Aalto University
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Oil Price Volatility, an Economic Determinant of Earnings Volatility

Empirical Analysis on Earnings Volatility of U.S. Oil and Gas companies between 1986-2016

Master's Thesis
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Abstract

This study examines whether oil price volatility, an economic determinant, has significant correlation with earnings volatility in the U.S. oil and gas companies. The study also explores whether earnings volatility has increased in the very industry for the last thirty years. Differences among sub groups within the industry are studied to add precision to the analysis.

The study applies pooled data OLS regression to explore the relation between oil price volatility and earnings volatility. The observation sample is collected from Compustat database in WRDS from 1986 to 2016.

Findings suggest that oil price volatility has positive relation with earnings volatility and cash flow of operations. Earnings volatility for the time frame from 2002 to 2016 is greater than before 2002 for the whole industry. The level of earnings volatility is larger for oil and gas producers(SIC1311) than for refineries(SIC2911) for both time periods. However, increasing degree of association between the two variables is observed only for oil and gas producers(SIC1311).

The study concludes that oil price volatility provides incremental information connected to earnings volatility associated risk in the U.S. oil and gas industry. Especially oil and gas producers were found significantly affected by oil price volatility in terms of earnings volatility.

Keywords earnings volatility, oil price, oil and gas industry, economic determinant, valuation, risk management, risk factor

Table of Contents

List of Tables

List of Figures

1 Introduction

Earnings is a performance measure frequently thought to be the most important performance measure in business and accounting. It contains various properties that convey information on firm performance, cost structure, economic strength, value, and risk. Especially earnings volatility provides precious information regarding the risk of a firm.

1.1 Background

Value of a firm is simply an aggregate sum of discounted cash flows (Brealey, Myers, & Allen, 2014) in corporate finance theory. When future cash flows are known explicitly valuation is an easy game. However, this is not what we can encounter in practice. Future cash flows are required to be forecasted to assess implied value in current terms. However the problem is predicting power of cash flow is low since it does not convey context of performance with. Although there is some controversy whether earnings or cash flows better suit for valuation purpose, supporting evidence for earnings are found in many accounting literatures. "Accounting system converts unobservable performance to observable earnings" as Dechow et al. (2010) cited. Earnings convey context regarding performance of past, current, and future, thus more informative for forecast purpose (Revsine, Collins, Johnson, & Mittelstaedt, 2005). Dechow (1994) and Penman et al. (1998) provides additional evidence that earnings is more useful than cash flow in terms of representing firm performance and relevance to valuation.

Anything making value uncertain or giving rise to change in value is risk factor. Smooth earnings, earnings volatility and earnings persistence are properties earnings related to risk of the firm value. Earnings volatility and earnings persistence are the properties having antipode position from smooth earnings. Managers and investors value smooth earnings highly (Graham, Harvey, & Rajgopal, 2005), (Hodge, 2003), and various measures are employed to accomplish this, such as earnings management and hedging (Hand, 1989). Earnings volatility is a measure how much far away earnings may be observed from the

average, a property associated to reliability (the lesser volatility the more reliable) of value and a measure for degree of risk. Earnings persistence is how much past earnings could explain current earnings, therefore related to predictability to future earnings. Therefore, assessing properties of earnings and finding determinants to earnings properties are highly related to valuation and risk management purpose. Especially in this study, I will focus on earnings volatility.

Earnings volatility is widely studied from the perspective of accounting; change in accounting standard (Dichev & Tang, 2008), conservatism in accounting and reporting (Givoly & Hayn, 2000). At the author's best knowledge, however, there is few research employing economic determinants in the study of earnings volatility. Only Donelson (2011) and Givoly (2000) incorporated economic events in their study on earnings volatility.

To find a promising economic determinant to explain earnings volatility, I narrowed down the focus area to the oil and gas industry where oil is a key product, raw material, and medium of business. Oil price is assumed to be significantly associated with earnings volatility, and it is posted in the open market which makes it a easily accessible variable. Regarding valuation and risk management in oil and gas firms, studies are restricted in perspective of earnings management upon political scrutiny (Han & Wang, 1998), shock after natural disaster (Byrad, Hossain, & Mitra, 2007), and political unease (Hsiao, Hu, & Lin, 2016). Applying economic factor in the research of earnings volatility for oil and gas firms is expected to provide incremental information in terms of reliable valuation and risk management purpose.

1.2 Objective and Contribution

The main objective of this study is to examine the relationship between oil price volatility and earnings volatility in the U.S. oil and gas industry. The association between the two variable is expected to provide incremental information valuable for the practice of valuation and risk management for investors, managers, and analysts. Stakeholders are thought to

better cope with uncertainties they may confront in the future when the relation is discovered. The relationship with cash flow volatility is also examined and compared with the results from earnings volatility.

Additional analysis for sub groups within the industry is performed to investigate sensitivity differences mainly between oil and gas producers(SIC1311) and refineries(SIC2911). Robustness test on size effect is considered and applied with dummy variables to reflect the difference in the average size of companies in SIC1311 and SIC2911 groups. Analysis to test whether earnings volatility has increased over time in oil and gas industry is conducted. Testing change in response rate of earnings volatility to oil price volatility over time is conducted in sub groups.

Pooled data ordinary least squares (OLS) regression method is used with 11,088 observations of quarterly accounting data gathered from Compustat database, and Western Texas Intermediate (WTI) crude oil spot price retrieved from FRED Economic database between 1986-2016 for the analysis.

1.3 Structure

This study consists of seven chapters. After introduction, chapter two starts with background theories and prior studies on properties of earnings relevant to this study; earnings management, earnings volatility, and earnings persistence. Emphasis is given to how earnings volatility is associated with reliability of firm value and how stakeholders respond toward its properties. In chapter three, theory and findings from literatures connecting value, risk and earnings properties are covered focusing on oil industry. Review on oil price theory and oil price history is followed to enhance understanding of the reader toward target industry. Research hypothesis is developed in chapter four based on preceding studies. Chapter five describes estimation models, data, variables and descriptive statistics before empirical research. Empirical analysis and findings are presented in chapter six; relationship between oil price volatility and earnings volatility, relationship between oil price volatility

and cash flow volatility, change in earnings volatility over the past thirty years, difference in response rate to oil price volatility within sub groups of the industry, which are the main objectives of this study. Limitations of this study are also discussed in the same chapter. Finally, conclusion chapter summarizes findings and contribution of this study.

2 Properties of Earnings

In this chapter I will present theory and literature survey about properties of earnings relevant to this study, which are earnings volatility and earnings persistence. It will help the reader to familiarize with background knowledge to understand how earnings volatility and earnings persistent are connected to valuation and risk management, and how the research question is developed in this study. Stakeholders' perception toward various earnings measures and properties, and measures taken by managers to attain the desired properties will be covered lastly.

2.1 Earnings Volatility and Earnings Persistence

There are many terms describing different traits of earnings. Among them earnings volatility, and earnings persistence are relevant to this study. I will briefly introduce concepts and research findings regarding them for further understanding.

Earnings volatility and earnings persistence are both measures to explain stability of earnings. Earnings volatility focus on deviation from average of past values from predetermined periods of time window. Whereas, earnings persistence puts more emphasis on extent of explanatory power of past earnings to current earnings.

There are two types of volatility, one is historical volatility and the other is implied volatility. Historical volatility is computed as standard deviation of certain property for the past fixed period. Standard deviation is square root of the average squared deviation of the data from its average. Therefore, the more the distance from the average, data produce larger standard deviation, and when data are all nearby the average it produces small standard deviation.

$$\sigma = \frac{\sum_{i=1}^{n}(R_i - R_{avg})^2}{n-1}$$

Where, σ is standard deviation of return, R_i, with average of R_{avg} for n observations. Implied volatility depends on options and contract associated with the asset of interest.

Historical volatility varies upon deciding how to calculate return and how to choose lookback window, the past time period to compute average and standard deviation. Two most frequently used method to calculate return are simple return and log return. Simple return is easy and intuitive way to use but is not additive, which means 10 percent rise and then 10 percent decline does not yield 0 percent return in total. On the contrary, log return has advantage being additive but difficult to use when value is negative.

A larger problem may come from choosing a lookback period. Lookback window is the length of time past to take account for calculation. Longer lookback period, in general, allows researchers to get a larger number of observations. However, it is questionable whether old data provides relevant information to explain recent numbers since many things including business environment and acceptable norms in performance changes as time goes. It is problematic when extraordinary big or small return caused by exceptional circumstances like natural disaster, great recession to disturb the next coming many years. (O'Neil, 2011) Using shorter lookback window allows volatility estimates to respond quickly to new information and frees researchers from concern on suitability and informative of old data. On the other hand, using small number of observations diminishes reliability of the result.

Care is required using standard deviation as a measure of volatility, where statistically there needs assumption of normal distribution on values. In other words, there is possibility to violate assumption on skewness and kurtosis. Observations may not exhibit symmetric distribution as usually assumed in regression models. They may also demonstrate abnormal peaks. Lastly, homoscedasticity is likely to be violated as time passes by. These limitations shall be attenuated while designing research models. Dichev et al. (2008) used earnings deflated by average assets when computing earnings volatility. Deflating by assets resolves scale issues arising when dealing accounting data, especially heteroscedasticity. It is also

thought much of skewness and kurtosis problem are resolved since deflation limits data departing from the majority group.

Earnings persistence is in conceptual, similar to earnings volatility but gives more emphasis on how much of past earnings is able to explain current earnings. As Dichev et al. (2008) noted "Persistence of earnings is the slope coefficient from a regression of current earnings on lagged earnings." Estimate of regression model demonstrates how much persistent earnings is observed in the time horizon.

Lipe (1990) made a research on stock return versus earnings. Based on previous research describing market return leading earnings (Collins & Kothari, 1989), he conducted additional study to find out the relationship assuming market has alternative information relevant in predicting future earnings. He used DDM to set stock price, earnings and alternative information to be explanatory variables. He found stock return had negative association with earnings predictability (less earnings variance), while positive correlation with earnings persistence as expected in the theory.

Dichev et al. (2008) examined correlation between revenue and expenses over 40 years period ending in 2003. He found explanatory power of contemporaneous expense on revenue had declined over the time, and suggested the result of this mismatch being the reason of increased volatility of earnings although volatility of revenue and expense remained somewhat the same. They attributed the reason to accounting standard movement toward balance sheet based perspective and real economy evolvement. They also found decreasing persistence of earnings and negative autocorrelation over the same time period. Cash flows measures are often used a proxy for real economy since it is unaffected by accruals. In the same research, Cash Flow from Operations (CFO) also showed decreasing explanatory power of contemporaneous expense, the same trend with earnings.

Donelson et al. (2011) studied with similar question with Dichev et al. (2008) but they more

disaggregated expenses into details like, “cost of goods sold, administrative expense, depreciation, taxes, other expense, and special items”. They found most of the fluctuation was resulting from increased number of special items; when removing data with large special items, change in expenses decreased substantially and explanation power of contemporaneous expense remained close to one. Next, they examined where was these special items was caused by, either through economic activity or changes in accounting standard. Their conclusion is economic events rather than accounting standard caused incremental variation by mismatch between contemporaneous revenue and expenses, therefore earnings variation. Donelson used five different proxies representing economic events affecting special items which are “negative employee growth, merger and acquisition, discontinued operations, negative revenue growth, and operating losses.”

Another approach of research sees emerging earnings volatility due to conservatism in accounting and reporting. Givoly et al. (2000) points out conservatism lying in the middle of recognizing timing of revenue and expenses. They focused on the declining profitability without corresponding decline in cash flows. Two phenomena accompanied were accumulation of negative accruals and more dispersed earnings during 1966 to 1998. When breaking down accruals, negative accumulation of non-operating accruals surpassed positive accumulation of operating accruals. Items for non-operating accruals were “loss and bad debt provision, restructuring charges, effect of changes in estimates, gains or losses on the sale of assets, asset write-downs, accrual and capitalization expenses, and the deferral of revenues and their subsequent recognition”. As can be inferred from the name of items, these are mostly related to incidents of business change, like restructuring, mergers and acquisitions, and others. While earnings were decreasing over time, variability of earnings had been increasing. As CFO failed to catch up with earnings variation, non-operating accruals were thought to be contributor to this phenomenon.

Dichev et al. (2009) studied to find evidence of the previous research, in belief that volatility arises from both economic shocks and accounting determinants which reduce the predictability of earnings. From empirical data, they found earnings volatility in upper

quintiles showed evidence having higher persistence while with lower volatility demonstrating lower persistence as predicted by theoretical model. Additional research on persistency estimate revealed that cash flow volatility and absolute amount of accruals in quintiles having ordered correlation with persistence of earnings. Noticeable founding is that earnings volatility had higher explanatory power predictability in future earnings than cash flow volatility did. This research was valuable in a sense being successful to demonstrate managers' belief with empirical evidence.

Kerstein et al. (1995) studied whether capital expenditures provide incremental earnings under an idea firm's investment is to increase value of the entity. They also considered increasing capital expenditure being a signal to the market that the firm has positive NPV projects while decreasing capital expenditure being the opposite signature. Unfortunately, they did not succeed to gain an obvious conclusion. Kothari et al. (2002) approached earnings variability from different perspectives, with the question whether R&D investments add more uncertainty in future earnings compared to capital expenditure in context of capitalization of the very expenses. They couldn't effectively measure how much, but, found that R&D investments generate more uncertain future benefits. This research was meaningful utilizing current factors in examining future earnings variability. On the other hand, Asthana (2006) found industry mean R&D intensity and individual firm's R&D intensity are correlated with persistence of abnormal earnings, possibly suggesting that these R&D expenses build entrance barrier as well as competence to the firm already in business. Livine et al. (2007) also compared earnings variability contribution between R&D and capital expenditure. This time, unlike Kothari's (2002) result, they found R&D contributing more on future earnings variability only on R&D intensive industries, for example, Pharmaceuticals, Computers, Instruments & Photos & Watches, and Electronics & Electric. The research suggests R&D have closely associated with profitability for industries with intensive R&D, whereas R&D did not drive profitability in CAPEX intensive industries.

Study on earnings persistence is often conducted together with study on earnings volatility. Frankel et al. (2009) provides reasoning how earnings variability and persistence relates in

a positive way. He cites, “timely recognition of losses simultaneously increase the volatility of earnings and reduces its persistence” which is also observed in the study of Donelson et al. (2011) Dichev et al. (2009) also reports empirical correlation between volatility and persistence in his research. Research on persistence have an underlying idea that higher persistency provides valuation number of higher quality (Dechow, Ge, & Schrand, 2010). But she also remarks that persistence is a result of fundamental performance and accounting system applied.

2.2 Value Relevance of Earnings and Earnings Properties

Valuation and Equity value had been mainly developed from finance, for example, Discounted Cash Flow (DCF) analysis. In terms of accounting, the most easy and relevant diversion of this model is simple Discounted Dividend Model (DDM) assuming firm distributes all the earnings to dividends and does not grow. There had been efforts to incorporate earnings in assessing equity value, eventually stock price. Ohlson (1995) theoretically demonstrated the equivalence of valuation model from DDM and book value plus present value of abnormal earnings model. One interesting idea behind his logic is that dividends are paid out from book value (future earnings), but not from current earnings.

Considerable amount of research was done regarding stock return and earnings including Kothari et al. (1995). Sloan (1996) examined two different components of earnings, which are accrual and cash flows. He found out cash flow components have higher persistence compared to accrual components, therefore more relevant to value. However study shows investors being unable to differentiate the two properties but to price stock based on the combined earnings. Richardson et al. (2005) extends Sloan’s (1996) study by associating reliability of accruals with persistence of earnings.

Collins et al. (1989) studied how stock returns respond to unexpected (scaled) earnings change, and called the regression coefficient, earnings response coefficient (ERC). The research is performed with data over 12-month period to estimate association between the

two variables. They found that ERC differs with relation to firm size which they posed as a proxy for difference in information environment, indicating larger firms providing more information to assess firm value. An interesting founding is that ERC has positive relation with growth prospects and earnings persistence of the firms.

There was a claim that relevance of earnings to value of equity had decreased over the time (Lev & Zarowin, 1999). However, there are contradictory research for example, Collins et al. (1997) shows although relevance of earnings had decreased because of hindering effect of one-time items and negative earnings, overall relevance of financial statement had not decreased but replaced by book value items.

There are arguments which one better suits for valuation purpose between earnings and cash flows. Dechow et al. (2010) cites, "accounting system converts unobservable performance into observable earnings". Earnings convey context of performance suitable for prediction. Frankel et al. (2009) presents two streams of approach where current earnings has a 'role' in predictions and valuation. The first approach is when function between earnings and cash flows are known by managers and investors, earnings links directly to value. The second approach considers current earnings as a "starting point for prediction" and incorporates other factors in valuation which coincides with Penman's (2013) approach introduced in the next chapter. Research from Dechow et al. (1994) and Penman et al. (1998) supports the second approach as earnings being relevant to valuation.

2.3 Stakeholders' Perception and Behavior toward Earnings and Earnings Properties

In earlier report, Hand (1989) cited "earning smoothing may be an effective way for a firm to provide the stock market with information as to the degree of future persistence of current earnings." Survey to CFOs by Graham et al. (2005) revealed managers concern and belief on earnings. They found CFO's have perception that investors consider much on earnings rather than cash flows of the firm, therefore, they also put emphasis on earnings. In their research, managers were willing to sacrifice long-term objective to meet short-term needs.

More precisely, they were ready to trade economic value to satisfy expectations of analysts and investors, which they believe is helpful method to maintain the stock price. Compared to constant cash flows or volatile earnings, they preferred smooth earnings revealing where their interest was lying, predictable earnings to both insiders and outsiders. Examined reason for putting emphasis on predictable and smooth earnings was first, to affect stock price and to help building their own reputation as manager.

To be more precisely, 159 out of 308 managers selected earnings as the most important performance measures to outsiders, and "86% agreed or strongly agreed that meeting earnings benchmarks helps company to build credibility with the capital market". Moreover, under hypothesis scenario of company not promising to meet the desired earnings, managers replied they would "decrease discretionary spending like R&D and advertising, or delay starting a new project being determined to sacrifice economic value", with 79%, 55% agreeing or strongly agreeing, respectively. Revisiting smooth earnings concern, they preferred it because, "it is perceived as less risky by investors", 88%, and "makes it easier for analysts/investors to predict future earnings", 79%. Combining the above findings, authors concluded managers were afraid that failure to meeting the target may interpreted as firm having unveiled problem and they even preferred to take actions like delaying investments to meet the target rather than exercising accounting manipulations. This articles revealed practitioners' thoughts on earnings and their concerns extensively. Of course there should be caution on cognitive problems and measurement errors in survey based information (Bertrand & Mullainathan, 2001). Indeed, "survey belief is not necessarily actions", as Hodge (2003) mentioned, however, this would be adequate starting for empirical research.

Hodge (2003) surveyed individual investors to examine how they perceive decreasing earnings quality and which stance they have on financial statements on evolving circumstances. Ironically investors rely more on audited financial statement as they perceive earnings quality as well as reliability of financial statement is decreasing.

Sometimes earnings are manipulated to meet the target value or desired properties. Earnings management is accounting play taking advantage of weak point or discretion of accounting rule to obtain certain accounting numbers at target. Different circumstances and different purposes stimulate earnings management in practice. Many time, earnings target and market consensus induce earnings management. Often managers' individual interest takes part in the maneuver.

Considerable amount of research had been conducted in the issue of earnings management and circumstances and purpose behind it. Jones (1991) did a pioneer research on earnings management with discretionary component of total accruals to measure earnings management. She found supporting evidence of managers making income decreasing accruals to benefit from import protection. Guenther (1994) found evidence of negative current accruals from large firms a year ahead Tax Reform Act of 1986 to cut tax rates from 46 percent to 34 percent.

Dechow et. al (2003) found earnings of firms reporting showed discontinuity around zero earnings. Less number of minus earnings just below zero earnings and more number of zero earnings were reported regarding distribution. That was a supporting evidence that firms were reluctant to release minus earnings news to public. It can be also inferred as minus earning is what managers want to avoid. Cahan et al. (1992) studied earnings management with discretionary accruals from Chemical firms at the time Congress was considering legislation of Comprehensive Environment Response, Compensation, and Recovery Act of 1980, when adopted were expected to cause costs to firms by setting up a Superfund funded by chemical industry themselves. Study evidence firms affected by Superfund took income reducing discretionary accruals while those who are unaffected did not.

Increasing income, big bath, and income smoothing comprise typical earnings management methods (Wild, Subramanyam, & Halsey, 2005, p. 87). Increasing income is a strategy to increase income, for example, using methods like advanced sales and then let accrual

reversals happen in the later period. In growing terms, effect of reversals is small. Big bath is used when company expects a huge loss. Managers choose a particular period to write off as much as possible, otherwise might had to function to reduce positive earnings. It is a type of income increasing strategy because one time drop will wipe out all bad credits from past and future so that they won't harm future earnings. Income smoothing is used to reduce volatility of earnings.

Sloan (Sloan, 1996) differentiated earnings to cash flow component which is thought to reflects true performance and accruals component related to earnings management. And he claimed that it's cash flow part which contribute persistence of earnings in the future. Xie (Xie, 2001) further sorted accruals to discretionary accruals and non-discretionary accruals to take into account differences in working capital required by various firms.

Bartov (1993) examined timing of earnings recognition in the context of real earnings management, in case of assets sales and investment. He conducted research from both aspects of purpose, earnings smoothing and keeping debt equity ratio. He reasoned managers use earning smoothing to meet previous year's EPS. Considering debt covenant issue, he also examined relation between debt equity ratio and income from asset sales. The findings provide evidence that both previous earnings target and debt equity ratio affecting the timing of earnings recognition from sales of assets. DeFond et al. (1994) examined abnormal accruals of companies reported debt covenant violations. It's plausible that managers in the risk of debt covenant to take actions to avoid such unwanted situation possibly with accruals. Models they used indicated that there were significant positive abnormal accruals, both in terms of total and working capital, a year before violation, presumably they tried to avoid violating covenant agreement.

DeFond et. al (1997) found empirical evidence on managers' behavior on earnings smoothing with regard to predicted future earnings. Prediction was made with Jones (1991) model. Managers presumed to secure their job, borrowed earnings from future earnings

when good performance is predicted for the next year. On the other hand, they saved current earnings when the opposite situation is predicted.

Cohen et al. (2008) report accrual-based earnings management had decreased after passage of Sarbanes-Oxley Act (SOX) in 2002, while in reverse, real earnings management had increased, suggesting replacement of earnings management type. They used three variables to represent real earnings management: abnormal cash flows from operations, abnormal production costs, and abnormal discretionary expenses (advertising, R&D and SG&A expenses) which were to give impact on "acceleration of the timing of sales, reporting lower cost of goods, decreasing discretionary expenses". All variables, except for abnormal cash flows from operations increased during and after SOX act.

Barton (2001) broadened research horizon to derivatives as a source of risk management, an alternative tool for smoothing earnings. From the idea that derivatives are used to correspond to uncertainties, Barton examined whether it substitutes the role of discretionary accruals used to control earnings volatility. He found companies holding large amount of derivatives had lower discretionary accruals suggesting possibility of substitution between the two.

3 Oil Industry

In this chapter I will introduce theories and prior studies regarding oil industry with emphasis on connection between properties earnings and valuation and risk of the firm. I will start from topics of firm valuation, risk management, and then review research on oil industry from perspective of valuation and risk management. Lastly, short introduction to oil price theory and oil price history is covered to help the reader to familiarize with oil industry and corresponding factors.

3.1 Valuation

Valuation posit one serious topic in the subject of corporate finance. Valuation is a procedure to find true and intrinsic value of assets and firms with available information (Penman, Financial Statement Analysis and Security Valuation, 2013). From equity to bond, debt and option, financial instruments traded at market are subject of valuation. Not only financial instruments but also tangible assets like land, buildings, and machineries as well as intangible assets like intellectual properties, and also firms and projects are target of valuation.

Valuation provides useful and helpful information for decision makers. Investors, analysts and managers; simply buyers and sellers of the target assets or firms are interested in the true value of the firm. Trades are completed when buyers and sellers agree upon price, other condition of goods to be traded, and when delivery is made. If there is market for trading the goods, it is convenient for both parties to make a deal. In this case, market price may be a good proxy for true value. However, a reliable market for desired goods is often unavailable or does not exist. Even though there is regularly quoted market for a certain item, participants may want to value price themselves with a sophisticated model, not just relying on the posted market price. There can be a gap between market price and valuation price depending on type of models and information utilized. Therefore, judgement from participants is required and understanding valuation model is crucial to end up with a satisfactory and desirable transaction.

There could be various methods for valuation. A simple way to value a stock price of company A when the very stock is not traded in stock market, for example, New York Stock Exchange (NYSE) is to compare company A with other comparable company B which is traded. Multiples: price-earnings ratio (P/E), price to book value ratio (P/B), and price to sales ratio (P/S) are commonly used numbers. The logic behind comparable method is that assets with the same specifications should have the same prices, or value. Preferred condition to compare companies is when they have similar business characteristics such as structure, size and industry.

The most basic and intuitive valuation model is Discounted Cash Flow (DCF) model (Brealey, Myers, & Allen, 2014, p. 83). The concept underlying DCF model is that aggregated cash flows discounted to present value should equal to the value, in other words current price (P) of specific asset in valuation. Equation (1) represents DCF model,

$$P = \sum \frac{CF_t}{(1+r)^t} \qquad (1)$$

When considering from equation (1) from the perspective of investor of this stock, for simplicity cash flow (CF) can be substituted by dividends received from the company, discount rate (r) by the required rate of return from the investor. Discounted Dividend Model(DDM) is a diversion of DCF model, substituting cash flow with dividend received, and cost of capital with the required rate of return of equity. The DDM model is the starting point of equity valuation, and/or stock price. Dividend turns out not to be a perfect substitute for cash flow because it does not represent the exact portion of cash flow for equity holder for the year of concern. Company policy, managerial discretion, market situation and lot more incorporates in deciding the amount of dividend each year.

Theoretically DCF model is simple and intuitive, however, imperfect when it comes to reality, in a way leaving a room of uncertainty in determining what is cash flow and which

discount rate to use. The fact that cash flow in the model is future amount leads to another drawback beyond exactness of cash flow amount. Because it is almost impossible to know all the future cash flows for each interval measurements at present time. Various forecast methods are used to estimate future cash flows in order to mitigate the deficiency coming from uncertain future cash flows. Often, historical numbers and estimated growth rates are utilized to project future figures.

Although DCF model has limitations and is imperfect, we can draw a light of precious insight to the firm when combined with other information available as complement and following a structured process. Fundamental analysis (Penman, Financial Statement Analysis and Security Valuation, 2013, p. 85) is a process producing estimate of a value and composed of 5 different steps. First is knowing the business. By understanding business by it's product, competitor, regulatory constraints and managements forms basis knowledge for valuation. Second is analyzing information with available inside or outside financial statements. Not only quantitative figures but also relevant quantitative information is valuable to use in the analysis. In the next step, payoff is forecasted. Deciding which factors to forecast payoff, for example, deciding among cash flows, dividends, earnings is part of the third stage. After that, assessing value is conducted using the proposed valuation model. And lastly, decision is made based on the computed value.

As mentioned above, there is no cash flows directly measurable when valuing a firm or equity value. Cash flow from operations (CFO) can be a proxy for cash flows. However, CFO itself does not convey context when it comes to forecasting future values. On the other hand, financial statement including earnings carry vast quantitative and qualitative information which can be utilized in understanding the context of final cash flows. As Penman (2013, p. 86) cited financial statement gives "the drivers of earnings and cash flow." One thing worth mentioning is that earnings and cash flows are fundamentally the same thing. It is the accrual accounting principle that makes the two figures different by altering acknowledgment timing of earnings and corresponding cash flows. Revsine (2005, p. 41) cites in his book,

"A natural consequence of accrual accounting is the decoupling of measured earnings from operating cash inflows and outflows. Reported revenues under accrual accounting generally do not correspond to cash receipts for the period. … In fact, accrual accounting can produce large discrepancies between the firm's reported profit performance and the amount of cash generated from operations. Frequently, however, accrual accounting earnings provide a more accurate measure of the economic value added during the period than to operating cash flows."

In other words, it means accounting numbers of sales and expenses, and finally earnings in the bottom line convey far more precious Economic information than cash flow from operations. Thus, these Economic information enables investors to make forecasts and valuation.

Now, let's turn our attention to the denominator in DCF equation, *r*, which is generally called cost of capital. For firms without any debt but gather capital by equity only, it is straightforward to measure cost of capital, which corresponds to required rate of return. However, for firms with debt, it is more complicated. The alternative method for valuation in this case is to find out total enterprise value first and then deduct debt value to end up with equity value. Weighted Average Cost of Capital (WACC) computed referring Capital Market Asset Pricing Model (CAPM) is frequently used in place of cost of capital in equation (1) (Brealey, Myers, & Allen, 2014, pp. 218, 480).

$$\text{WACC} = r_D(1 - T_c)\frac{D}{V} + r_E\frac{E}{V} \qquad (2)$$

Where, r_D and r_E are cost of debt and equity, T_c is marginal corporate tax rate, *D, E, V* are market value of debt, equity and firm respectively. As can be clearly seen from equation (2) combined with equation (1), cost of debt, cost of equity, debt ratio and corporate tax rate affects the value of the firm.

Valuation is not only useful for individual investors but also provides crucial information to managers of the company, (potential) lenders and acquirers. Managers may use valuation to estimate the effect of a certain managerial decision, for example, an investment decision. With the most precise information of the investment opportunity, managers can estimate in advance how much value will be added to the firm by that investment. At the same time, the computed result can be utilized to persuade capital providers either residing inside or outside of the firm. The counterpart of the persuader would be potential lenders and investors.

3.2 Risk Management

At any time, a firm faces risks. A company may have gone through a risk or maybe it is still on the way getting through the risk. Higher attention should put on the risk coming from the future. Uncertainty of future operating performance, market cost of resources and products, result of investment, evolving consumer tastes, devastating technology even natural disaster may lie in front of its business environment. There are of course, insider risk like agency problem, when the goal of the firm and its manager does not lie in line. Integrity concern on both employer and employee and the third party, like an auditor, may be a risk to the company as well. Most importantly, anything giving variation in firm value may be considered a risk factor. A field of Enterprise Risk Management (ERM) has drawn attention to benefit firms from a wide array of risks including "earnings and stock-price volatility, external capital costs, capital efficiency, and synergies between risk management activities." (Liebenberg & Hoyt, 2003)

Diversification is a conventional method to avoid unsystematic risk in classic finance theory. Investing on a portfolio of various stocks in different industries, regions, products is an example of diversification. Standard deviation of return of portfolio drops as more and more number of different stocks in the portfolio increases. (Penman, 2013, p. 648) Risk can be reduced down to the level of market risk, which still bears systematic risk.

Operational risk comes from the original operation of a company. If I extend the logic of

portfolio theory, operation risk can be mitigated by having as many as products, suppliers and buyers possible to reduce default risk, price risk, and supply shortage from contractors. Operating risk rises from uncertainty in operation, from selecting certain product, demand change of that product, competitors and substitutes in the market, and cost change or raw materials. Operating risk can be translated as variation in return on assets. The same asset as last year not guaranteeing the same return this year is a risk. Falling sales, increasing material cost, capital investment gives negative impact on return on assets. Slump from sales could in turn reduce credit grant from suppliers finally leading to additional liability risk.

Financial risk is driven by combination of financial leverage and net borrowing cost risk. Combined with operational spread, financial leverage can either give positive or negative effect on return. Net borrowing cost involves in operational spread hence affecting return. (Penman, 2013, p. 653). Lenders are always concerned about the risk of default when giving out money to companies. They may ask covenants to restrict company from making risky investment with their money. Examples of restrictions are setting limit on maximum ratio of interest to be paid, or putting sentence of seeps that company has to pay back the loan if it exceeds certain level of financial ratios like debt ratio. (Brealey, Myers, & Allen, 2014, p. 627)

To cope with and mitigate risk or maintain adequate level of risk, companies often use a method of hedging. Figuring out the risk factor and possible lose first, companies can utilize appropriate channels to reduce it. Insurances, options and forward and swaps are frequently used hedging instruments. Forward is a contract between two parties of seller and buyer at pre-determined price and amount of goods to be delivered at designated future time and place. It helps both parties to avoid risk from price fluctuation of commercials like corn, gold, coal and crude oil. Price and amount is fixed and uncertainty vanishes when making future contract. Future is a forward in standardized form with explicit and regulated exchange market in between participants to eliminate counterpart risk.

Another noticeable risk arises from interest conflict between firm and manager. Firm has it's own interest to thrive in the market, increasing sales and market share, finally providing profit to all shareholders. Managers are designated to realize the goal of the company, however, as an individual, managers also have their own objective. Large remuneration, securing his/her job, and advertising his/her reputation are those. When company performs well, manager will also benefit. However, that is not always the case. Sometimes managers turn down positive NPV project which takes time in order to maintain certain profit level in the short term. Agency problems which may be incorporated are reduced efforts, not doing his/her best effort to find operational method and projects to enhance value of the company; Entrenching investment, where manager invest projects which existing managers are skilled at and knows well. Compensation plans are implemented to alleviate agency problems. Stock option is a typical way to give incentive, making managers interest and that of stakeholders in line. But, this as well contains risk when managers take a behavior of gambling for redemption. Managers, having nothing to lose at the fail of the project but can expect a jackpot, can bet the whole company by taking on risk, even at a small probability of success. (Brealey, Myers, & Allen, 2014, p. 297)

Managers face scrutiny on earnings because of expectations from analysts and investors. Analysts forecast earnings of the company for upcoming announcement date. This estimate reflects market's expectation about the company's future earnings. It is called earnings surprise when actual performance surpass or does not meet the estimate of the market. (Revsine, Collins, Johnson, & Mittelstaedt, 2005, p. 293) Since the stock price already reflects expectation from the market assuming efficient market, disparity from market consensus brings immediate price change for the company stock. Sometimes firms also put explicit earnings target to meet for the upcoming quarterly or yearly earnings. These self announced earnings as well act as constraints to security price and decision from managers of the firm.

Managers may have incentives to manage earnings. He/she faces pressure to meet the expectation of stock market which is force from investors. He/her may have an incentive to

meet the expectation of recruiting market which is force from inside of him/herself. Since accounting principle is based on accrual accounting, there is a room for this manipulating being possible. Earnings management does not always mean fraud but could lie inside the boundary of accepted extent from GAAP. Likewise in the case of valuation, risk management is critical to all stakeholders including investors, lenders and managers. However, managers seem to be the highest related to issue of risk management since they have discretionary power to affect decision from hedging to accounting choice.

3.3 Research on Oil and Gas Companies – from Value and Risk Management Perspective

This section covers prior research on oil and gas industry related to value and risk management perspective. Finding out factors relevant to firm value and risk in the target industry is the purpose of this section.

Boyer et al. (2007) in their research on Canadian energy companies, found their stock returns are positively correlated with overall stock market return, oil price and natural gas price returns, and proven reserves, but negatively with interest rate. Interest rate is appreciated to debt and financing opportunity considering attribute of high investment capital required to purchase and operate equipment and properties. According to their research crude oil price return had much higher impact on value compared to natural gas price return, possibly reflecting the production value of each products. They also compared impact of crude oil price return between oil and gas producers and integrated firms finding smaller coefficient on integrated firms. Considering difference in size and their product mix, it is expectable result even though higher hedging tendency is observed among producers. Proven reserves are thought to "reduce operational risk, allow production increase and lead an appreciation of the firm's assets." (Boyer & Filion, 2007) The most interesting finding in their articles, in summary, is that they divided oil and gas companies in two different sub-categories and identified relevant determinants to each category.

Reserves is regarded to be an essential factor valuing oil and gas companies since they are resource of future economic benefit. Craswell et al. (1992) found in his study from Australian oil and gas companies, disclosure decision of proven reserves is motivated by contract cost, and interprets auditor quality as determinants. In addition, they have found firms with high variance in cash flows are more likely to disclose their reserves, possibly to provide additional information, a signal to market to add positive value, to reduce risk. But the latter was only weakly supported by statistics. In a similar vein, Berry et al. (2001) examines value relevance of current reserve disclosure for oil and gas companies. They argue exploration effort (expense) does not guarantee successful finding and adding value, but current level of reserves quantity leads future economic benefit to the company. However, opposite to their presumption, they found firm value is positively related to effort exerted by firms, however, firms ability to find new reserves (extending proved reserves) was not significant to firm value.

Han et al. (1998) studied earnings management of oil and gas companies upon political scrutiny from high oil price during Iraq invasion of Kuwait in 1990. Political cost, like windfall profits tax was considered in Congress to ripe excess profits from oil and gas companies. Oil price soared overnight although the level did not last long compared to previous crisis in 1970s. From their analysis discretionary accruals of 4th period of 1990 had negative residuals indicating negative accruals. Especially inventory level of LIFO firms increased at the same period signaling purchase of additional inventory to reduce income of the corresponding period. In earlier studies only for refineries in 1979 to 1988 , Hall (1993) suggested accounting change is used to deal at income increasing periods.

Additional evidence of earnings management by accruals are observed afterwards when there was supply shock after damage from hurricanes Katrina and Rita in 2005 (Byrad, Hossain, & Mitra, 2007), and during Arab Spring event in 2011 (Hsiao, Hu, & Lin, 2016). However, findings are inconsistent as Byrad et al. (2007) shown only refineries indicates abnormal accruals while Hsiao et al. (2016) demonstrates oil and gas producing firms driving income decreasing abnormal accruals.

Cormier et al. (2002) pointed out that oil price volatility provides earnings management opportunity to managers of oil and gas firms. In their research on earnings management of Canadian oil and gas firms, they examine value relevance of earnings, cash flow from operations, and oil and gas discoveries. They further focus on whether investors are able to counterbalance earnings management with complementary information. They found weak evidence that oil and gas firms systemically manage earnings, where most accruals were non-discretionary. Among three performance indicators, cash flow from operations dominated over the other two in terms of value relevance. Lastly, investors were able to differentiate and imply different valuation multiples from full cost and successful efforts method.

Not so many research had been done on the topic of oil and gas companies' risk management. Oil and gas industry is capital intensive and many production area is set nearby regions of unstable politics. These traits make performance outcome to be vulnerable to shock and volatile. Sadorsky (2001) tried to find risk factors in oil and gas industry in Canada from 1985 to 1998 with exchange rate, crude oil price, interest rate as possible variables. Surprisingly, his findings indicate that oil and gas companies stock return beta is less volatile than the Canadian market beta although oil and gas stock return were sensitive to above all factors.

Securities and Exchange Commission (SEC), by market risk disclosure rules (Financial Reporting Release No.48, 1997), required companies to disclose commodity price risk. Companies. Rajgopal (1999) found both tabular format: requiring information about fair values and contract terms, and sensitivity analysis format: estimates of potential loss in future performance provides risk relevant information arising from oil and gas price change. He (Rajgopal, 2000) estimated quarterly earnings change against oil price change in the period from 1987 to 1996 and examined whether estimated earnings sensitivity measures is risk relevant as well, although most firms release information in tabular form (Jin & Jorion, 2006). The articles provide SEC's perspective on risk relevance of commodity price and empirical evidence supporting it.

Another approach managing oil price risk is through hedging activities. Hedging is effective method and provides value in imperfect capital market by giving room to reduce volatility of earnings (Jin & Jorion, 2006). Jin et al. found from data on oil and gas companies' firm value between 1998 and 2001 where hedged firms were able to reduce stock price volatility, however, they failed to find strong evidence supporting value incremental property from hedging. Haushalter (2000) studied what affects firms' hedging policy and his research points evidence supporting financing cost to be related to the extent of hedging. He finds hedging is correlated to debt to asset ratio and oil and gas producers being more susceptible than refineries. From data he used, 100 U.S. oil and gas producers, about half did not hedge at all and only minimal number of firms hedged more than 50 percent of firms' total sales of the year. Among hedging method, fixed price contracts was most popular, comprising 40 percent. Similar research was followed by Pincus et al. (2002) which explains two methods reducing earnings variability; hedging by affecting cash flows, and abnormal accruals affecting earnings volatility. He examines whether these two are in substituting relation. His findings show hedging positions and abnormal accruals are independent except for the fourth quarter where they seem to substitute.

3.4 Oil Price Theory and Oil Price History

Oil price volatility is selected as independent variable to study earnings volatility in this study. Understanding factors causing volatility of oil price will add value when taking action is required to regarding the discovered economic determinant.

There had been a stream of research explaining oil price development with respect to overall economy change in Macroeconomic perspective. Hamilton (1983) showed a positive correlation between oil price growth rate and gross national product (GNP) growth rate in U.S. from 1948 to 1972 when oil price had been in increasing trend. Mork (1989) expanded research period and found that GNP growth rate responses asymmetrically to oil price change, especially in the period when oil market collapsed in the mid of 1980s. Above research demonstrates oil price has negative effect on GNP growth in the U.S. when oil price is increasing and close to zero effect in the opposite direction.

Another stream of research was conducted to evaluate oil price shock effect on equity market in short period of time. Elyasiani et al. (Elyasiani, Mansur, & Idusami, 2011) using GARCH model examined the effect of oil price change and oil price volatility to excess stock return and return volatilities in thirteen U.S. industries from 1998 to 2006. They found oil futures level and volatility both were risk factor in most industries, especially futures level having more influential than volatility in oil related sector. In earlier study, however, Huang et al. (Huang, Masulis, & Stoll, 1996) found oil future price change affects firms earnings, cash flows, dividend payment and stock prices of firms only in oil and petroleum industry, but not in other industries. They also found that in case of oil stocks, oil futures return lead stock returns by one period. Narayan et al. (Narayan & Sharma, 2011) examined lagged effect of oil price on firm returns of different industry sectors. They found returns from all the industries demonstrated lagged effect of oil price. However, depending on industries direction and strength of impact are observed to vary as number of lags increased up to 15 lags. Sabet et al. (Sabet, Cam, & Heaney, 2012) studied effect of BP oil spill over disaster due to explosion of Deepwater Horizon oil platform to other companies in the industries. Special attention was drawn whether market recognizes and separates associated subcontractors to BP with others. There is few research on long term relation between oil price shock and stock price returns. Mohanty et al. (2011) investigated with monthly data of oil price movement and stock returns of U.S. oil and gas companies from 1992 to 2008. They found market movement, book to market ratio, size affects stock return variations of oil and gas companies.

Oil price change can also be explained by disturbance in supply by political event and decisions. Before 1970s, world oil field and market outside the U.S. was divided and controlled by the Seven Sisters[1], while production amount and inter-state transportation inside the U.S. was restricted by TRC (Texas Railroad Commission). The price remained relatively stable ranging between $10~$20 at 2015 money value. A good season terminated with the U.S. losing its spare capacity at the end of 1960s and Saudi Arabia taking over the

[1] Seven Sisters : Anglo-Persian Oil Company (now BP); Gulf Oil, Standard Oil of California (now Chevron), Texaco (later merged with Chevron); Royal Dutch Shell; Standard Oil of New Jersey (Esso/Exxon) and Standard Oil Company of New York (Socony) (trading as Mobil now part of ExxonMobil) (Aljazeera, 2013)

status.

OPEC (Organization of Petroleum Exporting Nations) was established on 1960 to “maintain a steady stream of oil revenue to fund member countries’ development plans” (Evans, 2002) Two unexpected events happened in Middle East reminded OPEC members of their pricing power. In 1973, in response to the action taken by the U.S. on Arab-Israeli war, OPEC cut the production 5%, effectively raising the price. Again in 1979, member states and the rest of the world experienced the power of production cut after Iranian revolution. These, however, brought attention to energy security issue in many countries and urged development of oil fields outside OPEC countries. In addition, searching for alternative fuels and technology improvement for fuel efficiency were accelerated.

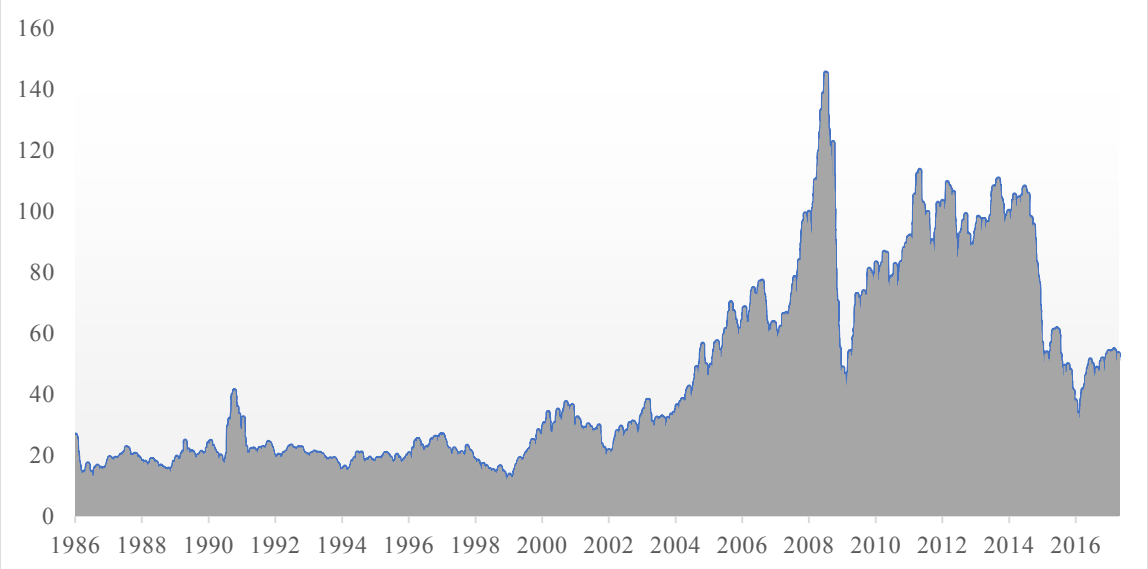
In mid-1980s, oil industry suffered from price drop owing to sluggish demand and incremental supply from non-OPEC countries. After several years of effort to cut the production resulting useless, Saudi Arabia took the opposite stance to increase production. The price plummeted in 1986 and dishonest member states had to cooperate again to cut production. In 1990s the market rallied and dropped by two big events; Iraqi Kuwait invasion in 1990 and Asian currency crisis in 1997. The market price soon stabilized due to quick response of oil producers both OPEC and non-OPEC countries offsetting the shock.

From 2002 to 2010, oil price had gradually increased due to sluggish incremental in supply and high demand growth from China and other Asian countries. Kilian et. al (2013) notes that repeated positive shocks from demand surprised forecasts on 2003 to 2008 reflecting unexpected economic growth in emerging economies. In his research, GDP forecast surprise for China, Russia, India, and Brazil was 0.12, 0.12, 0.3, 0.3 percentage points, respectively. The price was flat at high level (over $100 per barrel) for the past several years and collapsed to less than half in 2015. The production capacity growth (2.8mm/d) surpassed demand growth (1.9mm/d) in 2015 reflecting capacity expansion from the past few years (BP, 2016).

Figure 1. describes spot price of Western Texas Intermediate, FOB at Cushing Oklahoma from January 1986 to March 2017. After a sharp drop in price at 1985-1986, price was relatively stable until the end of 1990s except for a sharp increase in 1990-1991 Iraq-Kuwait invasion period and Russia, Asian currency crisis in 1997-1998. From 2002 to 2008 oil price graph demonstrates steady increase mainly due to demand shock from Asian economy. In 2008, oil price plummets to 2004 level reflecting collapse in U.S. financial sector but soon the price recovers and the new level seems to become around $100 barrel/day for the following a few years. There was another drop in 2014-2015 when the long rally resulting from growth shock finally ended.

Oil price has been fluctuating either by supply shock from political events or unpredicted demand shock. Oil price reflects real economy and at the same time real economy drives oil price. It will be an interesting issue to study how this volatility in oil price affects performance of firms in oil & gas industry.

Figure 1. WTI Spot Price (Dollars per Barrel)



Western Texas Intermediate (WTI) Spot Price Free on Board (FOB) (Dollars per Barrel). From January 1986 to March 2017. Data source from U.S. Energy Information Administration www.eia.gov

4 Hypothesis Development

This chapter is the beginning of empirical part of this study. I will first summarize logic behind research hypothesis, and develop hypothesis associating with background knowledge in oil and gas industry. Then finally present research objective and hypothesis that I am interested in to test.

4.1 Findings for Hypothesis Development

Theoretically, value of a firm should be the same as sum of discounted cash flows (DCF model) (Brealey, Myers, & Allen, 2014). Perfect information on future cash flow and exact discount factor are necessary for DCF valuation. Unlike simplicity of equation, there lies many obstacles in the field to resolve before approaching to the firm value. Source of cash flow in a company is of course generated from operation of business. Therefore, cash flow from operation (CFO) is an alternative proxy for cash flows in DCF model. However, CFO does not convey much context where the economic value comes from, therefore, difficult making forecast with it. Earnings, instead, embrace all relevant history and information required to assess current situation in addition, functional to forecast future figures.

There seems to be controversy which one is more value relevant between cash flow from operations (Sloan, 1996) and earnings (Ohlson, 1995). Again, there are also disagreement in diagnosing whether relevance of earnings to value of equity had decreased over time (Lev & Zarowin, 1999) or it's just hindering effect of large one-time items (Collins, Maydew, & Weiss, 1997). However, when considering Revsine's (Revsine, Collins, Johnson, & Mittelstaedt, 2005) remark that "earnings provide more accurate measure of economic value added", its materiality in value should not be underestimated. There is evidence that earnings is a better input variable for valuation purpose than cash flows (Penman & Sougiannis, 1998), (Dechow P. M., 1994).

Manager perceives earnings as the most important financial data over cash flows and others,

in belief that investors' concern lies there (Graham, Harvey, & Rajgopal, 2005). Investors are more relying on financial statement even they believe the quality is decreasing (Hodge, 2003). Earnings, indeed is still one most important performance indicator with respect to value of the firm.

Risk is uncertainty which may give variation to value of the firm. Risk comes from unpredictability in future performance, future price and cost, and any kind of threat blurring future performance, as a result yields uncertainty in value. Operation risk arises during normal operational act of the company. Material and product price change, supplier default, product change, emerging substitutes, new competitors in the market are all risk factors (Penman, 2013). Financial risk is driven by financial leverage and borrowing cost risk. Leverage itself maybe harmless but when combined with covenants it may restrict company from making a desired decision. Price risks are often reduced by hedging using derivatives or fixed contracts. Sometimes agency problem adds risk to corporation when managers' own benefit and that of the company conflicts. It is noticeable that decision making party is manager him/herself, and sometimes it is difficult to distinguish whether certain decision is made for individual or for the advantage of the company. Particular example is when company faces scrutiny because of earnings target set by analysts and investors (Cormier & Magnan, 2002). Management decision to meet the target executed at this situation may not be clearly judged whether it was to signal his ability to the recruiting market and/or to increase the value of the company.

Risk become manageable when risk factor is identified, correlation between the value and risk factor is known, and the movement of risk factor, thus, associated value is controllable or expectable. Earnings bear important traits associated with value and risk management perspective.

Necessary condition in valuation as well as key component in risk management is predictability (Penman, 2013). Proper valuation is possible only after earnings is reliable

and predictable. Risk management is associated with the same factor as valuation. Earnings volatility and earnings persistence are the two essential traits of earnings relevant to reliability and predictability of future earnings. In summary, understanding factors affecting earnings volatility and measures to attenuate it forms cornerstone in firm valuation and risk management.

One thing most studies agree upon is the value of smooth earnings (or cash flows) that is in the antipode position to earnings volatility and earnings persistence. Smooth earnings is connected to predictability, thus value and risk of the firm. Managers consider smooth earnings the most important trait of financial data they provide to investors (Graham, Harvey, & Rajgopal, 2005). Managers "smooth earnings to provide stock market with information of future persistence of current earnings" (Hand, 1989). Measures were taken to smooth, manipulate earnings in various purposes. For example, before government driven program or act (Jones, 1991) (Guenther, 1994), to keep earnings target and free from debt covenant issue (Bartov, 1993) (DeFond & Jiambalvo, 1994), and to secure their job(DeFond1997).

Sometimes earnings management is found to be employed to reduce volatility of earnings (Wild, Subramanyam, & Halsey, 2005). There had been significant amount of research regarding earnings management in various circumstances and purposes. Stable price brings a lot of advantages in operating a firm. Firm can provide more reliable financial data to investors and analysts which in return benefits firm by precise expectation and stable price. Financing will become less stressful to both parties. Recalling debt covenant contract (DeFond & Jiambalvo, 1994), smooth future income will add confidence to managers in their investment decisions.

Earnings management is frequently studied in the context functioning as forces for managers to meet the performance target (Graham, Harvey, & Rajgopal, 2005), political pressure to collect profits from certain industry (Han & Wang, 1998), and private concern of managers (DeFond & Park, 1997). All three circumstances are related to value either in terms of

present value or future cash flows. Failing to meet the performance target pulls down stock price of the firm. Government and public opinion try to transfer cash flows from company to the public, and many times manager's ability is referred from stable earnings. Accruals and real earnings manipulation methods are employed for earnings management.

There are studies examining reasons of increasing earnings volatility with respect to accounting choice, change in accounting standard (Dichev & Tang, 2009), conservatism in accounting and reporting (Givoly & Hayn, 2000). However, at my best knowledge, there aren't much articles examining economic factor as an explanatory variable in earnings volatility research. Only Donelson (Donelson, Jennings, & McInnis, 2011) studied possibility of incremental earnings volatility from economic events represented by negative employee growth, merger and acquisition, negative revenue growth and others. Givoly's (Givoly & Hayn, 2000) finding also suggest negative non-operating accruals and thus declining and dispersed earning arises from similar reason as Donelson described.

CAPEX and R&D expenditures have been considered from perspective of earnings volatility. Reasoning behind this is that the source of future earnings being the above two investments. Research mostly questions whether R&D expenditure brings about incremental volatility to earnings, therefore, should it be expensed or capitalized (Amir, Guan, & Livne, 2007), (Kothari, Laguerre, & Leone, 2002).

It seems reasonable that change in real economy has strong association with change in earnings throughout history. The reason there is not much research though, I assume, because it is difficult to devise a single independent economic variable adoptable to the whole industry. Therefore, I will focus on a specific industry where it is natural to come up with one most significant variable. In this study, I selected oil and gas industry as research target, and oil price volatility as an explanatory variable. In this study I will focus on earnings volatility which is simpler to compute and considered to have high correlation with persistence of earnings (Dichev & Tang, 2008).

Firm value and oil price should have a close relationship for oil and gas firms. Overall market return, oil price and gas price return, proven reserve, and interest rate are reported to have positive correlation with oil stock return (Boyer & Filion, 2007) (Sadorsky, 2001). Value relevance of proven reserves shows contradictory results (Craswell & Taylor, 1992) (Berry & Wright, 2001). Risk management efforts in oil and gas industry are mainly dealt in the context of earnings management. How these firms responded to political scrutiny during high oil price terms (Han & Wang, 1998), upon supply shock after hurricane Katrina and Rita (Byrad, Hossain, & Mitra, 2007), and during Arab Spring event (Hsiao, Hu, & Lin, 2016) are studied. Considering characteristics of oil and gas industry; subject to volatile oil price, adopting hedging strategy would be an alternative.

Examining relation between earnings volatility and oil price volatility is anticipated to give incremental information invaluable in valuation and risk management to firms in oil and gas industry. If managers become able to predict future volatility of oil price (note: not movement of oil price), then it will greatly improve their ability to attenuate volatility of value of firm, price, thus reduce risk. In other words, less volatile and smooth earnings performance may become possible without using earnings management. There are many benefits firm can harvest through less volatile earnings; reduce debt covenant uncertainty, less fluctuating stock price, investors' and analysts' credibility, and no need to manipulate accounting in purpose of risk management.

4.2 Developing Research Hypothesis

I will first examine association between earnings volatility and oil price volatility. Oil price volatility is expected to have positive relation with earnings volatility. Indeed, crude oil is one most important product, material, and medium in oil and gas industry. It is presumed that higher oil price leads to higher earnings to the firms in this sector. I will then break down companies in oil and gas industry into three sub groups and perform study to attain detailed results for each corresponding group. Oil and gas industry mainly consist of oil and gas producers (SIC1311), refineries (SIC2911), and oil and gas service companies (SIC1300 through SIC2999 except for SIC1311 and SIC2911) providing services to production

companies, and refineries. Oil and gas producers and refineries are two distinct and important sub groups which were commonly compared in the research. Refineries are on average larger than oil and gas producers, and sometimes they are vertically integrated containing oil and gas producing part, refining part, and marketing part as their sub business area.

Oil and gas producers explore oil and gas field, drill, and extract crude oil. The business area they are involved in is riskier than refineries partly due to uncertainty in possibility of discovering new reserves, geopolitical conflicts, and fluctuating product price. When crude oil price rises, these companies will benefit economically in terms of revenue in the short term. Capital expenditure may follow to increase when company decide to exploit high price opportunity, searching a new field and building up capital intensive facilities. Therefore, in the long run there are possibilities that these investments can pull down future earnings more than norm in price declining period.

Refineries use crude oil as raw material and their key products are gasoline, diesel, bunker oil, lubricants, naphtha and gas oils. Mostly product prices are connected to raw material price; when crude oil price rises, gasoline price inclines as well. Since their product is sold at consumer market, their performance receives more attention from public when oil prices soar. They disadvantage from high oil price considering material cost, however, compensates the loss from increased product price. Depending on inventory accounting scheme, reported earnings will be affected in different way when price fluctuates.

There is a controversy which is more value relevant between earnings and cash flows. Maybe because the process is associated with numerous factors and different times and environment. I will not study which one is more value relevant, instead, examine which one reflects changes in economic determinant (oil price volatility) more sensitively. After assessing relation between the two variables, possibility of predicting power will be analyzed. I will assess whether oil price volatility is leading indicator for earnings volatility.

In many research, earnings volatility had been reported to be increased (Dichev & Tang, 2008), (Givoly & Hayn, 2000) over decades. I will examine whether this trend has also happened in oil and gas industry for the last thirty years. Again analysis on sub group level will be conducted for precise understanding.

It seems apparent that earnings and crude oil price is associated with companies in oil and gas industry. I want to emphasis again that this study is focusing on oil price volatility affecting earnings volatility, not the level of price and earnings. There are two reasons behind this; one is to escape from modelling mistake many times happens when using level value, the other is that volatility provides more valuable information to risk management purpose than level indicators.

Relationship evidenced from testing hypothesis will provide incremental information for managers, investors, and analysts in valuation and risk management purpose. Especially for managers, this will contribute to provide additional and direct measures to attenuate earnings volatility and risk.

4.3 Research Hypothesis

Main objective of this study is to find if there is a positive relationship between oil price volatility and earnings volatility in oil and gas firms in the U.S.

H1: Oil price volatility has a positive relation with earnings volatility.

Next is to examine if there is sensitivity difference in earnings volatility to oil price volatility between oil and gas producers and refineries, two important sub groups within the industry. Similar analysis will be conducted with cash flow volatility in place of earnings volatility to assess which one reflects better the oil price volatility.

H2: Oil price volatility has a positive relation with cash flow volatility.

Another stream of analysis is testing whether earnings volatility has increased over time as many other research reports.

H3: Earnings volatility has increased over time.

Lastly, whether there was a change in degree of relationship between the two variables over time will be assessed.

H4: Degree of relation between oil price volatility and earnings volatility has increased over time.

5 Research Methodology

In this chapter, I will introduce research methodology starting from estimation models to data preparation and descriptive statistics. Models are constructed step by step reflecting findings and research questions drawn from chapter 4. Research method applied is pooled data regression analysis using ordinary least squares (OLS). The main regression model is developed to estimate effect of oil price volatility on earnings volatility. Simple t-test is applied to examine change in earnings volatility, and degree of relationship between oil price volatility and earnings volatility over time.

5.1 Estimation Models

Research idea begins from assumption that oil price is associated with earnings in oil and gas companies where oil is a key substance as product, raw material and medium of business. In brief, earnings can be thought to be a function of oil price as follows.

$$E_t = \alpha_1 + \alpha_2 OP_t + \varepsilon_t$$

Where,

E_t = income before extraordinary items deflated by average assets of year t and $t-1$

OP_t = crude oil price (Western Texas Intermediate spot price delivery at Cushing, Fed. Reserve Bank St.Louis)

Firm indicator, i suppressed for simplicity.

Earnings data is income before extraordinary items deflated by average assets of current and previous year. Earnings is deflated to reduce size effect for statistical analysis. It is well known large difference in size draw problems related to heteroscedasticity and reduce precision of coefficients. Oil price data is collected from FRED Economic data in Federal Reserve Bank of St.Louis. Western Texas Intermediate weekly spot price delivered at

Cushing Oklahoma is selected for oil price variable. It is believed to be the most relevant for oil and gas companies in the U.S.

Variance relation derived from the above equation is,

$$Var(E_t) = \alpha_2{}^2 Var(OP_t)$$

Historical volatility is computed as standard deviation of the variable which is square root of variance in this case. Since my research interest lies in correlation between volatility of each variables, I will transform equation a little and make basic regression equation,

$$EV_t = \beta_1 + \beta_2 OPV_t + \varepsilon_t \qquad (3)$$

Where,

EV_t = earnings volatility, standard deviation of E_t for 8 past periods from *t-7* to *t*

OPV_t = crude oil price volatility, standard deviation of OP_t return for 8 past periods equivalent (2 years from *t)* converted to annual volatility

Here, I use historical volatility for earnings volatility and crude oil price volatility.

Quarterly data is used instead of yearly data to increase number of observations while suppressing look back window to the past 2 years from the time of observation. More observations bring more reliable value for volatility, while smaller look back period saves observations being distorted from the past abnormal economic events which may not be relevant for current firm performance and volatility. Standard deviation of quarterly earnings data for 8 past periods are computed to yield earnings volatility. Standard deviation of weekly oil price return for the past 8 periods equivalent (2 years) is computed to yield oil price volatility and converted to annual value by multiplying square root of 52, where 52 is number of weeks in a year.

I included control variables frequently used to reflect differences in critical value which may affect firm performance and volatility, for example, firm size, financial leverage (Kothari, Laguerre, & Leone, 2002), (Luttman & Silhan, 2011). In addition to the above control variables, inventories seem adequate control variables for assessing volatility in oil and gas firms since sufficient amount of inventories may soothe price shocks thus smoothing earnings fluctuation. Capital expenditure also seems relevant variable however, somewhat tricky. Capital expenditure is expected to bring economic benefit to company however, timing of the benefit is hard to expect with certainty. Therefore, I only included inventories as an additional control variable.

$$EV_t = \beta_1 + \beta_2 OPV_t + \beta_3 MV_t + \beta_4 Inv_t + \beta_5 Lv_t + \varepsilon_t \qquad (4)$$

To distinguish companies in three different groups according to their main business area and assess sensitivity to oil price volatility, I added dummy variables SIC1311 and SICrest, each SIC number representing oil and gas producers (SIC1311) and the rest (non SIC1311 & non SIC2911), respectively. The rest are companies composed of SIC1300 through SIC2999, excluding SIC1311 and SIC2911, mostly being service companies providing goods and services to SIC1311 and SIC2911. SIC stands for Standard Industry Code. The reference group is refineries (SIC2911).

$$EV_t = \beta_1 + \beta_2 OPV_t + \beta_3 OPV_t * SIC1311 + \beta_4 OPV_t * SICrest + \beta_5 MV_t + \beta_6 Inv_t + \beta_7 Lv_t + \delta_1 SIC1311 + \delta_2 SICrest + \varepsilon_t \qquad (5)$$

Equation (5) is main regression model I will conduct estimation. Where,

MV_t = natural logarithm of market value of equity = ln (price close quarterly*common shares outstanding)

Lv_t = financial leverage = (long term debt total + debt in current liabilities) / (long term debt total + debt in current liabilities + market value of equity)

Inv_t = natural logarithm of inventories total

Natural logarithm of market value, computed as natural logarithm of price close quarterly times common shares outstanding, represents size of the firm. Here, logarithm is applied to reduce heteroscedasticity. Financial leverage is computed as long term debt plus debt in current liabilities divided by both debt terms plus market value computed above. Natural logarithm of inventories is used to assess inventory effect.

Cash flow from operations is thought to be a good proxy for cash flows to the entity, thus key factor for valuation (Brealey, Myers, & Allen, 2014). Estimating correlation between cash flow from operation volatility and oil price volatility may produce interesting results, free from accruals. Here, EV_t is replaced to $CFOV_t$ from equation (5) to compute how cash flows volatility react to oil price volatility, others being the same.

$$CFOV_t = \beta_1 + \beta_2 OPV_t + \beta_3 OPV_t * SIC1311 + \beta_4 OPV_t * SICrest + \beta_5 MV_t + \beta_6 Inv_t + \beta_7 Lv_t + \delta_1 SIC1311 + \delta_2 SICrest + \varepsilon_t \quad (6)$$

Where,

$CFOV_t$ = cash flows volatility, standard deviation of cash flows deflated by average asset, for 8 past periods from *t-7* to *t*

Size effect is analyzed by combining with another set of dummy variables; Big, Medium, and Small. Equation (7) will provide supplement information whether the difference in size between sub groups draws difference in response rate.

$$EV_t = \beta_1 + \beta_2 OPV_t + \beta_3 OPV_t * SIC2911\_Medium + \beta_4 OPV_t * SIC2911\_Small + \beta_5 OPV_t * SIC1311\_Big + \beta_6 OPV_t * SIC1311\_Medium + \beta_7 OPV_t * SIC1311\_Small + \beta_8 OPV_t * SICrest\_Big + \beta_9 OPV_t * SICrest\_Medium + \beta_{10} OPV_t * SICrest\_Small + \beta_{11} MV_t + \beta_{12} Inv_t + \beta_{13} Lv_t + \delta_1 Medium + \delta_2 Small + \delta_3 SIC1311\_Big + \delta_4 SIC1311\_Medium + \delta_5 SIC1311\_Small + \delta_6 SICrest\_Big + \delta_7 SICrest\_Medium + \delta_8 SICrest\_Small + \varepsilon_t \quad (7)$$

Main regression analysis utilizes pooled data OLS assuming constant slope coefficients over time. However, this assumption may not be true but degree of relationship changes. To test whether there was change in coefficient, I divided observations into two different groups, one from 1988 to 2001 and the other from 2002 to 2016. Then group t-test is performed to examine whether difference in earnings volatility between the two time frame is significant or not. Then separate pooled regressions sorted by these two groups are performed to test possibility of change in parameter coefficients. Dummy variable Time2002 is used to divide groups where value 1 is assigned to observations from and after 2002.

Lagged data of oil price volatility is employed to check whether oil price volatility has predictive power for future earnings volatility. 1 year period is chosen (from lag 1 to lag 3) for assessing time frame. Since equation (8) implies problems of autocorrelation, caution should be taken in interpreting the results. Alternative methods will be presented in empirical part to supplement the interpretation.

$$EV_t = \beta_1 + \beta_2 OPV_t + \beta_3 OPV_{t-1} + \beta_4 OPV_{t-2} + \beta_5 OPV_{t-3} + \beta_5 MV_t + \beta_6 Inv_t + \beta_7 Lv_t + \varepsilon_t \quad (8)$$

Alternative separate regressions sorted by dummy variables are performed for regression models with multiple dummy variables and displayed in appendix.

5.2 Data and Variables

Accounting raw data is collected from Compustat database in Wharton Research Data Services. Sample consist of U.S. oil and gas firms from SIC1300 to SIC2999 with data date between January 1986 and December 2016. Quarterly data is employed with all companies having fiscal year end at the last day of March, June, September, and December. 38,415 observations were obtained in perspective of available earnings data.

Companies with assets size less than 50 million US dollars are removed. Then the remaining data is cut off for companies having earnings volatility of top/bottom 1% to reduce statistical complexity and misunderstanding arising from outliers. After removing observations with missing control variables, for example, inventories, long term debt, price data and others, 11,088 observations were obtained for regression analysis which varies from 65 to 136 observations per each quarter.

Important variables are quoted once again for clarity. Income before extraordinary items (Compustat quarterly data item 8) deflated by average assets (Compustat quarterly data item 44) is used for calculating earnings volatility. 8 consecutive observations (from period t-7 to t), 2 years rolling windows, were employed to calculate volatility of earnings. Definition of variables and its source for raw data and regression model data used in the following analysis is summarized in table 1.

Spot oil price data of Western Texas Intermediate (WTI) is collected from FRED Economic data in Federal Reserve Bank of St. Louis. Simple return is computed from weekly data from January 1986 to December 2016. 2 years rolling windows, equivalent to past 8 periods are employed to calculate volatility of crude oil price (return). When oil price data date did not coincide exactly at the end of each month, the closest data date before the end date of financial report is employed for analysis.

Table 1. Variables

Variable	Source
Panel A: Raw Data	
ATQ	Assets-Total, Compustat Quarterly Data Item 44
IBQ	Income Before Extraordinary Items, Compustat Quarterly Data Item 8
DLCQ	Long Term Debt-Total , Compustat Quarterly Data Item 51
DLTTQ	Debt in Current Liabilities , Compustat Quarterly Data Item 45
INVTQ	Inventories-Total, Compustat Quarterly Data Item 38
CSHOQ	Common Shares Outstanding , Compustat Quarterly Data Item 61
PRCCQ	Price Close-Quarter, Compustat Quarterly Data Item
IBCY	Cash Flow from Operations, Compustat Quarterly Data Item 76
Panel B: Regression Model Data	
AA_t	Average Assets(*t,t-1*) = (Assets-Total at *t* + Assets-Total at *t-1*)/2
E_t	Earnings Deflated by Average Assets = Income Before Extraordinary Items at *t*/Average Assets(*t,t-1*)
EV_t	Earnings Volatility = Standard Deviation of E_t for the past 8 periods(from *t-7* to *t*)
OP_t	Crude Oil Price at t (WTI spot)
OPV_t	Oil Price Volatility = Standard Deviation of OP_t return for the past 8 periods equivalent (2 years from *t*)
MV_t	Natural logarithm of Market Value of Equity = ln(Common Shares Outstanding*Price Close-quarter)
Lv_t	Financial Leverage = (Long Term Debt-Total + Debt in Current Liabilities)/(Long Term Debt-Total + Debt in Current Liabilities + Market Value of Equity)
Inv_t	Natural logarithm of Inventories = ln(Inventories-Total)
CFO_t	Cash Flow from Operations Deflated by Average Assets = Cash Flow from Operations at *t*/Average Assets(*t,t-1*)
$CFOV_t$	Cash Flow Volatility = Standard Deviation of CFO_t for the past 8 periods(from *t-7* to *t*)
SIC1311	1 for SIC1311 companies, 0 for the rest
SICrest	1 for non SIC1311 & non SIC2911 companies
Time2002	0 for observations from 1988-2001, and 1 for 2002-2016

5.3 Descriptive Statistics

Descriptive statistics is presented for each raw data and regression model data separately in table 2. Mean, standard deviation, minimum and maximum are reported for sample observations employed in further test. 11,088 observations were assessed from *t*=1988 to 2016 with observations varying from 65 to 136 each quarter.

Table 2. Descriptive Statistics

n=11,088	Mean	Std. Deviation	Minimum	Maximum
Panel A: Raw Data				
ATQ	17426.08	49844.98	50.023	419648
IBQ	2744.412	7570.254	0	129025
DLCQ	591.7172	2194.487	0	34295.74
DLTTQ	255.5483	1202.226	-31764	16863
INVTQ	1005.395	3318.692	0.006	38921.24
CSHOQ	318.7336	881.3618	1.766	11488.5
PRCCQ	31.25558	28.08782	0.001	238.37
IBCY	17426.08	49844.98	50.023	419648
Panel B: Regression Model Data				
EV_t	0.022590	0.029292	0.001811	0.243533
OPV_t	0.293649	0.081227	0.147283	0.488670
MV_t	7.340547	2.283109	-4.23037	13.13373
Inv_t	3.80407	2.83555	-5.115996	10.5693
Lv_t	0.285935	0.216602	0	0.999800
$CFOV_t$	0.041737	0.048559	0.002361	0.7412
AA_t	17316.27	49603.25	36.41	418544.5
E_t	0.004426	0.049076	-0.683466	0.444537
CFO_t	0.012813	0.097949	-2.135153	0.630359

Variables are defined as follows: EV_t=Standard Deviation of E_t for the last 8 periods; OPV_t=Standard Deviation of OP_t return for the last 8 period equivalent; $CFOV_t$=Standard Deviation of CFO_t for the last 8 periods; AA_t=Average Assets of period t and t-1; E_t=Income Before Extraordinary Items deflated by Average Assets; MV_t=Natural logarithm of Market Value of Equity(millions); Inv_t=Natural logarithm of Inventories(millions); Lv_t=Financial Leverage; CFO_t=Cash Flow from Operations deflated by Average Assets; OP_t=Oil Price. The following variables are quarterly data: ATQ=Assets-Total; IBQ=Income Before Extraordinary Items; DLCQ=Long Term Debt-Total; DLTTQ=Debt in Current Liabilities; INVTQ=Inventories-Total; CSHOQ=Common Shares Outstanding; PRCCQ=Price Close-Quarter; IBCY=Cash Flows from Operations
Units for Assets are million $

Table 3. Supplement Descriptive Statistics for different SIC numbers

Raw Data	Mean	Std. Deviation	Minimum	Maximum	Ratio to Assets
Panel A: Complete Sample (n=11,088)					
ATQ	17426.08	49844.98	50.023	419648	
IBQ	255.5483	1202.226	-31764	16863	0.024
DLCQ	2744.412	7570.254	0	129025	0.152
DLTTQ	591.7172	2194.487	0	34295.74	0.044
INVTQ	1005.395	3318.692	0.006	38921.24	0.067
CSHOQ*PRCCQ	14537.18	42388.49	0.014547	505713.2	0.85
EV_t	0.022590	0.029292	0.001811	0.243533	
Panel B: SIC2911 only (n=2,545)					
ATQ	55491.97	90742.14	51.048	419648	
IBQ	942.3036	2164.431	-17150	16863	0.024
DLCQ	7062.638	13951.71	0	129025	0.154
DLTTQ	2176.113	4115.172	0	34295.74	0.045
INVTQ	3665.615	6121.733	0.098	38921.24	0.067
CSHOQ*PRCCQ	44701.58	77831.52	0.22432	505713.2	0.858
EV_t	0.015004	0.015316	0.001811	0.192059	
Panel C: SIC1311 only (n=5,108)					
ATQ	7522.957	17535.46	50.023	190155	
IBQ	60.09941	671.5959	-31764	6086.95	0.038
DLCQ	1824.932	3565.203	0	34804	0.203
DLTTQ	116.4921	538.1927	0	16663	0.031
INVTQ	187.6941	614.3301	0.013	7944	0.035
CSHOQ*PRCCQ	6048.519	13655.52	0.771289	143454.4	0.779
EV_t	0.029082	0.035969	0.001814	0.243533	
Panel D: Rest SIC numbers (n=3,435)					
ATQ	3949.359	7918.695	50.289	81171	
IBQ	37.371	266.6186	-6137	2218	0.034
DLCQ	912.3366	1867.31	0	18252	0.236
DLTTQ	124.5158	396.33	0	6172	0.05
INVTQ	250.3896	652.0083	0.006	5118	0.082
CSHOQ*PRCCQ	4811.325	12644.65	0.014547	152914.6	1.597
EV_t	0.018556	0.023468	0.001857	0.223690	

The following variables are quarterly data: ATQ=Assets-Total; IBQ=Income Before Extraordinary Items; DLCQ=Long Term Debt-Total; DLTTQ=Debt in Current Liabilities; INVTQ=Inventories-Total; CSHOQ=Common Shares Outstanding; PRCCQ=Price Close-Quarter; IBCY=Cash Flows from Operations

Sample mean and standard deviation of earnings volatility (EV_t) were 0.0226 and 0.0293 respectively, similar to the study of Dichev (2008) on the biggest 1,000 companies in the U.S. from 1986 to 2003. Inferring from quantiles graph and 75 percentile value of EV_t being 0.0250, majority of earnings volatility data are found to lie less or close to the mean but having long tail on the larger value end side. High volatility in earnings can be predicted from data rage of earnings from -0.6835 to 0.4445 while mean remaining close to zero. Large cash flow volatility is expected from even broader range of value distribution in cash flow from operations. There are 4,631 observations for dummy Time2002=0 and 6,457 observations for Time2002=1.

Table 3 presents descriptive statistics on sample observations depending on different SIC numbers. As different SIC number represents different sub groups within the same industry, companies with different SIC numbers have different size, financial structure, products, inventory level, customers, and thus, difference in risk factors. Refineries with SIC number 2911 are on average larger (average assets over 55 billion) than oil and gas producers with SIC number 1311 (average assets 7.5 billion) or other service companies (average assets 3.9 billion). Earnings volatility of SIC1311 companies has larger mean and standard deviation compared to other companies.

Correlation analysis is conducted to pick up an idea regarding relationship of variables. Correlation coefficients are significant in 5 percent level for most of variables except one which is between OPV_t and Inv_t. All raw data, assets, income from extraordinary items, long term debt, debt in current liabilities, market value, and cash flow from operations were highly correlated in positive direction which were expected. From the perspective of income before extraordinary items, correlation was the highest with cash flow from operations and relatively lower with debt bearinig items than with other variables.

From Table 4, earnings volatility (EV_t) is found to have positive correlation 0.175 with oil price volatility (OPV_t) as expected in chapter 4, suggesting possibility of OPV_t affecting

EV_t. EV_t on the other hand, had negative correlation with both market value (MV_t) of the company, and inventories (Inv_t). This latter observation suggests possibility of larger company size and more inventories are factors reducing earnings volatility. Financial leverage (Lv_t), on the other hand, has positive correlation with earnings volatility and negative correlation with market value and inventories. Cash flows from operations volatility ($CFOV_t$) revealed different degree but similar pattern with earnings volatility (EV_t).

Table 4. Correlation Statistics

n=11,088	Assets-Total	Income Before Extraordinary Items	Long Term Debt-Total	Debt in Current Liabilities	Inventories-Total	Market Value	Cash Flow from Operations
Panel A: Raw Data							
ATQ	1						
IBQ	0.6608	1					
DLCQ	0.8248	0.347	1				
DLTTQ	0.8189	0.5008	0.7005	1			
INVTQ	0.912	0.6195	0.7113	0.8332	1		
CSHOQ*PRCCQ	0.8561	0.7483	0.5404	0.6772	0.7802	1	
IBCY	0.75	0.8051	0.4364	0.5765	0.6982	0.7879	1

n=11,088	EV_t	OPV_t	MV_t	Inv_t	Lv_t	$CFOV_t$	E_t
Panel B: Regression Model Data							
EV_t	1						
OPV_t	0.175	1					
MV_t	-0.2949	-0.0581	1				
Inv_t	-0.2938	-0.0038*	0.8015	1			
Lv_t	0.2256	0.074	-0.3876	-0.1112	1		
$CFOV_t$	0.8304	0.1388	-0.2281	-0.2514	0.119	1	
E_t	-0.392	-0.0561	0.2572	0.1839	-0.341	-0.2981	1

The above table presents Pearson correlation coefficients between raw data and regression variables.
Variables are defined as follows: EV_t=Standard Deviation of E_t for the last 8 periods; OPV_t=Standard Deviation of OP_t return for the last 8 period equivalent; MV_t=Natural logarithm of Market Value of Equity(millions); Inv_t =Natural logarithm of Inventories(millions); Lv_t =Financial Leverage; $CFOV_t$=Standard Deviation of CFO_t for the last 8 periods. The following variables are quarterly data: ATQ=Assets-Total; IBQ=Income Before Extraordinary Items; DLCQ=Long Term Debt-Total; DLTTQ=Debt in Current Liabilities; INVTQ=Inventories-Total; CSHOQ=Common Shares Outstanding; PRCCQ=Price Close-Quarter; IBCY=Cash Flows from Operations
All significant at 5 percent level except for those with asterisk.

6 Findings

In this chapter I will present findings from regression analysis to answer research questions raised in chapter 4. I will go through and test hypothesis one by one with models developed in chapter 5.

6.1 Relation between Oil Price Volatility and Earnings Volatility

Main objective of this study is to find whether oil price volatility, an economic determinant, has relation with earnings volatility of U.S. oil and gas companies and how does it differ depending on different sub groups within the target industry. Prior research mainly focused on from perspective of accounting determinants' effect on earnings volatility; movement in accounting standard (Dichev & Tang, 2008), accounting conservatism (Givoly & Hayn, 2000), effect of R&D expenditures (Asthana & Zhang, 2006). Analyzing the effect of relevant economic determinant is the main contribution of this study.

Model (5) developed in chapter 5 is employed for the following empirical tests. In this model, dependent variable, earnings volatility (EV_t) is explained by economic determinant, oil price volatility (OPV_t) and control variables including, natural logarithm of market value (MV_t), natural logarithm of inventories (Inv_t), and financial leverage (Lv_t). Additional dummy variables, SIC1311 and SICrest are adopted to find different respond rates from different sectors within the same industry. Pooled data ordinary least square (OLS) regression is employed for the study ignoring the time frame. Additional regression is conducted separately by sorting data by SIC numbers and reported in appendix.

$$EV_t = \beta_1 + \beta_2 OPV_t + \beta_3 OPV_t * SIC1311 + \beta_4 OPV_t * SICrest + \beta_5 MV_t + \beta_6 Inv_t + \beta_7 Lv_t + \delta_1 SIC1311 + \delta_2 SICrest + \varepsilon_t \quad (5)$$

Table 5. Regression results for Earnings Volatility

Model1: $EV_t = \alpha_1 + \alpha_2 OPV_t + \alpha_3 MV_t + \alpha_4 Inv_t + \alpha_5 Lv_t + \varepsilon_t$ *(complete sample)*

Model2: $EV_t = \beta_1 + \beta_2 OPV_t + \beta_3 OPV_t * SIC1311 + \beta_4 OPV_t * SICrest + \beta_5 MV_t + \beta_6 Inv_t + \beta_7 Lv_t + \delta_1 SIC1311 + \delta_2 SICrest + \varepsilon_t$

Parameter estimates with t-statistics	***Model 1***	***Model 2***		
Variables	***Complete sample***	***SIC2911***	***SIC1311***	***The rest***
OPV_t	0.05803	0.00394**	0.00394**	0.00394**
	(18.28)	(0.6)	(0.6)	(0.6)
$OPV_t * SIC1311 \mid OPV_t * SICrest$			0.09988	0.02587
			(12.47)	(3.01)
MV_t	0.00020*	-0.00063	-0.00063	-0.00063
	(0.92)	(-2.67)	(-2.67)	(-2.67)
Inv_t	-0.00294	-0.00224	-0.00224	-0.00224
	(-18.1)	(-11.23)	(-11.23)	(-11.23)
Lv_t	0.02544	0.02147	0.02147	0.02147
	(18.44)	(15.15)	(15.15)	(15.15)
constant	0.00800	0.02781	0.02781	0.02781
	(4.66)	(11.38)	(11.38)	(11.38)
$SIC1311 \mid SICrest$			-0.02564	-0.01097
			(-10.23)	(-4.16)
n Number of observations	*11,088*	*2,545 reference group*	*5,108 with dummy SIC1311*	*3,435 with dummy SICrest*

Variables are defined as follows: EV_t=Standard Deviation of E_t for the past 8 periods; OPV_t=Standard Deviation of OP_t return for the past 8 period equivalent; $CFOV_t$=Standard Deviation of CFO_t for the past 8 periods; AA_t=Average Assets of period t and t-1; E_t=Income Before Extraordinary Items deflated by Average Assets; MV_t=Natural logarithm of Market Value of Equity(millions); Inv_t=Natural logarithm of Inventories(millions); Lv_t=Financial Leverage; CFO_t=Cash Flow from Operations deflated by Average Assets; OP_t=Oil Price

Reference group for regression with dummy variables is SIC2911 only. All coefficients are significant at 1 percent level except for those with double asterisks **. (t-values) are presented beneath estimates. Number of observations are; Complete sample:11,088 , SIC2911: 2,545, SIC1311:5,108, The rest:3,435

Regression results sorted by SIC numbers are presented in Appendix 1.

Table 5 reports results from main regression analysis. Results from two different models are displayed; one from model (4) for complete sample and model (5) with SIC dummy variables. First column shows results from complete sample of 11,088 observations from the whole oil and gas industry. The three columns on the right hand side display results from three sub groups depending on SIC numbers; SIC2911, SIC1311, and SICrest.

Slope coefficient of oil price volatility (OPV_t) at complete sample has value of 0.0580 and significant at 1 percent level suggesting as per regression result, null hypothesis H1 cannot be rejected. The estimate coefficient describes, the higher oil price volatility, the higher earnings volatility for companies in oil and gas industry. Inventories (Inv_t) have negative coefficient as expected, suggesting more inventories reduces earnings volatility. Financial leverage has positive coefficient probably suggesting financially constraint companies has difficulty in maintaining earnings. Market value was found insignificant at 5 percent level. Therefore, it is presumed that size effect is less probable cause of difference in earning volatility between large SIC2911 companies and small SIC1311 companies. Further test is conducted to examine whether this result denies size effect where smaller companies being more vulnerable to economic shock.

Analysis by different sub groups gives in depth understanding toward the industry. I divided oil and gas industry into three sub groups by SIC numbers and added dummy variables for analysis. SIC1311 of oil and gas producers whose main business is producing crude oil, SIC2911 of refineries consuming crude oil as raw material and produce petroleum, naphtha, lubricants and other oil derivatives, SICrest of companies providing services to both SIC1311 and SIC2911 companies are those. Some SIC2911 companies are vertically integrated corporations both produce crude oil and oil derivatives. Coefficient difference in oil price volatility between SIC2911 companies and SIC1311 is 0.0999 showing significant difference between the two sub groups. It is interesting that coefficient for SIC2911 companies was insignificant, suggesting its value is not different from zero. Table 5 reveals that relationship between oil price volatility and earnings volatility is driven by SIC1311, and SIC rest companies, but not by SIC2911 companies. In other words, SIC1311 companies

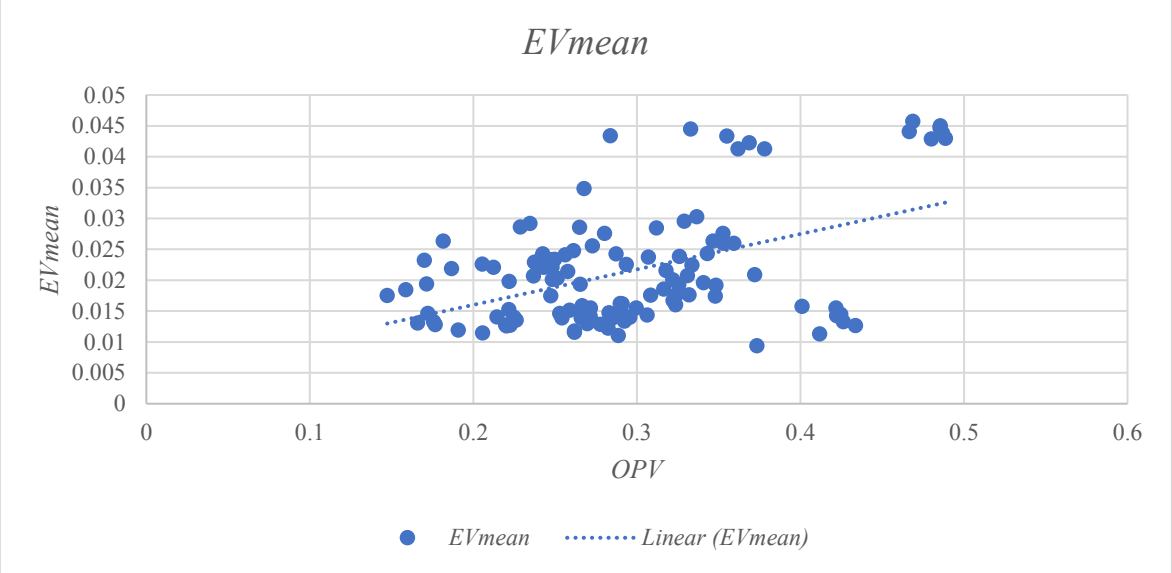
bears higher risk exposed to oil price fluctuation compared to SIC2911 companies although they are perceived as the same industry.

Another possible explanation SIC2911 companies having smaller earnings volatility and insignificant estimate compared to SIC1311 companies is political cost theory (Han & Wang, 1998), (Byrad, Hossain, & Mitra, 2007), (Hall, 1993). Refineries are exposed to public concern transparently due to its product being tightly bonded with everyday life of mass individual consumers. Increasing gasoline price is easily caught by eyes of individuals, journals and government. There could be more incentives for managers of refineries to perform earnings management to reduce earnings when extraordinary positive income is expected, thus, earnings are controlled smoother and less volatile in those companies. This is examined more deeply with cash flow volatility model (6) in the following section.

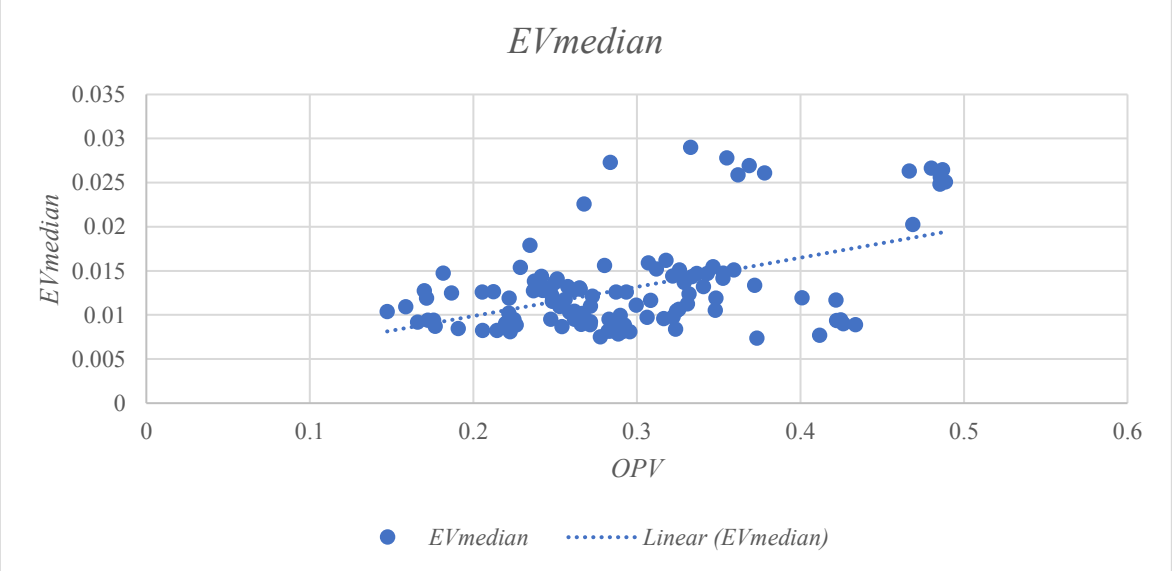
Figure 2 displays relation between quarterly mean earnings volatility versus oil price volatility in a compact way. Three groups of outliers are identified from the figure, each group of data originating from December 2008 to September of 2010, December 1990 to June 1992, and December 2015 to end of 2016 from left to right of the figure. All these three periods are when there was abrupt and tremendous price change of oil price due to Gulf War, Financial Crisis, and recent oil price drop begun in 2015, respectively. Further studies are required to judge whether these are outliers or the outcome of systematic defect in the model. Readers should bear in mind that sharp soaring or plummeting price can affect succeeding several periods significantly when using long-time-period rolling windows to compute volatility. For reference, I display quarterly mean of deflated earnings trendline from March 1988 to December 2016 in figure 3. It is clearly observed that three negative peak dates are December 1998, December 2008, and December 2015 which correspond to the beginning period of two outlier groups among three suggesting possibility of one time abnormal earnings shock which may be responsible for outlier groups. However, I would like to emphasize that further research should be conducted to draw a conclusion. Another possibility, shift in coefficient over time, is covered in section 6.3.

Figure 2. EV quarterly mean, median versus OPV

panel A: EV quarterly mean versus OPV



panel B: EV quarterly median versus OPV



Quarterly mean and median of earnings volatility plotted against oil price volatility for complete sample.

Figure 3. Earnings quarterly mean Trendline

Quarterly mean of deflated earnings from March 1988 to December 2016

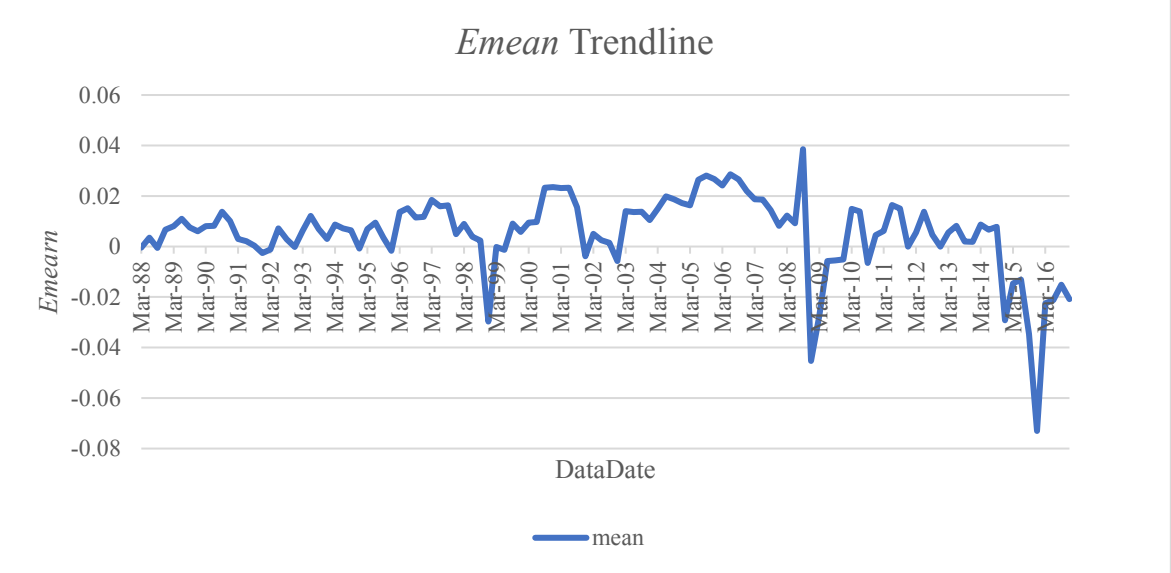


Table 6 reports additional test to identify whether size is the cause of distinct response rate between SIC1311 companies and SIC2911 companies. Additional dummy variable representing size is employed to test, Big standing for asset size larger than 5 billion US dollars, Small for asset size smaller than 1 billion, and Medium for those between 1 and 5 billion including the exact amounts. For simplicity, dummies for SIC numbers and dummies for size are multiplied to form composite dummy variables; SIC2911_Medium, SIC2911_Small, SIC1311_Big, SIC1311_Medium, and SIC1311_Small, SICrest_Big, SICrest_Medium, and SICrest_Small. Reference group is those satisfying large refineries (SIC2911_Big). Assets size of 1 and 5 billion dollars are chosen to separate observations evenly for each group.

All SIC2911 samples had insignificant slope coefficient for oil price volatility regardless of size. In SIC1311 companies, medium sized companies had the largest coefficient of 0.1404 (excluding insignificant β_2), much higher compared to 0.0604 for big and 0.0796 for small SIC1311 companies. From the regression result for different asset size, it does not seem that difference in response rate comes from size difference of oil and gas producers (SIC1311) and refineries (SIC2911).

Deriving from constant data and dummy estimates, base level of earnings volatility for SIC2911 companies were high; 0.0252 compared to SIC1311 companies having value close to zero. It seems earnings volatility of SIC2911 companies has minimum volatility base but tolerant to oil price volatility, while SIC1311 companies has close to zero base volatility but sensitive to oil price volatility. There is no evidence that size difference between different sub groups affects response rate. It is interesting that even within the same industry, sensitivity was significantly different. Further analysis is required to find where this immunity to oil price change for SIC2911 companies come from. All coefficient except for those with double asterisks were significant at 1 percent level.

Table 6. Oil Price Volatility coefficient comparison for different asset size and SIC

Model 1: $EV_t = \alpha_1 + \alpha_2 OPV_t + \alpha_3 MV_t + \alpha_4 Inv_t + \alpha_5 Lv_t + \varepsilon_t$ *(complete sample)*

Model 2: $EV_t = \beta_1 + \beta_2 OPV_t + \beta_3 OPV_t * SIC2911\_Medium + \beta_4 OPV_t * SIC2911\_Small + \beta_5 OPV_t * SIC1311\_Big + \beta_6 OPV_t * SIC1311\_Medium + \beta_7 OPV_t * SIC1311\_Small + \beta_8 OPV_t * SICrest\_Big + \beta_9 OPV_t * SICrest\_Medium + \beta_{10} OPV_t * SICrest\_Small + \beta_{11} MV_t + \beta_{12} Inv_t + \beta_{13} Lv_t + \delta_1 SIC2911\_Medium + \delta_2 SIC2911\_Small + \delta_3 SIC1311\_Big + \delta_4 SIC1311\_Medium + \delta_5 SIC1311\_Small + \delta_6 SICrest\_Big + \delta_7 SICrest\_Medium + \delta_8 SICrest\_Small + \varepsilon_t$

Parameter estimates with t-statistics			***Model 1***	***Model 2***		
Variables			***Complete sample***	***Big***	***Medium***	***Small***
Panel A: SIC2911_X sensitivity						
OPV_t			0.05803	0.00933**	0.00933**	0.00933**
			(18.28)	(1.09)	(1.09)	(1.09)
OPV_t $* SIC2911\_Medium$	| $OPV_t *$ $SIC2911\_Small$				-0.00267**	-0.03454**
					(-0.18)	(-1.76)
n	*Number observations*	*of*	*11,088*	*1489 reference group*	*606 with dummy SIC2911_Medium*	*450 with dummy SIC2911_Small*
Panel B: SIC1311_X sensitivity						
OPV_t				0.00933**	0.00933**	0.00933**
				(1.09)	(1.09)	(1.09)
OPV_t $* SIC1311\_Big$	| $OPV_t *$ $SIC1311\_Medium$	| $OPV_t *$ $SIC1311\_Small$		0.06035	0.14041	0.07961
				(5.05)	(11.94)	(7.02)
n	*Number observations*	*of*		*1459 with dummy SIC1311_Big*	*1518 with dummy SIC1311_Medium*	*2131 with dummy SIC1311_Small*
Panel C: SIC2911_X level						
constant			0.00800	0.02524	0.02524	0.02524
			(4.66)	(6.33)	(6.33)	(6.33)
$SIC2911\_Medium$	| SIC2911_*Small*				-0.00231**	0.00671**
					(-0.5)	(1.12)
Panel D: SIC1311_X level						
constant				0.02524	0.02524	0.02524
				(6.33)	(6.33)	(6.33)
$SIC1311\_Big$	| $SIC1311\_Medium$	| $SIC1311\_Small$		-0.01745	-0.03846	-0.01783
				(-4.78)	(-10.34)	(-4.67)

Variables are defined as follows: EV_t=Standard Deviation of E_t for the past 8 periods; OPV_t=Standard Deviation of OP_t return for the past 8 period equivalent; $CFOV_t$=Standard Deviation of CFO_t for the past 8 periods; AA_t=Average Assets of period t and t-1; E_t=Income Before Extraordinary Items deflated by Average Assets; MV_t=Natural logarithm of Market Value of Equity(millions); Inv_t=Natural logarithm of Inventories(millions); Lv_t=Financial Leverage; CFO_t=Cash Flow from Operations deflated by Average Assets; OP_t=Oil Price

X stands for size dummy: Big, Medium, Small

Reference group for regression with dummy variables is SIC2911_Big.

All coefficients are significant at 1 percent level except for those with double asterisks **.

(t-values) are presented beneath estimates.

6.2 Relation between Oil Price Volatility and Cash Flow Volatility

I am focusing on earnings volatility in this study because earnings measures are what managers and investors concern the most (Graham, Harvey, & Rajgopal, 2005). In addition, it bears context of operation properly for utilization in valuation and risk management purpose. Nevertheless, there is no doubt that cash flow is an important variable in valuation and as an indicator for soundness of operation. Therefore, I conducted another set of regression analysis setting cash flow from operations ($CFOV_t$), a dependent variable, to test whether it has relation with oil price volatility. This analysis is expected to answer some of questions arose during analysis at section 6.1 as well.

Overall the test results presented in table 7 resemble results from earnings volatility analysis in section 6.1. Generally, OPV_t slope coefficients are larger than earnings volatility case reflecting larger cash flow volatility. Results from the complete sample of 11,088 observations describe coefficient of oil price volatility being 0.0792, significant at 1 percent level, thus cannot reject the hypothesis H2. Therefore, it is assumed that oil price volatility has positive relation with cash flow volatility. Market value was insignificant like earnings volatility analysis. Cash flow volatility has larger average response rate and larger range compared to earnings volatility. Although further studies are required, accrual accounting and earnings management could be possible cause for smaller earnings volatility than cash flow volatility.

Similar to earnings volatility case, oil price volatility has larger impact on cash flow volatility for SIC1311 companies compared to SIC2911 and the rest. For SIC2911 companies estimate for OPV_t is insignificant while for SIC1311 companies, it is 0.1339, and 0.0326 (at 5 percent level) for the rest group of companies. Coefficient for oil price volatility was larger than earnings volatility case for both complete sample (0.0580 vs. 0.0792), and for SIC1311 companies (0.0999 vs. 0.1339). Possibility of smoothing effect of accrual accounting is proposed. Base level of earnings volatility for SIC2911 companies was larger than earnings volatility case; 0.0505 vs. 0.0278.

Since, again SIC2911 companies demonstrated coefficient for oil price volatility not different from zero, it is not possible to assess whether there is possibility of earnings management for SIC2911 companies with limited results. Again, further study should be conducted to draw a reliable conclusion.

Table 7. Regression results for Cash Flow from Operations Volatility

Model 1: $CFOV_t = \alpha_1 + \alpha_2 OPV_t + \alpha_3 MV_t + \alpha_4 Inv_t + \alpha_5 Lv_t + \varepsilon_t$ *(complete sample)*

Model 2: $CFOV_t = \beta_1 + \beta_2 OPV_t + \beta_3 OPV_t * SIC1311 + \beta_4 OPV_t * SICrest + \beta_5 MV_t + \beta_6 Inv_t + \beta_7 Lv_t + \delta_1 SIC1311 + \delta_2 SICrest + \varepsilon_t$

Parameter estimates with t-statistics	***Model 1***	***Model 2***		
Variables	***Complete sample***	***SIC2911***	***SIC1311***	***The rest***
OPV_t	0.07916	0.00740**	0.00740**	0.00740**
	(14.53)	(0.65)	(0.65)	(0.65)
$OPV_t * SIC1311 \mid OPV_t * SICrest$			0.13385	0.03255*
			(9.67)	(2.19)
MV_t	0.00042*	-0.00023**	-0.00023**	-0.00023**
	(1.12)	(-0.56)	(-0.56)	(-0.56)
Inv_t	-0.00440	-0.00385	-0.00385	-0.00385
	(-15.77)	(-11.17)	(-11.17)	(-11.17)
Lv_t	0.01979	0.01665	0.01665	0.01665
	(8.36)	(6.8)	(6.8)	(6.8)
constant	0.02649	0.05051	0.05051	0.05051
	(9)	(11.96)	(11.96)	(11.96)
$SIC1311 \mid SICrest$			-0.03613	-0.01224
			(-8.34)	(-2.68)
n *Number of observations*	*11,088*	*2,545 reference group*	*5,108 with dummy SIC1311*	*3,435 with dummy SICrest*

Variables are defined as follows: EV_t=Standard Deviation of E_t for the past 8 periods; OPV_t=Standard Deviation of OP_t return for the past 8 period equivalent; $CFOV_t$=Standard Deviation of CFO_t for the past 8 periods; AA_t=Average Assets of period t and t-1; E_t=Income Before Extraordinary Items deflated by Average Assets; MV_t=Natural logarithm of Market Value of Equity(millions); Inv_t=Natural logarithm of Inventories(millions); Lv_t=Financial Leverage; CFO_t=Cash Flow from Operations deflated by Average Assets; OP_t=Oil Price

Reference group for regression with dummy variables is SIC2911 only. All coefficients are significant at 1 percent level except for those with asterisks * and **. Coefficient significant at 5 percent level with asterisks *. (t-values) are presented beneath estimates.

Regression results sorted by SIC numbers are presented in Appendix 3.

6.3 Earnings Volatility, and Degree of Relation over Time

I will test whether earnings volatility has increased over the last thirty years as many researchers reports for large companies in the U.S (Dichev & Tang, 2008). Then whether there was change in degree of relationship between oil price volatility and earnings volatility is examined during the same time frame.

Research question begins from the trend outcome of mean value of earnings volatility and oil price volatility described in figure 4. It seems degree of association has increased from 2006 onward. To test hypothesis H3, observations are divided into two groups; former group with observations from 1988-2001, and the latter group from 2002-2016. As described in table 8, earnings volatility for the whole industry has changed from 0.0166 to 0.0269. In more detail, SIC2911 companies changed from 0.0120 to 0.0175, SIC1311 companies from 0.0203 to 0.0353. By group t-test, it is evidenced that estimates are different significantly regardless of sub groups at 5 percent level. As Dichev (2008) reported, the same trend is observed in the oil and gas industry.

Figure 4. EV quarterly mean, median, and OPV Trendline

Quarterly mean, median of earnings volatility, and oil price volatility from March 1988 to December 2016

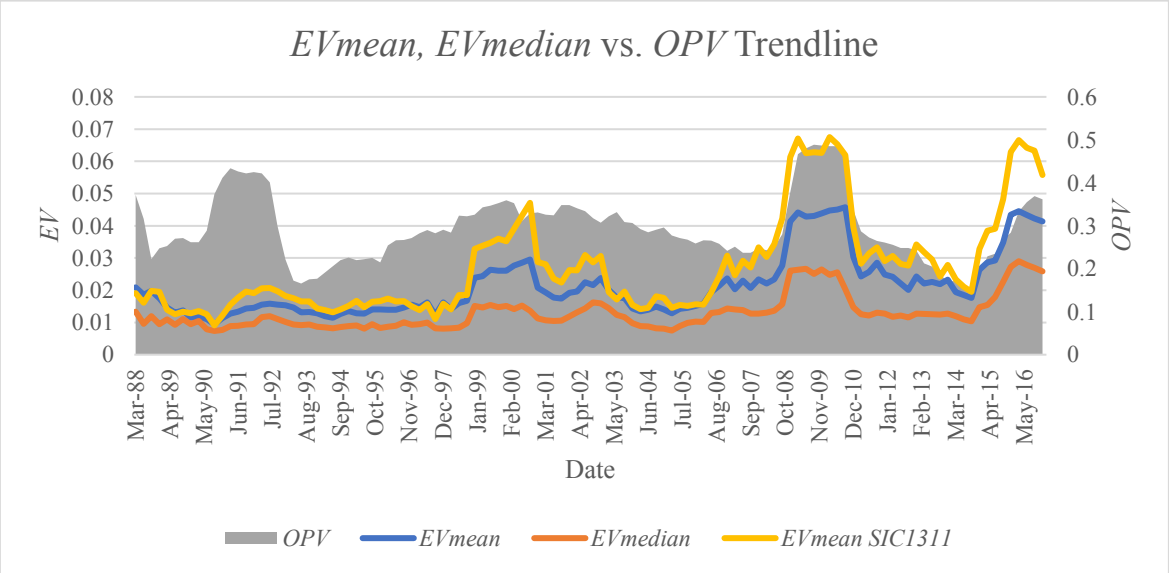


Table 9 provides comparison table on change in parameter estimate of oil price volatility over the same time period. Again, coefficient has increased for the whole industry from 0.0229 to 0.0727 suggesting oil price volatility became more relevant to explaining earnings volatility. However, results from SIC2911 sub group shows interesting feature, the coefficient has decreased from 0.0129 to 0.0110 between time period of 1988-2001 and 2002-2016. For SIC 1311 companies, on the other hand, the coefficient has tripled from 0.0410 to 0.1260. This findings suggest, while earnings volatility has increased over the past thirty years of time, its degree of association with oil price volatility had not increased in refineries, but significantly increased for oil and gas producers. Absolute magnitude of earnings volatility and degree of impact both has increased for oil and gas producers. Earnings volatility has increased but the degree of association has slightly decreased for refineries. This provides important message to managers in oil and gas producing companies that oil price is becoming more important to risk management of the company in SIC1311.

Table 8. EV comparison by two time periods

Variables	**Description**	***Complete period***	***1988-2001***	***2002-2016***	***Difference***
Panel A: All SIC					
EV	Earnings Volatility of test period	0.02259	0.01656	0.02691	-0.01035
t-stat					-18.63
P-value					0
n	*Number of observations*	*11,088*	*4,631*	*6,457*	
Panel B: SIC2911					
EV	Earnings Volatility of test period	0.01500	0.01198	0.01748	-0.0055
t-stat					-9.16
P-value					0
n	*Number of observations*	*2,545*	*1,144*	*1,401*	
Panel C: SIC1311					
EV	Earnings Volatility of test period	0.02908	0.02025	0.03530	-0.01505
t-stat					-15.05
P-value					0
n	*Number of observations*	*5,108*	*2,110*	*2,998*	

Table 9. Estimate Comparison by two time periods

Model: $EV_t = \alpha_1 + \alpha_2 OPV_t + \alpha_3 MV_t + \alpha_4 Inv_t + \alpha_5 Lv_t + \varepsilon_t$

Variables	**Description**	***Complete period***	***1988-2001***	***2002-2016***
Panel A: All SIC				
OPV_t	Oil price volatility	0.05803	0.02285	0.07265
		(18.28)	(5.52)	(17.18)
n	*Number of observations*	*11,088*	*4,631*	*6,457*
Panel B: SIC2911				
OPV_t	Oil price volatility	0.01140	0.01294	0.01097*
		(3.28)	(2.92)	(2.32)
n	*Number of observations*	*2,545*	*1,144*	*1,401*
Panel C: SIC1311				
OPV_t	Oil price volatility	0.10203	0.04095	0.12601
		(17.76)	(5.31)	(17.17)
n	*Number of observations*	*5,108*	*2,110*	*2,998*

All coefficients are significant at 1 percent level except for those with asterisk *, **. Coefficients with asterisk * is significant at 5 percent level. (t-values) are presented beneath estimates. Coefficients with double asterisks ** are insignificant at 5 percent level. Observations are sorted by SIC numbers before running regression.

6.4 Predictive power of Oil Price Volatility against Earnings Volatility

It is found from this study that oil price volatility has association with earnings volatility and cash flow volatility in oil and gas firms in the U.S. In addition, it is revealed that the degree of impact differs corresponding to sub groups inside the industry. Therefore, oil price volatility is assumed to be relevant economic determinant for earnings volatility in oil and gas industry. As prior research demonstrates, earnings volatility is an important measure for valuation and risk management purpose (Graham, Harvey, & Rajgopal, 2005). Managing and predicting oil price volatility, thus is one way to mitigate risk and reduce corresponding cost. Expanding the logic, it would be more valuable if oil price volatility has predictive power to earnings volatility so that managers could prepare for future earnings change with respect to leading oil price volatility.

To test whether it has predictive power, I performed the following test; earnings volatility is regressed against a set of lagged data (from current to lag 3, corresponding to 1 year back) of oil price volatility as in model (8) in chapter 5. This regression has defects because *OPV* regressors are autocorrelated sharing overlapping data when calculating volatility. *OPV* collects data from 2 years back to current time, *OPV_1* from 2 years 3month back to 3month from contemporaneous data point, and so on with *OPV_2* and *OPV_3* bearing distance of 3 months. As reported in table 10 all lagged *OPV* variables has insignificant coefficient at 5 percent level.

It may be better to apply time series analysis to test the hypothesis considering autocorrelation. However, since my data is incomplete panel data with missing data points, it is not simple process to make up a model. Alternatively, I regressed by each lagged oil price volatility one at a time separately for supplement test. *EV* is regressed with *OPV* then *OPV* is replace by *OPV_1*, *OPV_2*, and *OPV_3* consecutively. Results described in table 10 for complete sample reports decreasing coefficient as lag number increases, suggesting decreasing correlation to earnings volatility. The same trend happens to SIC1311 companies as well. I could not find clear evidence that oil price volatility had clear predicting power on earnings volatility with my sample data and measures.

Table 10. Regression results with lagged data on Oil Price Volatility

Variable	Description	Coefficient	t-Statistics	P value
Model: $EV_t = \beta_1 + \beta_2 OPV_t + \beta_3 OPV_{t-1} + \beta_4 OPV_{t-2} + \beta_5 OPV_{t-3} + \beta_6 MV_t + \beta_7 Inv_t + \beta_8 Lv_t + \varepsilon_t$				
Panel A: Regressed with series of lagged OPV, complete sample(n=11,088)				
OPV_t	Oil Price Volatility	0.08035	8.95	0
OPV_{t-1}	Oil Price Volatility lag 1 period(quarter)	-0.02841**	-2.52	0.012
OPV_{t-2}	Oil Price Volatility lag 2 period(quarter)	0.00242**	0.28	0.778
OPV_{t-3}	Oil Price Volatility lag 3 period(quarter)	0.00421**	0.71	0.475
MV_t	ln(Market Value)	0.00018**	0.82	0.413
Inv_t	ln(Inventories)	-0.00293	-18.03	0
Lv_t	Financial Leverage	0.02522	18.23	0
Model: $EV_t = \beta_1 + \beta_2 OPV_{t-n} + \beta_3 MV_t + \beta_4 Inv_t + \beta_5 Lv_t + \varepsilon_t,\ n = 0,1,2,3$				
Panel B: Regressed separately with single lagged OPV, complete sample(n=11,088)				
OPV_t	$n = 0$	0.05803	18.28	0
OPV_{t-1}	$n = 1$	0.05060	16.07	0
OPV_{t-2}	$n = 2$	0.03911	12.86	0
OPV_{t-3}	$n = 3$	0.02916	9.9	0
Model: $EV_t = \beta_1 + \beta_2 OPV_{t-n} + \beta_3 OPV_{t-n} * SIC2911 + \beta_4 OPV_{t-n} * SIC1311 + \beta_5 MV_t + \beta_6 Inv_t + \beta_7 Lv_t + \delta_1 SIC2911 + \delta_2 SIC1311 + \varepsilon_t,\ n = 0,1,2,3$				
Panel C: Regressed separately with single lagged OPV, SIC1311 only(n=5,108)				
OPV_t	$n = 0$	0.10203	17.76	0
OPV_{t-1}	$n = 1$	0.08802	15.4	0
OPV_{t-2}	$n = 2$	0.07092	12.79	0
OPV_{t-3}	$n = 3$	0.05537	10.27	0

Variables are defined as follows: EV_t=Standard Deviation of E_t for the past 8 periods; OPV_t=Standard Deviation of OP_t return for the past 8 period equivalent; $CFOV_t$=Standard Deviation of CFO_t for the past 8 periods; AA_t=Average Assets of period t and t-1; E_t=Income Before Extraordinary Items deflated by Average Assets; MV_t=Natural logarithm of Market Value of Equity(millions); Inv_t=Natural logarithm of Inventories(millions); Lv_t=Financial Leverage; OP_t=Oil Price
OPV_{t-1}: 1 period(quarter) lagging data of OPV_t
OPV_{t-2}: 2 period lag of OPV_t
OPV_{t-3}: 3 period lag of OPV_t
All coefficient significant at 1 percent level except for those with double asterisks ** which were insignificant at 5 percent level.

6.5 Limitations

This research has limitations arising from various reasons. Some related to sample characteristics, some restrictions on models, and some from lack of ability of researcher. Most accounting data has difference in size exposed to heteroscedasticity problems. Heteroscedasticity distorts standard error and reduce precision of results. To reduce problems arising from heteroscedasticity, earnings and cash flow data are deflated by average assets, natural logarithm is applied to market value and inventories data. Most data were symmetrical in terms of skewness and kurtosis, probably due to large sample size. Only natural logarithm of market value showed moderate level of skewness which was discarded during analysis.

Data are collected across the firms up to 136 firms per quarter and across time horizon from 1986 to 2016. If possible panel data analysis would have been an alternative method to apply to such a data set. However, since firms enter and exit from business frequently during the time periods, some variables are not collected due to various reasons (no price available, data not reported in quarterly reports, etc.) data set were incomplete in terms of panel data. Observations were dropped when there were any missing variables, assets less than 50 million US dollars were dropped to avoid extreme figures from small companies, data were truncated top/bottom 1 percent from perspective of earnings volatility. There should be minimal problem when applying ordinary least squares for regression with truncated data of 1 percent.

Spot price of Western Texas Intermediate (WTI) delivery at Cushing is selected as proxy for oil price in this study. Future price may be used instead of spot price in the research since spot price is more sensitive to abrupt economic event and news. It would be an alternative approach to examine hypothesis with future price in the future research. However, in this research, to exclude any other affection including hedging possibility, spot price is maintained.

Pooled data ordinary least square (OLS) regression is adopted to conduct research. Cross section autocorrelation is thought to be less influential because, observations were examined inside the same industry and same sub groups. Pooled data assumes constant estimates across the time which may not be adequate condition for fast changing business environment. Test by dividing observations into two different time period examines this possibility.

Regression results depicted low R square from 0.062 to 0.281 indicating indirect evidence of model misspecification. Various economic and accounting determinants would affect earnings volatility, some cross affecting each other. It is almost impossible to include all relevant variables and analyze with simple ordinary least square regression models. Rather I put meaning by finding and including valid economic determinants in the model which was rare in accounting research.

Volatility is computed with 8 data points which is less than normally thought as enough. In finance 21 or 30 data points are frequently used to assess stock price volatility. Small data points cause imprecision of results as noticed. Even with such a small data points look back windows extends to 2 years back from current time, which means performance figures 2 years ago affects current earnings volatility. A sharp data may have strong impact for upcoming 7 data points which were thought suspicious for the reason of outlier groups in figure 2.

Oil and gas producers can choose either to apply full cost accounting or successful cost accounting when recognizing exploration cost under U.S. GAAP. In full cost accounting, all cost related to exploration of a new reserve is capitalized regardless of successful or failure. On the other hand, in successful cost accounting, only those costs related to successful findings are capitalized. Therefore, depending on exploration activity, there should be different affect in income statement, balance sheet, and cash flow from operations. Market is known to able to distinguish full cost and successful cost accounting methods. In ordinary case, successful accounting companies are thought to have more volatile earnings and cash

flow from operations. However, thinking about when would oil and gas producers would invest on exploration; most likely when the oil price is rising and at high level, it may act to reduce extraordinary high income and curtail volatility. I did not reflect these difference in analysis since quarterly data did not provide accounting methods unlike yearly data and the complexity of designing the model.

Earnings management stemming from various reasons might have affected findings. It may have associated with, especially between different SIC numbers and comparison between earnings volatility and cash flow volatility. Further study incorporating earnings management is recommended for reliable findings.

7 Conclusion

Earnings volatility has been a topic of interest in accounting research for several decades. Its value relevant property draw attention not only from academia but also from professions. Low volatility and smooth earnings enables managers, investors, and analysts to mitigate risk of uncertainty and value the target company with higher confidence level, accompanied by stable response from market participants. Therefore, reliable and relevant information on determinants and corresponding relationship with earnings volatility is thought to be valuable for all stakeholders. Especially for managers, understanding degree of association between earnings volatility and its determinants, and at the same time, possessing skills to predict direction and magnitude change of determinants seem crucial in perspective of risk management.

Study on earnings volatility had been conducted mainly from perspective of accounting determinants; accounting choice, accounting conservatism, movement in accounting standard, and specific type of accounting events. At the author's best knowledge, there is few research from the point of view incorporating economic determinants as an independent variable in examining earnings volatility. Economic determinant has distinct features; it affects all companies associated with, its information on movement is available at the market. The author believe economic determinants can provide additional information relevant to value and risk of specific company as well as the whole industry when association between them is clarified.

This study features evidence on positive association between oil price volatility and earnings volatility in the U.S. oil and gas industry. Among sub-groups within oil and gas industry, oil and gas producers (SIC1311 companies) were found to possess the highest level of connection between the two variables. Size effect were relatively insignificant factor determining the degree of impact. Further study on relationship between oil price volatility and cash flow, and predictive power of the economic determinants were performed. Findings reveal evidence that earnings volatility has increased over the past thirty years in oil and gas

industry. Greater average volatility was observed in 2002-2016 observations compared to 1988-2001 observations from all sub groups divided by SIC numbers. Regression results demonstrates, parameter coefficient of oil price volatility with respect to earnings volatility is also greater in recent time frame. However, incremental amount was significant only for SIC1311 companies while slight decrement is observed for SIC2911 companies from sub group analysis. Larger absolute value and growing trend implies increasing impact of oil price volatility to SIC1311 sub groups' earnings volatility. Quarterly accounting data of 11,088 observations between 1986 to 2016 from Compustat database and WTI spot price referred from FRED Economic data are employed for this study.

In summary, earnings volatility of oil and gas producers (SIC1311 companies) demonstrated to be highly associated with oil price volatility. Degree of association between the two variables became larger over the last thirty years in oil and gas producers while refineries were insignificant. In other words, impact of oil price volatility, an economic determinant, to risk of the firm is significant and has increased over time for oil and gas producers only. Earnings volatility itself had been found to increase in oil and gas industry regardless of sub groups for the last thirty years. Findings from this study is expected to provide incremental information to identify, understand, and assess determinants to earnings volatility and to examine their impact on risk of the firm. Further study overcoming limitations of this study is believed to benefit managers, investors, and analysts in terms of valuation and risk management.

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Appendices

Appendix 1. Regression results for Earnings Volatility (Derivative of Table 5)

Model: $EV_t = \beta_1 + \beta_2 OPV_t + \beta_3 MV_t + \beta_4 Inv_t + \beta_5 Lv_t + \varepsilon_t$

sorted by SIC2911 and SIC1311

Variable	Description	Coefficient	t-Statistics	P value
Panel A: Complete Sample (n=11,088)				
OPV_t	Oil Price Volatility	0.05803	18.28	0
MV_t	ln(Market Value)	0.00020	0.92	0.357
Inv_t	ln(Inventories)	-0.00294	-18.1	0
Lv_t	Financial Leverage	0.02544	18.44	0
Constant		0.00800	4.66	0
Panel B: SIC2911 only (n=2,545)				
OPV_t	Oil Price Volatility	0.01140	3.28	0.001
MV_t	ln(Market Value)	-0.00010	-0.26	0.796
Inv_t	ln(Inventories)	-0.00264	-7.66	0
Lv_t	Financial Leverage	-0.00162	-0.71	0.475
Constant		0.03036	14.48	0
Panel C: SIC1311 only (n=5,108)				
OPV_t	Oil Price Volatility	0.10203	17.76	0
MV_t	ln(Market Value)	-0.00067	-1.49	0.137
Inv_t	ln(Inventories)	-0.00286	-8.3	0
Lv_t	Financial Leverage	0.03272	13.26	0
Constant		0.00105	0.3	0.765
Panel D: Rest SIC numbers (n=3,435)				
OPV_t	Oil Price Volatility	0.02928	6.29	0
MV_t	ln(Market Value)	-0.00196	-6.13	0
Inv_t	ln(Inventories)	-0.00081	-2.93	0.003
Lv_t	Financial Leverage	0.01442	7.53	0
Constant		0.02269	9.41	0

Variables are defined as follows: EV_t=Standard Deviation of E_t for the past 8 periods; OPV_t=Standard Deviation of OP_t return for the past 8 period equivalent; $CFOV_t$=Standard Deviation of CFO_t for the past 8 periods; AA_t=Average Assets of period t and t-1; E_t=Income Before Extraordinary Items deflated by Average Assets; MV_t=Natural logarithm of Market Value of Equity(millions); Inv_t=Natural logarithm of Inventories(millions); Lv_t=Financial Leverage; CFO_t=Cash Flow from Operations deflated by Average Assets; OP_t=Oil Price

Observations sorted by sub groups by SIC number and run regression separately.

Appendix 2. Oil Price Volatility coefficient comparison for different asset size and SIC (Derivative of Table 6)

Model: $EV_t = \beta_1 + \beta_2 OPV_t + \beta_3 MV_t + \beta_4 Inv_t + \beta_5 Lv_t + \varepsilon_t$

sort by SIC2911_Big, SIC2911_Medium, SIC2911_Small, SIC1311_Big, SIC1311_Medium, and SIC1311_Small

Classification		Description	Number of Observations	Coefficient	t-Statistics
OPV_t		Complete Sample	11,088	0.05803	18.28
OPV_t	SIC2911_Big	Assets > 5 billion	1489	0.01264	5.06
OPV_t	SIC2911_Medium	5 >=Assets >= 1	606	0.03537	4.62
OPV_t	SIC2911_Small	Assets < 1 billion	450	-0.01063*	-0.67
OPV_t	SIC1311_Big	Assets > 5 billion	1459	0.07469	12.63
OPV_t	SIC1311_Medium	5 >=Assets >= 1	1518	0.14897	16.97
OPV_t	SIC1311_Small	Assets < 1 billion	2131	0.08537	7.21
OPV_t	The rest	All excluding SIC1311 and 2911	3435	0.02928	6.29

SIC2911_Big stands for SIC2911 companies with assets larger than 5 billion US dollars,
SIC2911_Medium: SIC2911 companies with assets between 1 and 5 billion including boundary value,
SIC2911_Small: SIC2911 companies with assets less than 1 billion. Same size applies for SIC1311_Big, SIC1311_Medium, and SIC1311_Small.
All coefficients significant at 1 percent level except for one with asterisk *.
Observations sorted by sub groups by SIC number & size and run regression separately.

Appendix 3. Regression results for Cash Flow Volatility (Derivative of Table 7)

Model: $CFOV_t = \beta_1 + \beta_2 OPV_t + \beta_3 MV_t + \beta_4 Inv_t + \beta_5 Lv_t + \varepsilon_t$

sort by SIC2911 and SIC1311

Variable	Description	Coefficient	t-Statistics	P value
Panel A: Complete Sample (n=11,088)				
OPV_t	Oil Price Volatility	0.07916	14.53	0
MV_t	ln(Market Value)	0.00042	1.12	0.263
Inv_t	ln(Inventories)	-0.00440	-15.77	0
Lv_t	Financial Leverage	0.01979	8.36	0
constant		0.02649	9	0
Panel C: SIC2911 only (n=2,545)				
OPV_t	Oil Price Volatility	0.01977	3.75	0
MV_t	ln(Market Value)	0.00307	5.66	0
Inv_t	ln(Inventories)	-0.00640	-12.27	0
Lv_t	Financial Leverage	-0.01510	-4.4	0
constant		0.04438	13.98	0
Panel C: SIC1311 only (n=5,108)				
OPV_t	Oil Price Volatility	0.13464	13.41	0
MV_t	ln(Market Value)	-0.00171	-2.18	0.029
Inv_t	ln(Inventories)	-0.00393	-6.53	0
Lv_t	Financial Leverage	0.03889	9.02	0
constant		0.02002	3.28	0.001
Panel D: Rest SIC numbers (n=3,435)				
OPV_t	Oil Price Volatility	0.04036	5.08	0
MV_t	ln(Market Value)	-0.00197	-3.63	0
Inv_t	ln(Inventories)	-0.00215	-4.59	0
Lv_t	Financial Leverage	-0.00206	-0.63	0.529
constant		0.04867	11.84	0

Variables are defined as follows: EV_t=Standard Deviation of E_t for the past 8 periods; OPV_t=Standard Deviation of OP_t return for the past 8 period equivalent; $CFOV_t$=Standard Deviation of CFO_t for the past 8 periods; AA_t=Average Assets of period t and t-1; E_t=Income Before Extraordinary Items deflated by Average Assets; MV_t=Natural logarithm of Market Value of Equity(millions); Inv_t=Natural logarithm of Inventories(millions); Lv_t=Financial Leverage; CFO_t=Cash Flow from Operations deflated by Average Assets; OP_t=Oil Price

Observations sorted by sub groups by SIC number and run regression separately.