UNIVERSITY OF GOTHENBURG
SCHOOL OF BUSINESS, ECONOMICS AND LAW

Reserve replacement in the oil and gas industry -

A study on cost differences

Bachelor Thesis in Business Administration,
Accounting & Industrial and Financial
Management, Spring Term 2015
School of Business, Economics and Law
University of Gothenburg

Authors: Peter Gedeck
Daniel Vigh

Mentor: Gunnar Rimmel

Abstract

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Background and the question at issue: When attempting to increment oil and gas reserves, an oil and gas company typically has two possibilities, either to prospect and develop reserves or to acquire reserves through a takeover of another company with proved reserves. In this thesis, the reader will find an approximated answer to the question at issue about which of these alternatives is the most cost effective.

Purpose: The thesis was written with the intent to fill some of the holes in the academic literature regarding the cost effectiveness, related to the increment of oil and gas reserves. The paper also contains a discussion about the determents of value and costs in the oil and gas industry, written with the intention to contribute to the illumination of the economical dynamics of the industry.

Delimitations: Some generalizations have been made in this thesis in order to increment the transparency and perspicuousness of the study.

Methodology: This thesis was enabled by a thorough study of relevant academic research and empirical data, e.g. annual reports and press releases. The costs and outcomes of exploration activities between the years 2009-2013 was gathered from the ten largest oil and gas companies, according to the market capitalization per 2015-04-15, and compared to eight acquisitions that where considered to be a appropriate.

Conclusions: The findings of this study indicate that, from a strictly economic perspective, that the alternative to prospect and develop oil and gas reserves is the most cost effective way to increment reserves, although the findings are not statistically significant.

Possible stakeholders: This thesis should be interesting to anyone who takes particular interest in the oil and gas industry.

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1. Introduction

1.1 Background

Klaus Mohn stated in his Ph.D. thesis that "*As all fossil fuels are non-renewable, access to producible reserves is a special and critical issue. Unless oil and gas production volumes are replaced through successful exploration efforts, the basis for future production will be undermined*". (Mohn, 2008, p. 16). Gilbert & Scheck (2014) reported on the matter of major oil and gas companies failing to replace their production with new reserves. The authors highlighted the raising prospecting and commercializing costs of oil and gas companies during the last few years for three of the branches giants: Chevron Corp., Exxon Mobil Corp and Royal Dutch Shell PLC.

These facts indicate that oil and gas companies invest more money in finding less oil than they did some years ago. Vivoda (2009) confirms this trend, reporting that five majors of the industry only replaced 51.7 % of their produced oil between the years 2003 - 2007.

Macalister (2014) reported that "The costs of a trouble-prone drilling programme in Arctic waters off Alaska have contributed to Shell being forced to issue a shock profit warning". The author continues to explain that Shell spent USD 5 billion in 2013 on Arctic drilling "without any tangible result". Macdonald-Smith (2014) reported on the escalating development costs of the Gorgon liquefied natural gas project in Western Australia, in which Shell has a 25 % stake. "The original budget for the first three LNG trains was $US37billion, but it has been twice increased and is now $US17 billion higher, with some doubts still whether that will be the final figure".

Steven Kopits, an analyst at Princeton Energy Advisors, claimed that "*Oil majors are being eaten alive on exploration costs*" (Philips, 2014). In the article "Why Oil Prices Haven't Gone Crazy" Philips further presents the following figure:

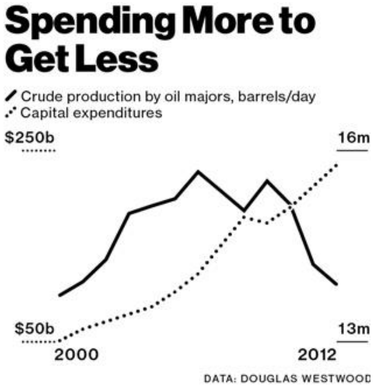

Figure 1. Crude production and Capital expenditure. Source: Philips (2014)

The figure above illustrates that oil and gas majors have increased their combined capital expenditures from USD 50 billion in the year 2000 to USD 250 billion in the year 2012. Despite a fivefold increase in capital expenditures, the companies' crude production was roughly the same in the year 2012 as in the year 2000.

An alternative approach to replacing fading resources is an acquisition of a smaller oil and gas company with proven reserves.

Kang & Gismatullin (2010) reported that the Korean National Oil Corporation (KNOC) won control over the Scottish oil producer Dana Petroleum PLC. The offer was of a hostile nature and represented a 59 % premium over the closing price of Dana Petroleum's shares "*the day before Dana first announced the approach July 1*".

Schaps & Zhdannikov (2015) reported on Shell announcing a cash and share offer for BG Group for approximately 47 billion GBP on 8 April 2015. The offer represents a premium of approximately 50 % over the closing price of BG Group shares on 7 April 2015.

Oil companies' ability to replace their production with new findings in a cost effective manner is very important for the companies' long-term survival, but not least to meet the world's energy demand. The matter of companies spending more to get less oil and gas becomes even more intriguing when it's paired up with OPECs outlook of the world's long-term oil demand. The outlook is presented in the figure below:

Long-term oil demand in the Reference Case *mb/d*

	2013	2015	2020	2025	2030	2035	2040
OECD	45.9	45.8	45.0	43.8	42.0	40.0	38.2
Developing countries	39.0	41.2	46.5	51.9	57.1	62.2	67.0
Eurasia	5.1	5.2	5.5	5.6	5.7	5.8	5.9
World	90.0	92.3	96.9	101.3	104.8	108.0	111.1

Figure 2. Long-term oil demand. Source: Organization of the Petroleum Exporting Countries (2014)

According to this forecast, the world's oil demand will increase by 23.44% from the year 2013 to the year 2040. Indeed, there seems to be some urgent issues that need to be solved by the world's oil and gas companies.

Mohn (2008) argued that empirical studies of the exploration process conducted by oil and gas companies are necessary to gain insight into the fundamentals of oil and gas supply. Furthermore, Mohn (2008) reasoned that empirical studies of the investment process among oil and gas companies is a key factor for understanding the economics of oil and gas supply. Mohn (2008) also expressed the belief that such empirical studies may be interesting not only for academics but also for strategists and governments

1.2 Problem discussion

In practice, an oil and gas company looking to increase their reserves can choose between two possibilities. The first would be an acquisition of another, preferably smaller, company with proven oil and gas reserves. The second possibility for the companies would be the task of finding, prospecting and commercializing oil and gas reserves on their own.

Given the assumption that an oil and gas company desires to be a long-term competitor in the branch, or aspires to be an attractive target for a company looking for acquisitions the replacement of the oil and gas reserves is essential.

The matter of oil and gas companies' methods and costs to increase oil and gas reserves is an important subject, both from the companies' perspective as well as a larger macro perspective. Oil and gas companies have to replace produced oil and gas with new reserves with an economic rationally method to avoid being "eaten alive", as well as meet the increasing world demand for oil and gas. This is a massive challenge, which have to be addressed in a rigorous and efficient manner.

As indicated above, an oil and gas company might face the reality of producing more oil and gas than they manage to replace. A replacement ratio, which could be considered healthy, should always be over 100 % (Vivoda, 2009). On the 27th of February 2006, Schwartz (2006) stated that the reserve replacement is the best indicator of a company's ability to maintain or increase production in the future.

1.3 The question at issue

One of the intriguing questions in the governance of an oil and gas company is how to handle fading reserves. A likely supplementary question is the one of what kind of replacement would be most cost effective. Would it be more cost effective to acquire a smaller company with reserves or to prospect and to commercialize oil and gas in own regime? From these reflections, the following question at issue is derived for examination in this study:

While looking to increment fading oil and gas reserves, are there any cost differences between acquisitions of companies with proven reserves as opposed to the prospection and commercialization of unexploited resources?

1.4 Purpose

The purpose of this study is to evaluate potential cost differences between exploring and commercializing oil and gas reserves for oil companies, compared to takeovers of other oil and gas companies with the intention to gain access to proven oil and gas reserves. Further, this study will illuminate the economic dynamics and decisions of the branch that are related to the replacement of oil and gas reserves.

1.5 Delimitations

In order to fulfill the purpose of this paper and answering the question at issue in a transparent manner, delimitations was a necessity to make. These delimitations are explained below.

Wilkinson (2014) wrote in the Oil & Gas Journal, reporting on a study conducted by the "Australian Bureau of Statistics and the Australian Petroleum Production & Exploration Association" (APPEA). The authors of the study concluded that the cost of drilling offshore in Australia has fivefold since 2003. The study reveals that the average cost of drilling an offshore well is more than 130 million AUD, which equals approximately to 100 million USD. Augustine et al. (2006) explains that the average onshore drilling cost in the U.S during 2003-2006 with an average depth of 4092 meters was 2.9 million USD. These facts illuminate the cost differences between onshore and offshore oil and gas operations.

Oil companies have different exposure to offshore operations. Higher exposure to offshore operations leads to higher finding and development costs as well as operation costs. Onshore and offshore drilling costs can differ greatly in any given country, accounted by different factors such as drilling time and geological complexity. Due to the complexity of this matter, no consideration will be given to the level of exposure to offshore, respectively onshore, operations that a company participates in when calculating its finding and development costs.

Different countries and governments adopt different taxation on oil and gas companies. The production sharing contracts between governments and oil and gas companies states how much of the produced oil and gas that will accrue the government in terms of royalties and taxes, etc. The differences in fiscal terms result in differences in the valuation of an oil and gas companies oil and gas reserves. Due to the complexity of this matter, this study will not take differences in taxation, and fiscal terms in production sharing contracts into consideration when analyzing the empirical data of this research.

Oil and gas exploration and production is associated with environmental risks, e.g. the 25th year anniversary of Exxon Valdez (Walters, 2014) last year and, more recently, BP´s disaster with Deepwater Horizon (Paton, 2015). The risks of exploitation of oil and gas can lead to environmental and monetary cost and concerns, but due to the complex nature of these risks and costs, they will not be consolidated in this study.

2. Theoretical framework

In the first section of this chapter, a presentation is given to previous research which carries relevance to this study. The second section contains a discussion of general characteristics and definitions of the oil and gas industry that are keen for this study. In section three, some of the commonly used methods for valuation of oil and gas companies are mentioned. In the fourth and final section, some of the commonly used definitions of finding and development costs are presented.

2.1 Previous research

Whilst researching which earlier studies have been conducted in the field examined in this study, there was no academic work found that makes a direct comprehension between finding and development costs and acquisition costs of oil and gas companies. Although, some relevant studies were found in these researches, these studies are presented in this section.

In “Valuing Barrels of Oil Equivalent” Smith (2014) explores differences in the valuation of barrels of oil equivalent (BOE), in two different conversion measurements. Smith states in the abstract of his study that *“... the extent of bias in estimates of value, cost and profitability is indeed large*”. The author explains that combined volumes of oil and gas are measured by barrels of oil equivalent, which is the aggregate of a relative thermal content of two energy sources. Smith (2014, p. 1) further states that one “*barrel of oil is usually counted as equivalent to 6 MCF (thousand cubic feet) of gas*”. Smith stresses that the ratio between the price of a barrel of oil and thousand cubic feet of gas is often larger than 6, the thermal conversion ratio. Smith concludes that a BOE with a high ratio of oil is worth more than a BOE with a low ratio of oil. This means that the higher oil/gas ratio the BOE has, the more lucrative it is to develop it. The historic oil/gas price ratio is presented in figure 3 below.

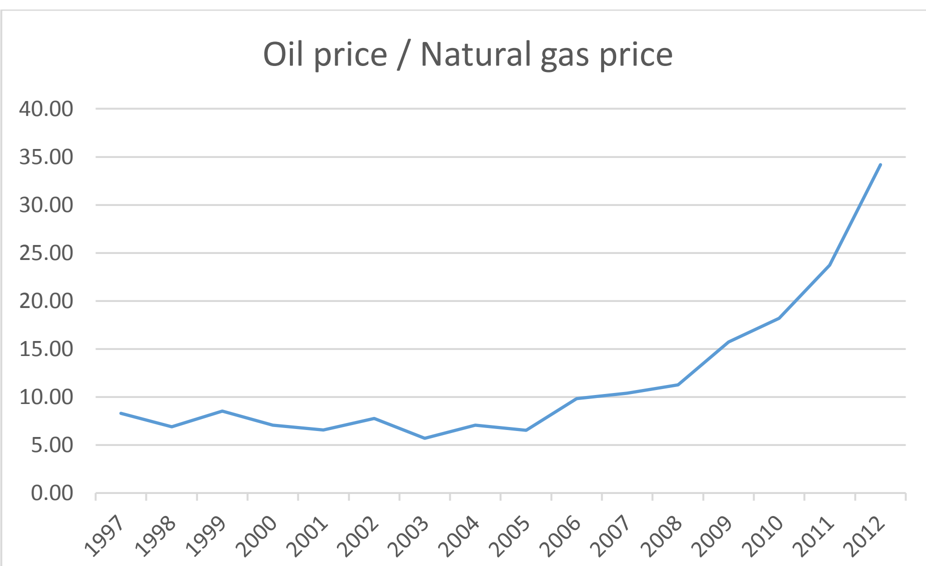

Figure 3. WTI Cushing oil spot price ($ per barrel) divided by Henry Hub Natural gas price ($ per million BTU). Sources: U.S. Energy Information Administration [2], 2015 and U.S. Energy Information Administration [3], 2015

According to Silverman (2015) one cubic foot of gas equals 1030 BTU. Therefore, one MCF equals 1 030 000 BTU. The U.S. Energy Information Administration presents historical gas prices in USD/million BTU ≈ USD/MCF. BTU is used in figure 3 above.

Smith explains that a BOE with thermal equivalence is calculated as:

$$BOE_{(t)} = Q_o + \frac{Q_q}{6}$$
$$Q_o = volume\ of\ proved\ oil\ (Barrels)$$
$$Q_q = volume\ of\ proved\ gas\ (MCF)$$

Furthermore, a BOE with economic equivalence is calculated as:

$$BOE_{(e)} = Q_o + Q_q * (\frac{P_q}{P_o})$$
$$P_g = Price\ of\ gas\ (\$\ per\ MCF)$$
$$P_o = Price\ of\ oil\ (\$\ per\ barrel)$$

Smith concluded that there were large valuation differences when using thermal or economic equivalent of BOE. For example, the author found that the finding and development cost (FDC) for Chevron during 2011-2013, using thermal equivalent BOE, was 36.35 USD while using economic equivalent to the FDC was 49.59 USD. The same comparison for ExxonMobil resulted in FDC using BOE_t of 25.14 USD and FDC using $BOE_{(e)}$ of 44.4 USD. These differences do indeed provide empirical evidence that there are major differences between the usages of the thermal conversion vs. the economic conversation.

As pointed out by Smith (2014); the definition of BOE with thermal equivalent does not considerate that the price of oil and gas differ, even when calculating price/thermal content. This fact makes the use of BOE with thermal conversion irrational when comparing the economic value of oil and gas companies' reserves. Therefore, this study will rely on the definition of BOE with economic conversion (BOE_e) when comparing economic values.

One weakness, as well as strength, with the economic conversion of BOE is the matter of reoccurring fluctuations in oil and gas prices. These price fluctuations will lead to that fluctuations of BOE with the economic conversion will be more dramatic than the fluctuations of the BOE with thermal conversion.

Adelman & Watkins (2004) concluded in their study "Costs of Aggregate Hydrocarbon Reserve Additions" that the costs of finding new oil reserves is difficult to subdivide between oil and gas reserves. The authors argue that the use of barrels of oil equivalent with thermal conversion creates economic fictions. Adelman & Watkins (2004, p. 20) state that "*the validity of a thermal conversion factor rests on oil and gas being close substitutes overall end uses… the aggregation technique preferred by industry, the investment community and governments has been to translate gas to oil 'equivalent' by using a fixed physical thermal conversion factor or a factor intended to some fixed BTU price equivalence…*".

2. 2 Characteristics and definitions of the oil and gas branch

2.2.1 Oil and Gas Reserves

The replacement of fading reserves is keen for companies that operate in the commodity sector. In the oil and gas industry, there are different classifications of reserves and resources. According to the Society of Petroleum Evaluation Engineers (2007) reserves are defined as "*those quantities of oil and gas anticipated to be economically recoverable from discovered resources*". Furthermore discovered resources are "*... those quantities of oil and gas estimated on a given date to be remaining in, plus those quantities already produced from, known accumulations*". Discovered resources consist of recoverable resources (i.e. reserves) and unrecoverable resources.

2.2.2 Reserves Categories

The Society of Petroleum Evaluation Engineers (2007) recognizes that geological and engineering knowledge, as well as professional judgment, are required to estimate reserves. Reserves are mainly based on analysis of drilling, geological, geophysical and engineering data. The use of technology and economic conditions are also used to quantify reserves. The relationship between resources and reserves is visualized in figure 4 and discussed further below.

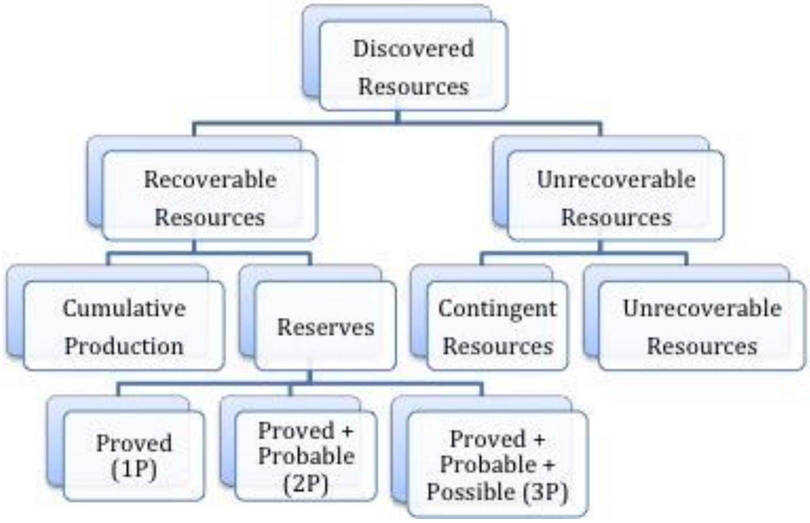

Figure 4. The relationship between resources and reserves.

Proved oil reserves are defined by Society of Petroleum Evaluation Engineers (2007, p. 10) as "*reserves that can be estimated with a high degree of certainty to be recoverable*". Proved reserves, 1P, (conservative estimate) have a 90 % probability of recovery.

Probable reserves are defined by the same society as "*those additional reserves that are less certain to be recovered than proved reserves*" by Society of Petroleum Evaluation Engineers (2007, p. 10). Proved + Probable reserves, 2P, (realistic estimate) have 50 % probability of recovery.

Furthermore, possible reserves are defined by the Society as "*those additional reserves that are less certain to be recovered than probable reserves*". Proved + probable + possible reserves, 3P, (optimistic estimate) have a 10 % probability of recovery according to the Society of Petroleum Evaluation Engineers (2007, p. 10).

Another important type of resource is the Contingent resources. This category is described by the Society of Petroleum Evaluation Engineers (2007, p. 10) as "*those quantities of oil and gas estimated on a given date to be potentially recoverable from known accumulations but are not currently economic. Contingent resources include, for example, accumulations for which there is currently no viable market*".

According to the Society of Petroleum Evaluation Engineers (2007) proved + probable reserves (2P) is the most realistic estimate of oil reserves. Furthermore, proved reserves (1P) are considered to be a relative conservative estimate. When oil and gas companies in financial statements report on the net change in reserves, the amounts are of the category "proved reserves". Due to how the oil and gas companies report on the net change in reserves, calculations in this study will be performed with 1P reserves in the denominator.

Undiscovered future recoverable resources are an estimate of future production and are referred to as prospective resources (Society of Petroleum Evaluation Engineers, 2007).

2.2.3 Strategic and political characteristics

Nie & Dowell (2012) wrote about how China National Offshore Oil Company (CNOOC), a state-owned oil company, tried to purchase an American oil company (Unocal). The authors explained how 41 members of the U.S. Congress demanded "*a rigorous review of CNOOC's bid. The 41 Congress men argued that the offer was not a free market transaction and that it was part of an attempt to control energy resources and influence in Asia*" (Nie & Dowell, 2012, p. 49). Furthermore, the U.S. Department of Defense warned that a potential takeover of Unocal by CNOOC could give China access to deep-sea drilling technology that could be used for military purposes. The Pentagon claimed that a "*Communist ownership of a U.S. oil company could present a national security risk*". The story ended with Chevron purchasing Unocal while the Chinese government and CNOOC backed off.

The takeover of Dana Petroleum by Korea National Oil Company is another example where the strategic importance of oil assets triggered an acquisition. In a press release, the former chairman of Dana Petroleum, Colin Goodall, commented *"... KNOC has an urgent need for reserves and production to meet its published corporate targets, set by national priorities. Dana's assets and operational management teams are of strategic importance to KNOC and Dana shareholders should rightly demand a full and fair value for surrendering control of a strong independent company, with high quality assets dominated by OECD oil production.*" (Dana Petroleum, 2010) The statement was an attempt to defend Dana Petroleum from a takeover, this attempt failed, and Dana was acquired by KNOC.

2.2.4 The price of oil

The price of oil is highly volatile and can affect the investment sentiment of decision makers within oil and gas companies. The historic price of crude oil is presented in figure 5 below.

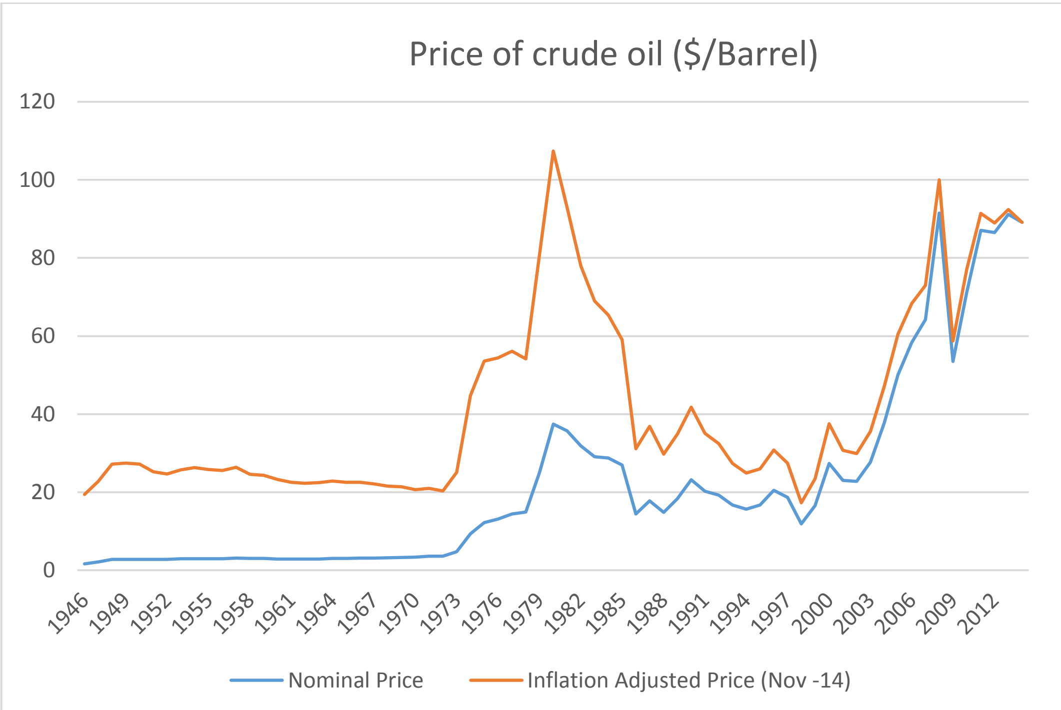

Figure 5. The price of oil, 1946-2014. Source: (McMahon, 2014)

Low oil prices make decision makers more restrictive, e.g., Royal Dutch Shell plc (2015) reported that the company will cut their capital spending during 2015-2017 by minimum 15 billion USD due to lower oil prices. Scheyder (2015) reported that Chevron plans to cut their capital expenditure by 13% in 2015 compared to 2014. Furthermore, Chevron's CEO John Watson marked that "*some projects would not be able to compete internally for capital with oil prices CLc1 below $110 per barrel*".

2.3 Reserves increment through acquisitions

The oil and gas industry, along with other commodity industries, is of a somewhat different nature than many other industries. For example, there is the matter of exhaustible resources that need to be considered when evaluating an oil and gas company (Howard & Harp, 2009). Methods for evaluation oil and gas companies might be of an econometric nature such as techniques presented by Mohn (2008). Other authors suggest methods with emphasis on cash flows, e.g., Howard & Harp (2009). Meanwhile, some authors discuss models that focus on the net present value of proved reserves (Adelman & Watkins, 1992) as determinants of the economic value of an oil and gas company.

As sophisticated these different kinds of evaluation methods might be, they might be more suitable as consultancy when making difficult investment decisions. The results of these calculations will not necessary represent the price an oil major needs to pay when looking to replace their fading oil and gas resources through acquisition of a smaller oil and gas company. These thoughts will be rationalized and discussed more in the method section of this study, along with a presentation of the approach used in this study when estimating the price tag of incrementing BOE through acquisitions.

2.4 Reserves increment through exploration

Wright & Gallun (2008) explains that finding costs are an important performance measure that is difficult to define. The authors argue that the difficulties derive from the lack of "*consensus regarding which costs should be included as finding costs*" (Wright & Gallun, 2008, p. 711). The timing of when finding costs occur and when the new reserves are recognized is also problematic. Wright and Gallun (2008, p. 712) further explain that reserves can be "*added through discoveries and extensions, purchases of reserves in place, revisions in reserve estimates and enhanced recovery*".

Bush & Johnston (1998) argue that calculating the costs of finding oil and gas is difficult to practice due to the magnitude of variables like discoveries, acquisitions, revisions, enhanced recovery, and conversion of gas to oil. Furthermore, the authors describe three methods of calculating finding costs:

$$Method\ A\text{: } \frac{\text{Exploration expense only}}{\text{Reserve additions (excluding revisions)}}$$

$$Method\ B:\ \frac{\text{Exploration expense only}}{\text{Reserve additions (including revisions)}}$$

$$Method\ C:\ \frac{\text{Exploration and development expense}}{\text{Reserve additions (including revisions }+\text{ enhanced recovery)}}$$

Method C is called "finding and development cost" (FDC). Acquisition costs are sometimes included, which is problematic due to the lack of standardization (Bush & Johnston, 1998). Oil and gas companies regularly engage independent reserve engineering consultants to evaluate the company's oil and gas reserves. These third-party evaluations are the fundament of the oil and gas reserves and resources estimates later presented in the company's annual reports.

The Energy Information Administration (2015) states that **extensions** are defined as "*The reserves credited to a reservoir because of enlargement of its proved area. Normally the ultimate size of newly discovered fields, or newly discovered reservoirs in old fields, is determined by wells drilled in years subsequent to discovery. When such wells add to the proved area of a previously discovered reservoir, the increase in proved reserves is classified as an extension*".

Furthermore U.S. Energy Information Administration (2015) explains that **revisions** are defined as "*Changes to prior year-end proved reserves estimates, either positive or negative, resulting from new information other than an increase in proved acreage (extension). Revisions include increases of proved reserves associated with the installation of improved recovery techniques or equipment. They also include correction of prior report year arithmetical or clerical errors and adjustments to prior year-end production volumes to the extent that these alter reported prior year reserves estimates*."

Schlumberger (2015) explains that the world wide average recovery factor for an oilfield is approximately 40%. This means that about 60% of an oilfield is left untapped because of technical and economic factor. The purpose of **enhanced oil recovery (EOR)** is to increase the recovery factor and thereby increase the recoverable volume of oilfields. Schlumberger further declares, "*the difficulty is ensuring the proper chemical interaction and subsequent flow conformance of the EOR sweep front to recovery more oil, more quickly. Making the right* *parametric decisions regarding a chosen EOR technique, while evaluating dynamic economic conditions, compounds these complex challenges*".

In a study conducted by Gaddis et al. (1992) the finding costs of ten of the largest American oil and gas companies during 1986-1990 was studied. The companies that were studied were Amoco, ARCO, Chevron, Conoco, Exxon, Marathon, Mobil, Philips, Texaco, and Unocal. The authors concluded that there were large differences in finding costs depending on which definition is used (e.g. Method A, Method B or Method C). The results of their efforts are presented in the figure 6 below.

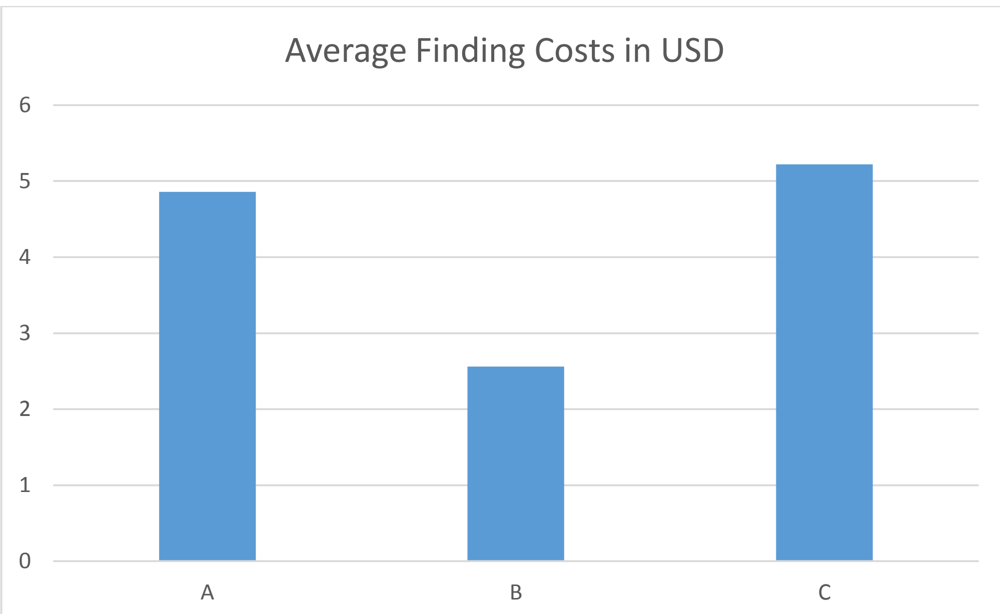

Figure 6. Average Finding Costs in USD with Method A, B and C. Source: (Gaddis et al. 1992)

Average finding cost with method A was 4.86 USD, with B 2.56 USD, with C 5.22 USD. Gaddis et al. (1992) also provided the average FDC (calculated with "Method C") for the companies during different years. The findings are presented in figure 7 below.

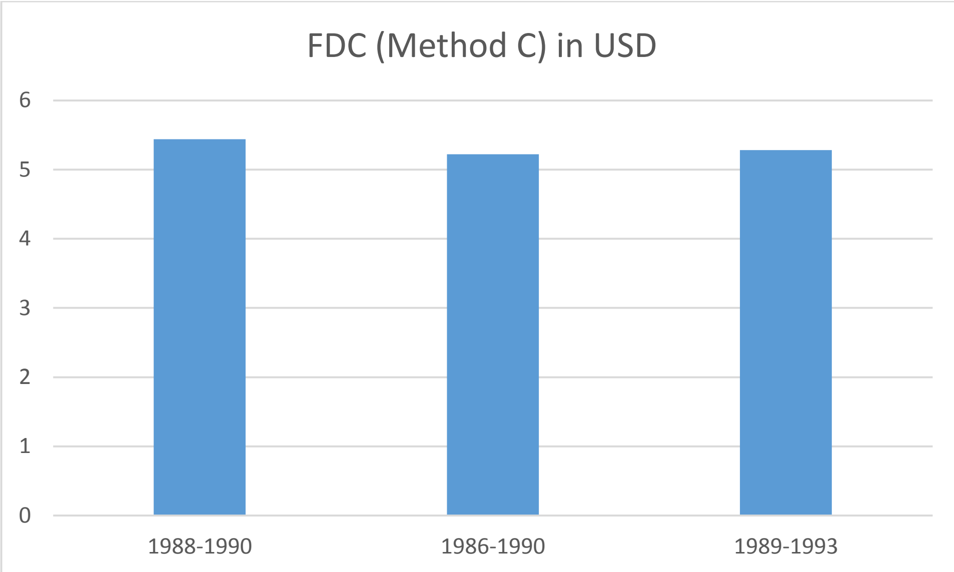

Figure 7. Average Finding Costs with method C (FDC). Source: (Gaddis, Brock & Boynton, 1992)

Figure 7 illustrates the differences in average finding and development cost (Method C) for the same companies. During 1988-1990, the average FDC was 5.11 USD, during 1986-1990 the average FDC was 5.22 USD, during 1989-1993 the cost was 5.28 USD.

(Bush & Johnston, 1998) highlights the importance of using one method consequently when calculating and comparing finding costs between oil companies.

3. Methodology

The methodology of this thesis is derived from its theoretical framework. This chapter contains a briefing upon the methods that are used to enable for the contemplation and gathering of empirical data. In the second part of this chapter, the tools that are relied upon in order to conduct an analysis of the empirical data are presented.

3.1 Marginal costs

To enable for a comprehension between the replacement costs of the major oil and gas companies, the use of marginal costs is a distinctive and intuitive method. Frank (2009, p. 303) writes, "*Marginal costs… is the change in total cost that results from producing an additional unit of output*". In this study, the marginal cost is defined as the additional cost for a company to add one more barrel of oil equivalent (BOE) to their reserves.

3.2 Gathering of the empirical data

The empirical data related to prospection and exploration activities (FDC) are mainly gathered from the examined companies' annual reports and will be delimited to consolidated subsidiaries, no consideration will be given to associated entities.

Data that describes takeovers, on the other hand, are mainly gathered from the involved companies' press releases. In similarity to the marginal cost of incrementing oil reserves through exploration and prospection, a marginal cost of incrementing oil and gas reserves through acquisitions is calculated.

3.2.1 FDC of BOE_e

The FDC will be calculated in accordance with "Method C" as described by Bush & Johnston (1998). In this paper, the economic conversion is the chosen approach when contemplating the results of joint oil and gas operations. The formula for calculating FDC is:

$$FDC = \frac{Exploration\ and\ development\ expense}{Reserve\ additions\ (including\ revisions\ +\ enhanced\ recovery)}$$

This formula does need a minor manipulation as the examined companies operate with both oil and gas commodities. The target of the manipulation will be the denominator as it should, in this study, represent the oil and gas operations as a joint venture.

The denominator will be handled as the result of the "*Reserve additions (including revisions + enhanced recovery")* for oil and gas activities combined, as BOE with economic conversion.

The economic conversion of BOE is calculated as:

$$BOE_{(e)} = 1P\ gas\ oil\ (barrels) + 1P\ gas\ reserves(MCF) * \frac{Price\ of\ gas\ (\$\ per\ MCF)}{Price\ of\ oil\ (\$\ per\ barrel)}$$

This yields that the FDC with the economic conversion will be calculated as:

$$FDC_{BOE\ economic} = \frac{Exploration\ and\ development\ expense}{1P\ oil\ reserves\ (barrels) + 1P\ oil\ gas\ reserves(MCF) * \frac{Price\ of\ gas\ (\$\ per\ MCF)}{Price\ of\ oil\ (\$\ per\ barrel)}}$$

3.2.2 Companies FDC that will be examined

This study focuses on the FDC of the ten largest listed oil and gas companies, according to the market value in USD per 2015-04-15. The FDC of the following oil and gas companies presented in figure 8 will be calculated and analyzed:

Figure 8. Market capitalization in billion USD. Source: Google Finance 2015-04-15

3.3 The marginal cost of acquisitions

The FDC will be compared to the marginal cost that is derived from incrementing reserves through a takeover of another oil and gas company. This marginal cost of acquisitions will be calculated by the following formula:

Marginal cost of incrementing oil and gas reserves through acquisition:

$$\frac{purchase\ sum}{obtained\ barrels\ of\ oil\ equivalent\ (BOE)}$$

The numerator will be defined by the total amount spent in eight different acquisitions. In these acquisitions eight larger oil and gas companies purchased smaller ones. The denominator will be the total amount of BOE obtained in each of the takeovers.

The acquisitions that are consolidated to the calculations are by the specimens below. Acquisitions that have been dismissed are for instance the takeover of Dana Petroleum by KNOC. Dana Petroleum does not audit 1P reserves solely and could therefore not be included in this study. The takeovers of XTO Energy, Petrohawk Energy Corporation and Progress Energy are not included in this study because they are mainly natural gas companies. Further the potential takeover of BG Group by Shell is not included because the transactions have not yet occurred. The main theme when choosing which acquisitions should be consolidated to the calculations was quality above quantity, which also explains that only eight acquisitions are consolidated. The selection of acquisitions was based on the following variables:

- The target company was an oil company or an oil and gas company
- Transaction value of minimum USD 1 billion
- The transaction took place during 2005-2015

Furthermore, Oil and gas companies can have operations with different type of oils and gases, i.e. light oil, heavy oil, bitumen and LNG (Liquid Natural Gas). To provide a fair and true picture, all these operations will be included when calculating FDC and marginal acquisition costs.

3.4 Analysis of data

In order to conduct a sophisticated analysis and draw conclusions about potential cost differences, some statistical tests will be performed. The framework of these tests is presented in this section chapter. In order to enhance the transparency, the analysis will be based on an averaged FDC as well as an averaged marginal cost of incrementing oil reserves through acquisitions.

3.4.1 Wilcoxon Signed Rank Test

A non-parametric Wilcoxon Signed Rank test can be used to determine whether there are any statistical significant differences between the means between two groups. The samples are related and the population cannot be assumed to be normal distributed (Field, 2013).

The following hypothesis will be tested at a significance level of 95%:

$$H_0: s_1 = s_2$$
$$H_A: s_1 \neq s_2$$
$$where$$
$$s_1 = 5\ Year\ average\ FDC$$
$$s_2 = Average\ marginal\ cost\ of\ acquistions$$

The statistics program SPSS will be used to perform the test.

3.4.2 Regressions

SPSS will also be used to perform statistical regressions. A brief introduction to regressions is given in the following quote in "Statistics for business and economics" by Cortinhas & Black (2012, p. 493) "*Regression analysis is the process of constructing a mathematical model that can be used to predict or determine one variable or other variables*".

The regression analysis will be performed in order to evaluate whether the market capitalization of the examined companies determines their cost of finding and develop reserves. It should be mentioned that market caps will be compared to the respective companies five years average FDC.

3.5 Reliability

The strengths in this study are the quantitative approach in the collection and the analysis of data. No interviews have been conducted which minimizes the risk of subjectivity and influences from possible biases. Possible weaknesses in this study are the limited amount of data. More data would increase the credibility of the study. An aspect that also decreases the reliability of this study is the fact that the FDC is compiled from the years 2009-2013 while the studied acquisitions spans from 2005-2015. The time span for acquisitions was increased from the original intent to observe acquisitions between the years 2009-2013 to 2005-2015, because of the lack of transactions during 2009-2013. This can be viewed as a trade-off where more data points were considered to be more valuable than the decrease in reliability from comparing FDC and marginal costs from acquisitions from different time spans.

4. Empirical Findings

This chapter contains a presentation of empirical data, gathered and calculated according to the methods described in the methodology chapter. The data of this chapter will be analyzed, commented and explained in the succeeding analysis chapter.

In table 1 below the companies, total expenditures on exploration and development of reserves are presented. The table also contains the "output" of these expenses in the form of barrels of oil equivalent (BOE) with thermal and economic conversion. In the column that is named "FDC (BOE 'type of conversion')" the exploration plus development expenses is divided by the net change in reserves from the prior year. Therefore, FDC can be contemplated as a form of marginal costs for exploration and developing reserves. In some cases there is a negative FDC, this was due to some major negative revisions of prior estimates.

The exploration and development expenses, oil and gas reserves was gathered from the companies' annual reports. In terms of oil and gas prices, the yearly average price of each commodity was used when calculating BOE_e with the following formula presented in the methodology:

$$BOE_{(e)} = 1P\ gas\ oil\ (barrels) + 1P\ gas\ reserves(MCF) * \frac{Price\ of\ gas\ (\$\ per\ MCF)}{Price\ of\ oil\ (\$\ per\ barrel)}$$

As explained in the methodology, the FDC per BOE_e was calculated as

$$FDC_{BOE\ economic} = \frac{Exploration\ and\ development\ expense}{1P\ oil\ reserves\ (barrels) + 1P\ oil\ gas\ reserves(MCF) * \frac{Price\ of\ gas\ (\$\ per\ MCF)}{Price\ of\ oil\ (\$\ per\ barrel)}}$$

In appendix 1, a spreadsheet containing all data and calculations from which the table 1 below was derived.

Company & Year	Exp. & dev. costs	BOE Thermal	BOE Economic	FDC (BOE Thermal)	FDC BOE (Economic)
ExxonMobil					
2009	19222	-1178	5296	-16.3	3.6
2010	25352	990	2639	25.6	9.6
2011	26990	10599	755	2.5	35.8
2012	28953	721	-2198	40.1	-13.2
2013	22456	1350	1249	16.6	18.0
Chevron					
2009	13751	1283	4985	10.7	2.8
2010	16979	292	322	58.2	52.7
2011	35002	1403	5119	24.9	6.8
2012	23294	885	1685	26.3	13.8
2013	29062	583	772	49.9	37.6
BP					
2009	13201	1094	3438	12.1	3.8
2010	12381	677	1646	18.3	7.5
2011	12835	339	1626	37.9	7.9
2012	16909	-39	751	-433.6	22.5
2013	18363	731	4094	25.1	4.5
Conocco					
2009	8424	885	765	9.5	11.0
2010	7833	556	1279	14.1	6.1
2011	10503	661	1087	15.9	9.7
2012	14213	379	340	37.5	41.7
2013	16179	729	1478	22.2	11.0
BHP					
2009	2563	144	488	17.8	5.3
2010	2857	172	128	16.6	22.3
2011	2814	184	894	15.3	3.1
2012	7497	330	592	22.8	12.7
2013	7893	248	513	31.9	15.4
Royal Dutch Shell					
2009	18834	3594	683	5.2	27.6
2010	17385	1178	367	14.8	47.4
2011	16857	1057	473	15.9	35.6
2012	27260	483	396	56.4	68.9
2013	32118	1384	438	23.2	73.3
CNOOC					
2009	7308	365	543	20.1	13.5
2010	5906	345	371	17.1	15.9
2011	7807	300	-23	26.0	-338.0
2012	10183	545	746	18.7	13.6
2013	14548	475	909	30.7	16.0
PetroChina					
2009	23855	1581	4223	15.1	5.6
2010	27003	1620	4528	16.7	6.0
2011	26432	1327	3578	19.9	7.4
2012	34667	1841	6225	18.8	5.6
2013	33346	1536	4832	21.7	6.9
Total					
2009	9864	554	713	17.8	13.8
2010	9970	550	1473	18.1	6.8
2011	13687	515	3363	26.6	4.1
2012	16819	532	937	31.6	17.9
2013	21767	381	609	57.2	35.8
Sinopec					
2009	10460	299	97	35.0	107.6
2010	10269	323	165	31.8	62.1
2011	11634	410	791	28.4	14.7
2012	15138	426	628	35.5	24.1
2013	16320	230	394	71.1	41.4

Table 1. Exploration and development costs (FDC) in millions of USD. BOE in millions. FDC in USD per BOE_e.

The results in column "FDC BOE (Economic)" in table 1 above explains how much each company invested in exploration and development of oil and gas to add one BOE_e per year. It is obvious that there are large differences in the FDC per BOE_e from year to year and between the companies.

Table 2 below contains the five years average FDC with thermal and economic conversion for the respective company. Table 2 can be viewed as a summarizing of table 1. As seen in table 2, there are large differences in FDC, even when using five years averages.

Company	5y Avg FDC thermal	5y Avg FDC economic
ExxonMobil	13,7	10,8
Chevron	34,0	22,7
BP	-68,0	9,2
Conocco	19,8	15,9
BHP	20,9	11,7
Royal Dutch Shell	23,1	50,5
CNOOC	22,5	-55,8
PetroChina	18,4	6,3
Total	30,3	15,7
Sinopec	40,3	50,0

Table 2. Five year average FDC per 1P BOE with thermal and economic conversion

Figure 9 below visualizes the five years average FDC for a BOE_e

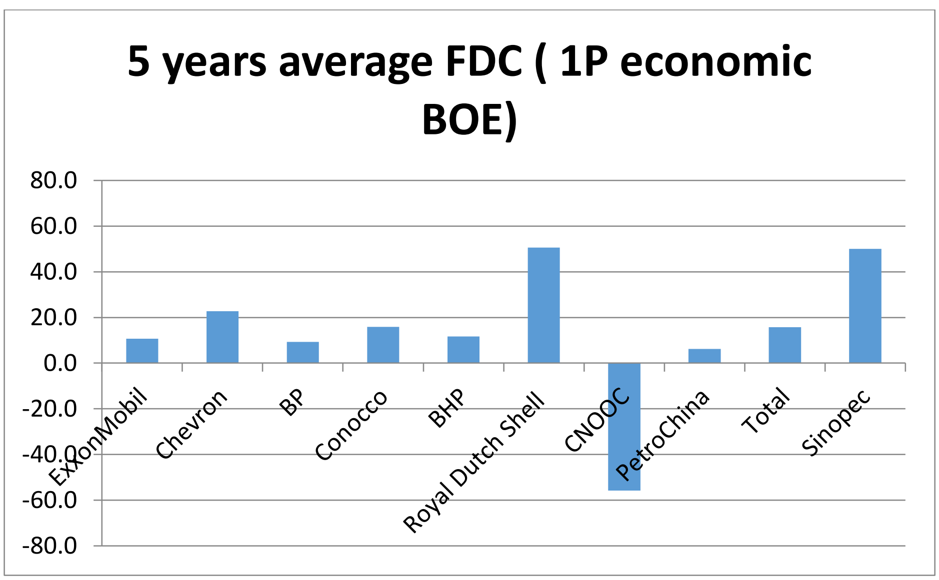

Figure 9. 5 years average FDC (1P economic BOE)

Table 3 below contains the acquisitions that matched the specimens of the methodology chapter. The column named as "Marginal Cost" is calculated as the purchase price divided by the acquired amount of BOE_e.

Acquirer	Target	Year	Price (USD)	Acquiered amount of BOE (economic)	Marginal Cost
Chevron	Unocal	2005	17 000 000 000	1 508 990 113	11.3
Sinopec	Tanganyika Oil	2008	2 000 000 000	170 000 000	11.8
India Oil and Natural Gas Corportation	Imperial Energy	2008	2 580 000 000	787 218 220	3.3
Sinopec	Addax Petroleum	2009	7 300 000 000	214 200 000	34.1
Freeport McMoRan	Plains Exploration & Production Company	2013	16 300 000 000	282 137 063	57.8
CNOOC	Nexen	2013	15 100 000 000	788 027 046	19.2
Glencore Xstrata Plc	Caracal Energy Inc.	2014	1 350 000 000	18 800 000	71.8
Repsol	Talisman	2015	8 300 000 000	442 366 378	18.8

Table 3. Acquisitions

Figure 10 below is a visualization of the marginal cost of acquisitions presented in table 3.

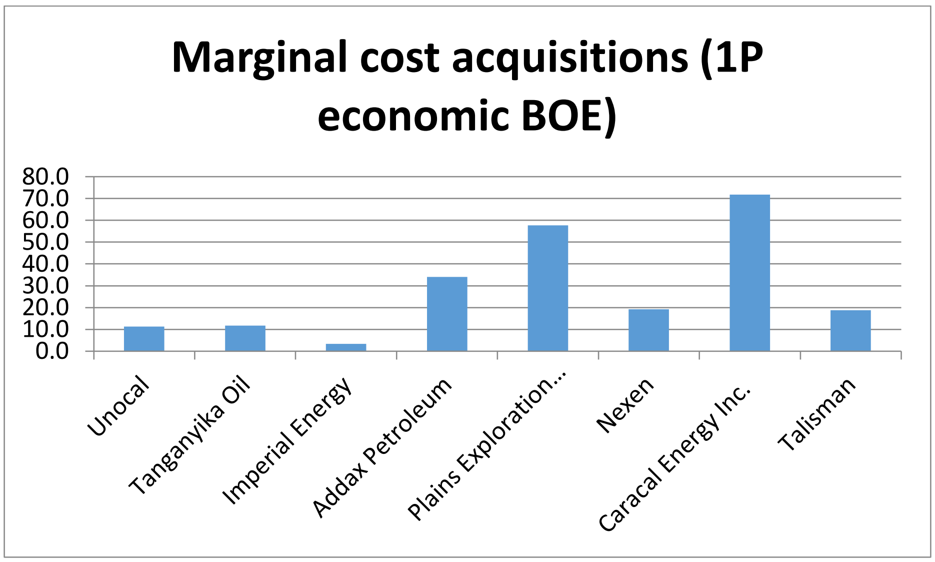

Figure 10. Marginal cost of acquisitions (1P economic BOE)

The results in the column "Marginal Cost" in table 3 above explains how much the acquiring company had to gain access to the target company's BOE_e. As with the FDC, there are large differences between the "Marginal Costs". Further analysis and possible reasons for the large differences will be conducted in the analysis chapter. In Appendix 2 the reader can find the spreadsheet from which table 3 above was derived.

Table 4 below contains descriptive statistics for the data presented in table 2 and 3. The table provides the fact that the marginal cost of incrementing reserves through acquisitions (presented as “takeovers”) exceeds the five year average of FDC with approximately 107.8 %. This suggests that it was more expensive for oil and gas companies to increment their oil and gas reserves (BOE_e) by acquiring other companies than exploring and developing on their own. The statistics also shows that there is a large standard deviation in both of the data sets. The above stated results and findings will be analyzed and discussed in the following chapter.

One-Sample Statistics

	N	Mean	Std. Deviation	Std. Error Mean
5Y FDC Economic	10	13,711	29,2128	9,2379
Takeovers	8	28,487	24,3750	8,6179

Table 4. Descriptive statistics

5 Analysis

This chapter contains comments and analysis of the preceding chapter. To further evaluate the differences between FDC and the marginal costs of takeovers, some statistical tests are performed and commented.

5.1 Costs and outcomes of exploration and development vs. acquisition activities

All oil and gas companies have different characteristics in the form of operating costs, future potential reserves (2P/2C), taxation, royalties, the proportion of 1P to 2P reserves, strategic assets and so on. Therefore, a general formula or model to evaluate all these businesses would be complex. The volatile prices of oil and gas are other variables that make the valuation task even more complex. These complexities also apply when comparing FDC and marginal acquisition costs.

In this study, the differences in the two costs will be viewed as, more or less, universal indicators for the price that the oil and gas companies will face when increment their oil and gas reserve (BOE_e). This view is a generalization, but still it serves as an indicator.

5.2 Related samples tests

In this section, the discrepancy between FDC for a BOE_e and the marginal cost of acquisitions is tested for statistical significance. The test will be commented upon and discussed.

Since:

$$H_0: s_1 = s_2$$
$$H_A: s_1 \neq s_2$$
$$where$$
$$s_1 = 5\,Year\ average\ FDC\ for\ a\ BOE_e$$
$$s_2 = Average\ marginal\ cost\ of\ acquistions$$

SPSS yielded the following output to the test:

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The median of differences between 5y Avg FDC economic and Marginal Cost (Acquisitions) equals 0.	Related-Samples Sign Test	,727[1]	Retain the null hypothesis.
2	The median of differences between 5y Avg FDC economic and Marginal Cost (Acquisitions) equals 0.	Related-Samples Wilcoxon Signed Rank Test	,327	Retain the null hypothesis.
3	The distributions of 5y Avg FDC economic and Marginal Cost (Acquisitions) are the same.	Related-Samples Friedman's Two-Way Analysis of Variance by Ranks	,480	Retain the null hypothesis.
4	The distributions of 5y Avg FDC economic and Marginal Cost (Acquisitions) are the same.	Related-Samples Kendall's Coefficient of Concordance	,480	Retain the null hypothesis.

Asymptotic significances are displayed. The significance level is ,05.

[1] Exact significance is displayed for this test.

Table 5. Nonparametric tests between 5 years average FDC with economic conversion (1P) and Marginal cost of acquisitions with economic conversion (1P)

The null hypothesis should be retained. This leads to the conclusions that the descriptive difference between the 5 years average FDC of the then examined companies and the marginal cost of acquisitions is not statistical significant at a significance level of 95%. The lack of statistical significance of the test results could be explained by the small sample size and the high standard deviations.

The calculations of BOE with economic conversion (as well as the thermal conversion calculations) yielded some negative values. As mentioned earlier, this is due to some major negative revisions of prior estimates of reserves, which may have contributed to the high standard deviations.

With facts above considered, the question remains on how much the results of the Wilcoxon Signed Rank test really should be relied upon as a legitimate determent of the statistical significant difference between FDC and the marginal cost of acquisitions.

As seen in figure 9 and 10, there are apparently some takeovers and FDCs that stands out. These outliers will be further analyzed in the following section.

5.2.1 Analyze of outliers

As mentioned, the non-significant result from the Wilcoxon Signed Rank Test can partly be explained by the high standard deviations. The large standard deviations can be explained by some extreme outlier values in the data sets. In the FDC data set, presented in table 2, Royal Dutch Shell, CNOOC and Sinopec stands out as extreme values. Royal Dutch Shells extreme FDC could be derived from the company's commitment to exploration in the Artic Sea. Shell invested USD 5 billion in 2013 on Arctic drilling "without any tangible result" (Macalister, 2014). Another explanatory factor could be the escalating development costs of Gorgon project where the original budget of USD 37 billon has been increased by USD 17 billion. Shell have a 25% stake in Gorgon project (Macdonald-Smith, 2014). CNOOC's negative FDC of -55.8 USD per economic BOE can be explained by the company's large downward revisions in its gas reserves, presented in appendix 1. An additional explanatory factor could be the fluctuations in the prices of oil and gas. The FDC with thermal conversion for CNOOC was 22.5 USD, this indicates that the prices of the commodities had an influence on CNOOC's FDC.

The marginal cost of acquisitions that is most remarkable is Glencore Xstratas purchase of Caracal Energy for 71.8 USD per BOE with economic conversion. According to Caracal Energy Inc (2014), the company had 1P reserves of 18.8 million BOE and 4.1 billion of prospective resources at year-end 2013. In other words, Caracal Energy had significant future potential in terms of oil and gas reserves and production at the time Glencore Xstrata acquired Caracal. This can be an explanatory factor in Glencore willingness to pay 71.8 USD per BOE_e at that time.

In the studied takeovers, India Natural Oil and Natural Gas Company's purchase of Imperial Energy yielded the lowest marginal cost of acquisitions as of 1P BOE_e. This could be explained by the fact that 100% of Imperial Energy's operations are located in Russia. The high-risk political environment of Russia could be an explanatory factor for the low marginal cost of acquisition of Imperial energy (3.3 USD per BOE_e).

5.3 Regression – FDC and Market Capitalization

The purpose of this section is to examine whether the market capitalization of an oil and gas company has an effect on its FDC. A regression test was conducted using SPSS. Market capitalization was chosen as the predictor variable and five years average FDC as the outcome variable. The results of the test are presented below in table 6, 7 and 8.

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	,017[a]	,000	-,125	32,2485

a. Predictors: (Constant), Market Cap

Table 6. Regression - Model Summary

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	14,653	20,138		,728	,488
	Market Cap	,005	,098	,017	,049	,962

a. Dependent Variable: 5y Avg FDC thermal

Table 7. Regression between FDC and Market Cap

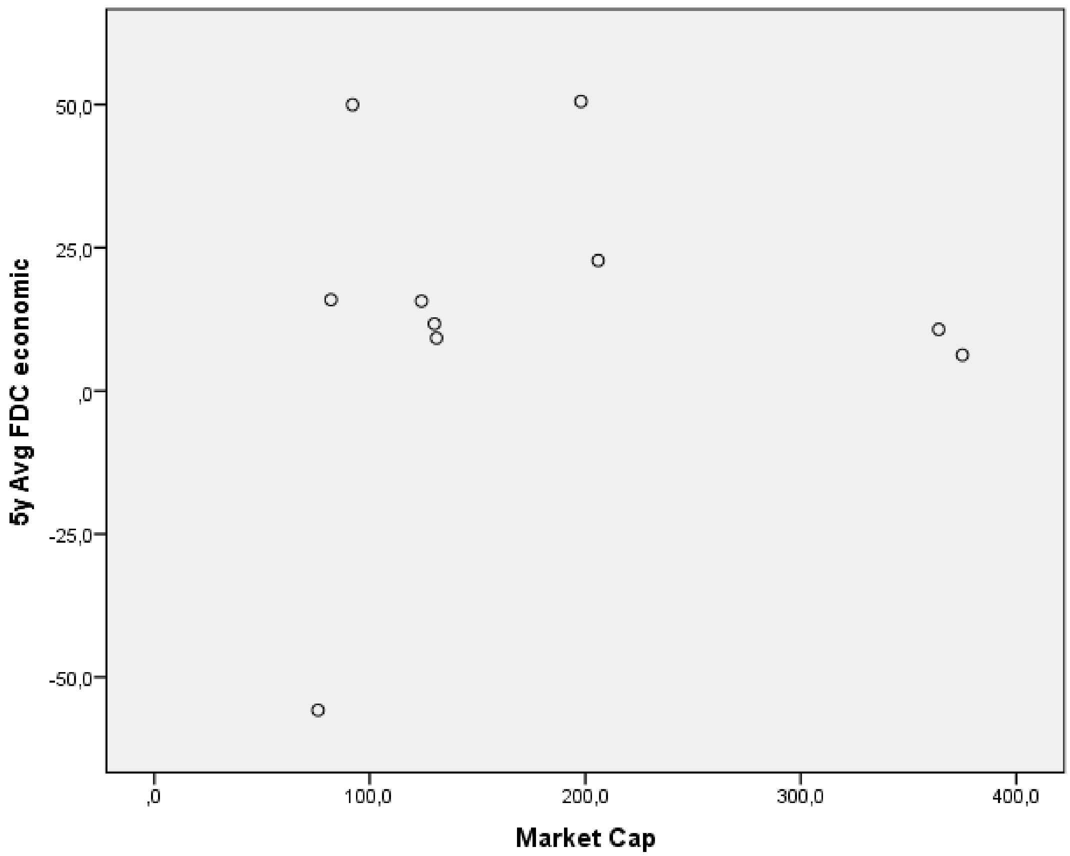

Figure 11. Scatter Plot - FDC and Market Cap

The regression is very weak; the test yielded a coefficient of determination (r^2) of 0.000 and an adjusted r^2 of -0.125, which is illustrated in table 6. The lack of correlation is also visualized in a scatter plot, figure 11 above. According to these findings, there is no correlation at all between the market cap of the examined companies and their cost of prospecting and commercializing oil and gas reserves (BOE_e). The development and exploration costs are direct costs and could, therefore, explain the similarities between the FDC of smaller and larger oil and gas companies. If some overhead cost was included, the FDC for larger oil and gas companies would probably be larger than for smaller companies.

5.4 Incitements for mergers and acquisitions

Given that the five years average FDC per BOE_e was USD 13.7 and the marginal cost of acquisitions was USD 28.48, why would an oil and gas company consider purchasing another company? This question is indirectly addressed in the purpose of this thesis as this study also was set illuminate the economic dynamics and decisions of the branch.

Even though exploration and commercialization seems to be the most cost effective alternative to increment oil and gas reserves, several benefits can be obtained from acquisitions of other companies. By acquiring another company, the buyer can reduce the competition in a region, segment or country, which can add value. As mentioned by Nie & Dowell (2012), takeovers can be performed with large strategic and political motives, for example, the takeover of Unocal by Chevron. This is an aspect that is difficult to quantify and assign a value to. Access to new technology can also be a motive to acquire another company within the oil and gas industry. Furthermore, takeovers can create operational and financial synergies that create value. The above discussed motivations for takeovers can be an explanatory factor to why some companies are willing to pay more than their FDC when acquiring another company, this could also explain the significant bid price premiums mentioned in the background of this study.

6 Conclusions & Discussion

The questions at issue of this thesis is: *while looking to increment fading oil and gas reserves, are there any cost differences between acquisitions of companies with proven reserves as opposed to the prospection and commercialization of unexploited resources?*

The non-parametric Wilcoxon Signed Rank test suggests that the null hypothesis should be retained, which means that there is no difference between the five years average FDC and the marginal cost of takeovers. However, the results from this test was not statistical significant. There are indications that the alternative to prospect and commercialize oil and gas reserves in own regime is the more cost effective approach to increment reserves. The five years average FDC was USD 13.7 and the margin cost of acquisitions was USD 28.48. The findings in this paper was not statistical significant, but given the mentioned unfavorable circumstances of the Wilcoxon Signed rank test, the findings are believed to serve as, at least, an indicator. The large standard deviations and the small sample size was contributory sources that made the test non-significant. To reduce the large standard deviation, the outliers could have been removed and a new test could have been conducted. Due to the already small data sets, especially the takeovers data set, it was considered not to be appropriate to remove the outliers.

The large standard deviations in the “takeovers data set” indicates that the amount of BOE_e cannot be used as the only variable to explain the takeover price. To cut back competition, political motives, national interest, financial synergies, access to new technology are some factors that can be explanatory to the large fluctuations in the marginal cost of acquisitions. It can with some certainty be said that oil and gas companies have more motives when acquiring other companies, than to solely increment their oil and gas reserves (BOE_e).

A complex aspect of the FDC is the fact that it can take several years from that an oil and gas company commits to exploration and development activities until it can book oil and gas reserves from that particular activity. This can lead to skewness when calculating FDC. A part of this effect can be reduced by using multiple year averages, as in this study. In this study, a five years average of FDC was used. A ten years average might have smoothened out the FDC and reduced the standard deviation in the data set. This could have increased the chance to obtain a statistical significant result.

It is clear that the deliberations and incitements that shape the decision making in oil and gas industry are derived from a complex nature, difficult to concretize fully within the scope of this thesis. However, the findings of this study provide at least some evidence that acquisitions of oil and gas company may be done, or rejected, by other motives than a short termed interest of incrementing oil and gas reserves. Otherwise, the discrepancy between the FDC and the marginal cost of incrementing and reserves through acquisitions would serve as an argument, perhaps impossible to overcome, when the governance of an oil and gas company elaborates about how the reserves should be incremented.

Furthermore, this study concluded that the market capitalization of an oil and gas company has no effect on its FDC. This can be explained by the fact that FDC only contains direct costs that are exploration costs and development costs. If some overhead cost had been included in the FDC, companies with larger market capitalization would probably have higher FDC than companies with smaller market capitalizations.

To summarize, this study concludes that there is no difference between the five years average FDC and the marginal cost of acquisitions, though the test was not statistical significant. Some indications suggests that the more cost effective approach to increment oil and gas reserves is to explore and develop rather than acquiring other oil and gas companies. This study further concludes that there is no correlation between the market capitalization of an oil and gas company and its FDC.

6.1 Suggestions for further research

As some analytics of the branch speculate that a new wave of mergers and acquisitions might be incoming as an effect of falling oil prices, it would perhaps be possible to make a new study like this one in the near future and consolidate a whole new set of data. More data does improve the quality and credibility of studies. The discrepancy between FDC and marginal costs of acquisitions would also deserve some more attention and through examination. A study with ten year average FDC and more takeovers would probably decrease the standard deviations within the data sets and increase credibility. Another possible study could be to evaluate possible cost differences for oil and gas companies trying to increment oil and gas reserves, where FDC is compared to asset sales between companies. Above all, more studies in the area like this one would benefit the accumulated knowledge of the industry and academia.

6.2 Contribution

Possible interested parties could be decision makers in oil- and gas companies of various sizes, institutional- and private investors, politicians and, of course, academia due to the lack of research on this subject. This thesis is to be viewed as an attempt to fill the mentioned holes of the academic regarding the cost effectiveness of the process of incrementing oil and gas reserves. Furthermore, the study discussed the incitements of the acquisitions of oil and gas companies.

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7.1 Annual Reports

The following companies' annual reports where consulted when the FDC where calculated for the fiscal years 2009 – 2013:

- Chevron
- ExxonMobil (Exxon)
- PetroChina
- Sinopec
- Royal Dutch Shell
- Total
- BHP Billiton (BHP)
- British Petroleum (BP)
- ConoccoPhillips
- China National Offshore Oil (CNOOC)

7.2 Appendixes

Appendix 1 - FDC											
Cushing WTI Spot price ($/barrel)			Henry Hub Natural Gas Spot Price ($ per million BTU)				1 ft3 of natural gas yields ≈ 1030 BTU				
2009	61.95		3.94								
2010	79.48		4.37								
2011	94.88		4								
2012	94.05		2.75								
2013	97.98		3.73								
Changes in oil reserves are presented in millions of barrels and gas reserves as billions of cubic feet											
All amounts represent combined oil and gas expidentures and in millions of dollars											
Year	**Revis.**	**Exte./Discov.**	**Impr. Recov.**	**Total**	**Explor. Costs**	**Develop. Costs**	**Exp.+ dev costs**	**BOE(T)**	**BOE(E)**	**FDC BOE(T)**	**FDC BOEE**
ExxonMobil	OIL										
2009	-2225	142	0	-2083	3056	16166	19222	-1178	5296	-16.3	3.6
2010	368	182	5	555	2993	22359	25352	990	2639	25.6	9.6
2011	9418	1129	0	10547	2452	24538	26990	10599	755	2.5	35.8
2012	326	760	7	1093	2782	26171	28953	721	-2198	40.1	-13.2
2013	608	541	0	1149	2389	20067	22456	1350	1249	16.6	18.0
ExxonMobil	GAS										
2009	-248	5676	0	5428							
2010	644	1964	0	2608							
2011	39	271	0	310							
2012	-2191	-39	0	-2230							
2013	512	693	0	1205							
Chevron	OIL										
2009	355	52	50	457	1924	11827	13751	1283	4985	10.7	2.8
2010	103	63	74	240	1578	15401	16979	292	322	58.2	52.7
2011	197	299	58	554	19112	15890	35002	1403	5119	24.9	6.8
2012	313	217	77	607	2439	20855	23294	885	1685	26.3	13.8
2013	322	78	57	457	3186	25876	29062	583	772	49.9	37.6
Chevron	GAS										
2009	569	4387	0	4956							
2010	197	110	2	309							
2011	415	4680	1	5096							
2012	660	999	8	1667							
2013	636	104	15	755							
BP	OIL										
2009	-55	378	203	526	2805	10396	13201	1094	3438	12.1	3.8
2010	-146	131	421	406	2706	9675	12381	677	1646	18.3	7.5
2011	-159	206	21	68	2413	10422	12835	339	1626	37.9	7.9
2012	-349	26	158	-165	4356	12553	16909	-39	751	-433.6	22.5
2013	-129	46	132	49	4811	13552	18363	731	4094	25.1	4.5
BP	GAS										
2009	853	1435	1117	3405							
2010	-2206	2171	1659	1624							
2011	554	266	803	1623							
2012	-2036	831	1961	756							
2013	667	2480	945	4092							

Conocco	OIL										
2009	512	237	17	766	1517	6907	8424	885	765	9.5	11.0
2010	160	128	58	346	1566	6267	7833	556	1279	14.1	6.1
2011	100	301	82	483	2262	8241	10503	661	1087	15.9	9.7
2012	15	293	16	324	2169	12044	14213	379	340	37.5	41.7
2013	86	379	21	486	2355	13824	16179	729	1478	22.2	11.0
Conocco	GAS										
2009	394	319	3	716							
2010	912	323	25	1260							
2011	406	602	59	1067							
2012	-274	578	27	331							
2013	688	765	6	1459							
BHP	OIL										
2009	42	20	1	63	488	2075	2563	144	488	17.8	5.3
2010	77	64	11	152	851	2006	2857	172	128	16.6	22.3
2011	7	5	23	35	675	2139	2814	184	894	15.3	3.1
2012	184	14	34	232	1272	6225	7497	330	592	22.8	12.7
2013	-71	220	14	163	719	7174	7893	248	513	31.9	15.4
BHP	GAS										
2009	29	275	180	484							
2010	45	11	64	120							
2011	793	96	4	893							
2012	447	135	3	585							
2013	-1180	1684	3	507							
Royal Dutch Sh	OIL										
2009	1894	596	40	2530	3873	14961	18834	3594	683	5.2	27.6
2010	723	147	62	932	4371	13014	17385	1178	367	14.8	47.4
2011	84	311	2	397	5722	11135	16857	1057	473	15.9	35.6
2012	542	86	10	638	8685	18575	27260	483	396	56.4	68.9
2013	294	182	412	888	8685	23433	32118	1384	438	23.2	73.3
Royal Dutch Sh	GAS										
2009	2156	4225	0	6381							
2010	331	1104	41	1476							
2011	639	3322	0	3961							
2012	-1583	638	16	-929							
2013	2105	709	160	2974							
CNOOC	OIL										
2009	137	140	0	277	1175	6133	7308	365	543	20.1	13.5
2010	30	256	0	286	1195	4711	5906	345	371	17.1	15.9
2011	67	238	1	306	1511	6296	7807	300	-23	26.0	-338.0
2012	111	312	0	423	2129	8054	10183	545	746	18.7	13.6
2013	-41	366	0	325	3015	11533	14548	475	909	30.7	16.0
CNOOC	GAS										
2009	197	328	0	525							
2010	-593	948	0	355							
2011	-356	311	9	-36							
2012	-353	1087	0	734							
2013	-85	982	0	897							

PetroChina	OIL											
2009	-192	1005	73	886	3706	20149	23855	1581	4223	15.1	5.6	
2010	-78	877	74	873	6490	20512	27003	1620	4528	16.7	6.0	
2011	-76	746	66	736	6055	20376	26432	1327	3578	19.9	7.4	
2012	-16	737	86	807	6605	28062	34667	1841	6225	18.8	5.6	
2013	-124	775	84	735	6986	26360	33346	1536	4832	21.7	6.9	
PetroChina	GAS											
2009	-1273	5440	0	4167								
2010	-1456	5936	0	4480								
2011	-751	4298	0	3547								
2012	-16	6217	0	6201								
2013	-2707	7511	0	4804								
Total	OIL											
2009	179	261	0	440	1326	8537	9864	554	713	17.8	13.8	
2010	73	234	0	307	1460	8510	9970	550	1473	18.1	6.8	
2011	-127	81	0	-46	1756	11931	13687	515	3363	26.6	4.1	
2012	146	232	0	378	2363	14456	16819	532	937	31.6	17.9	
2013	160	121	0	281	2453	19314	21767	381	609	57.2	35.8	
Total	GAS											
2009	-212	897	0	685								
2010	967	489	0	1456								
2011	330	3035	0	3365								
2012	-96	1022	0	926								
2013	-851	1449	0	598								
Sinopec	OIL											
2009	86	69	131	286	2352	8108	10460	299	97	35.0	107.6	
2010	85	69	144	298	2541	7728	10269	323	165	31.8	62.1	
2011	126	82	72	280	3344	8290	11634	410	791	28.4	14.7	
2012	9	151	163	323	3653	11485	15138	426	628	35.5	24.1	
2013	-10	175	0	165	3092	13228	16320	230	394	71.1	41.4	
Sinopec	GAS											
2009	52	27	0	79								
2010	23	45	81	149								
2011	-74	849	4	779								
2012	278	232	109	619								
2013	-326	714	0	388								
Comments:												
BHP's fiscal years run from June to June												
Exchange rate conversion for CNOOC, PetroChina and Sinopec was performed according to:												
Amounts calculated with the exchange rate at 21.5.15												
1 RMB = 0,161378 USD												
Costs in RMB can be found in the companies annual reports												
Exchange rate conversion for Total was performed according to:												
Amounts calculated with the exchange rate at 21.5.15												
1 EURO =1.113648 USD												

Appendix 2 - Takeovers

Aquirer	Target	Year	Price (USD)	1P Oil Res.	2P res.	1P/2P	1P Gas (BCF)	Oil Price / bbl	Gas Price / MCF	BOE E	Price/2P res.	Price/1P BOE E
Chevron	Unocal	2005	17 000 000 000	659 000 000	1 800 000 000	36.61%	6 568	56.64	7.33	1 508 990 113	9.4	11.3
Sinopec	Tanganyika Oil	2008	2 000 000 000	170 000 000	778 000 000	21.85%	0	99.67	7.97	170 000 000	2.57	11.8
ONGC	Imperial Energy	2008	2 580 000 000	739 000 000	920 000 000	80.33%	603	99.67	7.97	787 218 220	2.8	3.3
Sinopec	Addax Petroleum	2009	7 300 000 000	214 200 000	537 000 000	39.89%	0	61.95	3.67	214 200 000	13.6	34.1
Freeport McMoRan	Plains Expl. & Prod. Co.	2013	16 300 000 000	244 030 000	634 000 000	38.49%	1 001	97.98	3.73	282 137 063	26	57.8
CNOOC	Nexen	2013	15 100 000 000	772 000 000	2 300 000 000	33.57%	421	97.98	3.73	788 027 046	6.6	19.2
Glencore Xstrata Plc	Caracal Energy Inc.	2014	1 350 000 000	18 800 000	64 300 000	29.24%	0	93.26	4.37	18 800 000	21.00	71.8
Repsol	Talisman	2015	8 300 000 000	114 100 000	1 104 000 000	10.34%	4 785	48.54	3.33	442 366 378	7.5	18.8
	Average		**8 741 250 000**	**366 391 250**	**1 017 162 500**	**0**	**1 672**	**81.96**	**5.26**	**526 467 353**	**11.2**	**28.5**