean	SD	N	p25	p50	p75
1(CAPEX Discussed)	Report	0.57	0.50	15,438	0.00	1.00	1.00
CAPEX Change	Report	0.06	0.80	7,405	-1.00	0.00	1.00
CAPEX Opinion	Report	0.18	0.53	8,353	0.00	0.00	1.00
Word Count	Report	3,141.94	994.38	15,438	2,370.00	3,175.00	3,967.00
Observations	15438						

This table provides the summary statistics for the analyst reports from InvesText during the period 2010-2023. *1(CAPEX Discussed)* is an indicator that equals 1 if the analysts discusses capital expenditure in the report and 0 otherwise. *Opinion* takes a value of 1 if the report views the company's CAPEX positively, 0 if it views it neutrally, and -1 if it views it negatively. *Change* takes a value of 1 if the summary indicates that the company's CAPEX is greater than the analyst's benchmark, 0 if the company's CAPEX is in line with the analyst's benchmark, and -1 if the company's CAPEX is less than the analyst's benchmark. *Word Count* counts the number of words used in each analyst report.

Table 11: Analyst Report: Sentiment - Investment Matrix

	Opinion			
Change	Negative	Neutral	Positive	Total
Down	133	1,067	956	2,156
Unchanged	27	2,256	259	2,542
Up	373	1,557	636	2,596
Total	533	4,910	1,851	7,294

table cross-tabulates *Opinion* and *Change*. *Opinion* is coded as 1 if the report views the company's CAPEX positively, 0 if neutral, and -1 if negative. *Change* is coded as 1 if the report indicates CAPEX is above the analyst's benchmark (Up), 0 if in line with the benchmark (Unchanged), and -1 if below the benchmark (Down).

Table 12: Analyst Report: Regression Analysis

	Dependent Variable: Opinion				
	(1)	(2)	(3)	(4)	(5)
CAPEX Change	-0.199***	-0.191***	-0.190***	-0.188***	-0.187***
	(0.013)	(0.013)	(0.015)	(0.015)	(0.015)
# Obs	4,774	4,772	4,774	4,772	4,772
R-squared	0.091	0.137	0.100	0.144	0.145
Firm FE	N	Y	N	Y	Y
Year FE	N	N	Y	Y	Y
Brokerage FE	N	Y	Y	N	Y

This table reports the regression result of the following specification for the period 2016 to 2023:

$$Opinion_{isjd} = \alpha + \theta Change_{isjd} + FirmFE + BrokerageFE + YearFE + \epsilon_{isjd}$$

where i denotes a firm, s a report, j a brokerage firm, d a date, and t a year. The dependent variable is $Opinion_{isjd}$ which takes a value of 1 if the report views the company's CAPEX positively, 0 if it views it neutrally, and -1 if it views it negatively. The independent variable is $Change_{isjd}$ which takes a value of 1 if the summary indicates that the company's CAPEX is greater than the analyst's benchmark, 0 if the company's CAPEX is in line with the analyst's benchmark, and -1 if the company's CAPEX is less than the analyst's benchmark. The constant term is omitted for clarity. The regression includes firm, year, and brokerage firm fixed effects. The standard errors are clustered at the firm level. Statistical significance is denoted by *, **, and *** at the 10%, 5%, and 1% levels, respectively.

Table 13: Cumulative Abnormal Returns (CARs) around Report Issuance by Investment Opinion

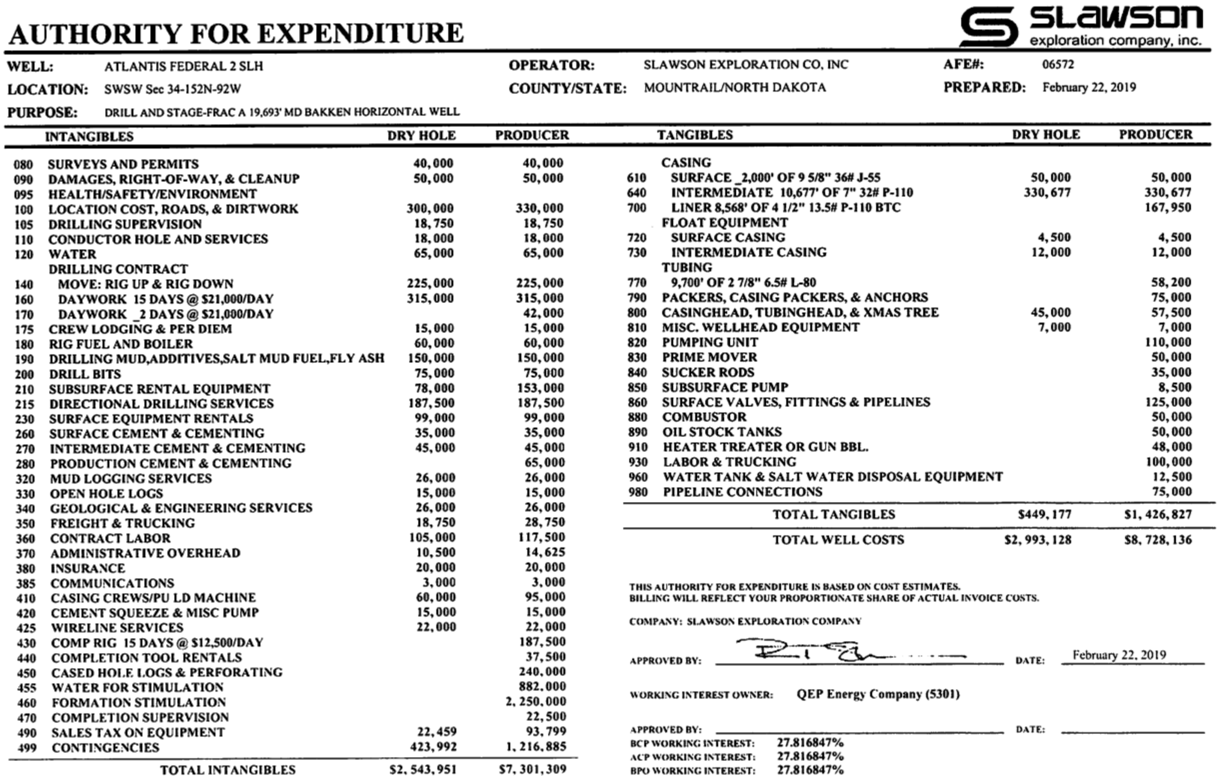
	Positive Opinion		Neutral Opinion		Negative Opinion		
Event Period	CAR	# Obs	CAR	# Obs	CAR	# Obs	Positive - Negative
(0,0)	0.57***	1,823	-0.23***	4,779	-1.94***	514	2.51***
(0,1)	1.17***	1,823	-0.23**	4,779	-3.25***	514	4.41***
(0,2)	1.25***	1,823	0.00	4,779	-3.35***	514	4.69***
(0,3)	1.26***	1,823	-0.01	4,779	-1.88	514	3.14***

This table reports the stock market reaction to analyst reports based on different opinions regarding the company's capital expenditure. The analyst reports are collected from InvesText for oil and gas firms covering the period from 2010 to 2023. Each report is classified as having positive, neutral, or negative opinions on the company's capital expenditure using ChatGPT4o. *CAR* refers to the cumulative abnormal returns starting from the current analyst report date, where abnormal return is defined according to the CAPM. *Event Period* is the period over which the cumulative abnormal return is estimated. The estimation window is 100 days, with a minimum requirement of 70 non-missing return observations within this window to produce estimates of expected return. Additionally, a 50-trading-day gap is imposed between the end of the estimation window and the beginning of the event window. Statistical significance is denoted by *, **, and *** at the 10%, 5%, and 1% levels, respectively.

Appendices

A Appendix A: Oil and Gas Industry

Appendix Figure A1: The Cost of Drilling Example from an AFE Filing



AUTHORITY FOR EXPENDITURE

slawson exploration company, inc.

WELL: ATLANTIS FEDERAL 2 SLH
OPERATOR: SLAWSON EXPLORATION CO, INC
AFE#: 06572
LOCATION: SWSW Sec 34-152N-92W
COUNTY/STATE: MOUNTRAIL/NORTH DAKOTA
PREPARED: February 22, 2019
PURPOSE: DRILL AND STAGE-FRAC A 19,693' MD BAKKEN HORIZONTAL WELL

	INTANGIBLES	DRY HOLE	PRODUCER
080	SURVEYS AND PERMITS	40,000	40,000
090	DAMAGES, RIGHT-OF-WAY, & CLEANUP	50,000	50,000
095	HEALTH/SAFETY/ENVIRONMENT		
100	LOCATION COST, ROADS, & DIRTWORK	300,000	330,000
105	DRILLING SUPERVISION	18,750	18,750
110	CONDUCTOR HOLE AND SERVICES	18,000	18,000
120	WATER	65,000	65,000
	DRILLING CONTRACT		
140	MOVE: RIG UP & RIG DOWN	225,000	225,000
160	DAYWORK 15 DAYS @ $21,000/DAY	315,000	315,000
170	DAYWORK _2 DAYS @ $21,000/DAY		42,000
175	CREW LODGING & PER DIEM	15,000	15,000
180	RIG FUEL AND BOILER	60,000	60,000
190	DRILLING MUD,ADDITIVES,SALT MUD FUEL,FLY ASH	150,000	150,000
200	DRILL BITS	75,000	75,000
210	SUBSURFACE RENTAL EQUIPMENT	78,000	153,000
215	DIRECTIONAL DRILLING SERVICES	187,500	187,500
230	SURFACE EQUIPMENT RENTALS	99,000	99,000
260	SURFACE CEMENT & CEMENTING	35,000	35,000
270	INTERMEDIATE CEMENT & CEMENTING	45,000	45,000
280	PRODUCTION CEMENT & CEMENTING		65,000
320	MUD LOGGING SERVICES	26,000	26,000
330	OPEN HOLE LOGS	15,000	15,000
340	GEOLOGICAL & ENGINEERING SERVICES	26,000	26,000
350	FREIGHT & TRUCKING	18,750	28,750
360	CONTRACT LABOR	105,000	117,500
370	ADMINISTRATIVE OVERHEAD	10,500	14,625
380	INSURANCE	20,000	20,000
385	COMMUNICATIONS	3,000	3,000
410	CASING CREWS/PU LD MACHINE	60,000	95,000
420	CEMENT SQUEEZE & MISC PUMP	15,000	15,000
425	WIRELINE SERVICES	22,000	22,000
430	COMP RIG 15 DAYS @ $12,500/DAY		187,500
440	COMPLETION TOOL RENTALS		37,500
450	CASED HOLE LOGS & PERFORATING		240,000
455	WATER FOR STIMULATION		882,000
460	FORMATION STIMULATION		2,250,000
470	COMPLETION SUPERVISION		22,500
490	SALES TAX ON EQUIPMENT	22,459	93,799
499	CONTINGENCIES	423,992	1,216,885
	TOTAL INTANGIBLES	$2,543,951	$7,301,309

	TANGIBLES	DRY HOLE	PRODUCER
	CASING		
610	SURFACE _2,000' OF 9 5/8" 36# J-55	50,000	50,000
640	INTERMEDIATE 10,677' OF 7" 32# P-110	330,677	330,677
700	LINER 8,568' OF 4 1/2" 13.5# P-110 BTC		167,950
	FLOAT EQUIPMENT		
720	SURFACE CASING	4,500	4,500
730	INTERMEDIATE CASING	12,000	12,000
	TUBING		
770	9,700' OF 2 7/8" 6.5# L-80		58,200
790	PACKERS, CASING PACKERS, & ANCHORS		75,000
800	CASINGHEAD, TUBINGHEAD, & XMAS TREE	45,000	57,500
810	MISC. WELLHEAD EQUIPMENT	7,000	7,000
820	PUMPING UNIT		110,000
830	PRIME MOVER		50,000
840	SUCKER RODS		35,000
850	SUBSURFACE PUMP		8,500
860	SURFACE VALVES, FITTINGS & PIPELINES		125,000
880	COMBUSTOR		50,000
890	OIL STOCK TANKS		50,000
910	HEATER TREATER OR GUN BBL.		48,000
930	LABOR & TRUCKING		100,000
960	WATER TANK & SALT WATER DISPOSAL EQUIPMENT		12,500
980	PIPELINE CONNECTIONS		75,000
	TOTAL TANGIBLES	$449,177	$1,426,827
	TOTAL WELL COSTS	$2,993,128	$8,728,136

THIS AUTHORITY FOR EXPENDITURE IS BASED ON COST ESTIMATES.
BILLING WILL REFLECT YOUR PROPORTIONATE SHARE OF ACTUAL INVOICE COSTS.

COMPANY: SLAWSON EXPLORATION COMPANY

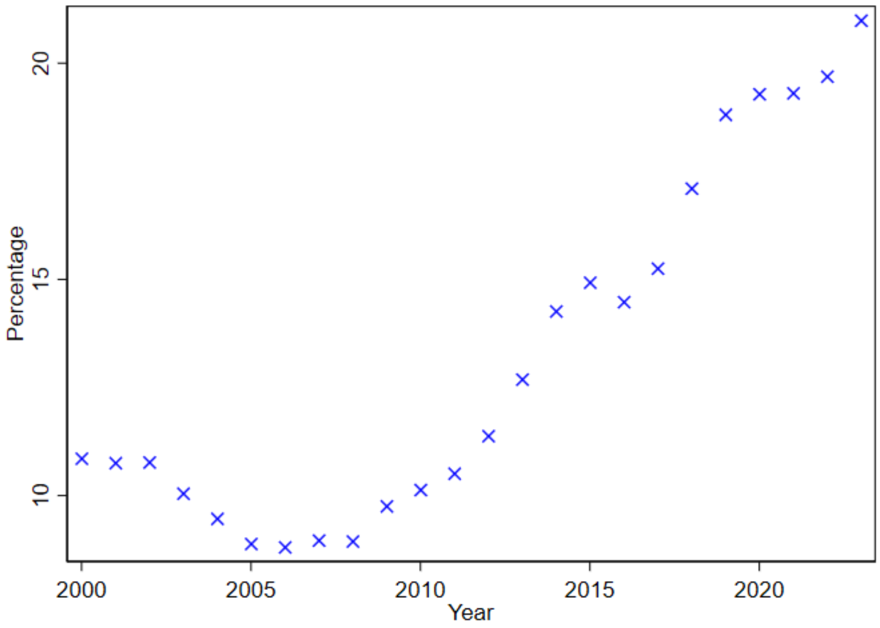
APPROVED BY: ______________ DATE: February 22, 2019

WORKING INTEREST OWNER: QEP Energy Company (5301)

APPROVED BY: ______________ DATE: ______________
BCP WORKING INTEREST: 27.816847%
ACP WORKING INTEREST: 27.816847%
BPO WORKING INTEREST: 27.816847%

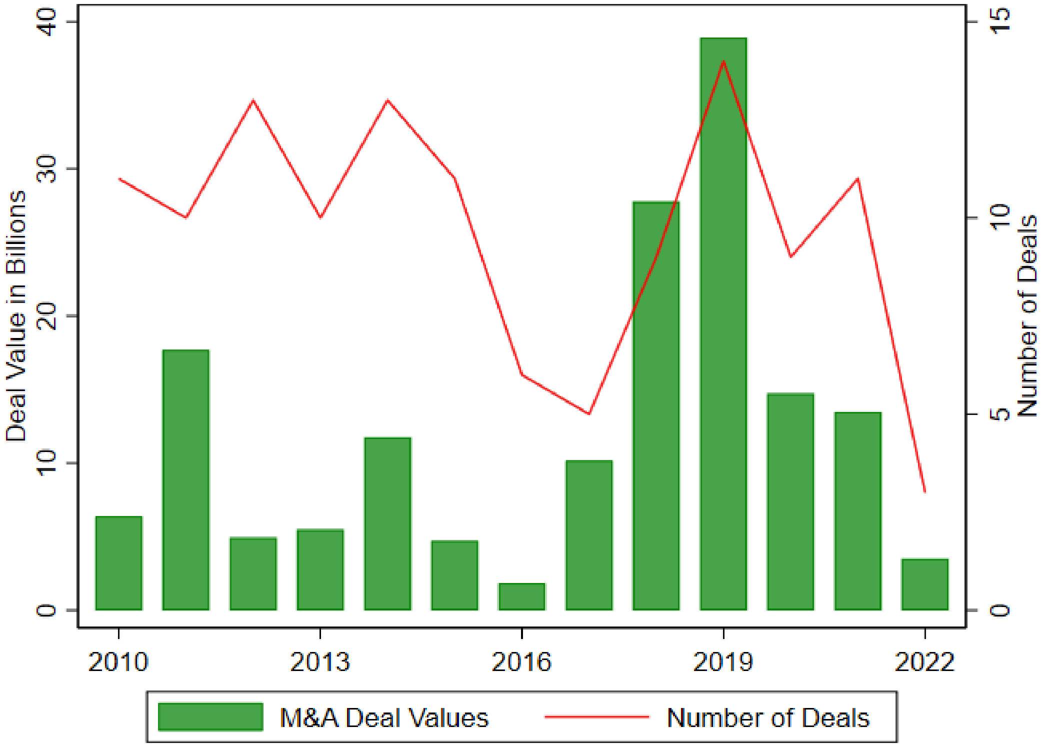
This figure provides an example of drilling costs from the Authorization for Expenditure (AFE) filing by Slawson Exploration Company. An AFE filing provides an estimate of the expenses associated with various operations, such as drilling, completing, equipping, or plugging an oil or gas well. The company prepared the filing for a well located in North Dakota in February 2019.

Appendix Figure A2: U.S. Petroleum Production



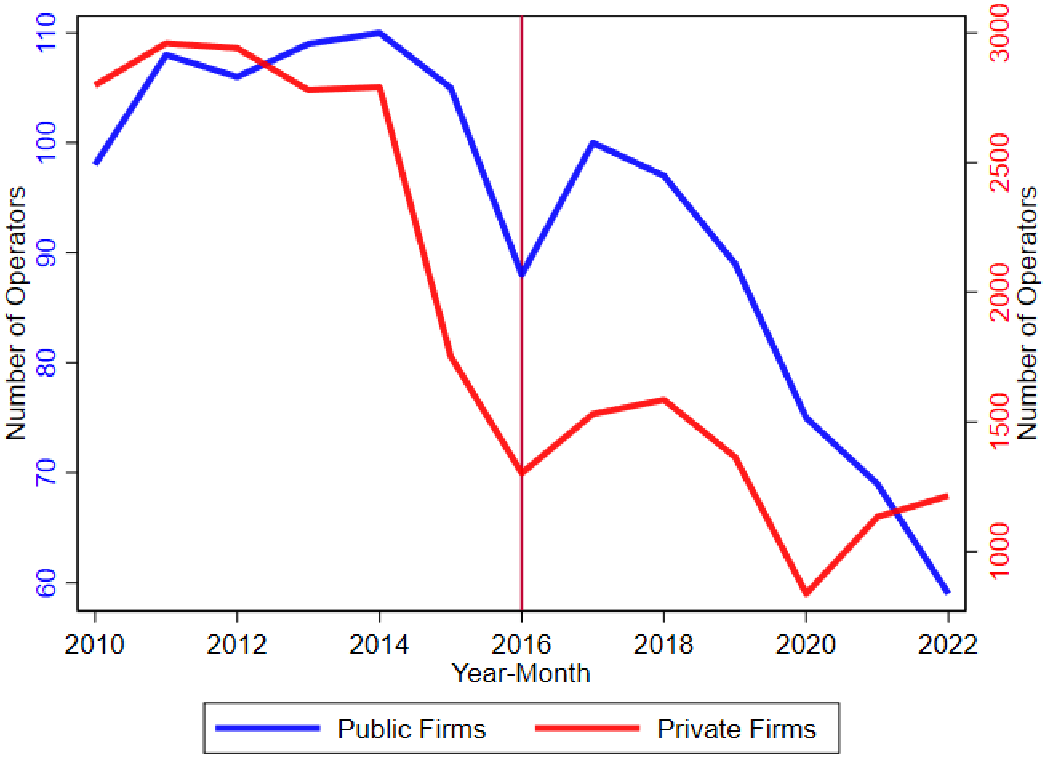
This figure plots the share of U.S. petroleum and other liquids production relative to global production from 2000 to 2023. The data is obtained from U.S. Energy Information Administration.

Appendix Figure A3: M&A Activity by Public Firms



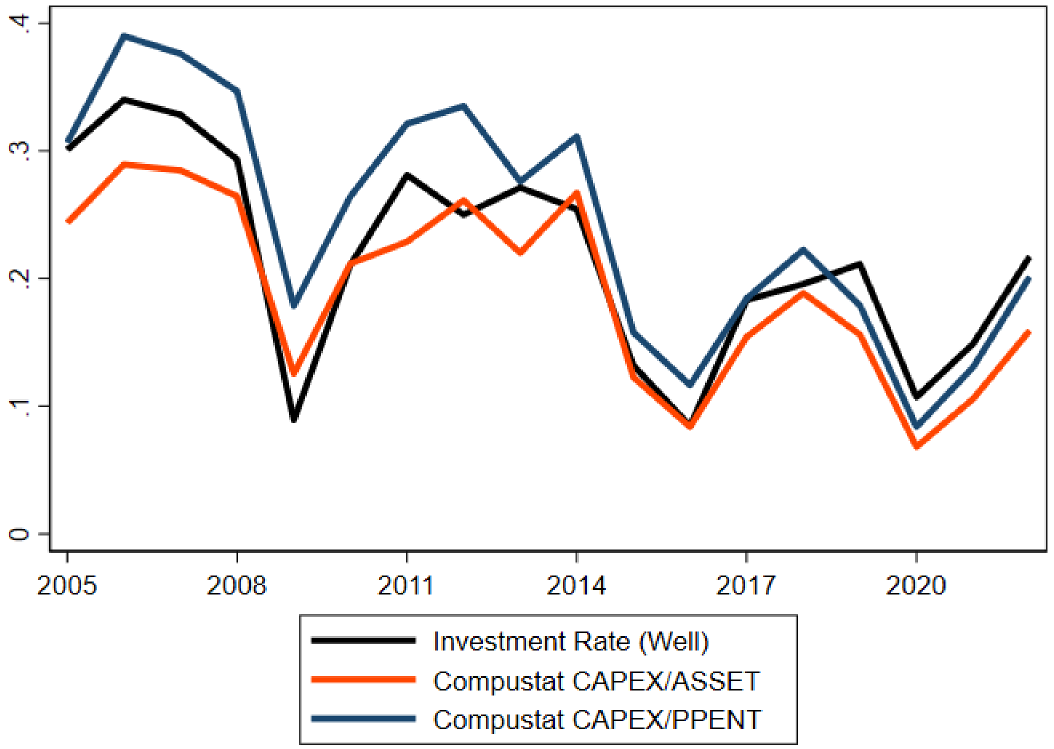
This figure plots the total value of M&A deals, as well as the number of deals, in a given year by public oil and gas firms from 2010 to 2022. The value of deal sizes is adjusted for inflation, expressed in 2005 dollars. The data is obtained from SDC Platinum. The acquiring public firms are classified under SIC industry codes 1311 (Crude Petroleum and Natural Gas) or 2911 (Petroleum Refining). I filter the target firms to include only those classified under SIC code 1311 to ensure that the targeted firms are in the E&P sector.

Appendix Figure A4: Active Operators in US Onshore E &P Industry



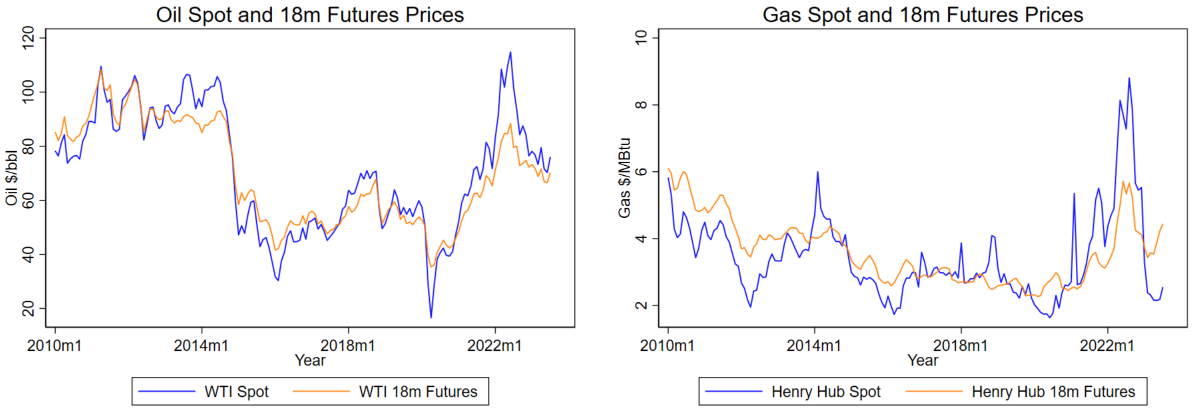
This figure plots the number of active operators over time, where an active operator is defined as a firm with at least one drilling record in the Enverus data between 2010 and 2022. Public firms are defined as those present in both the CRSP and Enverus datasets with at least one drilling record in the given year. The public firms included are those with at least 30 drilling records over their lifetime and classified under the SIC industry codes 1311 (Crude Petroleum and Natural Gas) or 2911 (Petroleum Refining).

Appendix Figure A5: Comparison of Investment Measures: Enverus drilling data versus Accounting data



This figure compares the medians of different measures of the annual investment rate using Compustat accounting data and Enverus drilling data. The comparison is based on the same set of sample firms, meaning that all firms must have data available in both Compustat and Enverus drilling. *Investment Rate (Well)*, based on Enverus drilling data, is constructed by dividing the number of wells drilled by a firm in a given year by the number of wells drilled over the previous 5 years. *Compustat CAPEX/ASSET* calculated by dividing the total capital expenditures of a firm in a given year by the lagged total assets. *Compustat CAPEX/PPENT* is calculated by dividing the total capital expenditures of a firm in a given year by the lagged net property, plant, and equipment.

Appendix Figure A6: Monthly Oil and Gas Prices



(a) Oil

(b) Gas

This figure presents the monthly WTI spot and 18-month futures oil prices, as well as the monthly Henry Hub spot and 18-month futures gas prices, covering the period from January 2010 to June 2023. The spot prices for oil and gas are sourced from the Energy Information Administration (EIA), while the futures prices are obtained from Bloomberg.

Appendix Table A1: Annual Firm-Level Financial Statistics (2010-2023) for Public Firms

Panel A: Enverus-Compustat

	Mean	SD	Count	P25	P50	P75
Return on Assets	-0.07	0.33	1,234	-0.06	0.02	0.06
Log(Total Assets)	8.16	2.27	1,235	6.84	8.19	9.58
Tobins' Q	1.40	0.65	1,227	1.00	1.22	1.58
Debt Ratio	0.35	0.26	1,232	0.20	0.30	0.44
Investment Intensity	0.25	0.26	1,223	0.09	0.17	0.30
Num. Analysts	16.78	12.17	1,300	7.00	15.00	26.50
Observations	1300					

Panel B: InvesText-Enverus-Compustat

	Mean	SD	Count	P25	P50	P75
Number of Reports	22.86	14.34	713	12.00	21.00	32.00
Number of Reports (per Brokerage Firm)	11.68	7.10	713	7.00	11.00	16.00
Return on Assets	-0.07	0.32	666	-0.06	0.02	0.06
Log(Total Assets)	8.55	1.34	667	7.58	8.54	9.55
Tobin's Q	1.36	0.53	664	0.99	1.24	1.58
Debt Ratio	0.38	0.24	667	0.24	0.33	0.45
Investment Intensity	0.27	0.17	699	0.15	0.23	0.35
Observations	713					

This table presents summary statistics for the sample of publicly listed firms at the firm-year level over the period from 2010 to 2023. The sample in Panel A consists of firms from the Enverus database with at least 30 drilling records during their operational history and classified under the Standard Industrial Classification (SIC) codes 1311 (Crude Petroleum and Natural Gas) or 2911 (Petroleum Refining). The sample in Panel B consists of firms in the intersection of the Enverus-Compustat sample and the InvesText sample. To be included in the InvesText sample, firms must be headquartered in the United States, classified under SIC code 1311, and covered by at least one of the brokerage firms (e.g., JP Morgan, Wells Fargo, or RBC) in the InvesText database. *Return on Assets* is calculated as net income (ni) divided by total assets (ta). *Log(Total Assets)* represents the natural logarithm of total assets (ta). *Tobin's Q* is computed as $(at + (csho \times prcc_f) - ceq)/at$. *Debt Ratio* is defined as the total debt ($dlc + dltt$) divided by total assets (ta). *Investment Intensity* measures the ratio of capital expenditures ($capx$) to total assets (ta). *Num. Analysts* indicates the number of analysts covering the company in a given year. *Number of Reports* is the number of analyst report for each company in a given year. *Number of Reports (per Brokerage Firm* is the number of analyst report for each company per each brokerage firm for a given year.

Appendix Table A2: Summary Statistics for Oil and Gas Prices

	Mean	SD	Count	P25	P50	P75
WTI Spot	62.78	25.54	94	43.14	59.91	82.79
WTI Futures 3M	63.09	25.38	94	44.07	60.99	81.45
WTI Futures 6M	62.98	25.27	94	46.07	61.81	82.81
WTI Futures 12M	62.29	25.13	94	44.34	61.96	82.29
WTI Futures 18M	61.55	24.94	94	43.90	61.13	83.06
CBOE Crude Oil ETF Volatility Index	39.05	14.75	64	30.96	36.12	44.15
Observations	94					

This table presents summary statistics for the sample of quarterly oil prices from 2000Q1 to 2023Q2. Spot prices (per barrel) are obtained from the Energy Information Administration. Futures prices for the 3-month, 6-month, 12-month, and 18-month maturities are sourced from Bloomberg. The CBOE Crude Oil ETF Volatility Index (OVX) is obtained from the Federal Reserve Bank of St. Louis and is available only from 2007Q3 onward.

B Appendix B: Adjusting for Technological Differences

I compare the investment behavior between public and private firms, accounting for the technological improvements in the oil and gas exploration and production industry. Combined with hydraulic fracking technologies, horizontal drilling has become the majority of wells drilled in the United States (Energy Information Administration (2018)). Specifically, I compare the sensitivity of drilling horizontal wells to prices between public and private firms for the period 2016Q1-2023Q2 using the following Poisson regression (2).

In Column (1), the coefficient on $Price$ implies that public firms increase horizontal well counts by 1.7% per $1 increase, while private firms' responsiveness is 3.3% (sum of coefficients). Column (2) uses total drilling length and yields similar magnitudes (2.0% vs. 3.4%). Column (3) shows no significant gap in low-price periods, while Column (4) shows that public firms are unresponsive in high-price periods, compared to a 2.3% semi-elasticity for private firms.

Appendix Table B1: Elasticity of Drilling Activity Between Public and Private Firms

	(1) Hwell	(2) Lateral Length	(3) Hwell: Low Price	(4) Hwell: High Price
Price	0.017***	0.020***	0.071***	-0.000
	(0.002)	(0.002)	(0.006)	(0.004)
Private × Price	0.016***	0.014***	-0.008	0.023***
	(0.003)	(0.004)	(0.012)	(0.005)
Private	-1.995***	-2.063***	-0.233	-3.013***
	(0.306)	(0.318)	(0.683)	(0.525)
# Obs	15,299	14,875	6,575	6,007
Pseudo R-squared	0.770	0.856	0.755	0.782
Firm FE	Y	Y	Y	Y

This table estimates the elasticity of investment across ownership types. The regression results are based on the following Poisson regression specification:

$$\log(E(Y_{it}|X_{it})) = \beta_1 Price_{t-1} + \beta_2 Price_{t-1} \times Private_{it} + \beta_3 Private_{it} + FirmFE_i$$

The data are a quarterly panel spanning from 2016Q1 to 2023Q2. For Column (1), (3), and (4), the dependent variable is the number of oil horizontal wells drilled in each year-quarter. In Column (2), the dependant variable is the total lateral length for all horizontal drilled by a firm in a each year-quarter. Column (3) is a subsample of the periods where the price is lower than $55, and Column (4) is a subsample of the periods where the price is greater than $55. Standard errors are clustered at the firm level. *Price* is the lagged 18-month WTI futures price,. *Private* is a binary indicator equal to 1 if the company is private, and 0 otherwise. Statistical significance is denoted by *, **, and *** at the 10%, 5%, and 1% levels, respectively.

C Appendix C: Conceptual Framework

Model of Public Firm

I first consider a case with only one type of firm (i.e., a public firm) in the economy and examine how its investment behavior differs under monopsony compared to a competitive benchmark. The representative firm produces a homogeneous product (oil) and takes the market price P as given. The firm maximizes revenue net of input costs. I assume that production is proportional to investment, so revenue is determined as $P \times Q$, where Q represents investment. The firm incurs costs that increase with investment, reflecting the reality that E&P firms do not perform drilling themselves but instead rely on oilfield service providers. The firm maximizes operational profit, defined as total revenue minus investment-related input costs:

$$\max_{Q} \Pi = \max_{Q} \Big(P - C(Q) \Big) Q \tag{6}$$

where $Q \geq 0, P \geq 0$.

I assume that the input cost curve $C(Q)$ is given by the following equation:

$$C(Q) = \begin{cases} w + bQ & Q \leq \overline{Q} \\ w + a(Q - \overline{Q}) + b\overline{Q} & Q > \overline{Q} \end{cases} \tag{7}$$

where $a > b > 0$. The input cost function $C(Q)$ is piecewise-linear, featuring a kink at the threshold $\overline{Q}$.[52] This cost structure aligns with real-world industry characteristics.[53] Given the fixed availability of fracking crews, drilling equipment, and other oilfield services, input costs rise steeply beyond a certain investment threshold. The cost curve implies that the firm faces relatively stable input costs up to $\overline{Q}$, but beyond this point, costs escalate sharply due to capacity constraints in the industry.[54]

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[52] While I use a piecewise-linear input cost curve for illustrative purposes, other hockey-stick-shaped cost curves (e.g., $C(Q) = Q^2 - Q$) yield similar results.

[53] Many industry experts note that input costs rise gradually when investment demand is low but increase sharply when demand intensifies. For example, the former CEO of Pioneer Natural Resources highlighted this constraint, explaining that "if we wanted to grow more than 5 percent, I'd have to call up all the service contractors; they're going to charge me 30 to 40 percent more; it's going to take a year to build new equipment; it's going to take two years to start showing results." (See Slav, Irina, Dec 21, 2022, Shale Giant Pioneer Explains Why U.S. Drillers Won't Drill More, Oilprice.com).

[54] The idea that the input cost curve for capital goods is upward-sloping in the short run and that capital suppliers capture much of the benefit from tax incentives as input prices adjust upward is empirically studied in Goolsbee (1998).

Competition

As a benchmark, I consider a representative firm that takes input prices as given, reflecting a competitive market structure. The representative firm takes the input cost curve as given and chooses investment to equate marginal cost with the output price.

Under perfect competition, the representative firm takes input prices as given and invests until marginal cost equals the output price P. Assume that the market price P is greater than w, ensuring that the firm makes a nonzero investment despite rising input costs. The representative firm's optimality condition under competition equates marginal cost to price:

$$P = \begin{cases} w + bQ & Q \leq \overline{Q} \\ w + a(Q - \overline{Q}) + b\overline{Q} & Q > \overline{Q} \end{cases} \tag{8}$$

From this condition, the optimal investment level Q^* is determined as:

$$Q^* = \begin{cases} \frac{P-w}{b} & P \leq w + b\overline{Q} \\ \frac{P-w+(a-b)\overline{Q}}{a} & P > w + b\overline{Q} \end{cases} \tag{9}$$

Similarly, the elasticity of investment to price, denoted by ε, is given by:

$$\varepsilon = \begin{cases} \frac{P}{P-w} & P \leq w + b\overline{Q} \\ \frac{P}{P-w+(a-b)\overline{Q}} & P > w + b\overline{Q} \end{cases} \tag{10}$$

These results indicate that, in a competitive environment, the firm increases investment as prices rise, with greater investment sensitivity (higher elasticity) when prices are below the threshold (i.e., $P \leq w + b\overline{Q}$).

Monopsony

I now consider the case where the firm acts as a monopsonist with market power over input prices. Unlike in the competitive setting, the monopsonist recognizes that its investment decisions influence input costs and incorporates this into its optimization problem, resulting in a modified first-order condition: $P = C'(Q)Q + C(Q)$

$$P = \begin{cases} w + 2bQ & Q \leq \overline{Q} \\ w - a\overline{Q} + b\overline{Q} + 2aQ & Q > \overline{Q} \end{cases} \tag{11}$$

The optimal investment level under monopsony is:

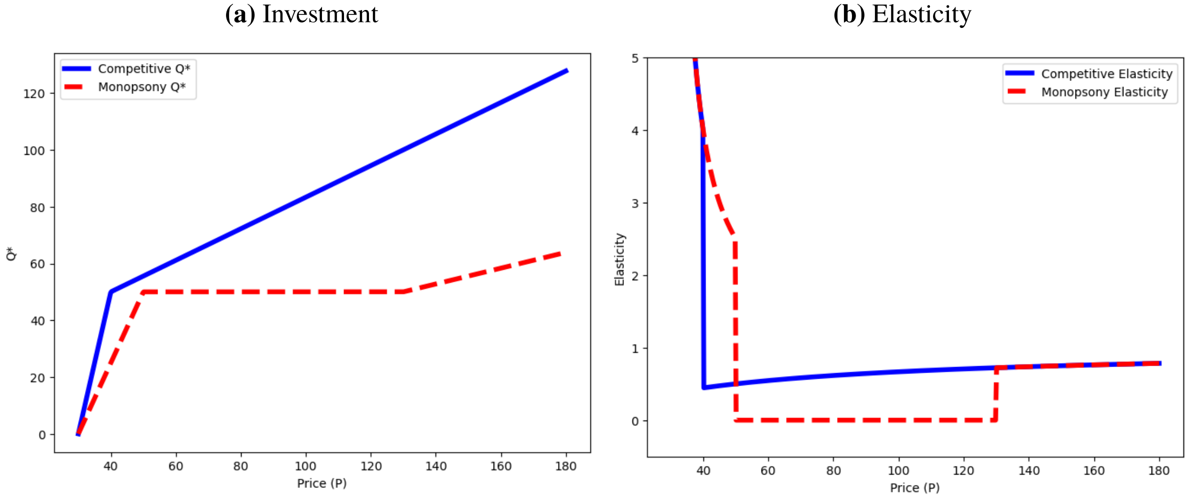
$$Q^* = \begin{cases} \frac{P-w}{2b} & P \leq w + 2b\overline{Q} \\ \overline{Q} & w + 2b\overline{Q} < P \leq w + (a+b)\overline{Q} \\ \frac{P-w+(a-b)\overline{Q}}{2a} & P > w + (a+b)\overline{Q} \end{cases} \tag{12}$$

The corresponding elasticity of investment to price is:

$$\varepsilon = \begin{cases} \frac{P}{P-w} & P < w + 2b\overline{Q} \\ 0 & w + 2b\overline{Q} < P \leq w + (a+b)\overline{Q} \\ \frac{P}{P-w+(a-b)\overline{Q}} & P > w + (a+b)\overline{Q} \end{cases} \tag{13}$$

Proposition 1 *Under competition, investment is strictly increasing in price, resulting in positive elasticity at all price levels. By contrast, in the monopsony case, there exists a range of prices over which investment remains constant at $\overline{Q}$, generating zero elasticity within that interval.*

Appendix Figure C1: Comparison of Competitive and Monopsony Outcomes



This figure compares optimal investment levels and the price elasticity of investment under competitive and monopsony market structures. The figure is generated using the parameter $a = 0.2$, $b = 1.8$, $w = 30$, and $\overline{Q} = 50$.

As a result, the firm strategically restricts investment at higher price levels to avoid sharp increases in input costs, leading to zero elasticity over a range of prices, as the firm holds investment constant despite rising prices. Figure C1 illustrates how optimal investment and elasticity respond to price changes in both the competitive and monopsony cases. In the competitive case, the firm takes input costs as given and continuously increases investment as prices rise, leading to a strictly positive investment elasticity at all price levels. In contrast, in the monopsony case, the firm strategically limits investment at the threshold $\overline{Q}$ over a range of prices to avoid steeply rising input costs. Within this range, investment remains fixed, resulting in zero elasticity. When prices fall below this range, the firm resumes adjusting investment decisions, exhibiting an elasticity comparable to the competitive benchmark.

Model of Public and Private Firm

Now I introduce the private firm into the stylized model. Both types of firms take the market price P as given. The operational profit Π_i for firm i is determined by the revenue from production net of the total cost:

$$\max_{Q_i} \Pi_i = \max_{Q_i} PQ_i - C_i Q_i \tag{14}$$

where $Q_i \geq 0$.

Each type of firm i (public/private) faces the input cost curve:

$$C_i = C_i(Q_{pri}, Q_{pub}) \tag{15}$$

The representative public and private firms are different in the following dimensions. First, the private firm is competitive. Thus, the representative private firm, lacking market power to influence the input cost, takes the input cost as given. In contrast, the public firm could exercise market power against the oilfield service firms. This assumption is consistent with the idea that private firms tend to be smaller players which do not have the operational size to affect the input cost curve they face. Second, I assume that the structure of the economy is a Stackelberg duopoly game where the private firm is a follower and the public firm is the leader. Therefore, the public firm considers the private firm's response when deciding its own investment level.

I consider an input cost function jointly determined by the investment levels of public and private firms.[55] The amount of capital utilized by each type firm partially affects the investment

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[55] I do not take into account trivial cases where the input cost curve for each type is either entirely independent of one another or completely overlaps. In the first scenario, public firms behave similarly to the single-type case. In the second scenario, public firms lack the incentive to limit investment because the entry of private firms diminishes

cost of the other. The input cost functions for both types of firms are given by:

$$C_{pub}(Q_{pri}, Q_{pub}) = \begin{cases} w + a(Q_{pri} + Q_{pub}) & Q_{pri} + Q_{pub} \leq \overline{Q} \\ w + b(Q_{pri} + Q_{pub} - \overline{Q}) + a\overline{Q} & Q_{pri} + Q_{pub} > \overline{Q}\ , Q_{pub} \leq \overline{Q} \\ w + c(Q_{pub} - \overline{Q}) + bQ_{pri} + a\overline{Q} & Q_{pub} > \overline{Q} \end{cases} \tag{16}$$

$$C_{pri}(Q_{pri}, Q_{pub}) = \begin{cases} w + a(Q_{pri} + Q_{pub}) & Q_{pri} + Q_{pub} \leq \overline{Q} \\ w + d(Q_{pri} + Q_{pub} - \overline{Q}) + a\overline{Q} & Q_{pri} + Q_{pub} > \overline{Q}\ , Q_{pub} \leq \overline{Q} \\ w + e(Q_{pub} - \overline{Q}) + dQ_{pri} + a\overline{Q} & Q_{pub} > \overline{Q} \end{cases} \tag{17}$$

where $a, b, c, d, e > 0$ are constant.

The input cost functions illustrate how the input costs for public and private firms vary based on their own levels of investment Q and the combined levels of both firms' investment.

When the total level of investment does not exceed a threshold in the common pool (i.e. $(Q_{pri} + Q_{pub}) \leq \overline{Q}$), the input cost curve for both firms increase slowly at a rate of a. However, if the combined investment of both firms exceeds the constraint, but the public firm's investment is still less than or equal to the constraint (i.e. $(Q_{pri} + Q_{pub}) > \overline{Q}\ , Q_{pub} \leq \overline{Q}$), the input cost for both firms increases linearly by the amount that the total investment exceeds the constraint $\overline{Q}$. When the public firm's investment alone exceeds the constraint (i.e. $Q_{pub} > \overline{Q}$), the public firm's input cost increases more rapidly with respect to its own investment exceeding $\overline{Q}$. The parameter c and b represent the own-effect and spillover effect for the public firm, respectively. The parameter d and e represent the own-effect and spillover effect for the private firm, respectively. I assume that the own effect is always larger than the spillover effect (i.e. $c > b > a$ and $d > e > a$).

Finally, I make two additional assumptions. First, I assume the public firm is more efficient in scaling up investments than the private firms. This implies that $d > b$ and $d + e > c + b$. Second, I assume that the spillover effect from the public firm to the private firm is not large enough to crowd out the private firm completely in the industry. (i.e. $c > e$). This is a reasonable assumption since the private firm has not been crowded out by the presence of the public firm despite the public firm is likely to have advantages in scaling up investments even in the early 2010s when the industry is less consolidated.

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potential benefits of restricting investment.

Competition

I first consider a competitive benchmark where the public firm does not have the market power to influence the input cost curve, and take the input cost curve as given. Suppose the non-trivial case that $P > w$.

When both types of firm act competitively, the optimal level of investment for each type of firm is given by (18) and (19), and the corresponding elasticity is given by (20) and (21). Note that when $P \leq w + a\overline{Q}$, both public and private firm jointly invest $\frac{P-w}{a}$. Each type invests a fraction of the joint investment (x for the public and $(1-x)$ for the private firm).

$$Q^*_{\text{pub}} = \begin{cases} x\dfrac{P-w}{a} & \text{if } P \leq w + a\overline{Q} \\ (P-w)\left(\dfrac{d-b}{cd-be}\right) + \left(1 + \dfrac{a(d-b)}{cd-be}\right)\overline{Q} & \text{if } P > w + a\overline{Q} \end{cases} \tag{18}$$

$$Q^*_{\text{pri}} = \begin{cases} (1-x)\dfrac{P-w}{a} & \text{if } P \leq w + a\overline{Q} \\ (P-w)\left(\dfrac{c-e}{cd-be}\right) - \dfrac{a(c-e)}{cd-be}\overline{Q} & \text{if } P > w + a\overline{Q} \end{cases} \tag{19}$$

$$\varepsilon_{\text{pub}} = \begin{cases} \dfrac{P}{P-w} & \text{if } P \leq w + a\overline{Q} \\ \dfrac{P}{P-w+\left(\frac{cd-be}{d-b}\right)\left(1+\frac{a(d-b)}{cd-be}\right)\overline{Q}} & \text{if } P > w + a\overline{Q} \end{cases} \tag{20}$$

$$\varepsilon_{\text{pri}} = \begin{cases} \dfrac{P}{P-w} & \text{if } P \leq w + a\overline{Q} \\ \dfrac{P}{P-w-a\overline{Q}} & \text{if } P > w + a\overline{Q} \end{cases} \tag{21}$$

See Proofs for the derivation.

In the competitive equilibrium, both the public and private firm invest a fraction of the total investment when the price is low. Thus, both types of firms exhibit the same elasticity. When the price is high, the elasticity of the private firm is higher than that of the public firm. However, both firms exhibit non-zero positive elasticity.

Monopsony

I now consider the case that the public firm acts as the monopsonist in the input market. When the private firms are competitive and the public firm exercise market power, the optimal level of investment for each type of firm is given by (22) and (23), and the corresponding elasticity is given by (24) and (25).

$$Q^*_{\text{pub}} = \begin{cases} x\frac{P-w}{a} & \text{if } P \leq w + a\overline{Q} \\ \overline{Q} & \text{if } w + a\overline{Q} < P \leq \left(w + \left(a + \frac{cd-be}{d-b}\right)\overline{Q}\right) \\ \left(\dfrac{P-w}{2}\right)\left(\dfrac{d-b}{cd-be}\right) + \dfrac{\overline{Q}}{2} - \dfrac{a(d-b)}{2(cd-be)}\overline{Q} & \text{if } P > w + \left(a + \frac{cd-be}{d-b}\right)\overline{Q} \end{cases} \tag{22}$$

$$Q^*_{\text{pri}} = \begin{cases} (1-x)\frac{P-w}{a} & \text{if } P \leq w + a\overline{Q} \\ \frac{P-w}{d} - \frac{a}{d}\overline{Q} & \text{if } w + a\overline{Q} < P \leq \left(w + \left(a + \frac{cd-be}{d-b}\right)\overline{Q}\right) \\ (P-w)\left(\dfrac{1}{d} - \dfrac{e(d-b)}{2d(cd-be)}\right) + \left(\dfrac{e}{2d} - \dfrac{a}{d} + \dfrac{ae(d-b)}{2d(cd-be)}\right)\overline{Q} & \text{if } P > w + \left(a + \frac{cd-be}{d-b}\right)\overline{Q} \end{cases} \tag{23}$$

$$\varepsilon_{\text{pub}} = \begin{cases} \frac{P}{P-w} & \text{if } P \leq w + a\overline{Q} \\ 0 & \text{if } w + a\overline{Q} < P \leq \left(w + \left(a + \frac{cd-be}{d-b}\right)\overline{Q}\right) \\ \dfrac{P}{(P-w) + \left(\frac{cd-be}{d-b} - a\right)\overline{Q}} & \text{if } P > w + \left(a + \frac{cd-be}{d-b}\right)\overline{Q} \end{cases} \tag{24}$$

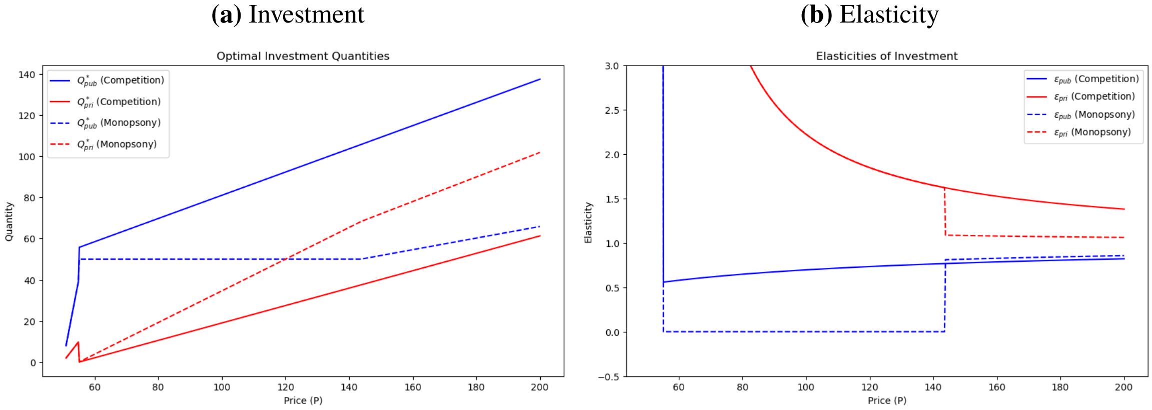
$$
\varepsilon_{\text{pri}} = \begin{cases} \dfrac{P}{P-w} & \text{if } P \leq w + a\overline{Q} \\ \dfrac{P}{P-w-a\overline{Q}} & \text{if } w + a\overline{Q} < P \leq \left(w + \left(a + \frac{cd-be}{d-b}\right)\overline{Q}\right) \\ \dfrac{P\left(\frac{1}{d} - \frac{e(d-b)}{2d(cd-be)}\right)}{(P-w)\left(\frac{1}{d} - \frac{e(d-b)}{2d(cd-be)}\right) + \left(\frac{e}{2d} - \frac{a}{d} + \frac{ae(d-b)}{2d(cd-be)}\right)\overline{Q}} & \text{if } P > w + \left(a + \frac{cd-be}{d-b}\right)\overline{Q} \end{cases} \tag{25}
$$

See Proofs for the derivation.

Proposition 2 *If both types of firms behave competitively, the elasticity of investment in response to price is always strictly positive. When the public firm exerts market power, there is a range of prices where it restricts its output to avoid sharply rising input costs, leading to zero elasticity. In contrast, the competitive private firm continues to exhibit positive elasticity.*

When the price is low, the public firm makes the same investment behavior as in the competition case. Both types of firms exhibit the same elasticity of investment to price. However, when the price is reasonably high, the public firm has an incentive to exercise market power by restricting the investment at $\overline{Q}$ to prevent a sharp increase in input cost due to competition from private firms. In contrast to the competitive benchmark, where both type of firms exhibit non-zero elasticity, the monopsonist public firm's investment shows zero elasticity in response to price. When the price is extremely high, the public firm has the incentive to make investment above the constraint.

Appendix Figure C2: Comparison of Competitive and Monopsony Outcomes



(a) Investment

(b) Elasticity

This figure compares the optimal investment and the elasticity of investment to price for the public and private firm under the competitive and monopsony cases. The figure is generated using the parameter $a = 0.5$, $b = 0.5$, $c = 0.8$, $d = 1.5$, $e = 0.6$, $w = 50$, $x = 0.5$, and $\overline{Q} = 50$.

Proofs

Competition

By the free entry of firms, there cannot exists the case where $Q_{pri} + Q_{pub} > \overline{Q}$, $Q_{pub} \leq \overline{Q}$ in the equilibrium.

Consider $Q_{pri} + Q_{pub} \leq \overline{Q}$. By the free entry of firms,

$$P = w + a(Q_{pri} + Q_{pub}) \tag{26}$$

Thus, $Q_{pub} + Q_{pri} = \frac{P-w}{a}$. Each type of firm invests a fraction of the joint investment yields $Q_{pub} = x\frac{P-w}{a}$ and $Q_{pri} = (1-x)\frac{P-w}{a}$. Since $Q_{pri} + Q_{pub} = \frac{P-w}{a} \leq \overline{Q}$, it follows that this equilibrium exists for the range of price $P \leq w + a\overline{Q}$.

Consider the other case $Q_{pub} > \overline{Q}$. By the free entry of firms,

$$\begin{aligned} P &= w + a(Q_{pub} - \overline{Q}) + bQ_{pri} \\ P &= w + c(Q_{pub} - \overline{Q}) + dQ_{pri} \end{aligned} \tag{27}$$

Solving the two equations yields the results $Q_{pub} = (P-w)(\frac{d-b}{cd-be}) + (1 + \frac{a(d-b)}{cd-be})\overline{Q}$ and $Q_{pri} = (P-w)(\frac{c-e}{cd-be}) - \frac{a(c-e)}{cd-be}\overline{Q}$. Since $Q_{pub} = (P-w)(\frac{d-b}{cd-be}) + (1 + \frac{a(d-b)}{cd-be})\overline{Q} > \overline{Q}$, it follows that $P > w + a\overline{Q}$. ■

Monopsony

Consider the private firm first. By the free entry condition, the private firm enters into the market such that the price equals its marginal cost:

$$P = \begin{cases} w + a(Q_{pri} + Q_{pub}) & Q_{pri} + Q_{pub} \leq \overline{Q} \\ w + d(Q_{pri} + Q_{pub} - \overline{Q}) + a\overline{Q} & Q_{pri} + Q_{pub} > \overline{Q}\ , Q_{pub} \leq \overline{Q} \\ w + e(Q_{pub} - \overline{Q}) + dQ_{pri} + a\overline{Q} & Q_{pub} > \overline{Q} \end{cases} \tag{28}$$

Thus, the best response of the competitive private firm is given by

$$Q^*_{pri} = \begin{cases} \frac{P-w}{a} - Q_{pub} & Q_{pri} + Q_{pub} \leq \overline{Q} \\ \frac{P-w}{d} + \frac{d-a}{d}\overline{Q} - Q_{pub} & Q_{pri} + Q_{pub} > \overline{Q}\ , Q_{pub} \leq \overline{Q} \\ \frac{P-w}{d} + \frac{e-a}{d}\overline{Q} - \frac{e}{d}Q_{pub} & \frac{P-w}{c} + \overline{Q} \geq Q_{pub} > \overline{Q} \\ 0 & Q_{pub} > \frac{P-w}{e} + \frac{e-a}{e}\overline{Q} \end{cases} \tag{29}$$

Given the optimal solution of the private firm, the public firm's optimization problem is given by

$$\pi = \max_{Q_{pub}} (P - MC_{pub}(Q_{pri}, Q_{pub}))Q_{pub} \tag{30}$$

such that (16) and (29) hold.

Consider the case $Q_{pri} + Q_{pub} \leq \overline{Q}$. Because of the presence of the private firms facing the same input cost curve, there is no incentive for the public firm to act strategically. Thus, each type of the firm acts competitively, yielding the same conclusion as the competitive case where each type of firm invest a fraction of the joint investment $\frac{P-w}{a}$.

If $Q_{pri} + Q_{pub} > \overline{Q}\ , Q_{pub} \leq \overline{Q}$, then the public firm faces the marginal cost curve $MC_{pub} = w + b(Q^*_{pri} + Q_{pub} - \overline{Q}) + a\overline{Q}$, with $Q^*_{pri} = \frac{P-w}{d} + \frac{d-a}{a}\overline{Q} - Q_{pub}$.

The profit of the public firm is given by

$$\pi = \left((P-w)(1-\frac{b}{d}) - \frac{a(d-b)}{d}\overline{Q}\right)Q_{pub} \tag{31}$$

where $\left((P-w)(1-\frac{b}{d}) - \frac{a(d-b)}{d}\overline{Q}\right)$ is positive as long as $P - w > a\overline{Q}$. This implies that the profit increases linearly with its investment level. Thus, the optimal level of investment by the public firm is to set its investment at the constraint (i.e. $Q^*_{pub} = \overline{Q}$) as long as $P - w > a\overline{Q}$.

If $\frac{P-w}{e} + \frac{e-a}{e}\overline{Q} \geq Q_{pub} > \overline{Q}$, then the public firm faces the marginal cost curve $MC_{pub} = w + c(Q_{pub} - \overline{Q}) + bQ^*_{pri} + a\overline{Q}$, with $Q^*_{pri} = \frac{P-w}{d} + \frac{e-a}{d}\overline{Q} - \frac{e}{d}Q_{pub}$.

The maximization problem for the public firm is

$$\max_{Q_{pub}} \left((P-w)(\frac{d-b}{d}) - \frac{cd-be}{d}Q_{pub} + \frac{cd-be+ba-ad}{d}\overline{Q}\right)Q_{pub} \tag{32}$$

The first order condition yields:

$$(P-w)(\frac{d-b}{d})+(\frac{cd-be+ba-ad}{d})\overline{Q}-2(\frac{cd-be}{d})Q_{pub}=0 \tag{33}$$

Thus Q^*_{pub} is given by

$$Q^*_{pub}=(\frac{P-w}{2})(\frac{d-b}{cd-be})+\frac{\overline{Q}}{2}-\frac{a(d-b)}{2(cd-be)}\overline{Q} \tag{34}$$

Since $Q^*_{pub}>\overline{Q}$, it implies that

$$P>w+(a+\frac{cd-be}{d-b})\overline{Q} \tag{35}$$

Suppose that the private firms are crowded out by the public firm. This implies that $Q_{pub}>\frac{P-w}{e}+\frac{e-a}{e}\overline{Q}$. The optimization problem for the public firm is then:

$$\max_{Q_{pub}}\left(P-(w+c(Q_{pub}-\overline{Q})+a\overline{Q}\right)Q_{pub} \tag{36}$$

Thus, the optimal Q^*_{pub} is given by

$$Q^*_{pub}=\frac{P-w}{2c}+\frac{c-a}{2c}\overline{Q} \tag{37}$$

Since it requires that $Q_{pub}>\frac{P-w}{e}+\frac{e-a}{e}\overline{Q}$, it must satisfy the following inequality:

$$\frac{P-w}{2c}+\frac{c-a}{2c}\overline{Q}>\frac{P-w}{e}+\frac{e-a}{e}\overline{Q} \tag{38}$$

Since it is already assumed that $c\geq e$, it follows that

$$P-w<\frac{c(e-a)+a(e-c)}{e-2c}\overline{Q} \tag{39}$$

Since $\frac{c(e-a)+a(e-c)}{e-2c}\overline{Q}$, is a negative number, this case is ruled out. ■

D Appendix D: Construction of HHI Delta

To construct the HHI delta measure, I merge historical stock data from CRSP with financial and accounting data from Compustat and institutional investor stock holding data from the Refinitiv/Thomson Reuters S34 dataset. I then restrict the sample to U.S. oil and gas (SIC 1311) firms headquartered in the U.S. with at least 30 wells drilled in Enverus Data during the 2000 to 2023 period. Given the several caveats in constructing the measure using the S34 dataset discussed in Backus et al. (2020) and Ben-David et al. (2021), I make the following adjustments to the data. First, I replace the number of shares outstanding information in the S34 dataset with the values found in CRSP's `shrout` variable whenever there is a discrepancy. (Second, I aggregate the subsidiaries and multiple entities into one large entity.)

I calculate MHHI and MHHI delta for each quarter (and each major oil and gas play) between 2002 and 2023. To construct the MHHI delta, I use the ratio of the shares owned by investor i to the total outstanding shares for firm j as a measure of the cash-flow right (i.e. β_{ij}). I use the ratio of voting shares[56] owned by investor i to the total number of outstanding shares for firm j as a measure of control share(i.e. γ_{ij}).

Several concerns are raised in Dennis et al. (2022) with regards to the measurement of control rights using the voting share variables in the S34 dataset.[57] Thus, I also calculate the MHHI and MHHI delta replacing γ_{ij} with β_{ij}, assuming that the control rights and cash-flow rights are in line with each other. I drop cases where a single institutional owner owns more than 50% of the total number of shares, following the data-cleaning suggestions in Backus et al. (2020). Also, I drop observation if investors have voting and nonvoting shares of less than 0.5% for a company in a given year-quarter. To estimate the market share, I use the quarterly sales values from Compustat.

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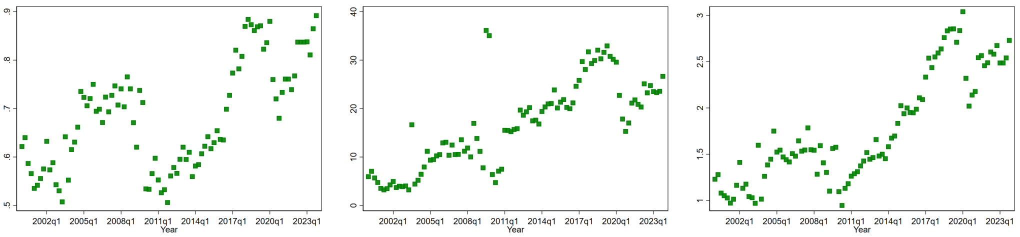
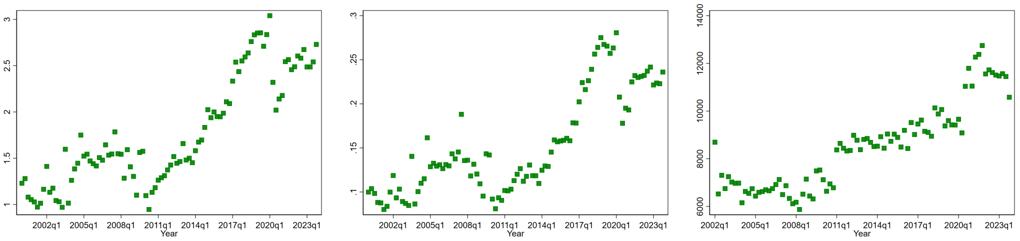
[56] I use the sum of shared and sole voting shares in the S34 dataset to obtain the total number of voting shares

[57] In particular, "sole", "no", and "shared" designations are left to the discretion of the reporting entity to the SEC 13F fillings from which the S34 dataset is constructed.

Appendix Figure D1: Concentration of Ownership in the Oil and Gas Industry Over Time



(a) CrossDummy **(b)** NumConnected **(c)** NumCross



(d) AvgNum **(e)** TotalCrossOwn **(f)** MHHI Delta

This figure plots the mean of the common ownership measures based on He and Huang (2017) from 2002Q1 to 2023Q4. $CrossDummy_{it}$ for firm i is a dummy variable indicating if it is held by blockholders who also hold at least one peer in a given year-quarter t. $NumConnected_{it}$ is the number of same-industry cross-held peers (i.e. public oil and gas exploration and production (SIC 1311) firms headquartered in the US with at least 30 drilling records in Enverus dataset.) that share any any common cross-holding institution with the firm i in a given year-quarter t. $NumCross_{it}$ is the number of unique cross-holding institutions in the 13F dataset that cross-hold the firm i in a given year-quarter t. $AvgNum_{it}$ is the average number of cross-held peers for firm i in a given t by its cross-holding institutions. $TotalCrossOwn_{it}$ is the sum of all cross-holding institution' share holdings in the firm i in a given t. $MHHIdelta$ is an index of concentrated ownership, and it is calculated as $\sum_j \sum_{k \neq j} s_j s_k \frac{\sum_i \gamma_{ij}\beta_{ik}}{\sum_i \gamma_{ij}\beta_{ij}}$, where γ_{ij} is the voting share of investor i in firm j, and β_{ij} is the share of firm j owned by investor i.

E Appendix E: Cost of Investor Pressure

Step 1: Estimate the counterfactual number of wells

First, I estimate the the estimate of the elasticity of drilling to price from (40) below for private and public sub-samples separately for the period 2016Q1-2023Q2:

$$\begin{aligned} \log(E(Q)|X)_{it} &= \gamma_1 + \gamma_2 ln(Price_{t-1}) \\ &= E(Q)|X)_{it} = exp^{\gamma_1} \times Price_{t-1}^{\gamma_2} \end{aligned} \tag{40}$$

where Q_{it} indicates the number of drilling for oil wells by a firm i during the quarter t. $Price$ is the 18-month WTI futures prices lagged by one quarter.

Appendix Table E1: Elasticity of Drilling Activity Between Public and Private Firms

	Dep. Varriable: # Oil Wells Drilled	
	Public	Private
	(1)	(2)
Constant (γ_1)	-0.364	-6.474***
	(0.497)	(0.443)
Log(Price) (γ_2)	0.983***	1.860***
	(0.123)	(0.109)
# Obs	2,299	44,305
Pseudo R-squared	0.745	0.513
Firm FE	Y	Y

This table reports the Poisson regression result for Equation 40. The dependent variable is the number of oil wells drilled in each quarter. The standard errors are clustered at the firm level. $Price$ is the 18-month WTI futures prices lagged by one quarter.

As discussed in the main text, the table above suggests that public firms are approximately twice less responsive to changes in oil prices than private firms. Updating Equation 40 based on the parameters (γ1, γ2,) in Column (1) for an average public firm yields:

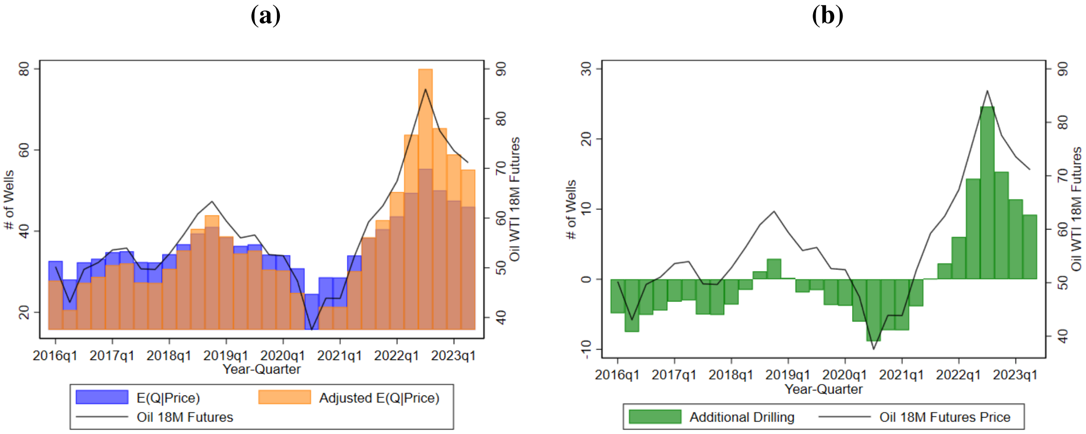
$$= E(Q)|X)_{it} = exp^{-0.364} \times Price_{t-1}^{0.983} \tag{41}$$

Now, I hypothetically adjust the parameter γ_2 for public firms by multiplying it by 2, so that they exhibit a similar level of elasticity as private firms (i.e. $\gamma_2^{public} \times 2 = 1.966$). Note that increasing the elasticity also substantially inflates the expected number of drilling $E(Q^{adj}|X)$ as well. To make sure that the total number of wells drilled during the period is the same, I multiply the new equation by a scaling factor by $\theta = \frac{\sum_t E(Q)_t}{\sum_t E(Q)_t^{Adj}}$. Thus, adjusting Equation (2) above gives:

$$= E(Q^{adj}|X)_t) = \theta \cdot exp^{-0.364} \times Price_{t-1}^{1.966} \tag{42}$$

Equation 42 suggests that the drilling of public firms would be more responsive to $Price$ during the high price periods while keeping the total number of drilling during the sample period would be the same. Figure E1 plots the expected drilling based on (41) and (42) in (a) and the number of additional drilling in (b).

Appendix Figure E1: Expected and Hypothetical Drilling

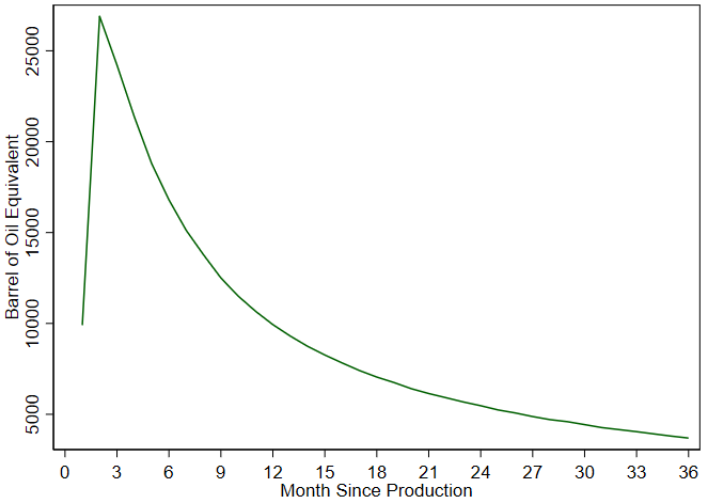


Equation 42 suggest that increasing the elasticity of drilling to price will effectively shift drilling from low price periods (pre-2021) to high price periods (post-2021).

Step 2: Expected Present Value for a Marginal Well

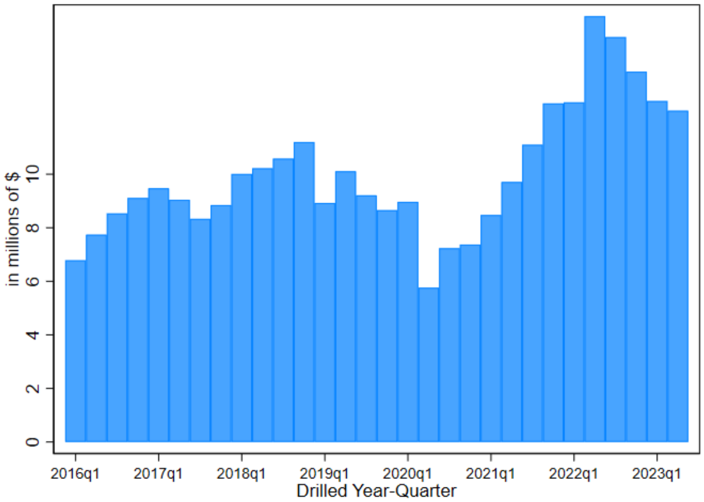
Next, I estimate the expected revenues from a marginal well drilled during the 2018-2023 period. Given that it is difficult to estimate the marginal quality of each well being drilled, I assume that a marginal well corresponds approximately to the 50^{th} percentile of the production distribution. I first calculate the monthly production of an marginal well that is drilled by a public firm during 2016Q1-2023Q2 for 36 months since the first production month. Figure E2 shows the production curve from a marginal well drilled during 2016Q1-2023Q2 up to 36 months.

Appendix Figure E2: Production Curves for a Marginal Well



The foregone revenues are calculated based on the production curves for a marginal well and the monthly prices. I use the monthly futures "strip" prices for the beginning of each quarter up to 36 months. (For instance, for 2016Q1, I use the monthly futures for delivery in 2016m2, 2016m3, and so on through 2021m2.) Then, I aggregate each revenue in each quarter at the annual level and obtain the present value by using 10% discount rate. Figure E3 plots the expected discounted revenues for a single marginal well drilled in each year quarter during the period 2016Q1-2023Q2.

Appendix Figure E3: Estimated Present Value for a Marginal Well Drilled in Each Quarter



Step 3: Foregone Revenues

In the last step, I compute the hypothetical revenues for an average public firm if we increase the elasticity of drilling to the price based on the previous steps. This involves multiplying the hypothetical changes in drilling resulting from the adjusted elasticity (step 1) by the anticipated present value for a marginal well (step 2) across each year-quarter during the period. As depicted in Figure E4 below, the hypothetical revenues derived from realigning drilling schedules more closely with price changes during the sample period indicate substantial potential gains for public firms. As a comparison, the sum of the discounted forgone revenues during the period is approximately \$501.65 million, which is around 21% of the average annual revenue of public firms[58] during the sample period.

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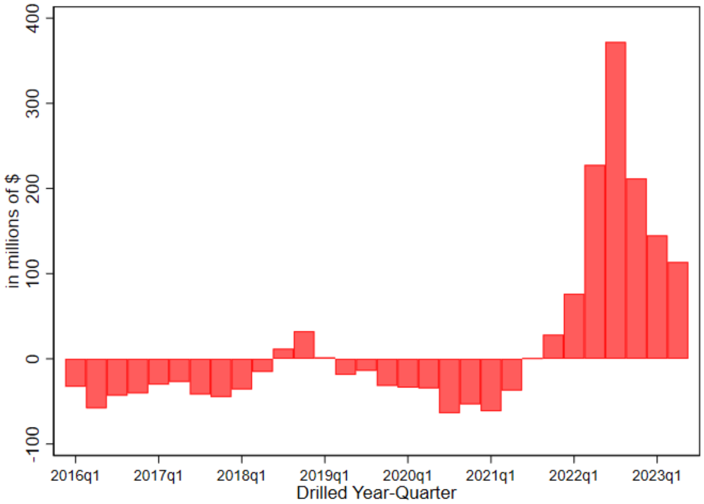
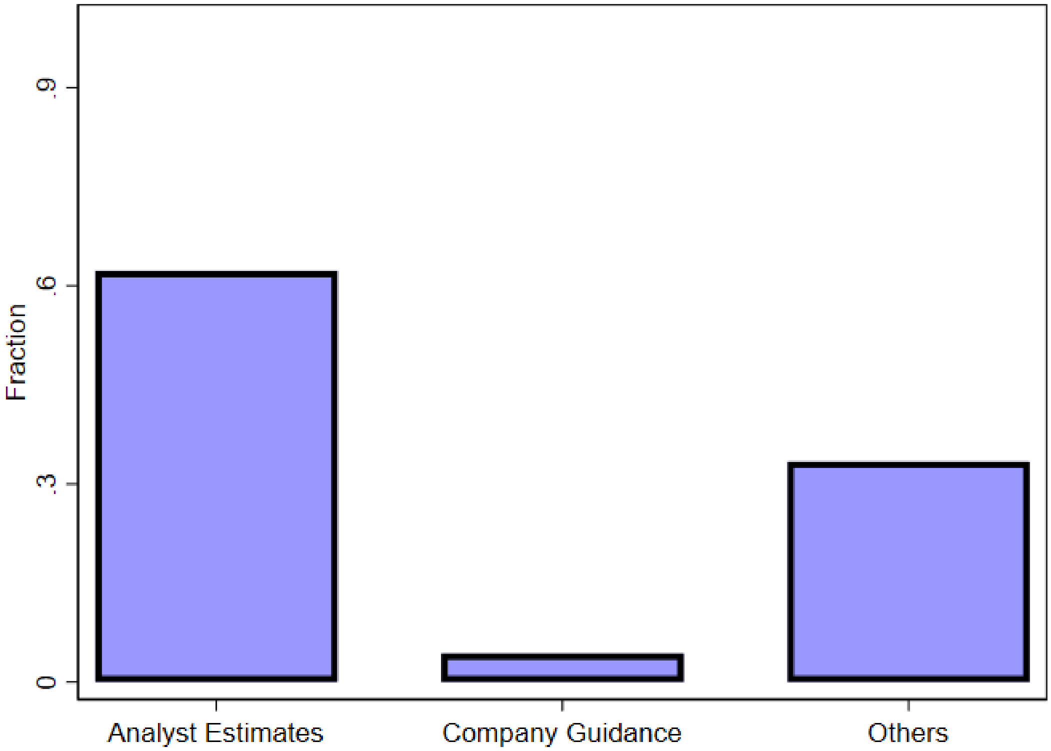
[58] The average annual revenue of public firms with SIC 1311 during 2016-2023 period is 2.391 billion.

Appendix Figure E4: Hypothetical Revenues



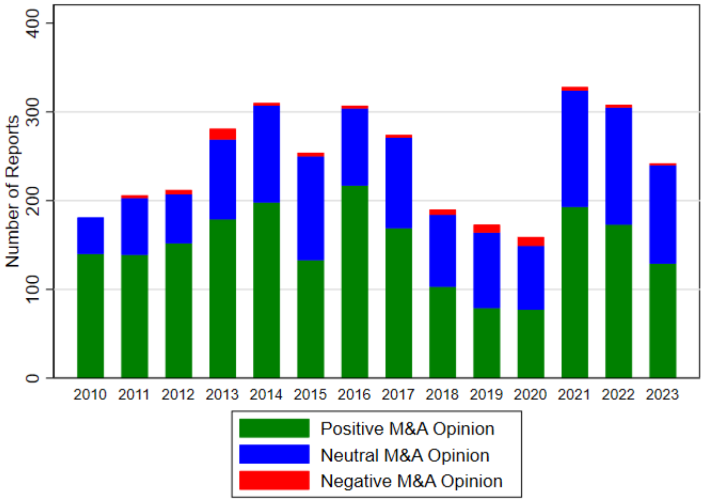
F Appendix F: Analyst Report

Appendix Figure F1: Analyst Capital Spending Benchmark



This figure plots the fraction of different categories for the capital spending benchmark in the analyst report data. *Analyst Estimates* refers to predictions or projections made by financial analysts, including terms such as "Estimate," "Street," and "Consensus". *Company Guidance* represents the official projections or expectations provided by the companies themselves, captured by keywords like "Guidance," "Budget," and "Plan". *Others* include any items not captured by the above categories.

Appendix Figure F2: on M&A in Analyst Reports



This figure plots the number of analyst reports discussing mergers and acquisitions involving the company covered. A report is classified as discussing mergers and acquisitions if GPT-4o identifies content related to the company's mergers and acquisitions in the United States. *Positive M&A Opinion* represents the number of reports classified as having a positive opinion by GPT-4o. *Neutral M&A* Opinion is the number of reports classified as having a neutral opinion by GPT-4O. *Negative M&A Opinion* is the number of reports classified as having a negative opinion by GPT-4o.

Appendix Table F1: Capital Spending Growth and Analyst CAPX Opinion

	(1) Capex Growth	(2) Capex Growth	(3) Capex Growth	(4) Capex Growth	(5) Capex Growth
CAPEX Opinion	0.052***	0.052***			
	(0.018)	(0.019)			
1(Positive CAPEX Opinion)			0.054**		
			(0.023)		
1(Neutral CAPEX Opinion)				-0.024	
				(0.020)	
1(Negative CAPEX Opinion)					-0.075**
					(0.035)
ln(Total Assets)		-0.248***	-0.248***	-0.248***	-0.248***
		(0.069)	(0.069)	(0.069)	(0.069)
ROA		0.052	0.055	0.060	0.055
		(0.277)	(0.277)	(0.277)	(0.278)
mtb		-0.002	-0.001	0.000	-0.002
		(0.058)	(0.057)	(0.057)	(0.057)
# Obs	8,076	7,679	7,679	7,679	7,679
R-squared	0.152	0.166	0.166	0.165	0.165
Mean of CAPEX Growth	0.137	0.138	0.138	0.138	0.138
Firm FE	Y	Y	Y	Y	Y
Quarter FE	Y	Y	Y	Y	Y
Brokerage House FE	Y	Y	Y	Y	Y

This table investigates the relationship between the company capital expenditure growth and analyst opinion on the company's capital spending. The regression results are based on the following regression specification:

$$CAPEXGrowth_{isjt} = \beta_1 CAPEXOpinion_{isjt} + \gamma X_{ijt} + FirmFE + BrokerageFE + QuarterFE$$

where i denotes a firm, s denotes a analyst report, j denotes a brokerage house, and t denotes a year-quarter. *CAPEXGrowth* is defined as the percentage change in the company's capital expenditure from quarter t to $t+1$ (i.e. $\frac{CAPEX_{t+1}-CAPEX_t}{CAPEX_t}$). *CAPEX Opinion* is assigned a value of 1 if the analyst has a positive view of the company's capital spending in report s for quarter t, 0 if the analyst has a neutral opinion, and -1 if the analyst has a negative opinion. *1(Positive CAPEX Opinion)* is assigned a value of 1 if the analyst expresses a positive opinion in report s for quarter t, and 0 otherwise. *1(Neutral CAPEX Opinion)* is assigned a value of 1 if the analyst expresses a neutral opinion in report s for quarter t, and 0 otherwise. *1(Negative CAPEX Opinion)* is assigned a value of 1 if the analyst expresses a negative opinion in report s for quarter t, and 0 otherwise. The control variables include *log(Assets)*, *ROA*, and *MTB*, where *log(Assets)* is the logarithm of total assets, *ROA* is net income divided by total assets, and *MTB* is the sum of market capitalization and book value of debt divided by total assets. All variables, except for *CAPEX Opinion*, are constructed using the quarterly COMPUSTAT dataset and are winsorized at the 1% level.

Appendix Table F2: Capital Spending Growth and Analyst CAPX Opinion (Firm-level)

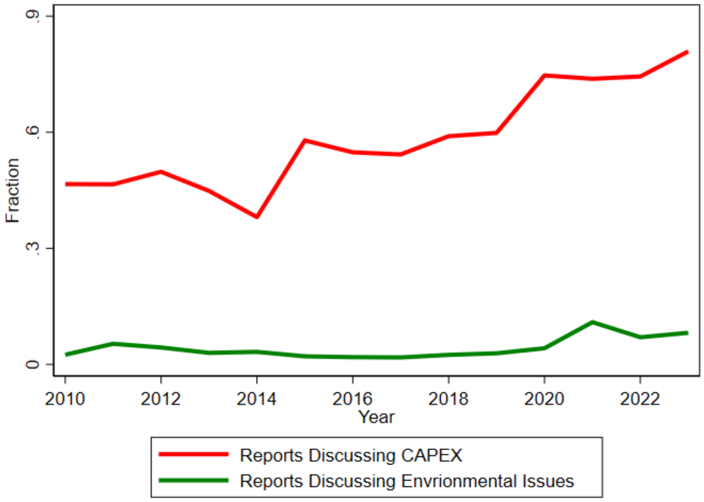
	(1) CAPEX Growth	(2) CAPEX Growth	(3) CAPEX Growth
Aggregate CAPEX Opinion	0.072*		
	(0.038)		
1(Net Positive CAPEX Opinion)		0.100*	
		(0.055)	
1(Net Negative CAPEX Opinion)			-0.064
			(0.068)
ln(Total Assets)	-0.298***	-0.305***	-0.295***
	(0.084)	(0.085)	(0.083)
ROA	0.651*	0.666*	0.672*
	(0.385)	(0.381)	(0.384)
mtb	-0.007	-0.013	-0.005
	(0.071)	(0.073)	(0.070)
# Obs	2,405	2,405	2,405
R-squared	0.147	0.147	0.146
Mean of Capex Growth	0.238	0.238	0.238
Firm FE	Y	Y	Y
Quarter FE	Y	Y	Y

This table investigates the relationship between the company capital expenditure growth and analyst opinion on the company's capital spending. The regression results are based on the following regression specification:

$$CAPEXGrowth_{it} = \beta_1 AggregateCAPEXOpinion_{it} + \gamma X_{it} + FirmFE + QuarterFE$$

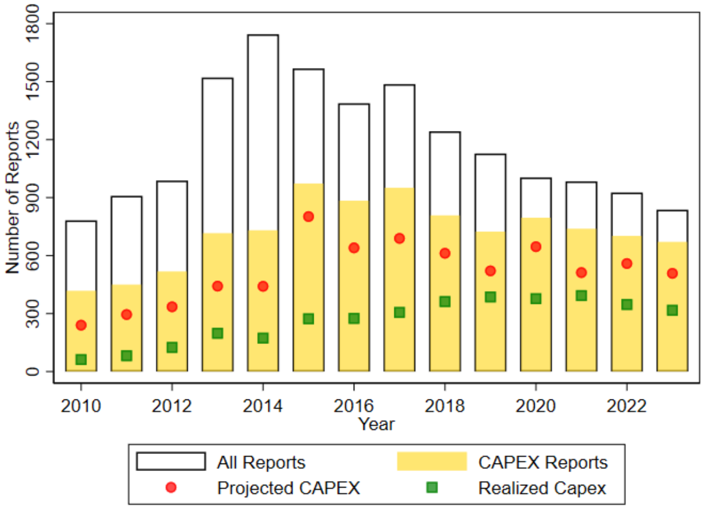
where i denotes a firm, and t denotes a year-quarter. *CAPEXGrowth* is defined as the percentage change in the company's capital expenditure from quarter t to $t+1$ (i.e. $\frac{Capex_{t+1}-Capex_t}{Capex_t}$). *CAPEX Opinion* is assigned a value of 1 if the analyst has a positive view of the company's capital spending in report s for quarter t, 0 if the analyst has a neutral opinion, and -1 if the analyst has a negative opinion. *Aggregate CAPEX Opinion* is the sum of all *CAPEX Opinions* for company i in quarter t, divided by the number of unique brokerage houses covering company i during quarter t. (i.e. $\frac{\sum_{it} CapexOpinion_{ist}}{\text{Number of analyst coverage(j)}}$).*1(Net Positive CAPEX Opinion)* is an indicator that equals 1 if company i has a net positive analyst opinion about its capital spending and 0 otherwise (i.e., $1(\sum_{it} \text{CAPEX Opinion}_{ist} > 0)$). *1(Net Negative CAPEX Opinion)* is an indicator that equals 1 if company i has a net negative analyst opinion about its capital spending and 0 otherwise (i.e., $1(\sum_{it} \text{CAPEX Opinion}_{ist} < 0)$). The control variables include *log(Assets)*, *ROA*, and *MTB*, where *log(Assets)* is the logarithm of total assets, *ROA* is net income divided by total assets, and *MTB* is the sum of market capitalization and book value of debt divided by total assets. All variables, except for *CAPEX Opinion*, are constructed using the quarterly COMPUSTAT dataset and are winsorized at the 1% level.

Appendix Figure F3: Comparison of CAPEX and Environmental Topics in Analyst Reports



This figure plots and compares the fraction of reports discussing the company's capital spending with those discussing the company's environmental issues. A report is classified as discussing capital spending if GPT-4o identifies content related to the company's investment, such as capital expenditure or capital spending. A report is classified as discussing environmental issues if GPT-4o identifies topics related to the company's climate strategies, waste management, pollution levels, or efforts in conserving natural resources.

Appendix Figure F4: Analyst Report Distribution



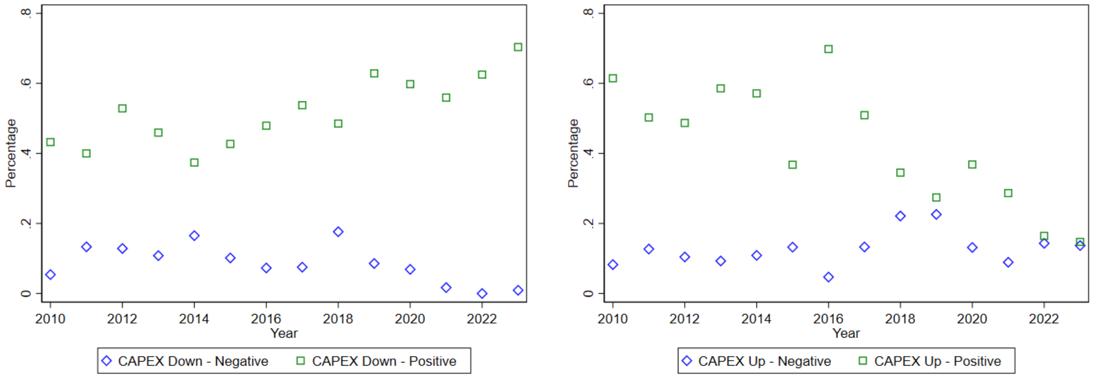
This figure plots the number of reports discussing capital expenditure. All reports are from InvesText Online Platform covering oil and gas exploration and production sector in the United States from the 2010-2023 period.

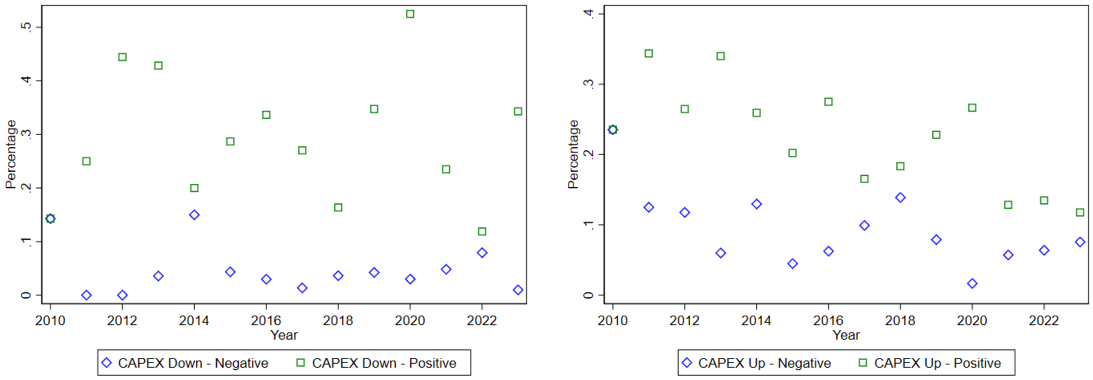
Appendix Figure F5: Instruction for ChatGPT4o: Projected/Realized CAPEX

```
"You are analyzing financial analyst reports."
"Q1. Can you tell me whether the report discusses the company's CAPEX (
   capital expenditure)?"
"If the company's CAPEX is discussed in the report, please answer all of
   the following questions."
"Make sure to distinguish if the report discusses the company's CAPEX
   projection or realized CAPEX or both."

"Q2. Did the company being analyzed increase, decrease, or keep its
   projected CAPEX?"
"Q2a1. How much is the reported projected CAPEX?"
"Q2a2. If the report discusses the projected CAPEX, does the report also
   discuss the benchmark for projected CAPEX? (i.e. increase/decrease/
   unchange the projected CAPEX relative to the benchmark)?"
"Q2a2. If no benchmark is mentioned, specify 'NA' and state that no
   benchmark was found in the report."
"Q2b. Does the report view the firm's projected CAPEX positively,
   negatively, or neutrally?"

"Q3. Did the company being analyzed increase, decrease, or keep its
   realized CAPEX?"
"Q3a1. How much is the reported realized CAPEX?"
"Q3a2. If the report discusses the realized CAPEX, does the report also
   discuss the benchmark for realized CAPEX? (i.e. increase/decrease/
   unchange the realized CAPEX relative to the benchmark)?"
"Q3a2. If no benchmark is mentioned, specify 'NA' and state that no
   benchmark was found in the report."
"Q3b. Does the report view the firm's realized CAPEX positively,
   negatively, or neutrally?"
```

This figure provides the instruction to Chat GPT-4 to classify each analyst report.

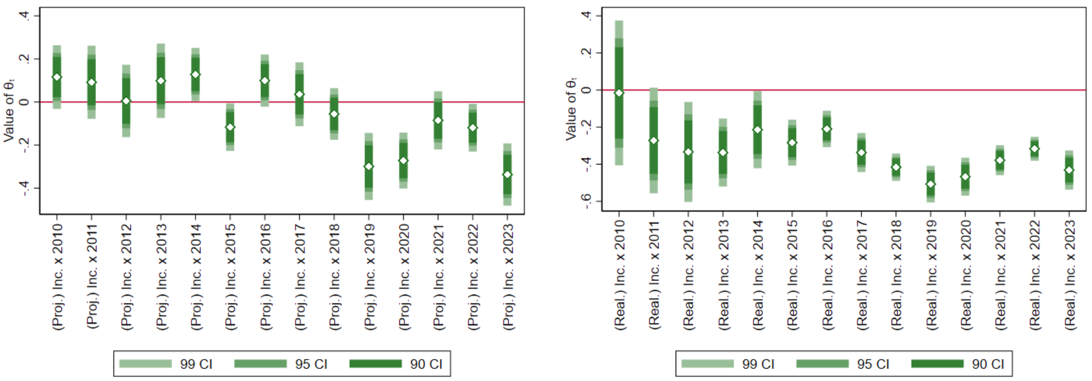
Appendix Figure F6: Analyst Sentiment Conditional on CAPEX


(a) Conditional on Prj. CAPEX Down **(b)** Conditional on Prj. CAPEX Up


(c) Conditional on Real. CAPEX Down **(d)** Conditional on Real. CAPEX Up

This figure plots the share of reports negative and positive conditional on CAPEX increasing/decreasing for each projected and realized CAPEX.

Appendix Figure F7: Analyst Report Sentiment and Investment Over Time



(a) Projected CAPEX

(b) Realized CAPEX

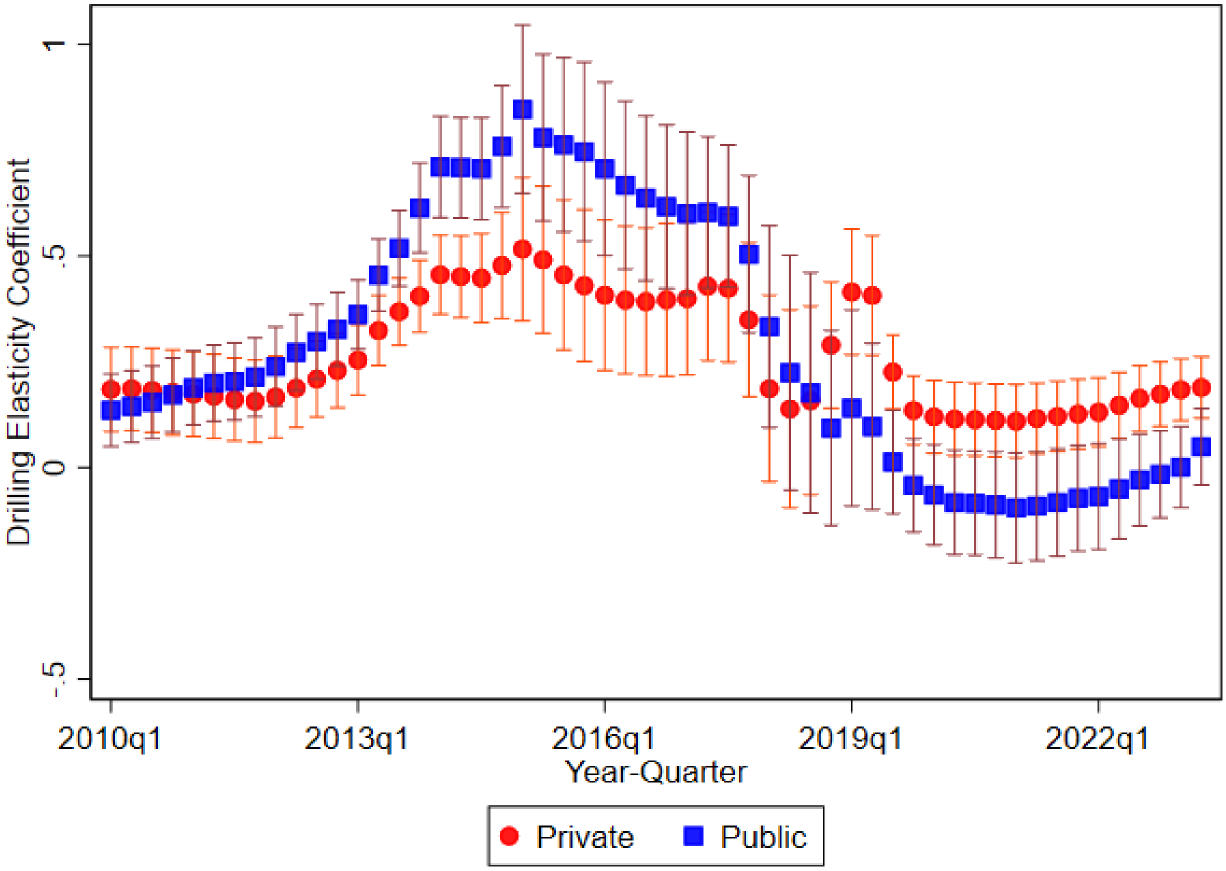
This figure reports the regression result based on the following specification:

$$Opinion_{ijt} = \alpha + \sum_{t} \theta_t Change_{ijt} + FirmFE + YearFE + BrokerageFE + \epsilon_{ijt}$$

Panel A presents the results for Projected CAPEX, while Panel B shows the results for Realized CAPEX. The dependant variable is $Opinion_{ijt}$ which takes a value of 1 if the summary indicates that the company increased its projected (realized) CAPEX, 0 if there was no change, and -1 if the company decreased its projected (realized) CAPEX. The independent variable is $\sum_t \gamma_t Change_{ijt}$, where $Change_{ijt}$ takes a value of 1 if the report views the company's projected (realized) CAPEX positively, 0 if it views it neutrally, and -1 if it views it negatively. The constant term is suppressed.

G Appendix G: Other Figures and Tables

Appendix Figure G1: Drilling Elasticity to Commodity Price (Gas Wells)

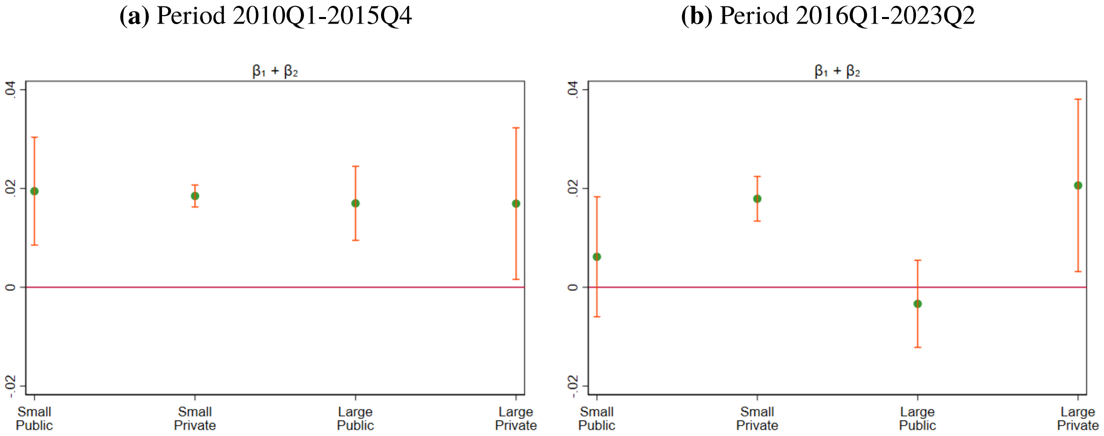


This figure plots the semi-elasticity of drilling to price coefficient in a +/- 12 rolling quarters around each sample point during the 2010Q1-2023Q2 period based on the following Poisson regression specification:

$$\log(E(Y_{it}|X_{it})) = \beta_1 Price_{t-1} + FirmFE_i$$

The dependent variable is the number of gas wells drilled in each year-quarter. Standard errors are clustered at the firm level. *Price* is the lagged 18-month Henryhub Gas futures price.

Appendix Figure G2: Elasticity of Drilling Activity to Oil Prices by Size and Ownership Type


(a) Period 2010Q1-2015Q4

(b) Period 2016Q1-2023Q2

This figure plots the semi-elasticity of drilling activity with respect to oil prices across different firm types (small-private, small-public, large-private, and large-public) during high-price periods. The regression results are based on the following Poisson specification:

$$\log(E(Y_{it}|X_{it})) = \beta_1 Price_{t-1} + \beta_2 Price_{t-1} \times 1(High_2) + \beta_3 1(High_2) + FirmFE_i$$

where Y_{it} is the number of oil wells drilled by firm i in quarter t, $Price_{t-1}$ is the 18-month futures oil price lagged one quarter, $1(High_2)$ is an indicator equal to one if the price exceeds $55, and $FirmFE_i$ denotes firm fixed effects. The standard errors are clustered at the firm level. Panel A reports estimates for 2010Q1-2015Q4, when oil prices exceeded $55 in all quarters except 2015Q4. Panel B reports estimates for 2016Q1-2023Q2. Firm size is defined relative to the median cumulative number of wells drilled among public firms during 2016Q1-2023Q2; firms above (below) this median are classified as large (small).