Do Private Firms Invest Differently than Public Firms? Taking Cues from the Natural Gas Industry*

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Abstract

We study the investment behavior of private and public firms using a dataset of onshore U.S. natural gas producers. We find that firm-level drilling by private firms is 60% less responsive to changes in natural gas prices, a measure that captures changes in investment opportunities. Exploiting county-specific shale gas discoveries as a natural experiment, we show that public firms increase drilling locally in response to these new capital-intensive growth opportunities, whereas private firms do not. We observe that private firms sell shale assets to public firms but are active buyers of projects with low capital requirements. These findings are not driven by heterogeneity in firm size, product markets, pricing, or costs. Our evidence is consistent with public firms being better positioned to take advantage of capital-intensive projects by having greater access to capital markets.

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1 Introduction

Understanding when and why listing status affects investment decisions is important due to the large role of private firms in the U.S. economy.[1] Public firms have better access to external finance than private firms (Pagano, Panetta, and Zingales (1998), Brav (2009), Schenone (2010), Saunders and Steffen (2011), and Maksimovic, Phillips, and Yang (2013)). Improved access to capital markets could make public firms more responsive to new investment opportunities. However, once publicly-traded, the separation of ownership and control can make a firm more prone to agency conflicts, whereby management's incentives can lead to significant distortions to investment policies (e.g., Jensen and Meckling (1976), Jensen (1986), Stein (1989), Bertrand and Schoar (2003)). In this study, we investigate how these forces affect the investment policies of public and private firms.

Empirically identifying the influence of listing-related frictions on investment decisions presents several challenges. Data on the capital projects of private firms are often unavailable, and it is challenging to accurately measure the investment opportunity set of firms (e.g., Erickson and Whited (2000), Alti (2003)). Moreover, differences between public and private firms may affect both listing status and investment decisions, making it difficult to draw conclusions regarding the impact of different frictions on investment policies.

We focus on project-level investment decisions in the U.S. natural gas industry, a setting that allows us to make significant progress in addressing these challenges. We observe 74,670 individual projects across both private and public firms with similar operational features.[2] Our setting has the additional advantage of offering two distinct sources of exogenous changes to investment opportunities, given by (1) changes in natural gas prices and (2) shale discoveries. We also exploit detailed information on each project's characteristics to test the importance of specific listing-related frictions.

We document three differences in investment behavior of public versus private firms. First, we gauge the response of private and public firms' drilling activity to changes in natural gas

[1] For 2008, we estimate that in the United States at least 94.3% of business entities were privately-held and 53.8% of aggregate business net income was from privately-held firms. These calculations are based on data reported by the Internal Revenue Service in its Integrated Business Dataset.

[2] We show that public and private firms in our setting are similar along many dimensions, including (1) access to drilling technology, (2) product markets, (3) pricing power, (4) cost structure, and (5) exploration activities.

prices. The profitability of drilling new wells is directly tied to natural gas prices (see Lake et al. (2013)). We find that drilling by private firms is 60% less sensitive to changes in natural gas prices than that of public firms. This difference occurs because public firms drill more wells than private firms when natural gas prices are high, whereas both types drill with similar intensity when prices are low.

Second, we show that private firms' investment responses are linked to project capital requirements. Using a natural experiment based on shale discoveries, we analyze *county*-level investments by private and public firms, both before and after a discovery in 102 different counties.[3] Using a difference-in-differences framework, we find that public firms respond to these positive shocks with an increase in drilling activity of 80.5%, whereas private firms do not show any increase. In contrast to shale projects, we find that private firms show a positive response to improvements in investment opportunities for less capital-intensive non-shale projects.

Third, by tracking asset ownership, we show that private firms sell projects with high capital requirements to public firms. We find that, after shale discoveries, private firms sell their shale drilling tracts to publicly-traded firms 63% of the time. This compares with private firms selling shale drilling tracts to other private firms only 5% of the time. This asset sale behavior is markedly different for non-shale low capital intensity projects, as private firms frequently buy non-shale assets.

What explains these differences in investment behavior? We evaluate two competing hypotheses. First, greater access to external capital could allow public firms to fund attractive investment opportunities better than private firms.[4] This difference in cost of external capital is often related to information-related frictions and agency conflicts.[5] Information asymmetry between insiders and outsiders can limit or even preclude raising external capital for investments. A public listing can reduce the information asymmetry, and thus mitigate the underinvestment problem. Changing listing status, however, comes with significant costs associated with an initial public offering (Ritter (1987)). Brau and Fawcett (2006) show in

[3]Section 2 outlines evidence that these discoveries provide positive shocks to the investment opportunity set of firms with existing operations in the area of a discovery.

[4]For survey evidence consistent with this hypothesis, see Brau and Fawcett (2006). In particular, they find that facilitating acquisitions is the primary motivation for going public.

[5]Information asymmetry creates both adverse selection (e.g., Myers and Majluf (1984), and Bias and Mariotti (2005)) and moral hazard (e.g., Holmstrom and Tirole (1997), and Biais et al. (2010)) issues.

their survey evidence that the most important reason to remain private is to retain control and ownership rights. Offsetting the benefit of greater capital access, greater separation of ownership and control makes public firms more likely to suffer from suboptimal investment decisions (e.g., Jensen and Meckling (1976)). In particular, our second hypothesis is that public firms are more prone to overinvesting or "empire building" due to the separation of ownership and control (e.g., Jensen (1986), Stulz (1990)).

Our findings are broadly consistent with our first hypothesis: greater access to external capital allows public firms to respond to investment opportunities better than private firms. Specifically, private firms respond to changes in investment opportunities for less capital-intensive non-shale projects, but not for more capital-intensive shale projects. Given the greater need for external capital for shale projects, this difference is consistent with private firms facing a higher cost of external capital. Consistent with information-related frictions, we find a weaker response to shale discoveries for private firms headquartered farther from the major North American financial hubs for the energy sector. Further corroborating this interpretation, we find that public firms raise significant amounts of external capital, particularly when natural gas prices are high. Specifically, the average public firm in our sample raises the equivalent of 15% of its total assets in high natural gas price years, compared with just 6% in low natural gas price environments. Lastly, we show that private firms have a much greater propensity to sell assets to public firms when they require significant capital investments.

Our results are less supportive of our second hypothesis that public firms are more prone to overinvesting or "empire building." Public firms drill more than private firms only when natural gas prices are high. This evidence is more consistent with public firms taking advantage of high price environments than with overinvestment. Additionally, we find a positive stock market reaction for public firms that acquire assets from private firms. This result is not consistent with an agency cost hypothesis. Moreover, during our sample period, public gas firms on average do not have positive free cash flow. As noted above, public firms rely on external capital markets to fund their drilling expenditures. Being required to access capital markets on a regular basis could result in a disciplinary effect, similar to that induced by product market competition (e.g., Jensen (1986), Giroud and Muller (2010)).[6]

[6]Using the Rajan and Zingales (1998) measure of external capital, we find that, during our sample period,

Given the capital needs required for shale development and the improved access to external capital that public firms have, one might expect private firms to undertake initial public offerings (IPOs) in order to develop their shale opportunities. While there were no IPOs in the first four years of our sample period, twelve private firms go public following shale discoveries. All but one state the need for better access to external capital to pursue shale drilling as the motivation for their IPO. The rate of IPOs following shale discoveries places our sample firms in the top 10% of all four-digit SIC codes during these years. However, many private firms in our sample chose to remain private. One novelty of our study is to highlight an alternative channel by which projects initially held by private firms are undertaken. We show that projects are redeployed across private and public firms through significant asset sale activity. This transfer of asset ownership allows private firms to benefit from their shale assets without incurring the development costs. It also serves to mitigate potential underinvestment concerns at the aggregate level (Shleifer and Vishny (1992), Maksimovic and Phillips (2001)).

Because of the endogenous nature of the listing decision, we do not rule out the possibility that other factors could also affect the investment behavior of private and public firms. An ideal empirical strategy would randomly assign a firm's listing status. Although we do not have a randomized experiment, our empirical design and quasi-natural experiment limit the potential impact of confounding variables. Specifically, an alternative interpretation would need to rely on the existence of a time-varying omitted variable that not only relates listing status to drilling activity but also explains why projects with higher capital requirements have different investment responses from private firms than projects with lower capital requirements.

This study contributes to an emerging literature on the behavior of private firms. Brav (2009) documents differences in capital structure decisions between public and private firms, whereas Michaely and Roberts (2012) show that listing status has an important influence on dividend policies. Both papers provide evidence consistent with differences in the cost of external capital influencing capital structure and payout policies. Sheen (2009) and Asker, Farre-Mensa, and Ljungqvist (2011) compare the investment behavior of public and private firms, albeit in empirical settings different from ours. Sheen (2009) analyzes multi-year plant

the average public natural gas producer raises 34% of its capital expenditures from external capital markets.

expansion decisions in the chemical industry and shows that private firms *anticipate* future demand better than their public counterparts, whereas we focus on investment *responses* to changes in investment opportunities. Asker et al. (2011) make use of a large dataset of private firms to show that public firms, compared to private firms, are less responsive to changes in their investment opportunities. Asker et al. (2011) show that their underinvestment result is driven by industries more prone to myopic behavior (e.g., Stein (1989)). Using Asker et al. (2011)'s measure of myopic behavior, we find that natural gas producers are less prone to "short-termism", which could explain why we observe different patterns of investment behavior.

The paper proceeds as follows. In Section 2, we provide background on the U.S natural gas industry. In Section 3, we describe our dataset. In Section 4, we present our methodology and results. Section 5 concludes.

2 Natural Gas Industry Background

Natural gas is one of the predominant sources of energy in the United States; it provides 26% of all the energy consumed. Natural gas drilling is widespread, with commercial production in 32 states. Drilling wells is the primary form of investment in this industry.[7] Once the initial capital is expended for drilling a well, it produces natural gas over several years. In this study we analyze the drilling activity of a comprehensive panel of public and private firms engaged in the onshore exploration and production of natural gas in the United States.

2.1 The Price of Natural Gas

> *The Company can adjust quickly to the changes in commodity prices if necessary. Equal has an extensive multiple year drilling inventory so it can increase capital spending in a higher commodity price environment.*
>
> - Equal Energy, a publicly-traded natural gas producer

[7] For the median public firm in our sample, we find that 83.5% of all capital expenditures goes towards drilling wells. A detailed analysis of the remaining capital expenditures reveals that these funds are spent on the acquisition of land and other investments related to the development of their natural gas properties.

Our first empirical tests use the price of natural gas to gauge the profitability of new wells. Our key justification for analyzing drilling responses to changes in natural gas prices is that a change in natural gas prices affects the investment opportunity set of both private and public firms similarly. Several pieces of evidence support this assumption. First, in terms of output, all projects yield the same fungible good, and because natural gas is provided by a competitive market of suppliers, firms in this industry obtain a similar price for their product. While geographical differences may yield different output prices, we show in Appendix A that there is a very high correlation in natural gas prices obtained across different regions of the United States during our sample period. Although geographical differences could lead to discrepancies in terms of well productivity, the regressions with firm-county-level fixed-effects control for these differences. Using detailed production data from two shale discoveries (see Appendix B, Panel B), we show that the output for shale wells is not statistically or economically different across private and public firms operating within the same area.

While gross revenues expand similarly for both private and public firms when natural gas prices increase, drilling costs could vary systematically in the cross-section. In particular, some industries exhibit increasing returns to scale, whereby large companies can extract discounts from suppliers and contractors on investments due to their scale. To test whether scale is a factor in per well costs, we hand-collect data on capital expenditures and wells drilled from 10-K filings of publicly-traded firms in SIC 1311 from 2006 to 2009. We then compute the average well cost for each firm and analyze how it varies within the universe of publicly-traded natural gas producers in our sample. Appendix C documents that there is no significant difference between the median per well cost of large and small publicly-traded firms in our sample, despite the fact that large firms are on average five to six times the size of small firms. This evidence serves to alleviate concerns that cost heterogeneity in the cross-section is driving our results. Overall, our sample firms produce an exogenously priced commodity and have a relatively homogeneous cost structure. Hence, a change in natural gas prices will affect the investment opportunity set of public and private firms similarly.

Finally, in terms of natural gas price dynamics, we perform an augmented Dickey-Fuller test and find that the time-series is stationary over our sample period.[8] Mean reversion in

[8] The null of a unit root in the time-series of monthly natural gas prices is rejected at the 1% confidence level.

the price of natural gas could mean that firms may not be able to capture increases in natural gas prices if prices revert after a well starts producing. However, in practice, producers can and do mitigate the risk of price fluctuations by hedging price risk for up to five years, using derivative contracts (see Lake et al. (2013)). The ability to hedge combined with the front loading of project cash flows suggests that a firm can "lock-in" prices for the most productive period of a new well.[9] We document a high correlation between the spot price of natural gas and futures prices up to 36 months out (see Appendix Figure A), and all our results are robust to using futures prices (see Appendix D).

2.2 Natural Experiment: Shale Gas Discoveries

2.2.1 Development of Natural Gas Shale

> *Today's tight natural gas markets have been a long time in coming, and distant futures prices suggest that we are not apt to return to earlier periods of relative abundance and low prices anytime soon.*
>
> \- Alan Greenspan, July 2003, Senate Energy Committee Testimony

Prior to the development of natural gas shale, the consensus view was that low supply levels of natural gas would persist for the foreseeable future. As recently as the year 2000, natural gas produced from shale comprised only 1% of natural gas production in the United States. The technological breakthroughs occurring in 2003 that combined hydraulic fracturing ("fracking") with horizontal drilling enabled the economically profitable development of shale (Yergin (2011)). As a consequence, natural gas produced from shale today comprises 25% of all U.S. natural gas production and new natural gas reserves from shale are now equivalent to a 100-year supply of U.S. natural gas consumption (Yergin (2011)). These advancements have resulted in new investment opportunities for the development and production of natural gas. Many shale discoveries have been made across the United States since

[9] An example of the production decline in a typical well over time is depicted in Appendix Figure B. For example, Lake et al. (2013) assume that 70% of available reserves are extracted in the first year.

2003.[10]

In our study, we compare investment decisions for shale versus non-shale projects. An important feature of this comparison is the difference in capital requirements to drill shale wells. While shale wells produce significantly more than non-shale wells, they are also significantly more expensive than non-shale wells. Lake et al. (2013) state that shale wells can cost between \$6.7M and \$9.5M, whereas non-shale wells usually cost less than \$1M. Our data allows us to make the distinction between the two types of wells. Both public and private firms have access to the same shale drilling technology, because it is made available by third party contractors (e.g. Halliburton). Confirming this statement, we find that 95.8% of publicly owned wells were drilled by contractors who also drilled privately owned wells. Therefore, firms are not required to make specific R&D investments for shale development. This mitigates concerns regarding potential differences in access to patents or technological know-how that could be problematic for tests using technological breakthroughs in other settings.

2.2.2 Profitability of Natural Gas Shale Drilling

Shale discoveries provide a positive shock to the investment opportunity set of firms. Below, we offer three pieces of evidence that suggest shale development is profitable during our sample period. The first piece of evidence is based on Lake, Martin, Ramsey, and Titman (2013) who provide a detailed evaluation of the cash flows associated with shale discoveries. Using data from a Haynesville shale well and extensive simulations, the authors find that most shale gas wells are profitable under their modeling assumptions. They show that the key driver of a well's net present value (NPV) is the price of natural gas with a breakeven point of \$3.80 per Mcf. Over the time period of shale production in our study from 2003 to 2012 natural gas prices averaged \$5.30 on an annual basis and only dipped below \$3.80 in two out of ten years.

The second piece of evidence is based on market measures of project profitability. If a firm

[10] In Panel A of Appendix B, we document the number of shale discoveries that occur each year. For our study, we focus on the six states with major natural gas shale discoveries: Arkansas, Louisiana, Oklahoma, Pennsylvania, Texas, and West Virginia.

has positive NPV projects, we expect it to have a market-to-book ratio (average q) above one. This is because the numerator (market value) includes the net present value of a firm's future investments or growth opportunities (Lindenberg and Ross (1981)). If shale development is not profitable, we would expect the negative cash flows from these projects to be recognized by the market and to observe market-to-book values significantly below one. During the time period of significant shale discoveries in our study (2003 to 2012), the average market-to-book ratio for public firms in our sample is equal to 1.52. This evidence is inconsistent with shale projects being unprofitable. Furthermore, over this ten-year time period, market participants have had significant time to analyze detailed data on the profitability of these projects, making it less likely that markets are misinformed.

The third piece of evidence, which suggests that shale resources are profitable to develop, is the frequent need to access external capital markets by natural gas producers to finance their capital expenditure programs. During our sample period, natural gas producers raise 34% of their capital expenditures from external sources. This capital raising activity means that, over a sustained period of time, investors have provided public firms with significant funding for shale wells. If shale wells were unprofitable, it is unlikely that capital markets would continue to provide funding over a prolonged period of time. Taken together, the evidence presented above implies that, during our sample period, shale discoveries provide positive shocks to the investment opportunity set of firms active in the area of a discovery.

2.2.3 Characteristics of Shale Discoveries

In this subsection, we highlight two features of shale discoveries that make their use particularly well suited in the context of a difference-in-differences approach. First, shale discoveries are staggered across 102 different counties over eight years.Using multiple staggered events as shocks to investment opportunities alleviates the risk that other confounding events could be driving the difference-in-differences results (Roberts and Whited (2012)). Second, shale projects offer very similar investment opportunities for both public and private firms already operating in an area of a shale discovery. In particular, we find no difference in well costs and production output for shale wells of private and public firms.[11]

[11] We provide empirical support for this claim in Panel B of Appendix B using unique operator-level data from the Oklahoma Corporation Commission on costs and production volumes from two shale discoveries.

3 Data

Data on drilling activity for private and public firms are obtained from Schlumberger Corporation's Smith International Rig Count; we refer to these data as our "drilling" dataset. Schlumberger reports information on every rig in the United States that is actively drilling a natural gas well. This dataset provides detailed information on where a natural gas well is being drilled, who is drilling it, and when it is being drilled, at a weekly frequency over the period 1997 to 2012.[12]

We conduct Lexis Nexis and Internet searches to determine whether natural gas producers in the drilling database are publicly-traded, a subsidiary of a publicly-traded firm, or a private firm. We only include firms in this study that could be conclusively validated as public or private. Drilling activity of a subsidiary is combined with the drilling activity of its parent. All publicly-traded firms not within SIC 1311 (Crude Oil & Natural Gas) are excluded from our sample for firm-level regressions. In particular, this restriction eliminates all the vertically integrated oil and gas companies, such as ExxonMobil, whose investment opportunity set is not well captured by changes in the price of natural gas due to their diversified lines of business (e.g., refining). Lastly, we exclude the twelve firms that switch from private to public or public to private during our sample period.

3.1 Firm-Level Data

We use the number of wells for which drilling operations have been initiated in year t, as our proxy for the amount of drilling investment (I) a firm makes in year t. A firm's capital stock (K) is the second metric for which we proxy. Net property, plant, and equipment (PP&E) is typically used as a proxy for the capital stock of a firm in large panel studies (e.g., Cleary (1999)). In the natural gas industry, net PP&E predominantly consists of proven reserves, that is reserves that are meant to be recoverable with reasonable certainty under the current geopolitical, economic, and technological conditions (FASB 19). To increase its productive capital, a natural gas producer must drill additional wells, thereby increasing the amount of natural gas it can book as reserves. Therefore, we define the stock of capital as the number of wells drilled over a preceding period of several years. For any given year, we

[12] Appendix E provides an example of the raw drilling data.

use the three most recent past years to achieve a balance between having a reasonably sized sample and having a good proxy for capital stock. Using the number of wells drilled over the prior three years requires that the sample for our regressions starts in the year 2000 rather than in 1997, meaning we have 13 years of data for our firm-level panel regressions. By computing the ratio of these two measures (I/K), we derive a measure of drilling investment intensity that is often used in the literature as the main dependent variable of interest for investment sensitivity regressions (e.g., Kaplan and Zingales (1997)).

To reduce the effect of outliers and ensure we have reasonable estimates of a firm's investment and capital stock, we apply a number of screens to the raw drilling data. Specifically, we require that a firm must drill at least one well to have a firm-year observation in the sample. This restriction ensures that only firms with active drilling programs are included. We also require that a firm have a minimum capital stock of at least 10 wells in the preceding three years, and we exclude observations with an I/K ratio above the 99th percentile.

Table 1 outlines the main sample used for the firm-level panel regressions. Our sample contains 380 unique private firms and 92 unique public firms that have 1,813 and 569 firm-year observations respectively over the 2000-2012 time period. Using the subset of Compustat firms in our sample, for which we have both drilling and accounting-based data, we find that our proxies for investment and capital stock enable us to construct I/K measures that are comparable across the two datasets.[13] Finally, we compute an annual measure of natural gas prices by taking the annual average of the daily wellhead gas prices obtained by natural gas producers, as reported by the U.S. Energy Information Administration.[14]

Table 1 reveals that private firms are on average smaller than public firms. To assess whether differences in size between public and private firms are responsible for how firms respond to changes in natural gas prices, we undertake several exercises. First, we increase the minimum size requirement for inclusion in the sample. Specifically, we require that both public and private firms have capital stock levels above different minimum threshold levels. Table 1 Panel B documents how the firm-size distribution changes for both public and private

[13]See Appendix Figure C.

[14]We document in Appendix A that the wellhead price of natural gas is highly correlated with natural gas "strip" futures prices and with the price of natural gas in different regions in the United States. This suggests that the wellhead price of natural gas is a reasonable proxy for the price a firm could obtain for its production, as well as its investment opportunities, regardless of a firm's specific region of operation.

firms when different size cutoffs are used. While size differences are reduced when we increase the size cutoffs, there remain significant disparities across the two types of firms.

To further address these size differences, we also construct a size-based matched sample. We follow the same nearest-neighbor matching methodology as in Asker et al. (2011). In particular, as soon as a private firm enters our sample, we match it to a public firm based on its capital stock value in the year it enters the sample. We keep the same match every year until the private firm or the matched public firm drops out of the sample. If the matched public firm drops from the sample, then we find a new match for the private firm in that year and keep it going forward. Similar to Asker et al. (2011), we match with replacement to ensure that we obtain the best match possible. This procedure yields a public-private sample matched on size, with 67 unique public firms and 354 unique private firms, and a total of 3,176 firm-years. As Panel B of Table 1 documents, our size matching generates remarkably comparable firm sizes across public and private firms in the year of the match, with a mean capital stock of public firms of 22.07 wells, compared with a mean capital stock of private firms of 22.15 wells. Relative to Asker et al. (2011), we further impose a 10% discrepancy tolerance threshold for each matched pair in the year of the match. It is important to note that our procedure does not oversample from a subset of small public firms. We find that the top decile of the most sampled public firms is matched to 23.6% of all private firm-year observations.[15]

3.2 Natural Experiment: County-Level Data

Our dataset contains specific information on the location of wells and well characteristics that allow us to observe where and when a shale discovery occurs. We use the same definition as Gilje (2011), who relies on the number of horizontal wells drilled in a given county.[16] Specifically, we define a shale discovery to have occurred when there have been more than 20 horizontal wells drilled in the county. Using this definition implies that more than 90% of all horizontal wells in our sample are drilled in county-years that are considered shale discovery county-years.

[15] Our main results are similar when we exclude these oversampled firms and their matches.

[16] Horizontal wells are the primary type of wells used to develop shale gas.

4 Methodology and Results

4.1 Investment Policies and Natural Gas Prices

Drilling activity is highly sensitive to changes in natural gas prices. Figure 1 highlights this relationship in our data. Figure 2 shows, however, that when this aggregate drilling activity is broken down between public and private firms, public firms appear to be more sensitive to changes in natural gas prices than private firms. The difference is particularly visible during the 2003-2008 run-up in natural gas prices when the drilling activity of public firms follows the upward trend in natural gas prices, while the drilling activity of private firms remains relatively flat over that time period.

Table 2 presents the results of univariate tests that compare drilling intensity levels of public and private firms in different natural gas price environments. We categorize each year of our sample period into three groups (low, medium, and high) based on the average natural gas price for that year relative to the other years. In low price environments, public and private firms do not have statistically different drilling intensity levels. Low price environments appear both at the beginning and at the end of our sample; this is important because it suggests that even in the presence of significant shale-related drilling opportunities, both public and private firms reduce their drilling activity in the presence of adverse natural gas prices. In two of the four years in the medium price environment, public firms invest significantly more than private firms, while they invest significantly more than private firms in all four high price years.

The univariate tests also show that drilling responses of public firms are more sensitive to natural gas prices than are private firms. Public firms increase their drilling activity significantly more than private firms when going from a low to a high price environment. Specifically, when comparing the drilling intensity mean values from the low price environment to the high price environment, public firms increase I/K from an average of 0.34 to 0.59, whereas private firms increase I/K from an average of 0.29 to 0.40. In terms of percentage change, public firm drilling increases 74% from the low price environments to the high price environments, compared with a 38% increase for private firms.

We more formally test these univariate results in a regression framework. To do so, we estimate a panel regression with firm fixed effects, controlling for any time-invariant unobserved differences across firms. Specifically, we run panel regressions for two measures of drilling activity (I/K and $log(I)$) regressed on indicator variables, $High_t$ and Low_t, respectively, the highest and the lowest price terciles during the sample period from 2000 to 2012. These price environment indicators are interacted with a private dummy also ($High_t * Private_i$ and $Low_t * Private_i$):

$$\begin{aligned} I_{i,t} &= \alpha + \beta_1 Low_t + \beta_2 Low_t * Private_i + \\ &\quad \beta_3 High_t + \beta_4 High_t * Private_i + \beta_5 Private_i + FirmFE_i + \varepsilon_{i,t} \end{aligned}$$

The key coefficient of interest in determining whether private firms' drilling levels are significantly different from those of public firms in high natural gas price environments is β_4, the coefficient on the interaction term $High_t * Private_i$. Similarly, the magnitude and sign of β_2, the coefficient on the interaction term $Low_t * Private_i$, provide an indication of how private firms respond relative to public firms in low natural gas price environments. The private dummy, $Private_i$, is absorbed by the firm fixed effects in our regressions. Results are shown in Table 3. We implement this test on a sample with minimum firm size cutoffs in columns (1)-(2) and (5)-(6) and on our size-matched sample in columns (3)-(4) and (7)-(8).

We find that the coefficient on the interaction term $High_t * Private_i$ is negative and statistically significant in all our specifications. These results indicate that private firms invest significantly less than public firms in high natural gas price environments. Conversely, the coefficient on the interaction term $Low_t * Private_i$ is not statistically significant in any specification. This result confirms the asymmetry documented earlier in Table 2. The differences in investment behavior between private and public firms occur in high price environments; when prices are high, public firms invest significantly more than their privately-held counterparts.

After analyzing drilling intensity levels across different price terciles, we estimate regressions measuring firm-level drilling sensitivities to changes in natural gas prices. Specifically, we run panel regressions for two measures of drilling activity (I/K and $log(I)$) regressed on natural gas prices (NG_t) and natural gas prices interacted with a private dummy ($NG_t * Private_i$):

$$I_{i,t} = \alpha + \beta_1 NG_t + \beta_2 NG_t * Private_i + \beta_3 Private_i + FirmFE_i + \varepsilon_{i,t}$$

The key coefficient of interest in determining whether private firms respond differently to changes in the price of natural gas is β_2, the coefficient on the interaction term $NG_t * Private_i$. The magnitude and sign on the coefficient of this term is an indication of how private firms respond relative to public firms for a given change in natural gas prices.[17]

Results are shown in Table 4 Panel A for I/K and Panel B for the $log(I)$ specification. To address concerns regarding differences in size, we implement several minimum size cutoffs in specifications (1)-(6). Additionally, we also run our tests on our size-matched sample in specifications (7)-(8).

We find that the coefficient on the interaction term $NG_t * Private_i$ is negative and statistically significant in all our specifications, including the matched sample. Specifically, the magnitude of the coefficient on the interaction term $NG_t * Private_i$ is equal to 60% of the magnitude of the coefficient on NG_t, indicating that private firms are significantly less responsive to changes in natural gas prices than their publicly-traded counterparts.

Do private firms respond at all to changes in the price of natural gas? To assess the effect of changes in the price of natural gas on private firms we need to test whether the combination of the coefficients on NG_t and $NG_t * Private_i$ is significantly greater than zero (H_0: $\beta_1 + \beta_2 = 0$ vs. H_a: $\beta_1 + \beta_2 > 0$). The results for this test are shown below the main regressions in both Panels A and B of Table 4. For example, in specification (2) of Panel A we find that the sum of the two coefficients is equal to 0.026 ($= 0.065 - 0.039$). The sum $\beta_1 + \beta_2$ is positive and statistically significant in all specifications found in Panels A and B of Table 4. This result means that private firms do react to changes in natural gas prices but to a lower degree than their publicly-traded counterparts.

In terms of economic magnitudes, relating the coefficients in specification (2) of Panel A to the median drilling intensity of each firm type implies that a one standard deviation increase in natural gas prices leads public firms to increase their drilling intensity ratio by 29%, while the drilling intensity ratio of private firms only increases by 15%. Similarly, in specification (2) of Panel B, with log of new wells as the dependent variable, we find that a one standard deviation increase in the price of natural gas leads public firms to increase the number of new wells by 30%, while private firms increase the number of new wells by only 17%.

[17] The private dummy $Private_i$ is absorbed by the firm fixed effects in our regressions.

The sign and significance of our results remain unchanged in most specifications, and the magnitude of our coefficient remains nearly the same throughout. When firms are matched on size in specifications (7)-(8), we find very similar and statistically significant results. This finding suggests that differences in size do not account for the observed differences in investment behavior.[18]

To further investigate how firm size, as opposed to listing status, affects our results we augment our baseline specification by adding size controls in our regressions in Table 5. To do so, we include an indicator variable for whether a firm is above the median firm in terms of size in a given year, and when the left-hand side variable is the logarithm of the number of new wells (log(I)), we include the logarithm of capital stock ($log(K)$) as a control variable for size ($Size_{i,t}$). Moreover, we include an interaction term between these measures of size and our investment opportunity measures $NG_t * Size_{i,t}$ to test whether being private proxies for a size effect. When we add both the interaction of price with the private dummy and the size dummy, we observe that the interaction with the private dummy remains statistically significant throughout all specifications in Table 5. This result provides further evidence that differences in size between private and public firms are not driving our results.

4.2 Quasi-Natural Experiment: Shale Gas Discoveries

Our firm-level results could be driven by some unobserved heterogeneity between public and private firms, such as geographic differences in natural gas development opportunities. In our quasi-natural experiment, we focus on county-level drilling activity by restricting our sample to the subset of firms that are active in a county *prior* to a shale discovery. After the discovery, all firms that were active in an area prior to a shale discovery have access to new investment opportunities (shale wells) located under their existing acreage.

4.2.1 Difference-in-Differences

We implement a difference-in-differences framework using data at the county level to test whether public and private firms respond differently to the new investment opportunities

[18]We provide a variety of robustness specifications (futures prices, quarterly frequency, excluding largest firms) in Appendix D. All results hold. Separately, in unreported results we run the same firm-level specification with different definitions of I/K. Specifically, we weigh shale wells from one to eight times more than non-shale wells in the definition of I/K, and the results hold as well. Lastly, in Appendices F and G, we show that these results are not driven by public firms with high shareholder-manager agency costs as proxied by low levels of insider ownership.

created by shale discoveries. The first difference can be viewed as comparing the number of new wells drilled pre- versus post-discovery, and the second difference can be thought of as the difference in how public and private firms respond to the shale gas discovery.

The dependent variable in our natural experiment is $I_{i,j,t}$, which corresponds to new wells drilled by firm i in county j at time t. The time period of shale discoveries in our sample spans 2003 to 2010, ensuring that we have a three-year pre- and post-event window for each discovery. For example, a discovery occurring in 2010 will have a pre-period of 2007, 2008, and 2009 and a post period of 2010, 2011, and 2012.

In our baseline difference-in-differences regressions, we explain $I_{i,j,t}$ with a post-discovery dummy variable ($PostDiscovery_{j,t}$) and post-discovery dummy interacted with a private dummy ($PostDiscovery_{j,t} * Private_i$):[19]

$$\begin{aligned} I_{i,j,t} &= \alpha + \beta_1 NG_t + \beta_2 PostDiscovery_{j,t} + \beta_3 PostDiscovery_{j,t} * Private_i \\ &\quad + \beta_4 Private_i + FirmCountyFE_{i,j} + \varepsilon_{i,j,t} \end{aligned}$$

The key coefficient of interest in determining whether private firms respond differently to shale discoveries is β_3, the coefficient on the interaction term $PostDiscovery_{j,t} * Private_i$. The magnitude and sign of this coefficient is an indication of how private firms respond relative to public firms to a shale discovery in a given county. We also include firm-county fixed effects to account for time-invariant heterogeneity of firm drilling policies in different counties. Our unit of observation is at the firm-county-year level, which allows us to benefit from the information contained in each annual observation when calculating our clustered standard errors (see Petersen (2009)). [20]

Table 6 documents that county-level drilling activity of public firms increases significantly after a shale discovery. Specifically, the coefficient on $PostDiscovery_{j,t}$ in specification (2) indicates that public firms increase the number of new wells by 5.34 wells after a shale discovery; this corresponds to a 80.5% increase relative to the average number of wells drilled in the pre-period by public firms.[21]The coefficient on the interaction term $PostDiscovery_{j,t} *$

[19]The direct effect of being private ($Private_i$) is subsumed by the firm-county fixed effects.

[20]We also perform the approach recommended by Bertrand et al. (2004) and collapse time periods for each discovery into two periods; one pre-period and one post-period. Results are quantitatively very similar and available upon request.

[21]We also undertake several tests of the internal validity of our natural experiment, following Roberts

$Private_i$ is negative and statistically significant, indicating that private firm drilling activity responds significantly less to a shale discovery. Furthermore, when testing whether private firms respond to a shale discovery with any increase in the number wells, we find that private firms do not increase the number of wells they drill ($\beta_2 + \beta_3 = -0.286$).

In specifications (3) and (4) we augment our baseline specification to test whether firm size could be driving differences in the responsiveness to shale discoveries. Specifically, we include both a size indicator variable ($SizeDummy_{i,t}$) and the size indicator variable interacted with the post-discovery dummy ($PostDiscovery_{j,t} * SizeDummy_{i,t}$). We use our proxy for capital stock at the firm-level as our size variable; the indicator variable takes the value of one for firms with above median size, and zero otherwise. Even after including size and its interaction term as additional controls, the coefficient on $PostDiscovery_{j,t} * Private_i$ remains statistically significant, indicating that listing status is not proxying for a size effect.[22]

4.2.2 Comparisons across Well-Types

In this section we decompose drilling activity across shale and non-shale wells, both before and after a shale discovery.[23] This comparison is important for our identification strategy: A shale discovery improves investment opportunities for shale drilling, so any increase in drilling activity post-discovery should be concentrated in shale wells. Results are shown in Table 7. Specification (3) documents an increase of 5.08 shale wells drilled by public firms after a shale discovery, suggesting that the majority of the increase in drilling activity we observe in Table 6 is due to shale drilling by public firms. In total, we find that 86.4% of shale drilling is conducted by public firms.

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and Whited (2012). A valid difference-in-differences empirical design requires that the "parallel trends" assumption be satisfied. In our setting, this corresponds to public and private firms having similar drilling activity trends in the absence of a shale discovery. Using falsification tests, we gauge whether pre-discovery trends differ between public and private firms prior to a shale discovery and find no differences between the two groups of firms (see Appendix H).

[22] We do not include a matched sample in our natural experiment because of the limited number of potential matches available among the public firms also operating within the county prior to the shale discovery. At the firm level, private firms have the full universe of public firms from which to obtain a match. However, at the firm-county level, a given private firm has on average only 2.97 public firms from which to obtain a match.

[23] We include all wells (both shale and non-shale wells) in Table 6 to allow for a comparison to the number of wells drilled by a firm prior to a shale discovery.

Importantly, the interaction coefficient $PostDiscovery_{j,t} * Private_i$ is not statistically significant in specification (6), indicating that, after a shale discovery, private and public firms continue to follow the same drilling policies for non-shale wells. Ultimately, public and private firms only differ in their more capital-intensive shale-related drilling activity after a shale discovery. In Figure 3, we report annual coefficients of drilling responses to shale discoveries for both shale and non-shale wells. As can be seen in the figure, both public and private firms undertake similar non-shale drilling activity (Figure 3.2), while public firms actively drill shale wells after a shale discovery (Figure 3.1).

4.2.3 Private Firms and Proxies for Access to External Capital

In this section we test whether there is any variation in the response of private firms to drilling shale wells after discoveries. Table 7 documents that there is a limited number of new shale wells drilled by private firms after a shale discovery ($\beta_2 + \beta_3 = 7.066 - 6.507 = 0.559$); however, differences in drilling policies *within* private firms may highlight whether access to external capital is important for the investment behavior we observe. Extant literature has documented the importance of distance between capital providers and firms (e.g., Petersen and Rajan (2002), Saunders and Steffen (2011)). If distance worsens the information asymmetry between firms and their providers of capital, we would expect private firms located farther from sources of capital to be less responsive to shale discoveries. To empirically test this conjecture, we collect information on the headquarters of each private firm in our sample. We then compute the distance between the private firm headquarters and major centers of energy banking (Denver, CO; Oklahoma City, OK; Tulsa, OK; Houston, TX; Dallas, TX; Austin, TX; San Antonio, TX).[24] We calculate a firm's minimum distance from one of these financial centers, and use this distance as a measure of potential information asymmetry between firms and capital providers. We subdivide private firms into two groups: those that are close to these financial centers (closer than median distance) and those that are far from these financial centers (farther than median distance). The results of this test are reported in Table 8. We find that private firms headquartered closer to energy financial

[24]These financial centers are the counties with the highest bank deposit totals, in the states that had the highest natural gas production in 2003. Because these states had historically high natural gas production prior to the advent of shale, these financial centers have developed expertise in making loans for natural gas shale related projects.

centers drill 0.74 shale wells after a shale discovery, compared with 0.36 wells for those farther from energy financial centers, a difference that is statistically significant. These results provide some support for distance-related informational frictions for capital and investment decisions.

Firm size may also affect a firm's access to external capital (Hadlock and Pierce (2010)). We empirically test whether larger private firms respond differently to shale discoveries than smaller private firms. In Table 8 we find that large private firms respond to shale discoveries by drilling 0.90 new shale wells, whereas small private firms drill only 0.29 new shale wells, a difference that is statistically significant. This differential result along firm size provides further support for the importance of the cost of external capital in private firms' investment decisions.

4.2.4 Comparison with Non-Shale Drilling Activity in Non-Shale Areas

To shed additional light on the interpretation of our natural experiment results, we compare the county-level shale discovery drilling responses of our main difference-in-differences test to *non-shale* county-level drilling responses to changes in natural gas prices outside of shale discoveries. This exercise allows us to compare two sets of investment responses at the county level: one for capital intensive shale discoveries and one for less capital intensive traditional non-shale wells. The results are given in Table 9. The last two (respectively first two) columns estimate the response using the (log) number of non-shale wells. Specifications (1) and (3) estimate the average response across all sample firms operating in non-shale counties, while specifications (2) and (4) allow for a different response across public and private firms.

As Table 9 shows, the sum of $\beta_1 + \beta_2$ is statistically significantly greater than zero in both specifications (2) and (4). Therefore, private firms do respond to changes in natural gas prices at the county level, though less than public firms given the statistically significant negative sign on β_2.

Relating the coefficients in specification (4) of Table 9 to the average county-level number of wells of each firm type implies that a one standard deviation increase in natural gas prices leads public firms to increase their number of new wells by 27%, while the number of new wells only increases by 9% for private firms. With the log specification in column (2), we find that a one standard deviation increase in the price of natural gas leads public firms to increase the number of new wells by 16% while private firms increase the number of new wells by only 5%. In both cases, private firms show a significant response that is approximately two-thirds less in magnitude than that of public firms. Ultimately, we have investment responses for two different project types: one with higher capital needs (shale in Table 7) and one with lower capital needs (non-shale in Table 9). We find a larger difference in response between private and public firms for the project type with high capital needs.

4.3 Corporate Activity and Shale Discoveries

4.3.1 Asset Sales

In this section, we study asset sales patterns of shale and non-shale drilling rights (tracts). Obtaining detailed data on drilling tracts is challenging. Therefore, we focus our analysis on data that are made available by the Oklahoma Corporation Commission, as well as on regulations and land ownership rights that make asset sales straightforward to infer in that state. Specifically, using production data we can observe who owns the drilling tracts with existing producing wells. If subsequent development is performed on a tract by a firm other than the firm with pre-existing producing wells, it means that the firm with pre-existing wells has sold the asset to a new firm. We use data covering more than 66,560 acres in two shale discoveries and 128,640 acres of non-shale tracts in Oklahoma over the period 2003 to 2010. Private firms hold 36,480 (54.8%) prior to two shale discoveries and 67,840 (52.7%) over the non-shale land.

The two shale discoveries in the state are the Woodford shale and Cana shale. They cover four counties: (1) Canadian county (discovery in 2008), (2) Coal county (discovery in 2006), (3) Pittsburg county (discovery in 2006), and (4) Hughes county (discovery in 2006) for the shale tracts. For non-shale transactions, we look at non-shale areas in Oklahoma between 2003 and 2010. More specifically, we focus on the ten most active survey townships (a survey township is a geographic area defined by the Public Land Survey System) in Oklahoma outside of shale discoveries for the 2003 to 2010 time frame. In Panel A of Table 10, we test whether drilling tracts are transferred from private to public firms in a significant manner after shale discoveries are made. We find that this is the case: 63% of acreage tracts held by private firms prior to a shale discovery are sold to public firms. In contrast, private firms sell only 5% of their drilling tracts to other private firms. These differences are statistically and economically significant.

One interpretation of the result above may be that private firms have a different business model than public firms, whereby they acquire acreage simply to sell to public firms interested in developing shale. We test this conjecture with the following three exercises. First, we hand-collect data on the dates the acreage was first acquired by private firms, and find that on average private firms acquire the acreage 11 years prior to the shale discovery. This result makes it unlikely that private firms would purchase these assets without the intention of developing them. Second, we collect data on the 74,760 wells in our dataset to determine whether they are "exploration" or "development" wells. If private firms were to focus more on the exploration of new drilling opportunities than public firms, we would expect to see large differences in the number of exploratory wells drilled across public and private firms. We actually find that the average *exploration* drilling intensity (I/K) is equal to 0.0718 for private firms and 0.0721 for public firms; the difference is neither statistically nor economically significant.

Last, in contrast to transaction patterns around shale discoveries, we show in Panel A of Table 10 that private firms are active acquirers of non-shale tracts. For non-shale assets, there are no statistically significant differences between the amount of privately-owned tracts bought by other private firms (39.6%) and the amount bought by public firms (38.7%). Overall, the evidence shown in this section highlights a significant transfer of capital intensive shale projects from private to public firms; this asset sale pattern is significantly different from the one observed for less capital intensive non-shale projects.

In Panel B of Table 10, we gauge the market reaction at the announcement of acquisitions by public firms of natural gas assets. The event dates are collected from the SDC database. Using CRSP data, we compute the cumulative abnormal return over a five-day window around the event. The statistical significance is computed following Patell (1976). While we find no statistically significant reaction to acquisitions of assets from other public firms, we find a positive and statistically significant market reaction at the announcement of acquisitions of privately-held assets. This evidence is consistent with public firms being better able to develop assets previously owned by private firms.

4.3.2 Initial Public Offerings

A change in listing status is a major corporate decision, and there are significant costs associated with an IPO (Ritter (1987)). There were no IPOs in the first four years of our sample. In contrast, 12 IPOs occur after the advent of shale drilling in 2003. While the number of IPOs during our sample period could seem relatively low, it does place natural gas firms in the top 10% of all four-digit SIC codes in terms of the number of U.S. IPOs during the time period of our study. Thus, the shift toward more IPOs observed after the advent of shale drilling is consistent with increased benefits associated with a public listing post-shale drilling. While we do not have enough IPOs for statistical analysis, the qualitative evidence we collect in Appendix I documents that 11 out of the 12 IPOs after 2003 use proceeds from the IPO to fund costly capital expenditure programs linked specifically to shale-related opportunities.

5 Conclusion

In this paper, we exploit a unique dataset of 74,670 individual projects undertaken by onshore U.S. natural gas producers to study how private and public firms differ in their investment behavior. We find that private firms respond less to changes in their investment opportunities than their publicly-traded counterparts. First, we show that while private and public firms drill with similar intensity in low price environments, public firms drill significantly more than private firms in high price environments. The drilling response to changes in natural gas prices is estimated to be 60% lower for private firms. Our second empirical approach implements a difference-in-differences methodology using county-level shale discoveries as a natural experiment to assess the responsiveness of private and public firms' drilling activity to capital intensive growth opportunities. Following a shale discovery, we find that public firms increase their county-level drilling activity by 80.5%, whereas private firms do not pursue these capital intensive shale projects.

The extant literature has established both empirically and theoretically why private firms are at a disadvantage when it comes to raising capital. Greater information asymmetries are often put forward as one of the main reasons why private firms face a greater cost of capital. We find some evidence consistent with this channel by showing that private firms located farther from sources of external capital respond less to capital intensive projects. Overall, our findings suggest that this cost of capital disadvantage translates into lower responses to changes in investment opportunities. The advent of shale drilling, which requires more capital than traditional drilling, arguably makes a public listing even more compelling. So why would a firm remain private in those circumstances? Prior literature sheds some light on this question. Both Brav (2009) and Brau and Fawcett (2006) link the decision to remain private to agency considerations. For instance, Brau and Fawcett (2006) find that ceding control rights to outsiders is one of the biggest costs of going public. As such, our findings relating listing status to investment responses could also be linked to agency and control concerns that lead private firms to forgo valuable new investment opportunities.

Listing-related frictions could potentially lead to significant inefficiencies in the face of large capital needs. However, we offer two pieces of evidence that suggest this is not the case. First, we see a shift toward more IPOs following the advent of shale drilling; private firms do respond to the increased benefits of a public listing during our sample period. Second, although private firms are active buyers of non-shale assets, a majority sell their shale drilling rights to public firms. By showing that private firms sell these capital intensive assets to the public firms that are more apt to invest the necessary capital in them, we highlight an important channel through which an economy can reach a more efficient outcome in terms of capital allocation. This result also highlights another channel through which capital-constrained private firms can monetize new investment opportunities without having to change listing status.

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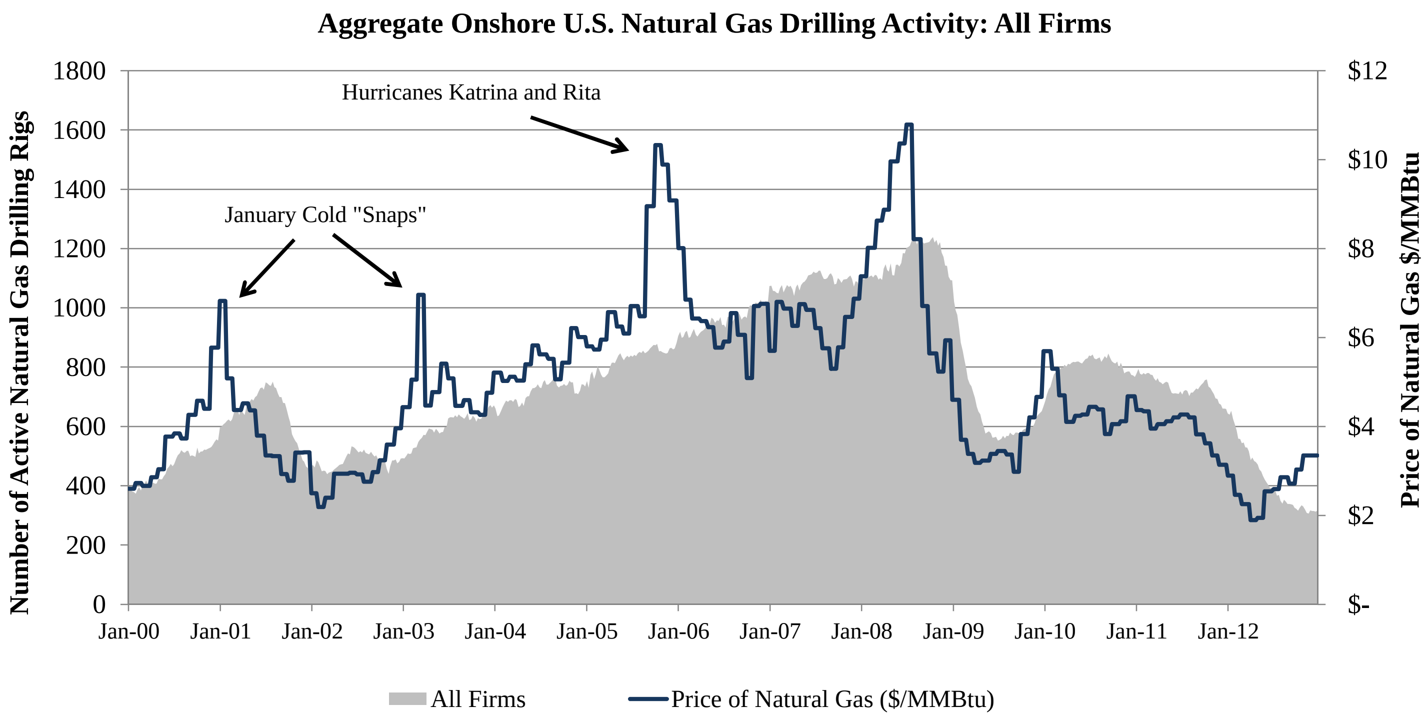


Figure 1: Onshore U.S. Natural Gas Drilling Activity: All Firms

This figure plots the weekly time-series of aggregate drilling activity in the onshore U.S. natural gas industry. The figure also shows the weekly time-series of the wellhead price of natural gas. The time period ranges from 2000 to 2012.

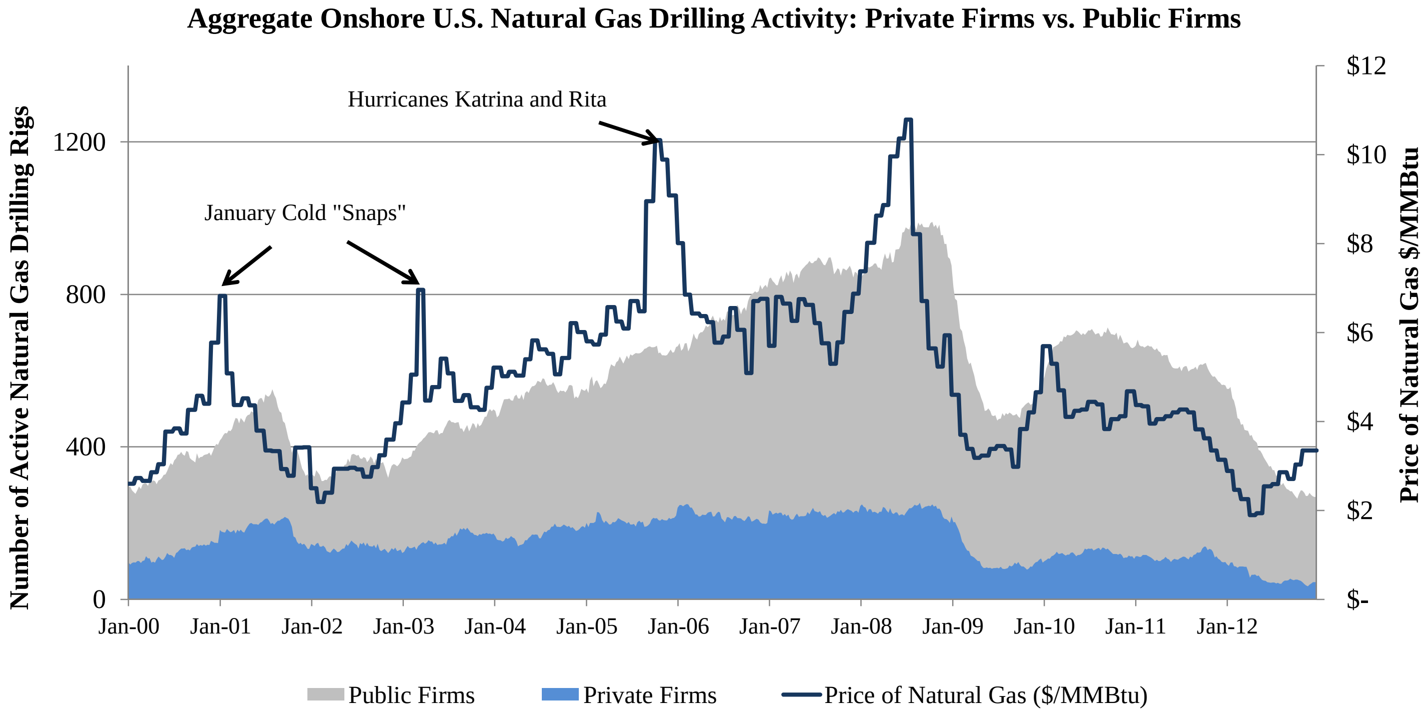
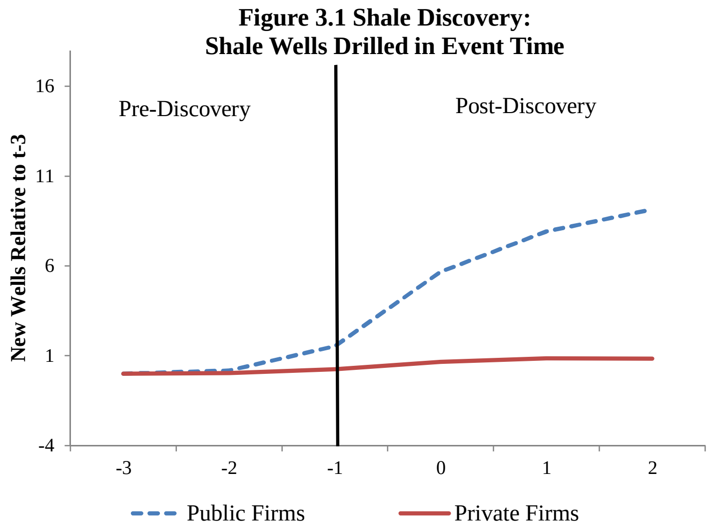


Figure 2: Onshore U.S. Natural Gas Drilling Activity: Private vs. Public Firms

This figure plots separately the weekly time-series of aggregate drilling activity in the onshore U.S. natural gas industry for public and private firms. The aggregate drilling activity of public firms is plotted as the upper boundary of the lighter shade, which is always greater than the aggregate drilling activity of private firms (darker shade) over the sample period. The figure also shows the weekly time-series of the wellhead price of natural gas. The time period ranges from 2000 to 2012.



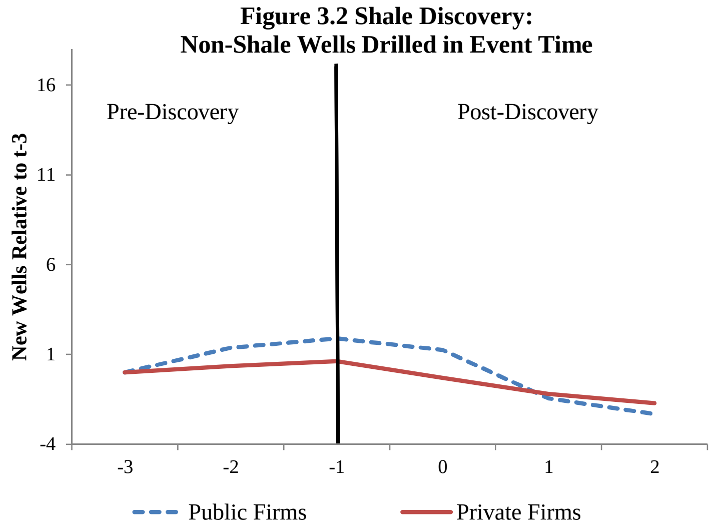


Figure 3.1: Shale Discovery: Shale Wells Drilled in Event Time
This figure plots separately the regression coefficients of dummy variables for the number of new shale wells drilled by private and public firms, based on the year relative to a discovery. The first year of a discovery is year 0. The first point is the plot of a dummy variable for time t-3 relative to the discovery. The dependent variable is the number of shale wells for a given firm in a county in a given year, so the coefficients can be interpreted as the change in drilling levels at different points in time relative to t-3. Natural gas prices and county-firm fixed effects are also included as controls in the regression.

Figure 3.2: Shale Discovery: Non-Shale Wells Drilled in Event Time
This figure plots separately the regression coefficients of dummy variables for the number of new non-shale wells drilled by private and public firms, based on the year relative to a discovery. The first year of a discovery is year 0. The first point is the plot of a dummy variable for time t-3 relative to the discovery. The dependent variable is the number of non-shale wells for a given firm in a county in a given year, so the coefficients can be interpreted as the change in drilling levels at different points in time relative to t-3. Natural gas prices and county-firm fixed effects are also included as controls in the regression.

Table 1. Summary Statistics

This table contains summary statistics for all publicly-traded and privately-held firms in the onshore U.S. Natural Gas industry for the period 2000 to 2012. For each firm, drilling activity (I) is defined as the total number of wells drilled in a given year and capital stock (K) is defined as the total number of wells drilled in the previous three years. Drilling intensity (I/K) is defined as the ratio of these two variables. A firm-year observation is included in our sample if it satisfies the following requirements: 1) non-missing capital stock, 2) drilled at least one well in current year, and 3) have capital stock greater than or equal to 10 wells. To mitigate the effect of outliers we exclude observations above the 99th percentile for I/K. Panel A reports summary statistics for drilling intensity (I/K), the logarithm of the number of new wells drilled (Log(I)) and natural gas prices over our sample period. Panel B highlights firm size differences between public and private firms for different capital stock (K) cutoffs and the matched sample. Similar to Asker et al. (2011), the matching is done on the capital stock (K) measure in the year that a private firm enters the sample. To be included, each matched pair is required to have no more than a 10% size difference in the year of the match. The matching technique is based on a nearest-neighbor approach, and the matched pair is kept until either the private firm is no longer in the sample or the matched public firm is no longer in the sample. If a public firm that has been matched leaves the sample, a new public firm is matched to the private firm based on the capital stock in that firm-year. The p-values are based on tests of differences in means (respectively medians). ***, **, and * indicates statistical significance at the 1%, 5%, and 10% level respectively.

Panel A: Descriptive Statistics for Key Variables

Drilling Intensity (I/K):	Public	Private	Difference	p-value
Mean	0.45	0.35	0.10***	0.000
Median	0.37	0.28	0.09***	0.000
Standard Deviation	0.36	0.31		

Drilling Activity (Log(I)):	Public	Private	Difference	p-value
Mean	3.58	2.00	1.59***	0.000
Median	3.61	1.95	1.67***	0.000
Standard Deviation	1.43	0.91		

Natural Gas Prices	$/MMBtu
Mean	4.90
Median	4.48
Standard Deviation	1.67
Number of Years in Sample	13

Panel B: Capital Stock Comparisons for Different Cutoffs and the Matched Sample

		Public	Private	Difference	p-value
	Mean	262.10	35.34	226.76***	0.000
K ≥ 10	Median	104	21	83***	0.000
	N	569	1813		
	Mean	331.80	75.55	256.25***	0.000
K ≥ 30	Median	145	48	97***	0.000
	N	441	567		
	Mean	383.21	116.41	266.79***	0.000
K ≥ 50	Median	177	78	99***	0.000
	N	374	273		
	Mean	22.07	22.15	-0.08	0.95
Matched sample	Median	14	15	-1	0.86
	N	1588	1588		

Table 2. Firm-Level Drilling Activity by Year: Private vs. Public Firms

This table compares the drilling intensity (I/K) levels between private and public firms for every year during the sample period from 2000 to 2012. The number of new wells drilled (I) and capital stock (K) variables are defined in Table 1. The variable NG State Prices takes on three values: (1) Low, (2) Med, or (3) High based on the natural gas price terciles (respectively lowest, middle, and highest third) during the sample period from 2000 to 2012. The differences in mean drilling intensity levels between public and private firms are reported with statistical significance based on a t-test. ***, **, and * indicates statistical significance at the 1%, 5%, and 10% level respectively.

		Mean Comparison		
Year	NG State Prices	Public	Private	Difference
2000	Low	0.52	0.48	0.05
2001	Med	0.50	0.48	0.02
2002	Low	0.40	0.30	0.09
2003	Med	0.43	0.33	0.11**
2004	Med	0.51	0.36	0.15***
2005	High	0.59	0.43	0.15**
2006	High	0.61	0.41	0.19***
2007	High	0.63	0.39	0.24***
2008	High	0.51	0.36	0.15**
2009	Low	0.16	0.20	-0.04
2010	Med	0.29	0.24	0.05
2011	Low	0.34	0.27	0.07
2012	Low	0.29	0.21	0.08

Table 3. Firm-Level Drilling Activity in Different Natural Gas Price Environments: Private vs. Public Firms

This table tests for differences in drilling activity, in both low and high price environments across public and private firms. The price environment indicator variables "Low" and "High" are based on the natural gas price terciles (respectively lowest and highest tercile) during the sample period from 2000 to 2012. The table reports results for drilling activity (number of new wells drilled) divided by the beginning of year capital stock measure (I/K) in columns (1) to (4) and for the logarithm of new wells drilled (Log(I)) in columns (5) to (8). The number of new wells drilled (I) and capital stock (K) variables are defined in Table 1. The different columns report the results for different samples based on size requirements, specifically columns (1)-(2) and (5)-(6) impose minimum capital stock levels of K ≥ 10, whereas columns (3)-(4) and (7)-(8) report results for our matched public-private sample, with matching based on capital stock (see Table 1 for details). The sample period is 2000 to 2012. All regressions include firm-level fixed effects. Standard errors are clustered by firm, with t-statistics reported in brackets below the coefficient estimates. The coefficient for $Private_i$ is not reported because it is not identified with $FirmFE_i$ fixed effects. ***, **, and * indicates statistical significance at the 1%, 5%, and 10% level respectively.

$$I_{i,t} = \alpha + \beta_1 Low_t + \beta_2 Low_t * Private_i + \beta_3 High_t + \beta_4 High_t * Private_i + \beta_5 Private_i + FirmFE_i + \varepsilon_{i,t}$$

	Dependent Variable = I/K				Dependent Variable = Log(I)			
	K ≥ 10		Matched on K		K ≥ 10		Matched on K	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
(β_1) Low_t	-0.085***	-0.115***	-0.105***	-0.136***	-0.199***	-0.237***	-0.192***	-0.228***
	[-5.56]	[-4.14]	[-5.06]	[-3.79]	[-5.82]	[-4.16]	[-5.64]	[-4.83]
(β_2) Low_t * $Private_i$		0.043		0.062		0.056		0.072
		[1.29]		[1.52]		[0.79]		[1.06]
(β_3) $High_t$	0.074***	0.160***	0.135***	0.229***	0.299***	0.470***	0.440***	0.584***
	[3.48]	[3.30]	[4.94]	[4.92]	[6.61]	[5.05]	[9.25]	[8.46]
(β_4) $High_t$ * $Private_i$		-0.113**		-0.187***		-0.226**		-0.289***
		[-2.11]		[-3.45]		[-2.13]		[-3.13]
(β_5) $Private_i$				Absorbed by $FirmFE_i$				
$FirmFE_i$	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R^2 Within	0.042	0.050	0.042	0.054	0.084	0.089	0.114	0.124
N - Total Firm Years	2382	2382	3176	3176	2382	2382	3176	3176
Private Firm Years	1813	1813	1588	1588	1813	1813	1588	1588
Public Firm Years	569	569	1588	1588	569	569	1588	1588

Table 4. Firm-Level Drilling Sensitivity to Natural Gas Prices: Private vs. Public Firms

This table tests for differences in drilling sensitivity to changes in natural gas prices across public and private firms. The sample period is 2000 to 2012. Panel A reports results for drilling activity (number of new wells drilled) divided by the beginning of year capital stock measure (I/K), while Panel B reports results for the logarithm of drilling activity (Log(I)). Capital stock (K) is defined in Table 1. The different columns report the results for different samples based on size requirements, specifically columns (1) to (6) impose minimum capital stock levels (K ≥ 10, K≥ 30, and K≥ 50 respectively), while columns (7) and (8) report results for our matched public-private sample, with matching based on capital stock (see Table 1 for details). All regressions include firm-level fixed effects. Standard errors are clustered by firm, with t-statistics reported in brackets below the coefficient estimates. The coefficient for $Private_i$ is not reported because it is not identified with $FirmFE_i$ fixed effects. * indicates significance at the 10% level, ** at the 5% level, and *** at the 1% level.

Panel A: $I/K_{i,t} = \alpha + \beta_1 NG_t + \beta_2 NG_t * Private_i + \beta_3 Private_i + FirmFE_i + \varepsilon_{i,t}$

Panel B: $log(I_{i,t}) = \alpha + \beta_1 NG_t + \beta_2 NG_t * Private_i + \beta_3 Private_i + FirmFE_i + \varepsilon_{i,t}$

Panel A: Dependent Variable = I/K

	K ≥ 10		K ≥ 30		K ≥ 50		Matched on K	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
(β_1) NG_t	0.036***	0.065***	0.040***	0.059***	0.045***	0.059***	0.053***	0.083***
	[7.03]	[5.33]	[5.46]	[4.81]	[5.85]	[5.88]	[4.44]	[3.70]
(β_2) NG_t * $Private_i$		-0.039***		-0.035**		-0.037**		-0.059**
		[-2.93]		[-2.38]		[-2.37]		[-2.52]
(β_3) $Private_i$				Absorbed by $FirmFE_i$				
$FirmFE_i$	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R^2 Within	0.032	0.040	0.054	0.064	0.088	0.101	0.031	0.041
N - Total Firm Years	2382	2382	1008	1008	647	647	3176	3176
Private Firm Years	1813	1813	567	567	273	273	1588	1588
Public Firm Years	569	569	441	441	374	374	1588	1588
Effect of NG_t on Private Firms								
$\beta_1 + \beta_2$ =		0.026***		0.024***		0.022*		0.024***
		[4.94]		[2.87]		[1.88]		[3.90]

Panel B: Dependent Variable = Log(I)

	K ≥ 10		K ≥ 30		K ≥ 50		Matched on K	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
(β_1) NG_t	0.123***	0.185***	0.156***	0.199***	0.189***	0.222***	0.151***	0.196***
	[9.24]	[7.22]	[7.55]	[7.90]	[7.50]	[8.52]	[6.79]	[5.13]
(β_2) NG_t * $Private_i$		-0.084***		-0.083**		-0.090		-0.091**
		[-2.80]		[-2.03]		[-1.52]		[-2.15]
(β_3) $Private_i$				Absorbed by $FirmFE_i$				
$FirmFE_i$	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R^2 Within	0.076	0.083	0.112	0.119	0.163	0.172	0.093	0.102
N - Total Firm Years	2382	2382	1008	1008	647	647	3176	3176
Private Firm Years	1813	1813	567	567	273	273	1588	1588
Public Firm Years	569	569	441	441	374	374	1588	1588
Effect of NG_t on Private Firms								
$\beta_1 + \beta_2$ =		0.102***		0.116***		0.132**		0.105***
		[6.63]		[3.62]		[2.48]		[5.82]

Table 5. Firm-Level Drilling Sensitivity: Size vs. Listing Status

This table compares the effects of differences in firm size and listing status on drilling sensitivity to changes in natural gas prices. The sample period is 2000 to 2012. Drilling activity (I) and capital stock (K) variables are defined in Table 1. Capital stock at the firm-level is used as our proxy for firm size; the size indicator variable (*Size Dummy* $_{it}$) takes the value of one for firms with above median size during a given year, and zero otherwise. The sample has a minimum capital stock cutoff of K ≥ 10. All regressions include firm-level fixed effects. Standard errors are clustered by firm, with t-statistics reported in brackets below the coefficient estimates. The coefficient for $Private_i$ is not reported because it is not identified with $FirmFE_i$ fixed effects. * indicates significance at the 10% level, ** at the 5% level, and *** at the 1% level.

Column 1: $I/K_{i,t} = \alpha + \beta_1 NG_t + \beta_2 NG_t * Private_i + \beta_3 Private_i + \beta_4 Size\ Dummy_{i,t} + \beta_5 NG_t * Size\ Dummy_{i,t} + FirmFE_i + \varepsilon_{i,t}$

Columns 2 and 3: $Log(I_{i,t}) = \alpha + \beta_1 NG_t + \beta_2 NG_t * Private_i + \beta_3 Private_i + \beta_4 Log(Size_{i,t}) + \beta_5 NG_t * Log(Size_{i,t}) + FirmFE_i + \varepsilon_{i,t}$

	I/K	**Log(I)**	
	(1)	(2)	(3)
NG_t	0.084***	0.181***	0.155*
	[5.34]	[5.04]	[1.89]
$NG_t * Private_i$	-0.042***	-0.087**	-0.080*
	[-2.90]	[-2.49]	[-1.79]
$Private_i$		Absorbed by $FirmFE_i$	
$Size\ Dummy_{i,t}$	-0.149***	0.193	
	[-2.60]	[1.15]	
$NG_t * Size\ Dummy_{i,t}$	-0.021**	0.005	
	[-2.08]	[0.16]	
$Log(Size_{i,t})$			0.236**
			[2.36]
$NG_t * Log(Size_{i,t})$			0.006
			[0.43]
$FirmFE_i$	Yes	Yes	Yes
R^2 Within	0.119	0.094	0.119
N - Total Firm Years	2382	2382	2382
Private Firm Years	1813	1813	1813
Public Firm Years	569	569	569

Table 6. Shale Discoveries and Drilling Activity: Private Firms vs. Public Firms

This table reports firm-county-level regressions that measure drilling responses by public and private firms to shale gas discoveries. The dependent variable is the number of wells drilled by firm (i) in county (j) in year (t). The sample period spans from 2000 to 2012, and covers shale discoveries that occur between 2003 and 2010. Capital stock at the firm-level is used as our proxy for firm size; the size indicator variable (*Size Dummy* $_{it}$) takes the value of one for firms with above median capital stock during a given year, and zero otherwise. The coefficient for $Private_i$ is not reported because it is not identified with $FirmCountyFE_{i,j}$ fixed effects. Standard errors are clustered by county, with t-statistics reported in brackets below the coefficient estimates, where * indicates significance at the 10% level, ** at the 5% level, and *** at the 1% level.

$$I_{i,j,t} = \alpha + \beta_1 NG_t + \beta_2 PostDiscovery_{j,t} + \beta_3 PostDiscovery_{j,t} * Private_i + \beta_4 Private_i + FirmCountyFE_{i,j} + \varepsilon_{i,j,t}$$

$$I_{i,j,t} = \alpha + \beta_1 NG_t + \beta_2 PostDiscovery_{j,t} + \beta_3 PostDiscovery_{j,t} * Private_i + \beta_4 Private_i + \beta_5 Size\ Dummy_{i,t} + \beta_6 PostDiscovery_{j,t} * Size\ Dummy_{i,t} + \beta_7 NG_t * Private_i + FirmCountyFE_{i,j} + \varepsilon_{i,j,t}$$

	I = New Wells Drilled				
	(1)	(2)	(3)	(4)	(5)
(β_1) NG_t	0.651***	0.690***	0.688***	0.686***	0.759**
	[2.92]	[3.24]	[3.23]	[3.20]	[2.19]
(β_2) $PostDiscovery_{j,t}$	2.801***	5.336***	5.424***	5.198***	5.268***
	[3.17]	[3.57]	[3.60]	[3.29]	[3.32]
(β_3) $PostDiscovery_{j,t}$ * $Private_i$		-5.623***	-5.699***	-5.511***	-5.622***
		[-3.89]	[-3.90]	[-3.67]	[-3.71]
(β_4) $Private_i$			Absorbed by Firm-CountyFE$_{i,j}$		
(β_5) Size $Dummy_{i,t}$			-1.429	-1.552	-1.525
			[-1.17]	[-1.07]	[-1.06]
(β_6) $PostDiscovery_{j,t}$ * Size $Dummy_{i,t}$				0.282	0.258
				[0.17]	[0.16]
(β_7) NG_t * $Private_i$					-0.161
					[-0.49]
Firm-CountyFE$_{i,j}$	Yes	Yes	Yes	Yes	Yes
R^2 Within	0.022	0.040	0.041	0.041	0.041
N	3318	3318	3318	3318	3318
Effect of $PostDiscovery_{j,t}$ on Private Firms					
$\beta_2 + \beta_3$ =		-0.286	-0.276	-0.313	-0.354
		[-0.91]	[-0.88]	[-0.93]	[-1.05]

Table 7. Shale Discoveries and Drilling Activity: Shale Wells vs. Non-Shale Wells

This table reports firm-county-level regressions that measure drilling responses, segmented by shale wells and non-shale wells, to shale gas discoveries. The dependent variable is the number of wells (shale or non-shale) drilled by firm (i) in county (j) in year (t). The coefficient for $Private_i$ is not reported because it is not identified with $FirmCountyFE_{i,j}$ fixed effects. Standard errors are clustered by county, with t-statistics reported in brackets below the coefficient estimates, where * indicates significance at the 10% level, ** at the 5% level, and *** at the 1% level.

$$I_{i,j,t} = \alpha + \beta_1 NG_t + \beta_2 PostDiscovery_{j,t} + \beta_3 PostDiscovery_{j,t} * Private_i + \beta_4 Private_i + FirmCountyFE_{i,j} + \varepsilon_{i,j,t}$$

$$I_{i,j,t} = \alpha + \beta_1 NG_t + \beta_2 PostDiscovery_{j,t} + \beta_3 PostDiscovery_{j,t} * Private_i + \beta_4 Private_i + \beta_5 Size\ Dummy_{i,t} + \beta_6 PostDiscovery_{j,t} * Size\ Dummy_{i,t} + FirmCountyFE_{i,j} + \varepsilon_{i,j,t}$$

	I = New Wells Drilled					
	Shale Wells			Non-shale Wells		
	(1)	(2)	(3)	(4)	(5)	(6)
(β_1) NG_t	-0.034	0.011	-0.006	0.685***	0.679***	0.692***
	[-0.22]	[0.08]	[-0.04]	[4.63]	[4.63]	[4.68]
(β_2) $PostDiscovery_{j,t}$	4.131***	7.066***	5.085***	-1.330***	-1.729**	0.113
	[6.14]	[6.28]	[3.79]	[-2.87]	[-2.37]	[0.18]
(β_3) $PostDiscovery_{j,t}$ * $Private_i$		-6.507***	-4.854***		0.884	-0.657
		[-5.91]	[-3.92]		[1.24]	[-0.98]
(β_4) $Private_i$	Absorbed by $Firm\text{-}CountyFE_{i,j}$					
(β_5) Size $Dummy_{i,t}$			-1.710**			0.158
			[-2.14]			[0.14]
(β_6) $PostDiscovery_{j,t}$ * Size $Dummy_{i,t}$			2.515**			-2.234**
			[2.04]			[-2.50]
$Firm\text{-}CountyFE_{i,j}$	Yes	Yes	Yes	Yes	Yes	Yes
R^2 Within	0.072	0.116	0.119	0.039	0.040	0.044
N	3318	3318	3318	3318	3318	3318

Table 8. Shale Discoveries and Drilling Activity: Financial Constraint Proxies in Private Firms

This table reports firm-county-level regressions that compare the drilling activity of shale wells across private firms. The table reports comparisons linked to two dimensions which may affect access to financing 1) Size 2) Distance to major energy lending centers. Specifications (1), (2), and (3) are comparisons of shale drilling responses of private firms headquartered in areas close to major energy lending centers. $PrivateClose_i$ takes the value of one for private firms with headquarters that are less than the median distance from energy financial centers (Denver, CO; Oklahoma City, OK; Tulsa, OK; Dallas, TX; Houston, TX; Austin, TX; San Antonio, TX). Specifications (4), (5), and (6) are based on comparisons shale drilling responses of private firms that are above median or below median size in a given year. The dependent variable is the number of shale wells drilled by firm (i) in county (j) in year (t). The sample period spans 2000 to 2012, and covers shale discoveries that occur between 2003 and 2010. Standard errors are clustered by county, with t-statistics reported in brackets below the coefficient estimates, where * indicates significance at the 10% level, ** at the 5% level, and *** at the 1% level.

$$I_{i,j,t} = \alpha + \beta_1 NG_t + \beta_2 PostDiscovery_{j,t} + \beta_3 PrivateClose_{i,t} + \beta_4 PostDiscovery_{j,t} * PrivateClose_{i,t} + FirmCountyFE_{i,j} + \varepsilon_{i,j,t}$$

$$I_{i,j,t} = \alpha + \beta_1 NG_t + \beta_2 PostDiscovery_{j,t} + \beta_3 Size\ Dummy_{i,t} + \beta_4 PostDiscovery_{j,t} * Size\ Dummy_{i,t} + FirmCountyFE_{i,j} + \varepsilon_{i,j,t}$$

	I = New Wells Drilled					
	Close to Energy Banking	Far from Energy Banking	All Firms	Big Firms	Small Firms	All Firms
	(1)	(2)	(3)	(4)	(5)	(6)
NG_t	0.065*	0.020	0.045*	-0.021	0.106***	0.047*
	[1.67]	[0.66]	[1.70]	[-0.50]	[4.09]	[1.79]
$PostDiscovery_{j,t}$	0.742***	0.360***	0.374***	0.900***	0.285***	0.240***
	[6.27]	[3.25]	[3.43]	[6.38]	[3.04]	[2.71]
$PrivateClose_i$			Absorbed by Firm-CountyFE$_{i,j}$			
$Size\ Dummy_{i,t}$						-0.211
						[-1.35]
$PostDiscovery_{j,t}$ * $PrivateClose_i$			0.359**			
			[2.32]			
$PostDiscovery_{j,t}$ * $Size\ Dummy_{i,t}$						0.687***
						[4.47]
Firm-CountyFE$_{i,j}$	Yes	Yes	Yes	Yes	Yes	Yes
R^2 Within	0.078	0.044	0.069	0.101	0.043	0.082
N	834	648	1482	725	757	1482

Table 9. Non-Shale Drilling Activity: Private Firms vs. Public Firms

This table tests for differences in investment sensitivity to changes in natural gas prices at the county level across public and private firms. The dependent variable is based on the number of non-shale wells drilled by firm (i) in county (j) in year (t). To avoid any confounding effects from shale discoveries, we focus only on non-shale (vertical) wells and only in county-years that do not experience a shale discovery. The sample period ranges from 2000 to 2012. The sample is based on firms with minimum capital stock levels of $K \geq 10$. All regressions include firm-county-level fixed effects. Standard errors are clustered by county, with t-statistics reported in brackets below the coefficient estimates. The coefficient for $Private_i$ is not reported because it is not identified with $FirmCountyFE_{i,j}$ fixed effects. * indicates significance at the 10% level, ** at the 5% level, and *** at the 1% level.

$$I_{i,j,t} = \alpha + \beta_1 NG_t + \beta_2 NG_t * Private_i + \beta_3 Private_i + FirmCountyFE_{i,j} + \varepsilon_{i,j,t}$$

	I = Log(New Wells Drilled)		I = New Wells Drilled	
	(1)	(2)	(3)	(4)
(β_1) NG_t	0.071***	0.100***	0.528***	0.831***
	[7.49]	[7.52]	[4.31]	[3.79]
(β_2) NG_t * $Private_i$		-0.067***		-0.680***
		[-4.58]		[-2.96]
(β_3) $Private_i$		Absorbed by Firm-$CountyFE_{i,j}$		
Firm-$CountyFE_{i,j}$	Yes	Yes	Yes	Yes
R^2 Within	0.024	0.030	0.013	0.018
N	9816	9816	9816	9816
Effect of NG_t on Private Firms				
$\beta_1 + \beta_2 =$		0.034***		0.151***
		[3.62]		[3.20]

Table 10. Sales of Acreage: Shale vs. Non-Shale

Panel A of this table reports acreage transactions between publicly-traded and privately-held firms in two shale discoveries and in non-shale areas with active sales of assets. The shale analysis is based on detailed production level data of the Woodford and Cana shale in Oklahoma. Specifically, using detailed production data from the Oklahoma Corporation Commission over the 2003 to 2010 time period in four counties ((1): Canadian county (discovery in 2008), (2): Coal county (discovery in 2006), (3) Pittsburg county (discovery in 2006), and (4) Hughes county (discovery in 2006)), we first compute the exact acreage that has pre-existing non-shale production prior to shale discoveries. We then compute the proportion of this acreage that is sold off after the shale discoveries are made. We infer that a transfer of acreage from producer A to producer B has occurred when producer B is producing on the acreage that producer A was developing prior to the shale discovery. The proportion of acreage held by private firms sold off to other private (respectively public) firms is computed, as well as the proportion of public acreage sold off to private (respectively other public) firms. For non-shale acreage transactions, we focus on the ten most active survey townships (a survey township is a geographic area defined by the Public Land Survey System) in Oklahoma outside of shale discoveries during the 2003 to 2010 time frame. These asset sales can serve as a basis of comparison for the shale transactions. Panel B computes the stock market reaction (cumulative abnormal returns CAR[-2;2]) around announcements of natural gas asset purchases by public firms. We separate the reaction for assets purchased from private firms relative to those purchased from other public firms. Transaction data is from SDC. Stock market data is from CRSP. Statistical significance is computed using Patell (1976). The differences in proportions sold off are reported with statistical significance based on a t-test. ***, **, * indicates statistical significance at the 1%, 5% and 10% level respectively.

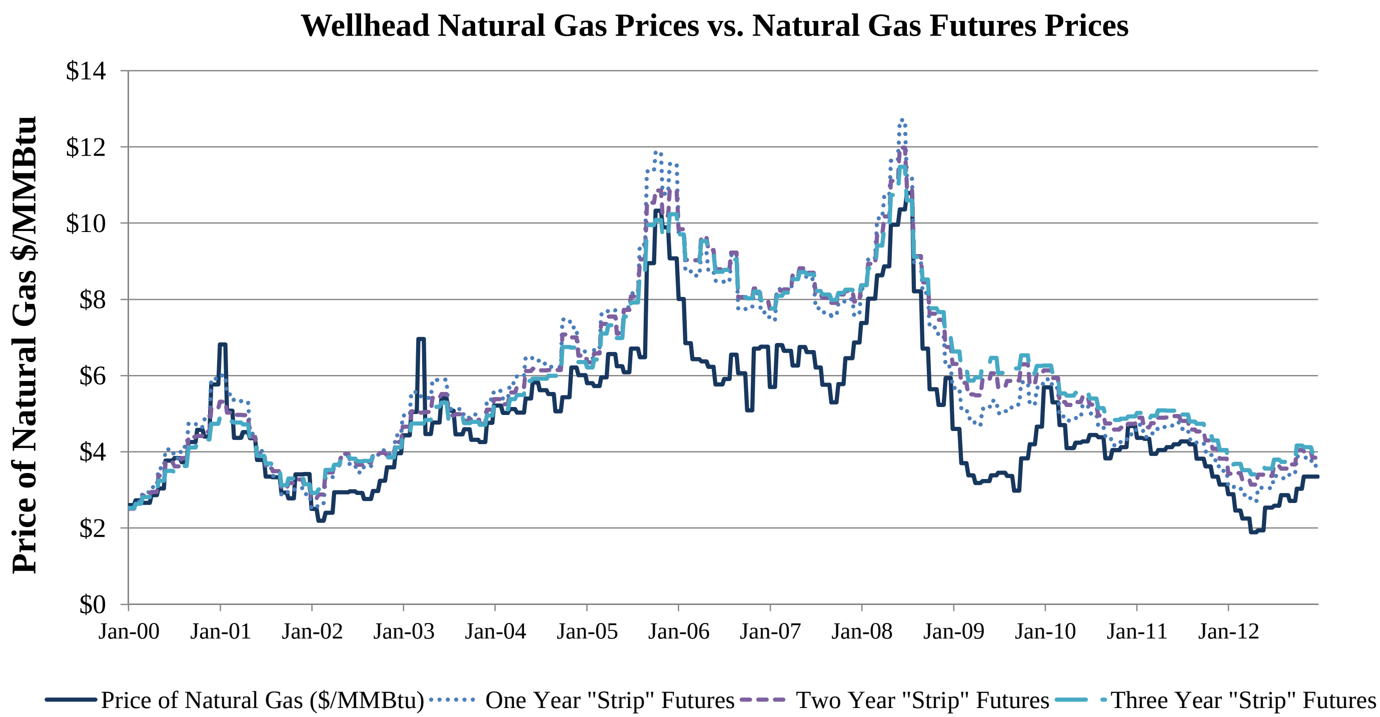
Panel A: Drilling Right Sale Comparisons

Number of Acres Held by Private Companies: Shale	36,480
Number of Acres Held by Private Companies: Non-Shale	67,840

	Private to Public Sale	Private to Private Sale	Difference
Shale Asset Sales	63.2%	5.3%	57.9%***
Non-Shale Asset Sales	38.7%	39.6%	-0.9%

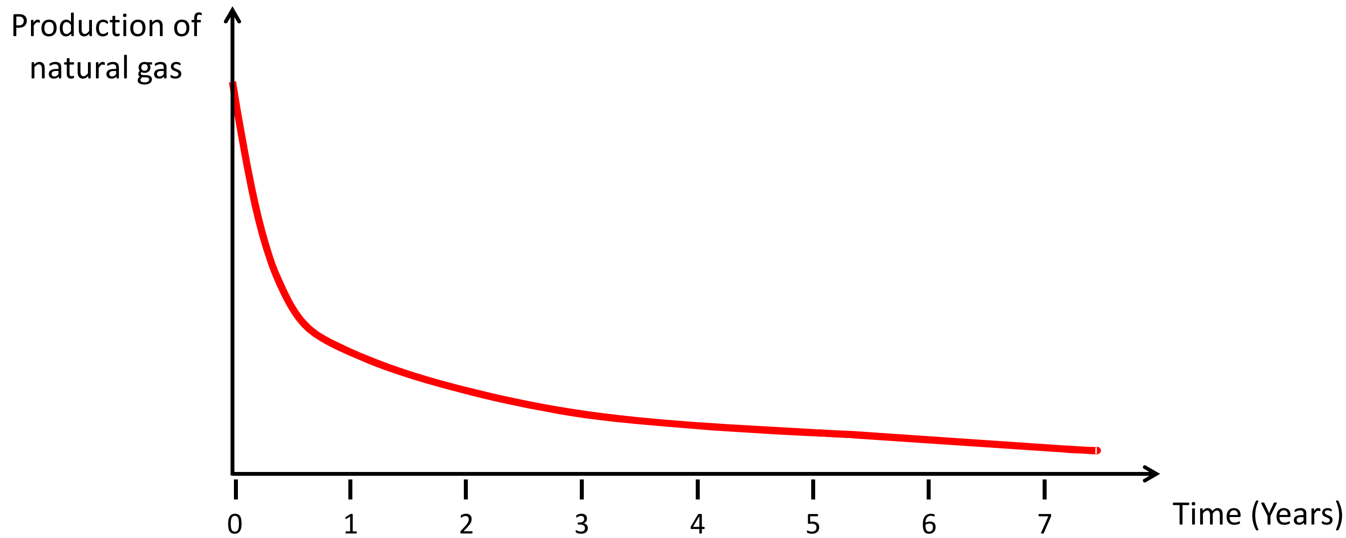
Panel B: Public Firm Stock Price Reaction to Asset Acquisitions

	Abnormal Return	p-value	Number of Events
Acquisition of Assets from Public Firms	-0.31%	0.48	139
Acquisition of Assets from Private Firms	0.38%**	2.25	167



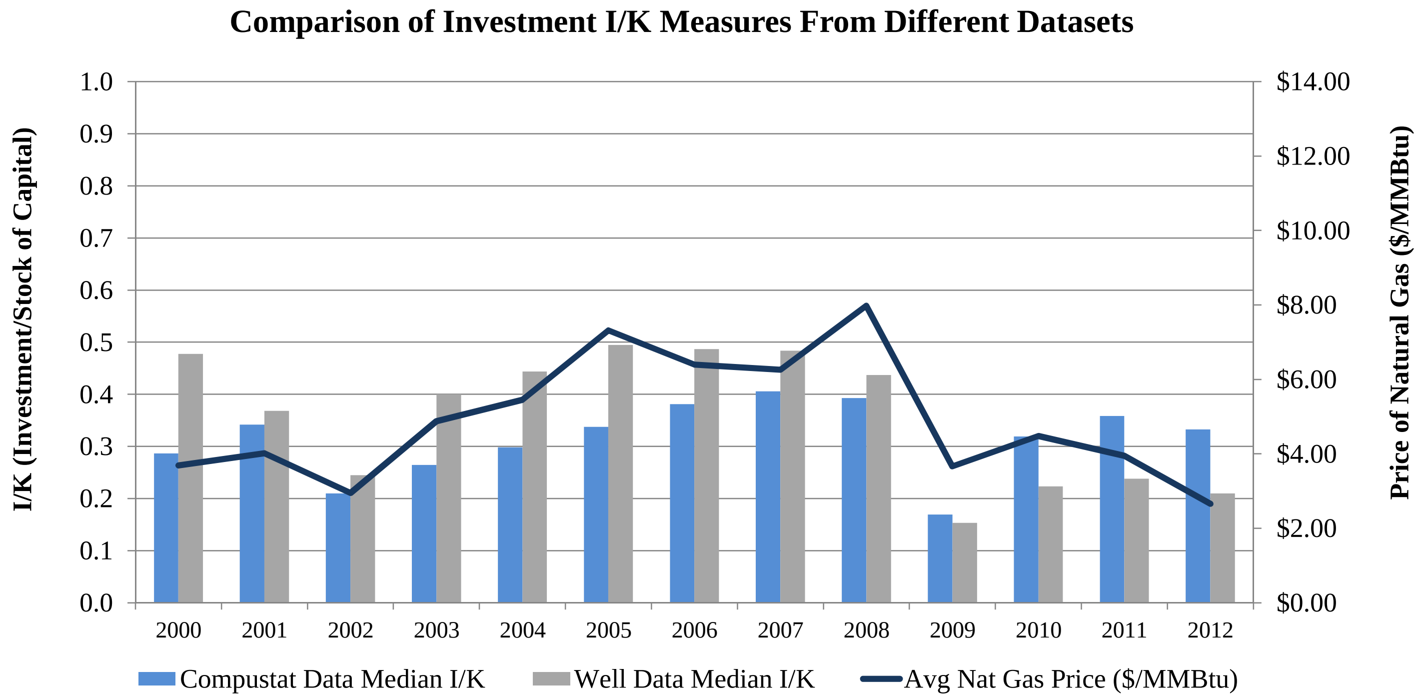
Appendix Figure A: U.S. Natural Gas Wellhead and Futures Prices

This figure plots wellhead natural gas prices and three different measures of natural gas futures prices. The wellhead natural gas price measure is the primary measure used in the study and is based on data from the U.S. Energy Information Administration (EIA). The natural gas price futures measures are calculated using the industry standard "strip" price convention which provides an average of futures prices of different maturities. Specifically, the "strip" price for any given time period to come is the average of all monthly natural gas futures prices over that time period to come. For instance, the one year strip is the average of all monthly futures prices with maturity date of twelve months or less. The futures prices used are NYMEX futures prices, which have a delivery point of a single location in Henry Hub, LA. This data is from Bloomberg.



Appendix Figure B: Example of Project Timeline

This figure plots a typical production curve over time for a natural gas well, once production begins. It is based on similar figures found in Lake, Martin, Ramsey, and Titman (2013) as well as company investor presentations.



Appendix Figure C: Comparison of I/K Measures based on Accounting Data versus Drilling Data

This figure compares the medians of two different measures of Investment/Capital Stock (I/K), one based on Compustat accounting data and one based on our drilling data, plotted with the annual average wellhead price of natural gas. The comparison is performed on the same set of sample firms, meaning that a firm must have both Compustat accounting data and drilling activity data in a given year, and be classified in SIC 1311 (Crude Petroleum and Natural Gas). The Compustat measure of I/K is calculated as investment (code: capx) divided by beginning of period net property, plant, and equipment (code: ppent). The drilling data measure of I/K is calculated as investment (proxied by the number wells drilled) divided by capital stock (proxied by the number of wells completed in the previous three years).

Appendix A. Correlation of Wellhead Price with Futures Prices and Regional Prices

This table reports correlations of the monthly wellhead price of natural gas reported by the EIA (the price data used for our main tests) with natural gas futures prices and regional natural gas prices over the time period 2000 to 2012. Natural gas futures prices are collected from Bloomberg, and calculated using the industry standard "strip" convention. The "strip" price of natural gas is the average price of natural gas futures prices with monthly expirations over a certain time period. For example, the 12-month strip price for January 2010 is comprised of the average of the futures price for delivery in February 2010, March 2010 and so on until delivery in January 2011. This smoothes out any seasonal fluctuations in futures prices. Regional hub prices are the average of spot prices at natural gas trading hubs in a given region; these are also obtained from Bloomberg.

Correlation With Futures Prices

	Futures 12 Month "Strip"	Futures 24 Month "Strip"	Futures 36 Month "Strip"
Wellhead Price of Natural Gas ($/MMBtu)	95%	91%	88%

Correlation With Regional Prices

	U.S. Gulf Coast	U.S. Midwest	U.S. Northeast	U.S. West
Wellhead Price of Natural Gas ($/MMBtu)	96%	95%	96%	91%

Appendix B. Shale Discovery Background

Shale discoveries at the county level represent local growth opportunity shocks for firms with existing operations in these areas. These shocks are used in the difference-in-differences estimations shown in Tables 6, 7, and 8. Panel A reports the number of shale discoveries at the county level over time. Shale discoveries are defined as in Gilje (2011), who relies on the number of horizontal wells drilled in a given county. Data requirements limit the discoveries to those made in 2010 or before. Specifically, we require three years of data for the post-discovery window and our dataset ends in 2012 so the latest discoveries have to be in 2010 to have a valid post-discovery window (2010-2012). Panel B compares shale-related production and well costs for private and public firms. Data on well production and well costs is for the Woodford (OK) and Cana (OK) shale discoveries, where detailed data on production and well costs are available from the Oklahoma Corporation Commission. Specifically, the panel reports results for shale well production (respectively shale well costs) regressed on a private dummy variable and township (precise location) and year fixed effects. These regressions test whether privately-held firms have different production levels (respectively costs) from the shale wells they undertake relative to their publicly-traded counterparts. * indicates significance at the 10% level, ** at the 5% level, and *** at the 1% level.

Panel A: Shale Discoveries Over Time

Year	**Discoveries**	**Cumulative Discoveries**
2003	4	4
2004	10	14
2005	3	17
2006	13	30
2007	14	44
2008	25	69
2009	15	84
2010	18	102
Total		**102**

Panel B: Shale Well Production and Cost Comparison

	Dependent Variable	
	Log(Production)	Log(Cost)
	(1)	(2)
$Private_i$	-0.044	-0.037
	[-0.36]	[-0.83]
$YearFE_t$	Yes	Yes
$TownshipFE_j$	Yes	Yes
Wells Drilled by Private Firms	165	165
Wells Drilled by Public Firms	793	755
R^2	0.387	0.553
N	958	920

Appendix C. Well Cost Comparison Large Firms vs. Small Firms

This table reports the median drilling cost per well for publicly traded firms within the industry code SIC 1311 (Crude Petroleum and Natural Gas) that are also in the drilling data sample. Firms are divided into two groups: 1) Large firms, defined as firms with total assets above the median asset size for all public firms in a given year and 2) Small firms, defined as firms with total assets below the median asset size for all public firms in a given year. The well cost for a firm is based on capital expenditures divided by the total number of all wells drilled by that firm in a given year, which is hand-collected information from each public firm's 10-K. The median asset values within small and large firms are also reported for each year. The differences in well cost and firm size (assets) across small and large firms are computed with statistical significance based on a median test (only p-values reported).

	Large Natural Gas Producers			Small Natural Gas Producers			Difference (only p-values reported)	
Year	Obs	Median Well Cost ($ Millions)	Median Assets ($ Millions)	Obs	Median Well Cost ($ Millions)	Median Assets ($ Millions)	Well Cost (p-value)	Assets (p-value)
2006	19	2.3	4829.8	19	2.8	893.0	0.330	0.000
2007	22	2.8	5529.2	23	2.2	861.0	0.460	0.000
2008	22	3.1	6234.9	22	3.7	1055.0	0.370	0.000
2009	18	4.5	6994.4	19	4.3	1435.0	0.870	0.000

Appendix D. Firm-level Drilling Sensitivities: Alternate Specifications

This table reports firm-level regressions of drilling sensitivity to natural gas prices for public and private firms using several alternative specifications relative to the main specification of Table 4. Drilling activity (I) and capital stock (K) are defined in Table 1. Panel A reports results for drilling activity divided by the beginning of year capital stock measure (I/K), while Panel B reports results for the logarithm of drilling activity (Log(I)). The sample period is 2000 to 2012. The columns report the results for several alternative specifications. Columns (1) and (2) use observations based on quarterly data as opposed to annual data. Columns (3) and (4) show results for the futures "strip" price of natural gas instead of the spot price. Columns (5) and (6) exclude the largest firms (firms with $K \geq 500$) from the sample. Columns (7) and (8) include time fixed effects in the specification. All regressions include firm-level fixed effects. Standard errors are clustered by firm, with t-statistics reported in brackets below the coefficient estimates. * indicates significance at the 10% level, ** at the 5% level, and *** at the 1% level.

Panel A: $I/K_{i,t} = \alpha + \beta_1 NG_t + \beta_2 NG_t * Private_i + \beta_3 Private_i + FirmFE_i + \varepsilon_{i,t}$

Panel B: $log(I_{i,t}) = \alpha + \beta_1 NG_t + \beta_2 NG_t * Private_i + \beta_3 Private_i + FirmFE_i + \varepsilon_{i,t}$

Panel A: Dependent Variable = I/K

	Quarterly		Futures		Excluding Largest Firms		Time FE	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
(β_1) NG_t	0.008***	0.013***	0.025***	0.049***	0.036***	0.069***	Absorbed by $TimeFE_t$	
	[7.40]	[5.16]	[5.54]	[4.60]	[6.69]	[4.84]		
(β_2) NG_t * $Private_i$		-0.007**		-0.032***		-0.042***		-0.030**
		[-2.56]		[-2.78]		[-2.80]		[-2.40]
(β_3) $Private_i$				Absorbed by $FirmFE_i$				
$FirmFE_i$	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R^2 Within	0.017	0.020	0.025	0.033	0.031	0.038	0.167	0.171
N - Total Firm Years	9525	9525	2382	2382	2302	2302	2382	2382
Effect of NG_t on Private Firms								
$\beta_1 + \beta_2$ =		0.006***		0.017***		0.026***		NM
		[5.54]		[3.58]		[4.93]		NM

Panel B: Dependent Variable = Log(I)

	Quarterly		Futures		Excluding Largest Firms		Time FE	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
(β_1) NG_t	0.082***	0.145***	0.093***	0.145***	0.120***	0.179***	Absorbed by $TimeFE_t$	
	[8.86]	[7.42]	[7.95]	[6.48]	[8.93]	[5.89]		
(β_2) NG_t * $Private_i$		-0.085***		-0.071***		-0.077**		-0.065**
		[-3.88]		[-2.71]		[-2.29]		[-2.21]
(β_3) $Private_i$				Absorbed by $FirmFE_i$				
$FirmFE_i$	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R^2 Within	0.041	0.049	0.069	0.076	0.071	0.076	0.150	0.154
N - Total Firm Years	9525	9525	2382	2382	2302	2302	2382	2382
Effect of NG_t on Private Firms								
$\beta_1 + \beta_2$ =		0.060***		0.075***		0.102***		NM
		[6.10]		[5.56]		[6.96]		NM

Appendix E. Dataset Example

The drilling dataset used in this study is compiled from the Smith International Rig Count (now a subsidiary of Schlumberger). Below is a portion of the raw output of a download of this data. The unit of observation of the dataset is: Rig-Week, which is defined as the week that a drilling rig is actively drilling a well. The number of rig-week observations corresponds to the number of weeks it takes to drill a given well. Our firm-year and firm-county-year datasets are constructed by computing the number of wells a given firm starts in a year or county-year. The unique identifier used for a well is its state + county + well name + well number. This data spans from 1997 to 2012, however, we use the first 3 years of data to build our capital stock (K) measures. As such, our sample period with complete data runs from 2000 to 2012.

FRIDAY DATE	COUNTRY	STATE	COUNTY	TEXAS RR DISTRICT	PARENT COMPANY NAME	COMPANY NAME	CONTRACTOR	CONTRACT TYPE	RIG NAME NUMBER TXT	RIG TYPE	RIG DEPTH RATING (FT)	WELL NAME	WELL NUMBER	SPUD DATE	LEASE NAME	WELL STATUS	WELL TYPE	WELL DIRECTION	PROPOSED DEPTH	WELL TARGET	WELL LOCATION
4/13/2012	UNITED STATES	OK	CANADIAN		CIMAREX ENERGY	CIMAREX ENERGY	CACTUS DRILLING	Day Work	148	Land	10000	WARD	5-28H	4/8/2012	WARD	DRILLING	Dev	Horizontal	17350	Gas	OnShore
4/20/2012	UNITED STATES	OK	CANADIAN		CIMAREX ENERGY	CIMAREX ENERGY	CACTUS DRILLING	Day Work	148	Land	10000	WARD	5-28H	4/8/2012	WARD	DRILLING	Dev	Horizontal	17350	Gas	OnShore
4/27/2012	UNITED STATES	OK	CANADIAN		CIMAREX ENERGY	CIMAREX ENERGY	CACTUS DRILLING	Day Work	148	Land	10000	WARD	5-28H	4/8/2012	WARD	DRILLING	Dev	Horizontal	17350	Gas	OnShore
5/4/2012	UNITED STATES	OK	CANADIAN		CIMAREX ENERGY	CIMAREX ENERGY	CACTUS DRILLING	Day Work	148	Land	10000	WARD	5-28H	4/8/2012	WARD	DRILLING	Dev	Horizontal	17350	Gas	OnShore

Field Description	
Friday Date	Date of the survey on rig counts
Country	United States, all data for this rig count are from the U.S.
State	U.S. State of Drilling Rig Activity
Texas RR District	Texas Railroad Commission District (the governing body for oil and gas development in TX), if the well is in Texas
Parent Company Name	The parent company name of the firm drilling the well
Company Name	The company name of the firm drilling the well
Contractor	The 3rd party contractor that is hired to drill the well
Contract Type	Day work, turn key, or footage. This specifies whether firms pay by the day (Day Work), the foot (footage), or a fixed amount (Turn Key) for the well
Rig Name Number TXT	The rig number that the contracting firm has assigned to the rif
Rig Type	Land or Off-shore, all observations used in our study are for Land Rigs
Rig Depth Rating (FT)	The listed depth at which the rig is rated to drill
Well Name	The name of the well being drilled
Well Number	The number assigned to the well, the combination of well name with well number creates a unique identifier for the well
Spud Date	The date the drilling rig began drilling a well
Lease Name	The name of the lease that a well is on
Well Status	A field which indicates whether a well is drilling, rigging down, or rigging up.
Well Type	A field which indicates whether a well is Development or Exploratory
Well Direction	A field which indicates whether a well is being drilled vertically or horizontally
Proposed Depth	The proposed depth in feet of a well
Well Target	An indication of whether the well is targeting natural gas, oil, or water
Well Location	An indicator field for whether the well is onshore or offshore

Appendix F. Shareholder-Manager Agency Costs: Drilling Level Comparison

This table compares the drilling intensity (I/K) levels between private firms, public firms with high insider ownership (low shareholder-manager agency costs), and public firms with low insider ownership (high shareholder-manager agency costs). The sample period is from 2000 to 2012. High (respectively low) insider ownership is defined as a firm with above (respectively below) median insider ownership in a given year. Annual data on insider ownership is hand-collected from proxy statements. Drilling activity (I) and capital stock (K) variables are defined in Table 1. The variable NG State Prices takes on three values: (1) Low; (2) Med and (3) High based on the natural gas price terciles (respectively lowest, middle, and highest third). The differences in mean drilling intensity levels between public firms with high insider ownership vs. public firms with low insider ownership, and respectively public firms with high insider ownership vs. private firms are reported with statistical significance based on a t-test. ***, **, * indicates statistical significance at the 1%, 5% and 10% level respectively.

		Mean I/K			Difference	
Year	NG State Prices	Public High Insider Ownership	Public Low Insider Ownership	Private	Public High Insider Ownership vs. Public Low Insider Ownership	Public High Insider Ownership vs. Private
2000	Low	0.62	0.50	0.48	0.13	0.15
2001	Med	0.55	0.44	0.48	0.11	0.07
2002	Low	0.35	0.34	0.30	0.01	0.05
2003	Med	0.41	0.43	0.33	-0.02	0.09
2004	Med	0.60	0.47	0.36	0.13	0.24**
2005	High	0.72	0.51	0.43	0.21	0.28*
2006	High	0.73	0.59	0.41	0.14	0.31**
2007	High	0.82	0.51	0.39	0.30**	0.43***
2008	High	0.58	0.49	0.36	0.09	0.22**
2009	Low	0.15	0.17	0.20	-0.02	-0.05**
2010	Med	0.25	0.28	0.24	-0.03	0.01
2011	Low	0.37	0.28	0.27	0.08	0.09
2012	Low	0.27	0.35	0.21	-0.08	0.06

Appendix G. Shareholder-Manager Agency Costs: Investment Sensitivity Comparison, Excluding Firms with Low-Insider Ownership

This table reports firm-level regressions of drilling sensitivity to natural gas prices for public and private firms, excluding public firms with low insider ownership (below median insider ownership level). Annual data on insider ownership is hand-collected from proxy statements. The sample period is from 2000 to 2012. Drilling activity (I) and capital stock (K) are defined in Table 1. The dependent variables in these regressions are different measures of drilling activity. Panel A reports results for the number of new wells drilled (I) divided by the beginning of year capital stock measure (I/K), while Panel B reports results for the logarithm of the number of new wells drilled (Log(I)). The columns report results for different subsamples based on size requirements, specifically columns (1) to (6) require different minimum levels of capital stock. All regressions include firm-level fixed effects. Standard errors are clustered by firm, with t-statistics reported in brackets below the coefficient estimates. * indicates significance at the 10% level, ** at the 5% level, and *** at the 1% level.

Panel A: $I/K_{i,t} = \alpha + \beta_1 NG_t + \beta_2 NG_t * Private_i + \beta_3 Private_i + FirmFE_i + \varepsilon_{i,t}$

Panel B: $log(I_{i,t}) = \alpha + \beta_1 NG_t + \beta_2 NG_t * Private_i + \beta_3 Private_i + FirmFE_i + \varepsilon_{i,t}$

Panel A: Dependent Variable = I/K

	K ≥ 10		K ≥ 30		K ≥ 50	
	(1)	(2)	(3)	(4)	(5)	(6)
(β_1) NG_t	0.034***	0.099***	0.041***	0.088***	0.044***	0.075***
	[6.11]	[4.63]	[4.67]	[4.60]	[4.66]	[5.85]
(β_2) $NG_t * Private_i$		-0.072***		-0.065***		-0.053***
		[-3.30]		[-3.10]		[-3.03]
(β_3) $Private_i$			Absorbed by $FirmFE_i$			
$FirmFE_i$	Yes	Yes	Yes	Yes	Yes	Yes
R^2 Within	0.028	0.040	0.052	0.078	0.076	0.103
N - Total Firm Years	2051	2051	761	761	442	442
Private Firm Years	1813	1813	567	567	273	273
Public Firm Years	238	238	194	194	169	169
Effect of NG_t on Private Firms						
$\beta_1 + \beta_2 =$		0.026***		0.024***		0.022*
		[4.94]		[2.86]		[1.88]

Panel B: Dependent Variable = Log(I)

	K ≥ 10		K ≥ 30		K ≥ 50	
	(1)	(2)	(3)	(4)	(5)	(6)
(β_1) NG_t	0.114***	0.216***	0.140***	0.205***	0.175***	0.238***
	[7.94]	[6.09]	[5.33]	[4.97]	[4.92]	[5.93]
(β_2) $NG_t * Private_i$		-0.114***		-0.089*		-0.107
		[-2.96]		[-1.71]		[-1.60]
(β_3) $Private_i$			Absorbed by $FirmFE_i$			
$FirmFE_i$	Yes	Yes	Yes	Yes	Yes	Yes
R^2 Within	0.065	0.071	0.083	0.090	0.122	0.133
N - Total Firm Years	2051	2051	761	761	442	442
Private Firm Years	1813	1813	567	567	273	273
Public Firm Years	238	238	194	194	169	169
Effect of NG_t on Private Firms						
$\beta_1 + \beta_2 =$		0.102***		0.116***		0.132**
		[6.63]		[3.61]		[2.47]

Appendix H. Pre-Discovery Parallel Trends

This table reports a falsification regression designed to test for "parallel trends" prior to shale discoveries. The dependent variable is the number of wells drilled by firm (i) in county (j) in year (t). The falsification tests in this table are based on moving a discovery in a given county three years earlier to create a $PlaceboDiscovery_{j,t}$ variable. Because this specification tests for trends during pre-discovery time periods, the sample time period is reduced by three years. Specifically, we move forward all discoveries occurring between 2006 and 2010 by three years so our "Placebo" discoveries range from 2003 to 2007. All regressions include firm-county fixed effects (fixed effect for each firm in each county). Standard errors are clustered by county, with t-statistics reported in brackets below the coefficient estimates, where * indicates significance at the 10% level, ** at the 5% level, and *** at the 1% level.

$$I_{i,j,t} = \alpha + \beta_1 NG_t + \beta_2 PlaceboDiscovery_{j,t} + \beta_3 Private_i + \beta_4 Size\ Dummy_{i,t} + \beta_5 PlaceboDiscovery_{j,t} * Private_i + \beta_6 PlaceboDiscovery_{j,t} * Size\ Dummy_{i,t} + \beta_7 NG_t * Private_i + \beta_8 Private_i + FirmCountyFE_{i,j} + \varepsilon_{i,j,t}$$

	I = New Wells Drilled	
	(1)	(2)
NG_t	0.696***	0.784***
	[5.07]	[3.99]
$PlaceboDiscovery_{j,t}$		0.154
		[0.15]
Size $Dummy_{i,t}$		-0.819
		[-0.76]
$PlaceboDiscovery_{j,t}$ * $Private_i$		-0.017
		[-0.02]
$PlaceboDiscovery_{j,t}$ * Size $Dummy_{i,t}$		1.076
		[1.18]
NG_t * $Private_i$		-0.452**
		[-2.48]
$Private_i$	Absorbed by Firm-$CountyFE_{i,j}$	
Firm-$CountyFE_{i,j}$	Yes	Yes
R^2 Within	0.034	0.045
N	2982	2982

Appendix I. Analysis of Company IPOs

This table reports data from the companies in SIC code 1311 that go public during the time period of shale discoveries in our study. It includes qualitative language on the use of proceeds, and classifies whether funding costly shale projects played a role in the decision to go public based on whether the proceeds were (1) going to be used for capital expenditures for drilling and development by a company with shale projects or (2) being used to repay prior indebtedness incurred to meet capital expenditure requirements. The source for the data is from the S-1 filings prior to when a company goes public.

Key	Firm	Fiscal Year	IPO related to funding shale projects?	Financing Language Details
1	Approach Resources Inc	2007	Yes	We intend to use the net proceeds of this offering to ***repay approximately $XX million outstanding under our revolving credit facility***, to repurchase shares of our common stock held by Neo Canyon Exploration, L.P. at a purchase price of $XX million and the remainder for general corporate purposes, ***including exploration and development activities, gas and oil reserves and leasehold acquisitions*** in the ordinary course of business and for working capital. At March 31, 2007, outstanding borrowings under our revolving credit facility totaled approximately $52.2 million with an interest rate of 7.02%. ***We incurred the debt under our revolving credit facility principally to meet our capital expenditure requirements*** and other working capital needs. We will have no outstanding borrowings under our revolving credit facility after the closing of this offering.
2	Bill Barrett Corp	2004	Yes	We intend to use the net proceeds of this offering to ***repay all of our outstanding indebtedness under our revolving credit facility*** and to ***fund exploration and development activities***, acquisitions, working capital and other general corporate purposes. Our revolving credit facility provides for commitments of $200 million with an initial borrowing base of $150 million. Currently, the borrowing base is divided into two parts, with the "Tranche A" portion making $100 million available for all corporate purposes and the "Tranche B" portion *making* ***$50 million available only to develop natural gas and oil properties***.
3	Concho Resources Inc	2007	Yes	We intend to use all of the net proceeds we receive from this offering to ***repay a portion of our outstanding indebtedness*** under our second lien term loan facility, our revolving credit facility or a combination of the foregoing. Under the terms of our second lien term loan facility, we are obligated to use not less than 50% of our net proceeds to repay our outstanding indebtedness under our second lien term loan facility. Our second lien term loan facility currently bears interest at 9.10% per annum and matures on March 27, 2012.
4	Continental Resources Inc	2007	No	The selling shareholder identified in this prospectus is offering shares of our common stock. We will not receive any proceeds from the sale of the shares by the selling shareholder.
5	Encore Energy Partners LP	2007	Yes	We intend to use the estimated net proceeds of approximately $190.1 million from this offering, after deducting underwriting discounts of $14.5 million and estimated offering expenses of approximately $2.5 million, to: • ***repay $64.9 million of indebtedness*** under our revolving credit facility; and • ***repay all $120 million of indebtedness***, together with accrued interest of $5.2 million, under a subordinated secured term loan agreement with one of EAC's subsidiaries. On March 7, 2007, we acquired oil and natural gas properties and related assets in the Elk Basin for approximately $328.7 million, including estimated transaction costs of approximately $0.3 million. We partially ***financed the acquisition*** and related costs with borrowings of $115 million ***under our revolving credit facility*** and proceeds from a $120 million subordinated secured term loan from EAP Operating, Inc., a wholly owned subsidiary of EAC. As of March 31, 2007, the interest rate was 7.1% under the revolving credit facility and 10.3% under the subordinated secured term loan.
6	Sandridge Energy Inc	2007	Yes	We intend to use these proceeds for general corporate purposes, including the ***acceleration of our drilling program*** in West Texas and the Piceance Basin.
7	Venoco Inc	2006	Yes	We anticipate that the net proceeds will be used as follows: 1. for potential acquisitions; 2. to ***supplement our existing sources of funding for our capital expenditure program*** *as needed*; and 3. for general corporate purpose
8	Pinnacle Gas Resources Inc	2007	Yes	We plan to use all of the net proceeds we receive from this offering for ***accelerated capital expenditures***, infrastructure development and general corporate purposes.
9	Matador Resources Co	2012	Yes	We intend to use the net proceeds we receive from this offering to ***repay in full the $25.0 million term loan*** that is due and payable on December 31, 2011 and to ***repay in full the outstanding indebtedness under our revolving credit agreement*** ($60.0 million at October 31, 2011). Following the application of the net proceeds we receive from this offering, we will not have any long-term indebtedness outstanding and will have $78.7 million available for potential future borrowings (after giving effect to outstanding letters of credit). We intend to use the remaining net proceeds from this offering to ***fund a portion of our 2012 capital expenditure requirements*** and for potential acquisitions of interests and acreage.
10	Bonanza Creek Oil Co	2011	Yes	We intend to use a portion of the net proceeds from this offering to ***repay all outstanding indebtedness under our credit facility***, which as of April 30, 2011, was approximately $68.4 million. The remaining proceeds will be used to ***fund our exploration and development program*** and for general corporate purposes.
11	Laredo Petroleum Holdings	2011	Yes	We intend to use a portion of the net proceeds from this offering to ***repay $XX million of our outstanding indebtedness under our senior secured credit facility***, approximately $500 million of which was outstanding on August 19, 2011. The remaining net proceeds of approximately $XX, including the net proceeds from any exercise of the underwriters' option to acquire additional shares of common stock, will be used to ***fund our future exploration, development and other capital expenditures***, as well as for general working capital purposes.
12	Midstates Petroleum Co	2012	Yes	We intend to use $XX million of the net proceeds from this offering to ***repay all outstanding indebtedness under our revolving credit facility***. The remaining proceeds of approximately $XX million will be used to ***fund a portion of our exploration and development program***.