INVESTMENTS: EFFECT OF OIL PRICES

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Abstract

This paper studies the impact of oil prices on investment behaviour among oil and gas companies. In particular, we study the impact of dividend commitments, leverage and extent of vertical integration on the oil companies' investment responsiveness to oil price changes. We conjecture that when the oil price is falling, investments are held high by a high degree of vertical integration, but constrained by high debt levels and dividend payments. Similarly, we posit that when the oil price is falling, investments will fall most in companies with a high level of dividends or leverage, or low degree of vertical integration. Our results suggest that the extent of vertical integration affects investments. On the other hand, we find that dividend payments of companies with high level of dividends are not affected by falling oil prices. This suggests that oil companies are very committed to their dividend policies, and which is not affected by impaired financial performance.

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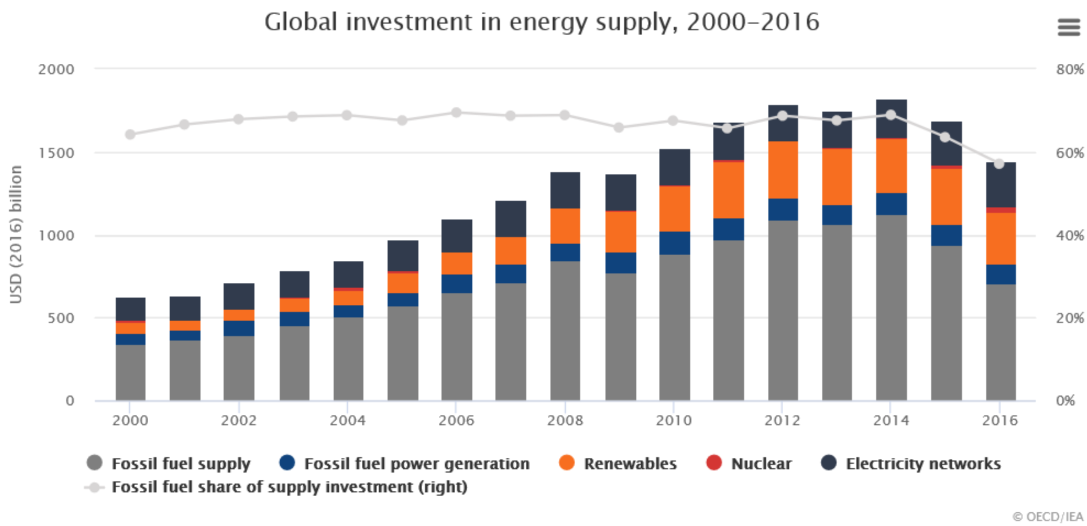
Keywords: *oil and gas companies, investments, capital formation, dividends, oil prices*

Introduction

This paper examines the investment behaviour in the energy sector, and in particular, how commodity price uncertainty influences investments among oil and gas companies. This topic is very relevant and topical given the recent downturn in the industry. The energy sector is undoubtedly important for the world economy, and changes in investments in oil and gas companies can have an impact beyond the energy industry. According to the International Energy Agency (IEA), energy investments represent approximately 2-3% of global GDP. During 2000-2014, investments more than tripled in nominal value (Figure 1). Although renewable energy production has increased its importance in recent years, investments in fossil fuels also tripled in the same period.

Figure 1. Global investment in energy supply 2000-2016.

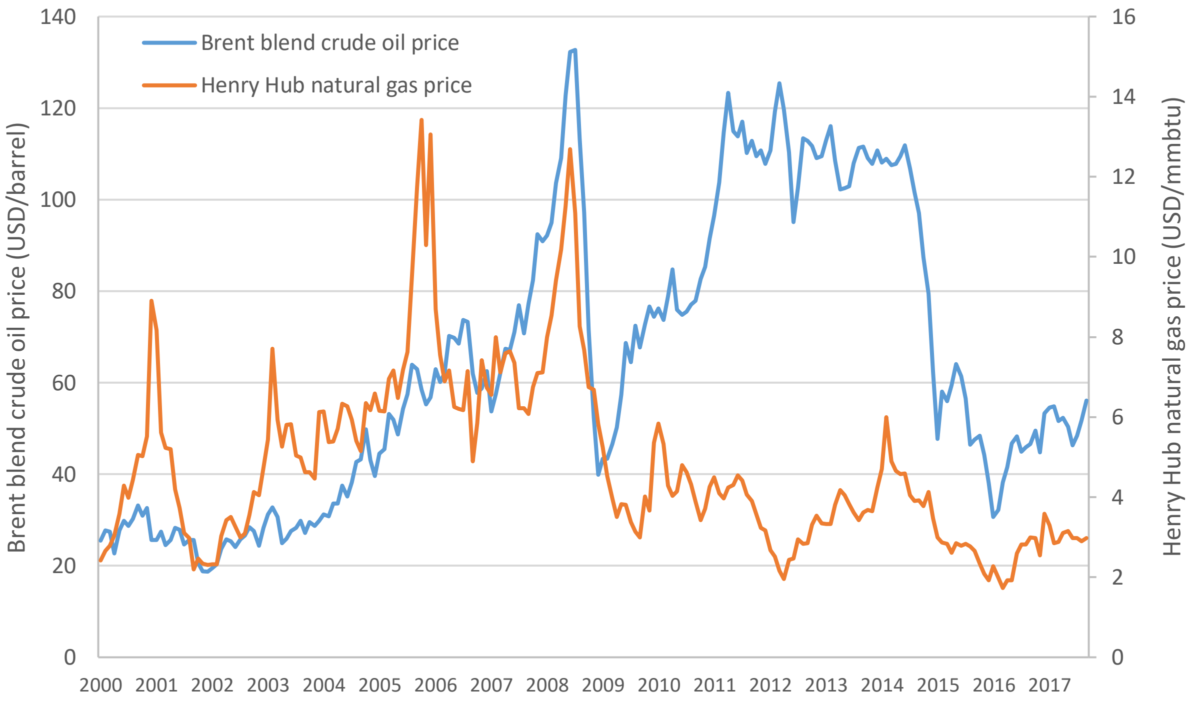


Note. Source: International Energy Agency

Since 2014, energy investments have declined. From an all-time high level of 1826 billion USD in 2014, investments have plummeted to 1394 billion USD in 2016, a decline of 432 billion USD (23.6%). However, fossil fuels seem to have taken the brunt of the investment decline -418 out of the 432 billion USD reduction comes from fossil fuel investment cutbacks, representing a whopping 99% of the investment decline during 2014-2016.

The reason for the cutbacks in fossil fuel investments can be attributed to the recent oil price crisis (Figure 2). Since June 2014, oil prices have fallen dramatically, from above 114 USD per, going below 28 USD per barrel in January 2016.

Figure 2. Oil and gas price development 2000-2016



Visual inspection of Figures 1 and 2 suggest that investments in fossil fuels broadly follow the development in the crude oil price. On an aggregate level, there seems to be a clear relation between commodity price and investments. On the company level, the relationship is more complex, affected by a multitude of factors, such as uncertainty, cash flows, and financial constraints.

One factor affecting investments is uncertainty. The oil industry is characterised by its risky nature, both in terms of geological and commodity price risks, but also for the substantial lead times between when exploration is carried out and the onset of production from an oilfield. Decade long lead times are not uncommon. In the face of uncertainty, managers have to take the decision of whether or not to make an investment. However, neither theory nor empirics provide a clear-cut explanation for how uncertainty impacts investments. According to standard neoclassical theory of producer behaviour, uncertainty will increase the value of an investment due to the convexity of the profit function, and therefore lead to a positive effect of uncertainty on investment (Oi, 1961; Hartman, 1972; Abel, 1983). Contrasting this view is the work on real options by Cukierman (1980), Bernanke (1983) and McDonald and Siegel (1986). Many investment decisions, especially in the oil and gas sector, involve sources of flexibility. In other words, firm and project managers can make new decisions in a project after the initial investment decision has been made. Typical examples include the flexibility to extend the lifetime of a project, to extend the scope of the project, or to postpone investment decisions. This type of project flexibility are called real options (for relevant examples from the energy industry see e.g. Biondi and Moretti, 2015; Xian et al., 2015; Fleten et al., 2016; Locatelli et al., 2016). The option to postpone an investment (also referred to as a deferral option or a waiting option) has attracted the attention of investment researchers. The real options view on the uncertainty-investment relation assert that there is a negative relation between uncertainty and investments since uncertainty increases the value of the waiting option. Increased uncertainty makes it more valuable for the decision maker to sit and watch how the uncertainty pans out instead of investing (i.e. exercising the option).

A limitation of the 'waiting option' view of the investment-uncertainty relation, is that by only focussing on the option to defer an investment decision, it excludes other types of real options. As stated above, an investment project can involve several types of real options. Kulatilaka and Perotti (1998) argue that an early investment can lead to a strategic advantage ('strategic investment') for a company. Under certain conditions, higher uncertainty can increase the value of this strategic benefit (also referred to as strategic growth options). The presence of several types of real options (basket of options) can lead to complex relations between uncertainty and investments (Kulikatala and Perotti, 1998; Sarkar, 2000; Folta and O'Brien, 2004; Henriques and Sadorsky, 2011). Hence, the theories do not provide a clear-cut indication of how increased uncertainty affects investments. Similarly, the empirical evidence is also mixed (Carruth et al., 2000).

One reason for the lack of 'unified' empirical evidence explaining how investment decisions are affected by uncertainty may lie in the selection of the uncertainty variable. Typically, empirical studies use historical volatility based on spot oil prices (Mohn and Misund, 2009; 2011), or oil futures prices (Henriques and Sadorsky, 2011). A more recent study uses implied volatility (Kellogg, 2014). It is well-know that the direction of price changes affect the size of volatility (Black, 1976). The 'leverage effect' is the term for the observation that volatility increases asymmetrically with positive versus negative changes in the price. Kristoufek (2014) provides evidence of a standard leverage effect in crude oil futures, i.e. a negative relationship between returns and volatility, suggesting that an oil price decrease impacts volatility more than an oil price increase does. Hence, the actual *direction* of oil prices can have an impact on the perception of uncertainty among oil company managers. It is therefore important to consider the oil price changes when investigating investment behaviour in the oil and gas sector. Instead of examining the impact on investment from oil price uncertainty in the form of volatility, we examine the impact of oil price changes, thereby capturing the asymmetric impact of oil price uncertainty.

The empirical literature also find that financial constraints can dampen investments. In the literature, the impact of how sensitive investments are to changes in cash flow is often used as a measure of financial constraints. The studies on the impact of cash flows on investments are typically based on the *q* theory of investment behaviour (e.g. refs). According to the *q* theory, cash flows should not affect investment rates since Tobin's average q should be an exhaustive metric for investments. However, several empirical studies have found evidence that investments are sensitive to cash flows (e.g. Fazzari et al., 1988). A recent study suggests that when oil companies are hit with a 'wall of cash' due to record high oil prices, the sensitivity of investments to cash flow decreases (Andrén and Jankensgård, 2015). These results suggests that the impact of cash flow on investment is complex, and not down to changes in profitability alone.

The literature suggests that capital market imperfections adversely affect investments (Hubbard, 1998), especially for the financially constrained firm (Fazzari et al., 1988). This literature asserts that the investment sensitivity to cash flows is a measure of financial constraints. The reasoning is that when firms face financial constraints, external financing is not always available. Hence, investments will be more dependent on internal funds, which come in the form of internally generated cash flows. Although the several studies find that investment sensitivity to cash flow tend to be higher for financially constrained firms, other studies have contested the view that investment sensitivity to cash flows is a measure of financial constraints (Kaplan and Zingales, 1997; Gomes, 2001; Chen and Chen, 2012). However, Moyen (2004) develops a model that reconciles the two opposing views, concluding that financial constraints have an adverse impact on the sensitivity of cash flows on investments.

In our study, we examine the impact of four types of constraints, low degree of vertical integration, high leverage, high dividend payments, and low cash flow levels. The oil and gas industry is typically divided into three segments along the value chain, upstream oil and gas exploration and production, midstream transportation, and downstream processing, refining, chemicals and marketing activities. Among these, the profitability of upstream business area is the most exposed to fluctuating oil and gas prices. The cash flows from the mid- and downstream sections, less so. Hence, a high degree of vertical integration entails that a substantial proportion of cash flows are less affected by oil price volatility, and can act as a buffer against the adverse effects of substantial oil price declines on cash flows. Hence, when the oil price falls, investments in integrated oil and gas companies can be maintained at a higher level than would be the case for exploration and production companies. The investment decisions in the former companies are less constrained by oil price uncertainty.

Leverage can also dampen investment appetite when the oil price falls. Although standard finance theory asserts that under conditions of market perfection, capital structure is irrelevant for the investment decision (Miller and Modigliani, 1958), the trade-off theory of capital structure states that increasing debt levels will increase the probability of default, and therefore the choice between debt and equity matters. Taking on debt is a financial commitment, and increases the riskiness of equity since the borrower needs to repay the loan and pay interest, independently of how the profitability of the company develops. A high debt level can therefore reduce the oil company's ability to make investments, especially in the case of oil price declines. We therefore expect that when the oil price is falling, investments will fall most in companies with a high debt level.

Moyen (2004, p. 2075) suggests, (although not explicitly part of her model) that "sticky dividends [...] would lead to a larger difference in cash flow sensitivities between firms with financing constraints and without constraint." Indeed, sticky dividends can in many respects be considered as a form of commitment. A firm's management is very reluctant to cut dividends, even when facing falling profits. Hence, one should expect an impact of dividend levels on investment rates during an industry downturn. When oil prices fall, oil companies that have in previous years paid high dividends will continue to do so even though their profits have fallen, simply because they are reluctant to cut dividends. We therefore expect that investments will be affected by a combination of oil prices, cash flows, dividends.

Moreover, we expect that when the oil price is falling, investments will fall most in companies with a low levels of cash flow, since low levels of cash flow suggests small financial slack. Moreover, we also expect that vertical integration will affect the impact of oil prices on investments since cash flows of vertically integrated companies will be less exposed to crude oil volatility.

We collect data from oil and gas companies over the period 1992-2015, totalling 3911 firm-year observations, and covering at least two substantial oil price declines, in 2007-2008 and post 2014.

Our results suggest that the extent of vertical integration affects investments. Surprisingly, we find that dividend payments of companies with high level of dividends are not affected by falling oil prices. This suggests that oil companies are very committed to their dividend policies, and which is not affected by impaired financial performance.

The remainder of the paper is organised as follows. First, we present a review of previous studies, followed by the description of the empirical methodology. Then, the data sample is presented, followed by the results and discussion. The final section concludes.

Methodology

The point of departure for our empirical model is the following empirical relationship between investments and cash flow:

$$\frac{I_{it}}{TA_{i,t-1}} = \beta_0 + \beta_1 \frac{CF_{it}}{TA_{i,t-1}} + \varepsilon_{it} \quad (1)$$

The ratio $\frac{I_{it}}{TA_{i,t-1}}$ is the investment rate, where I_{it} represents investments carried out by firm *i* in year *t* and $TA_{i,t-1}$ are total assets at the beginning of the year. CF_{it} denotes cash flows, and ε_{it} is the error term.

To capture how levels of oil prices, dividends, leverage and vertical integration affect investments, we examine the interaction between these variables. The resulting empirical model becomes

$$\frac{I_{it}}{TA_{i,t-1}} = \beta_0 + \beta_1 \frac{CF_{it}}{TA_{i,t-1}} + \beta_2 V_{it} + \beta_3 DIV_{it} + \beta_4 \Delta OP_t + \delta_1 \frac{CF_{it}}{TA_{i,t-1}} \times \Delta OP_t + \delta_2 V_{it} \times \Delta OP_t + \delta_3 DIV_{it} \times \Delta OP_t + \delta_4 LEV_{it} \times \Delta OP_t + \varepsilon_{it} \quad (2)$$

where V_{it} is the degree of vertical integration for company *i* at time *t*, ΔOP_t is the change in oil price between time *t-1* and time *t*, d_{it} is the dividend payout ratio for firm *i* at time *t*, and LEV_{it} is the leverage of company *i* at time *t*.

Of interest to this study are the interaction terms as they allow us to examine the impact on investment of high (or low) cash flows, dividends, and vertical integration, *when* oil prices increase or decrease. We interact cash flow, extent of vertical integration and dividend levels with the crude oil price. We propose the following hypotheses:

H_1: When the oil price is falling, investments will fall most in companies with a low level of cash flow.

We can test this hypothesis by examination of the coefficient on the interaction term between oil price and vertical integration, δ_1 in Eq. (2). A positive and statistically significant coefficient provides evidence for hypothesis H_1.

H_2: When the oil price is falling, investments are held high by a high degree of vertical integration, since this activity has countercyclical cash flows.

We can test this hypothesis by examination of the coefficient on the interaction term between oil price and vertical integration, δ_2 in Eq. (2). A positive and statistically significant coefficient provides evidence for hypothesis H_2.

H_3: When the oil price is falling, investments will fall most in companies with a high level of dividends (less funds for spending given that they wish to limit borrowing money to finance dividend payments)

We can test this hypothesis by examination of the coefficient on the interaction term between oil price and vertical integration, δ_3 in Eq. (2). A positive and statistically significant coefficient provides evidence for hypothesis H_3.

H_4: When the oil price is falling, investments will fall most in companies with a high level debt.

We can test this hypothesis by examination of the coefficient on the interaction term between oil price and leverage, δ_4 in Eq. (2). A positive and statistically significant coefficient provides evidence for hypothesis H_4.

Data sample and descriptive statistics

The sample in this study consists of US and international oil and gas companies between 1992 and 2015. We collect annual accounting data and market valuation from the JS Herold oil and gas company metrics database (www.ihs.com/herold). The variables used in our empirical model is calculated as follows. We use total capital expenditures (additions to property, plant and equipment) as a measure of company investments (I_{it}). The investment rate ($\frac{I_{it}}{TA_{it-1}}$) is calculated by dividing investments with total assets at the end of the previous year. Cash flow, CF_{it}, is taken as the operating cash flow collected from the statement of cash flows, and scaled by the previous year's total assets. The vertical integration measure, V_{it}, is calculated as the ratio of capitalized costs from upstream activities to total assets. The former data item is drawn from the supplementary information from oil and gas activities that all US listed oil and gas companies have to report in their annual financial reports as required by the Securities and Exchange Commission (see ASC, 2010). Hence, V measures the proportion of assets related to upstream oil and gas activities to the total assets. If V is large, then the oil company's activities are concentrated to the exploration and production part of the value chain. Companies with lower V will have a larger proportion of their assets in mid- and downstream activities such as transportation, processing, refinery, chemical and marketing activities. Leverage (LEV_{it}) is calculated as the ratio of total interest bearing debt to shareholders' equity, which can be found in the balance sheets. The dividend ratio (DIV_{it}) is the ratio of dividends to net income, taken from the income statements. The change in oil price is calculated as the annual percentage change in the spot oil price collected from the Energy Information Agency of the US Department of Energy (www.eia.doe.gov).

From a raw sample of 788 firms over 24 years (potentially 18912 firm years), after subtracting missing and discarded observations, the final sample consists of 3911 firm-year observations. We discard observations with negative numbers for shareholder's equity, debt and total assets. Furthermore, we winsorize 0.5% of the largest and smallest observations.

The descriptive statistics for the variables are described in Table 1. The average investment rate is 0.196, telling us that oil and gas companies make investments representing approximately 20% of their total assets per year. The cash flow generated, however, is only approximately 14% of their total assets, suggesting that over the period 1992-2015, oil companies did not generate sufficient cash flows to finance their investments. One explanation for this discrepancy is given in Figure 1, depicting a massive build-up in investments during the 2000s. The oil companies were spending substantial amounts on capital expenditure during this period of exceptionally high commodity prices.

The measure for vertical integration varies between 0 and 1 (as by construction), with an average of 0.665. In other words, approx. 66% of total assets come from upstream activities in our sample.

The average leverage ratio is around unity, meaning that the capital structure consists of 50% equity and 50% debt.

The average dividend ratio is around 48.5%, implying that approximately half of net income is paid out to the company's owners. However, the high standard deviation signals that the variation across companies is substantial.

The yearly oil price change has on average been 7.2%. This is quite high, and is a function of the exceptionally high crude oil prices the industry has witnessed over the period. In July of 2008, the Brent blend crude oil price reached an all-time high of 145.6 USD/barrel. Despite the high average oil price returns, the volatility has also been substantial, as seen from thee standard deviation of oil price changes. The largest price increase of 47% was seen in 2000, and the largest price decrease of -64% was from 2015.

Table 1. Descriptive statistics

	Mean	SD	Min	25 percentile	Median	75 percentile	Max
I/TA	0.196	0.138	0	0.098	0.161	0.257	1.305
CF/TA	0.139	0.139	-0.981	0.090	0.134	0.185	6.627
V	0.665	0.252	0	0.496	0.757	0.867	0.999
LEV	1.014	3.455	0	0.259	0.498	0.889	91.622
DIV	0.485	1.690	0	0	0.039	0.416	40.203
ΔOP	0.072	0.254	-0.638	-0.077	0.106	0.282	0.471

Note. The investment rate (*I/TA*) is calculated as the ratio of capital expenditures in year *t* to total assets at the end of year *t-1*, *CF/TA* is calculated as the ratio of cash flow from operations in year *t* to total assets at the end of year *t-1*, *V* is the ratio of capitalized costs from oil and gas activities to total assets, both in year *t*, *LEV* is the ratio of total interest bearing debt to total shareholders' equity, both in year *t*, *DIV* is the ratio of dividend payments to net income in year *t*, and *ΔOP* is the yearly change in the spot crude oil price during year *t*. The number of observations is 3911 firm-years, save *ΔOP* which is 14.

Table 2 presents the correlation matrix for the variables. All of the correlations are relatively low, and do not cause concern.

Table 2. Correlations

	I/TA	CF/TA	V	LEV
I/TA				
CF/TA	0.132			
V	0.384	0.134		
LEV	0.061	-0.053	0.036	
DIV	-0.125	0.002	-0.079	-0.018

Note. Cash flow (*CF/TA)* is calculated as the ratio of cash flow from operations in year *t* to total assets at the end of year *t-1*, degree of vertical integration (*V*) is the ratio of capitalized costs from oil and gas activities to total assets, both in year *t*, leverage (*LEV*) is the ratio of total interest bearing debt to total shareholders' equity, both in year *t*, dividend ratio (*DIV*) is the ratio of dividend payments to net income in year *t*. The number of observations is 3911 firm-years.

Results and discussion

The results from the empirical model in Eq. (2) are presented in Table 3. First we examine the results using the sample with both oil price increases and decreases, followed by the results in the case of oil price increases and decreases, respectively.

Table 3. Empirical results

	Full sample	Oil price increase	Oil price decrease
ΔOP	0.496	0.784	1.16
	(<0.01)	(<0.01)	(<0.01)
CF	0.423***	1.88***	-0.323
	(4.02)	(4.11)	(-1.41)
$CF \times \Delta OP$	1.17*	-0.928	-5.19***
	(1.90)	(-0.599)	(-2.77)
V	0.551***	0.273	9.40***
	(3.96)	(1.40)	(3.19)
$V \times \Delta OP$	0.342*	0.166	1.25**
	(1.72)	(0.369)	(2.48)
LEV	-0.00816	-0.139	-0.378
	(-0.827)	(-0.746)	(-1.48)
$LEV \times \Delta OP$	0.0181	-0.223	-0.210
	(0.0698)	(-0.369)	(-0.325)
DIV	-0.0196**	-0.000440	-0.0149
	(-2.45)	(-0.0292)	(-0.602)
$DIV \times \Delta OP$	0.00816	-0.00845	0.0707
	(0.275)	(-1.36)	(0.735)
Adj-R2	0.0164	0.0246	0.0281
F value	5.22***	5.34***	3.01***

Note. *ΔOP* is the yearly change in oil price, *CF* is cash flow (scaled by the previous year's total assets), *V* is a measure of vertical integration, *LEV* is leverage and *DIV* is dividends. T-values are in parantheses, and significance levels are given by asterisks, *: p<0.10, **: p<0.05, and ***: p<0.01. The empirical model is estimated using the full sample of oil and gas firms, both for years with oil price increases and decreases, as well as two subsamples for oil price increases and decreases, respectively.

The results from the full sample suggest that the investment rates in the oil and gas sector are positively affected by cash flow levels, but negatively impacted by dividend levels and degree of vertical integration (bearing in mind that a high *V* entails a low degree of vertical integration). The change in oil price in itself does not seem to affect investments, most likely since the cash flow variable will capture the impact of oil prices on profitability. In other words, the more profitable the firm is, the more it will invest. We also see that the companies which are more vertically integrated have lower investment rates than E&Ps do. The upstream companies invest more per dollar of assets than the integrateds. Moreover, high levels of dividends dampens investment rates.

By examining the coefficients on the interaction terms, we address our hypotheses. The first hypothesis asked if investments will fall most in companies with a low level of cash flow, when the oil price is falling. A positive and statistically significant coefficient on the interaction term between cash flow and oil price change (coeff: 1.17, p-value <0.10) provides evidence in favour of our hypothesis.

Next, we turn to the second hypothesis, asking whether investments are maintained by a high degree of vertical integration when the oil price is falling. The positive and significant coefficient on the interaction term between vertical integration and the change in oil price (coeff: 0.342, p-value <0.10) provides evidence that the higher the V, the more changes in oil price will affect investments. This means that when oil prices fall, investments fall more for companies with a high *V* (i.e. upstream companies), than for companies with a low *V* (i.e. integrated companies). This provides support for our second hypothesis.

Third, we address hypothesis 3, which asks if investments will fall most in companies with a high level of dividends in the face of declining oil prices. We find that there is a positive and non-significant coefficient on the interaction term between oil price changes and the dividend ratio. Our results suggest that oil companies with high levels of dividends do not cut investments when oil prices fall. This result does not provide support for our second hypothesis. However, the result is in line with the notion that dividends are 'sticky'. Oil company management are reluctant to cut dividends, even though oil prices fall, having an adverse effects on their ability to pay dividends.

Fourth, we address the fourth and final hypothesis, asking if investments will fall most in companies with a high level debt when oil prices are falling. While the coefficient on the interaction term is positive, it is not significant, and our results do not provide evidence in favour of Hypothesis 4.

Finally, to examine for any asymmetric effects between oil price increases and decreases, we divide the sample into two subsample, and rerun the empirical model in Eq. (2). The results suggest that there is asymmetrical interaction effects, that and oil price *decrease* has an effect on investments of a different magnitude than an oil price *increase*. Our results suggest that when oil prices increase, investments are significantly associated with cash flows, but there is an interaction effect. The more the oil price falls, the more the investment rates are sensitive to changes in cash flows.

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