Federal State Institution of Higher Professional Education
Saint-Petersburg University
Graduate School of Management

Bachelor thesis

Mergers and Acquisitions Deals Effectiveness: Evidence from the Oil and Gas Industry

The 4th year student
of the bachelor program
“International Management”
Mirsalekh Agaev

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Supervisor’s note on admission or
the non-admission of work to public protection,
dated signature of the supervisor
Anastasiya Laskovaya

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Saint-Petersburg
2023

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1. INTRODUCTION

This paper is devoted to the problem of measuring the effectiveness of mergers and acquisitions (M&A) deals in the oil and gas industry and to the development of a more reliable way to evaluate that effectiveness. Mergers and acquisitions usually have strategic value for firms, which highlights the importance of the correct measurements, since they lay the ground for decision making. However, there are a number of issues that may arise in the process of evaluation and may hinder it or lead to false results. Sometimes it might be difficult to clearly define goals of the M&A deals, which are crucial for assessment of the effectiveness, sometimes it might be difficult to measure the success of a deal and attribute it completely to the M&A activity due to some external factors (e.g., market conditions, regulatory environment, etc.) that can affect the firm's performance. It may also be the case that valuators may use inappropriate tools or simply not enough tools (e.g., use one approach) for assessing the effectiveness of the deal. For example, using discounted cash flow model alone may undervalue the potential of high-risk investments, while using real options alone may not consider the residual value of assets from the previous abandoned projects.

The relevance of this problem and this paper is dictated by the fact that measurement of the effectiveness (presented as synergy measurement – which is explained the next chapters) of an M&A deal is still an issue, because firms sometimes fail to estimate the value of the synergy correctly (McKinsey, 2020). Moreover, the paper is focused solely on the oil and gas industry, and there are several reasons for that. Firstly, although it is true that oil and gas industry receives more attention from the media and represents a significant share of the global M&A market, however researchers have paid much less attention to M&A deals in the oil and gas industry (Hsu et al., 2017). Moreover, Özgür and Wirl (2020) admitted that to their knowledge, academic reviews of M&A studies in oil & gas industries are rare. Secondly, according to Deloitte's 2019 oil, gas, and chemicals industry outlook, it was expected that the importance of new infrastructure would increase as a result of increased production and insufficiency of current infrastructure to handle the volumes. Considering the fact that planning and constructing new infrastructure have always been a very long process, new tactical M&A deals could be expected. Moreover, according to Deloitte's 2023 oil and gas industry outlook, new policies are expected to accelerate the clean energy transition and natural gas plays a new role in this transition. The energy policy in the US and Europe has pivoted in 2022 due to the Russian-Ukrainian conflict. Now, instead of getting rid of the natural gas, countries decided to reduce emissions from natural gas while developing cleaner alternatives. This fact combined with the fact that the US agreed to increase LNG exports to Europe through 2030 increases the necessity of natural gas investments, including investments into related infrastructure. In addition, Deloitte has revealed several trends for the coming year. The first trend is the increase in acquisitions in natural gas assets and resilient midstream infrastructure. The second trend is the increase in joint ventures and alliances to commercialize new clean energy technologies. The third trend is reduction of operational emissions through acquisition of assets with a strong ESG[1] profile. And the last trend is mitigation of inflationary pressures across the oilfield services sector through vertical integration. All these facts highlight the increasing relevance of M&A activities in the oil and gas industry, and hence the evaluation of M&A deals effectiveness in this industry. Finally, Kulik and Savina (2020) expressed in their paper the necessity for further analysis of other M&A deals in the oil and gas industry done specifically by using the methodology explained in this paper to confirm their conclusions.

The goal of this paper is to develop a methodology for evaluating the effectiveness of M&A deals in the oil and gas industry that would give more reliable, in that more precise, results compared to the alternative one-model valuation approach, which implies using only the discounted cash flow model. The goal may be considered to have been reached once all the objectives listed below are completed and using the new methodology produces more plausible results based on the case.

To reach the goal the following objectives are to be completed:

- review theoretical background for mergers and acquisitions;
- review empirical studies that have been made to assess the effectiveness of M&A deals;
- explain the methodology used in this paper;
- measure the effectiveness of M&A deal by using one-model valuation approach:
    - value the first firm prior to M&A deal by using DCF alone;
    - value the second firm prior to M&A deal by using DCF alone;
    - value the merged firm after M&A deal by using DCF alone;
    - compare the value of the merged firm to the sum of values of the firms prior to M&A deal;
- measure the effectiveness of M&A deal by using the two-model valuation approach (DCF coupled with a real option):
    - value the merged firm after M&A deal by using DCF combined with a real option;

[1] Refers to environmental, social, and governance (ESG), which is a framework designed for evaluating firm's performance and business practices on different ethical and sustainability issues.

  - compare the value of the merged firm to the sum of values of the firms prior to M&A deal;
- compare and discuss the results obtained by using the two approaches;
- develop recommendations for business valuation management;
- describe limitations of the current study.

To achieve the aforementioned goal and objectives, empirical research is conducted on the example of one M&A case. Moreover, to conduct the research, this paper uses the secondary data such as financial statements of the firms, academic literature – for example, Duc, Tien, and Van (2017), van Putten and MacMillan (2004), Kulik and Savina (2020), Cirjevskis (2021) to name a few – reports of the Big Four and Big Three, corporate news, Damodaran's investment valuation book, and Damodaran's online database (Damodaran Online).

This paper is valuable, in that it provides a methodology that could be used for evaluating the effectiveness (in terms of synergy) of already closed M&A deals and that would allow to make more precise evaluations. Moreover, if the historical data is replaced by the forecasted data, the methodology can also be used for predicting the effectiveness of potential M&A deals, which may assist managers during decision-making processes. Finally, this paper complements previous research done by other researchers, namely by Kulik and Savina, in a way that it provides additional evidence of the applicability of the combined approach (DCF coupled with a real option) in estimating the effectiveness of M&A deals in the oil and gas industry.

All things mentioned, the paper is devoted primarily to mergers and acquisitions, so the research object is M&A deals, and it focuses specifically on the oil and gas industry, which is the research subject.

The paper follows the following structure. To start off, theoretical frameworks on mergers and acquisitions and real options are described, and past research regarding the evaluation of M&A deals effectiveness are analyzed in the literature review. After that, in the methodology, the case sampling and criteria for the case selection are disclosed, and the models used in the paper are described and explained. Next, the description of the market and the firms related to the case is made. That is followed by explanations of the firms valuation process and the real option choice and its valuation. After that, the results are compared and discussed, and limitations with future research directions are described. Finally, the paper is closed by a conclusion that includes a short summary of the work done and the main recommendations that follow.

2. LITERATURE REVIEW

2.1. Theoretical review of mergers and acquisitions

When it is time to expand, corporations have two options: internal and external. Internal expansion refers to creating new units or entering new markets, however it is not always so easy due to obstacles that corporations may face. They might include the limited size of the target market, obsolete product category, governmental restrictions, lack of specialized knowledge necessary for the market entry or the launch of new production line, and others. Whenever internal expansion is not possible, external expansion is the only option and it refers to joint ventures or mergers and acquisitions (M&A). Kogut (1988) defined joint venture as a situation when two or more firms or parties pool a portion of their resources within a common legal organization. When it comes to mergers and acquisitions, Reed et al. (2007) describes a merger as a situation when one firm (acquiree) is combined with another (acquirer) and as a result it disappears into that firm, while acquisition refers to the transfer of ownership. It should be noted that the two terms are not the same, because there might be an acquisition without merger, when one firm buys a major part of stocks of another firm which is enough for a merger but decides to keep that company as a separate entity. An example of merger would be if one firm acquired another firm and “absorbed” it, so that the acquired company seized to exist as a separate entity and submitted to the acquiring company (e.g., Google and Android).

Although expansion might be a reason for M&A, there may be other reasons for it as well. According to KPMG’s report (2011), “Post merger people integration”, all these reasons may be aggregated into 6 groups:

- Growth;
- Synergy;
- Diversification;
- Defensive measures;
- Pressure to deal;
- Horizontal/vertical integration.

Reasons that fall under “growth” may include acquisition of new customers or access to brands, patents, facilities, technologies, qualified human resources (trained to tackle local challenges), etc. An example might be the upcoming acquisition of One Medical by Amazon, which will give Amazon 188 medical clinics across 29 markets. Reasons under “synergy” might be tied to the ability to be more successful or more productive as a merged entity rather than individually. This might be further linked to income growth, cost minimization, financial synergies, and clearer governance. An example that might be suitable here is the case of the acquisition of Saudi Basic Industries Corporation (SABIC), a Saudi chemical manufacturing company, by the Saudi Arabian Oil Group, a Saudi Arabian natural gas and petroleum company, which should produce synergetic value of $1.5 billion by 2025 (Zawya, 2021). Reasons under "diversification" may be connected to the mitigation of corporate risks. A suitable example might be the acquisition of 21st Century Fox by Disney, which was taken to diversify the firm into the internet video entertainment industry. "Defensive measures" reasons may be dictated by necessity to tackle risks that arise as a result of other firms' mergers that threaten one's market position. The merger of Exxon and Mobil might be a good example to that. Prior to the merger, the two firms were struggling to compete with other oil and gas firms, however the merger helped them compete better. Reasons from the "Pressure to deal" group might be related to the pressure on management to reinvent earnings. A great example might be the case of a merger between Bank of America and Merrill Lynch. The two firms were struggling financially and in order to avoid a collapse of the financial system, the U.S. government pressured Bank of America to acquire Merrill Lynch. Finally, reasons under "horizontal or vertical integration" may include achievement of dependable supply sources, reduction of supply costs, necessity for a specialized supply. A suitable example here might be the merger of Dow Chemical and DuPont, as a result of which the companies created a business that could control the entire supply chain in the chemical industry, from raw materials to finished products.

When one speaks of the effectiveness of M&A deals, one refers to the degree to which mergers or acquisitions achieve their intended goals and objectives. The same conclusion was reached by Nesterenko and Kolyshkin (2015). The goals of M&A and the reasons for M&A might be closely connected to each other. For instance, if a firm's goal is to acquire additional value in synergies, then the reason for M&A will be connected to that – i.e., synergy acquisition or value capture.

Since synergy generation might be one of the most common reasons and goals of M&A (Business insider, 2016), it might be worth speaking about it. When it comes to synergy, there are some issues that corporations may face in the process of its evaluation. One of the most common issues is the fact that the potential of high-risk investments often tends to be undervalued if discounted cash flow (DCF) analysis alone is used. On the other hand, if real-options analysis is used alone, then the model often does not consider the residual value of assets from the previous projects that were abandoned. For this reason, an approach that would combine DCF and real options approaches should be used when valuing synergies (van Putten and MacMillan, 2004).

2.2. Empirical review of M&A deals effectiveness evaluation

There is a number of research devoted to the evaluation of the effectiveness of M&A deals. Brotherson, Eades, Harris, and Higgins (2014) conducted interviews with eleven major investment banks, with Deutsche Bank AG, Credit Suisse, and JP Morgan being among them, to see how they used DCF model for estimating value of firms. Results suggest that all of the respondents used DCF as a standard method for estimating companies' value, especially if dealing with large firms, and a form of weighted average cost of capital (WACC) as a discount rate when assessing target firm's value. However, it has also been revealed that applying DCF model in the valuation of M&A deals requires art and judgement when faced with uncertain business forecasts.

Zavitsanos (2017) tried to estimate the value of two aquacultural Greek companies on their way to merger and assess their financial synergy value. In the valuation, the discounted free cash flow to the firm approach was used. The inputs for the valuation model were chosen by comparing the firms' financial ratios to the industry's for a specific period of time. For the discount rate calculation, the researcher used the capital asset pricing model. For the valuation of synergy, both the capital asset pricing model and the discounted free cash flow to the firm were used. The results of the self-conducted valuation were then compared to those of the published valuation in order to conclude on the applicability and reasonability of the chosen model and inputs. The research helped to reach certain conclusions. The value of the acquiring firm calculated via the model was within the boundaries given by the official published statement, which implies that the choice of the DCF to firm as a valuation model and inputs was reasonable. On the other hand, however, Zavitsanos stresses the importance of using several valuation approaches and being careful in the model choices due to the fact that using a single valuation method may not provide solid results.

In another research, Virabyan (2017) attempted to estimate the efficiency of M&A deals on example of Russian oil and gas firms by using Data Envelopment Analysis (DEA) approach. She concluded that DEA method is not always suitable for estimating the efficiency of M&A deals based on pre- and post-performance and added that after using DEA method it might be reasonable to conduct a complex assessment of the M&A efficiency by using more traditional approaches such as methods of shareholder return and financial statement analysis and taking into consideration motives and goals of the M&A deals.

Baldacchino, Camilleri, Magrin, and Grima (2022) published a paper in which they evaluated the mergers and acquisitions' (M&A) effectiveness on financial performance of the Maltese listed companies. The method they chose in order to make the evaluation is an event study on the movements of acquirers' share price coupled with semi-structured interviews that were conducted with relevant company representatives and Maltese stockbrokers. The research seems to have been prolific since researchers managed to reach several conclusions regarding the effectiveness of the M&A deals. However, they questioned whether the event study on share price movements, which was taken as a methodology, is a reliable way to assess the effectiveness of M&A.

Fallery and Tjendrasa (2022) tried to estimate the value of a relatively young renewable energy firm in Indonesia to reach the acquisition transaction. The method used in the research was DCF to firm with WACC taken as the discount rate. Along with the value of the firm that they have defined, Fallery and Tjendrasa came to a conclusion that DCF valuation heavily relies on its assumptions, but analysts have the power to choose these assumptions. Depending on the assumptions, the results of the firm valuation may differ.

M&A effectiveness might be a general notion, therefore its evaluation might focus not only on synergetic goals but others as well – in that case, research tools might differ. There is also a number of research that are devoted to evaluating the value of synergy specifically. Li Destri, Picone, and Mina (2012) tried to grasp the processes that underlie the genesis and assessment of synergies in M&A deals. They clarified to what extent and when it might be appropriate to use the DCF or the real options approaches for evaluating synergies. The researchers found that combining both financial tools makes the evaluation of M&A projects (by using the DCF combined with real options approach) possible.

Rotela Junior, Pamplon, and da Silva (2013) evaluated the efficiency of M&A deals in Brazil among publicly-traded firms. To measure synergy, they used models with multiple objectives from Goal Programming and Data Envelopment Analysis (GPDEA) and employed accounting indicators as input and output variables. The results of the study showed that the GPDEA performed better than other traditional models. Moreover, the researchers have introduced new application of GPDEA model – the dual application – which is claimed to provide better understanding of synergy creation.

In another research, Loukianova, Nikulin, and Vedernikov (2017) elaborated a model for assessing cumulative effect of synergies in M&A deals on the basis of real options method and then put the model to a test by estimating the synergy values in two M&A deals related to the pharmaceutical industry, which yielded sound results. The proposed model is loosely based on the method of Datar-Mathew, which requires stimulation modelling. Moreover, the researchers concluded that it is possible to incorporate real options into a valuation framework since it enables managerial flexibility.

Duc, Tien, Van (2017) used solely DCF model to estimate the synergy value of M&A deals in real estate and industry sectors in Vietnam. The researchers have found that not all M&A deals generated synergy value.

Marin and Tretow (2018) made a series of synergy evaluations based on multiple M&A cases in the industrial software industry. As a methodology, they used an approach that combined the DCF and multiples methods to mechanically derive value. On top of that, the researchers used the granular approach to estimate sources, sizes, and timings of synergies. The results have shown that significant synergetic value may not have been captured in the valuation models.

Kulik and Savina (2020) assessed the efficiency of an M&A deal in oil & gas industry by using real options approach combined with DCF model. The study showed positive results for potential investment, which otherwise (if DCF alone was used) would be negative.

In a recent study, Zhu and Meng (2021) tried to evaluate the synergy effect obtained as a result of M&A in China and analyze whether the acquiring firm could profit from the M&A deal. The synergy was measured by using neural networks method, which fits the relationship between factors that influence the synergy and the relative value of the synergy after M&A. Furthermore, the researchers built an M&A synergy prediction model and compared the relative value of M&A synergy (predicted by this model) with the relative value of synergy achieved by other firms that completed M&A to predict the results of M&A. The research showed that the neural network model can predict the effect of the M&A synergy more accurately than traditional methods (e.g., cash flow and stock return changes).

Cirjevskis (2021), in his research, explored numerous types of synergies in one recent case of M&A related to the banking industry and he valued those synergies by using the real options approach. The research found that the real options method might be a useful valuation method of M&A synergies and it might be used as a decision-making tool in the banking industry.

Toborek-Mazur and Partacz (2022) measured the synergy in M&A during COVID-19 pandemic. To do that, the researchers used methods of comparative and descriptive analysis based on review of both domestic and foreign literature and critically assessed results from data given by five recognized financial, accounting, and advisory agencies. As a result, researchers managed to assess the impact of synergy on both the value and number of M&A deals during the pandemic.

Real options approach in valuation was used also by other researchers. For instance, Cirjevskis (2021) used real options approach to value a dynamic capabilities-based synergy in two highly strategic M&A deals. Jing, Na, Mingzhi, and Ruixue (2011) applied real options method to logistics enterprises in order to estimate the value of managerial flexibility after the M&A deal. Moreover, Dunis and Klein (2005) used real option pricing theory to analyze a sample of 15 mergers and acquisitions in the European financial services industry and were one of the few and probably the first to question the applicability of the option pricing to valuation of managerial flexibility.

Overall, it might be summarized that existing research present various approaches as to synergy valuation specifically, so to M&A effectiveness valuation in general. Speaking of the latter, researchers used methods like DEA and share price analysis coupled with semi-structured interviews. When speaking of the synergy valuation, the most popular of all appears to be the real options approach combined with the DCF model as at least six aforementioned articles featured this method. The other approaches that have been mentioned in the articles include the multiples method combined with DCF, the neural networks method, the GPDEA method, and the methods of comparative and descriptive analysis. There are also some researchers that used the one-model valuation approach for that purpose, that is solely the discounted cash flow model. However, these approaches were not as widespread as the combined approach (DCF coupled with a real option).

This paper is specifically focused on measuring the effectiveness of an M&A deal in the oil and gas industry in terms of reaching its intended goal regarding synergies for a couple of reasons. Firstly, the gain of synergetic value is one of the most common reasons for M&A deals (Business insider, 2016). Secondly, unlike other reasons for M&A deals, synergy may be more relevant to finance and may be more suitable for financial valuation, as it is based on numbers. For example, if the goal of the merger was to gain access to dependable supply sources, then the usage of financial models for evaluating the effectiveness of the M&A deal might be redundant.

Therefore, the discounted cash flow (DCF) model combined with the real options method has been chosen as methodology to assess the M&A effectiveness in terms of synergy generation and to show that the combination of these methods may be used to assess the effectiveness of M&A deals in the oil & gas industry. There are several reasons for that. Firstly, according to van Putten (2004), this approach may provide more reliable estimation results than other methodologies featuring only one approach (e.g., DCF only or real options only). Moreover, Cirjevskis (2020) tested the real option method based on three case studies in consumer goods industry and came to conclusion that the application of the real options may help to estimate synergies. In his another research (2021), Cirjevskis explored some benefits of dynamic capability-based synergy and limits to value a synergy based on two M&A deals in the IT and communications industry and real options theory. He concluded that during an M&A deal an acquirer converts the deal into a value creation process, i.e. synergies, which, as he claimed, can be valued by real options. In addition, Jiang and Liu (2021), when valuing the underlying business of 12 companies, established that there is a significant difference between the appraised value of the real options method and the income method (DCF) and found the real option method to be more suitable for the valuation. Furthermore, Wan-Lu (2005), when assessing the value of an M&A deal in the financial services industry, found that as opposed to using the DCF model solely, the combination of DCF model and the real option produced results indicating that the M&A deal between the two firms was worth and implied potential value. Secondly, this approach has been popular with researchers and proved its applicability in other industries. Thirdly, the chosen methodology minimizes subjectivity factor which may be inherent for other valuation approaches, in that it is a quantitative approach which is solely based on numbers taken from the financial statements and various databases. Fourthly, this approach may be simpler compared to others, which may allow valuators to assess and compare more potential M&A deals and may help decisions get made faster.

To illustrate that this approach works, in this paper, the one-model valuation approach, which implies using the DCF model alone, will be used first, followed by the combined or the two-model valuation approach, and the results will be then compared.

2.3. Theoretical review of real options

An option is an asset that provides the holder with the right to buy or sell a specified quantity of underlying asset at a fixed price (also called exercise or strike price) at or before the expiration date of the option, which depends on whether the option is American or European.

American options allow the holder to exercise the option at and before the expiration date of the option, while European options can be exercise only at the expiration date. Moreover, options can be call and put options. Call options give the holder the right to buy the underlying asset at the strike price at any time prior to the expiration date of the option (if these are American options), while put options give the holder the right to sell the underlying asset at the strike price at or before the expiration date of the option (again, if these are American options) (Damodaran, 2012).

A real option refers to a right, but not an obligation, to take a specific action in the future at some specific cost with regard to a tangible or intangible asset (e.g., acquiring a partner's ownership share or opening a new subsidiary) (Belderbos and Zou, 2009). This might be a useful tool for managers taking investment decisions, since whenever there is uncertainty about the asset's value, the option allows them to collect new information and act only if it is beneficial to do so (Trigeorgis, 1996).

It is important to differentiate the real options from the financial options. A real option is a right to make a potentially value-creating investment, while financial option is the right to buy or sell a financial asset at a given price (Vishwanath and Krishnamurti, 2009). What is more, according to Li (2007), the exercise prices of real options are most of the time not precisely known ex ante (e.g., the future costs of setting up a greenfield in another country) and sometimes are negotiated ex post (e.g., the price for purchasing a JV partner's stake) unlike the exercise prices of financial options that are specified in the contract.

The possibility of taking an action to buy, sell, or change an asset based on new information gathered in the future constitutes a form of managerial flexibility, which, in turn, defines the value of a real option. However, there are three factors that may also affect its value, they include uncertainty, risk of early expiration or competitive preemption, and irreversibility (Chi et al., 2019). When speaking of the uncertainty, the extent to which it affects the value of a real option depends on the level and type of uncertainty (exogenous and endogenous). Usually, the exogenous type of uncertainty requires less efforts, time, and money from the firm to gain new information, while the endogenous type requires right the opposite. The easier to gain the information, the less the value. Irreversibility refers to how easy it is to reverse the decision. If the decision can be reversed without costs, then the value of the real option may be limited. Risk of early expiration or competitive preemption relates to the likelihood that the benefits from the taken action may disappear early or significantly decrease due to government's or competitors' moves. Needless to say, if the likelihood is great, then the value of real option may be lower (Chi et al., 2019).

Trigeorgis (1996) claimed that various types of real options may provide valuable operating flexibility to management, and he explained that on the example of the oil and gas industry. In short, Trigeorgis identifies eight types of real options:

1. Option to defer (options that do not specify a precise time for investment to be made, rather it is flexible);
2. Time-to-build option (options giving an opportunity to make an investment by stages and stop at any point);
3. Option to expand (options that allow to expand the investment, that is production or other business operations, in case of favorable market conditions);
4. Option to abandon (option allowing the manager to stop participating in a project and sell the assets on secondary market in case of worsening market conditions);
5. Option to switch (options allowing to make changes in input and output components in case of significant changes in market conditions);
6. Growth option (options allowing to make an initial investment for growing its future value);
7. Option to contract (options allowing to reduce scale of operations)
8. Option to shut down and restart operations (options allowing to stop operations and renew them later)

The option to defer provides an opportunity to delay market entry when there is demand uncertainty. In other words, it lets managers put off an investment for some time (e.g., up to one year) in order to benefit from the resolved uncertainty about, for example, oil prices. Management will exercise its option to extract oil only if oil prices rise sufficiently, otherwise, if prices decrease, they will not go on with the project, which may help save the planned costs. The value of the investment opportunity is greater, the closer the option to its expiration date. Therefore, there is similarity between the option to defer and an American call option on the part of gross present value of expected operating cash flows of the completed project, where an exercise price is equal to the required costs. This type of option is particularly valuable in such industries like resource extraction due to long investment horizons and high uncertainties.

When it comes to time-to-build options, in real life, most projects are not financed in a single upfront payment, rather they are financed by installments. Staging capital investment as a series of installments provides management with valuable options to “default” at any given stage. For example, if after exploration the reserves or oil prices turn out to be very low, the project may be abandoned. Therefore, each stage may be perceived as an option on the value of next stages and can be valued in a way similar to the compound options valuation. This type of options is useful in industries that are capital-intensive with high uncertainty and long development (e.g., large-scale constructions, energy-generating plants, etc.), R&D-intensive, or in industries like venture-capital financing.

The option to expand allows to increase production capacity or an outsourcing arrangement. For example, management can increase the scale or rate of production if oil prices or other conditions turn out to be more favorable than expected. This option has some resemblance with a call option to buy an extra part of the base-scale project by paying the follow-on cost (cost of increasing production), which is the exercise price. The investment opportunity with the option to expand can be perceived as the base-scale project coupled with a call option on future investment. This option is exercised only if market developments turn out favorable and it can make a base-case investment, which seems unprofitable at first, worth undertaking.

The option to contract allows management to reduce the scale of operations or operate below capacity, thus sparing part of planned investment costs if market conditions turn out more unfavorable than expected. The flexibility to diminish loss is similar to put option on part of the base-scale project with potential cost savings being the exercise price. This option might be valuable if new product is introduced in uncertain markets.

Option to shut down and restart operations refers to the opportunity to shut down operations temporarily if market conditions are unfavorable and restart operations if they are favorable again. For instance, if oil prices are not high enough so that revenues cannot cover variable operating costs, operations might be halted and resumed when oil prices increase. In this case, operation in each year may be perceived as a call option to receive that year's cash revenues by paying the exercise price equal to variable operating costs. This option might be typically found in natural-resources industries (e.g., mining industry, consumer goods industry, apparel industry, etc.).

The Option to abandon is an option that gives an opportunity to exit a market or sell a technology in case of market conditions deterioration. If for example oil prices continuously decline or operations perform poorly due to some other reasons, management may not want to continue incurring fixed costs. Instead, they might have an option to permanently abandon the project in return for its resale value. This option may be perceived as an American option on the current value of the project with resale or best-alternative-use value being the exercise price. The more general the purpose of the asset is, the higher the resale value and option to abandon is.

Such options may be found in the financial services industry, other industries that are capital-intensive (e.g., airlines industry), etc.

The option to switch allows to switch suppliers, inputs, or outputs. For instance, if an oil refinery can be designed to use alternative forms of energy to convert crude oil into different products (outputs), it would provide valuable flexibility to switch the input from the current to the cheapest future. The source of this option may be not only technologies that allow to switch inputs or outputs but maintaining relationships with suppliers as well, which can be switched as their relative prices change. Process flexibility is useful in facilities that depend on feedstock, which include, for example, oil, electric power, chemicals, and crop switching. Product flexibility is useful in the automobile industry, the consumer electronics industry, the toy industry, etc., i.e., industries where product demand is volatile.

Finally, the option to grow (the growth option) refers to an option that allows to realize and capitalize on other projects, which may bring much more value than the initial project but which are possible only once the initial project is completed. Such options have considerable strategic importance. Imagine that an oil refinery is based on a new and technologically superior process developed and tested in a pilot plant. Even though this facility may appear unattractive in isolation, it may be only the first in a series of similar facilities, opening doors to other opportunities, if the process is successfully developed and commercialized. The value of these initial projects comes from the future growth opportunities they may unlock (e.g., oil reserves, access to a new market, or strengthening firm's core capabilities and its strategic positioning). The opportunity to invest in initial project is similar to an option on options, i.e., an inter-project compound option. Such options are found in all strategic or infrastructure-based industries (e.g., R&D, multinational operations, strategic acquisitions, etc.).

Such operating and strategic flexibility represented by these real options can be achieved at various stages during the value chain, as noted by Trigeorgis (1996).

The real options in the oil and gas industry may be different and related to entering or exiting an exploration field, production, R&D projects, drilling, etc. (Kulik and Savina, 2020).

In general, the value of an option may be determined by six variables related to the underlying asset (Damodaran, 2012):

- current value of the underlying asset – since options derive their value from underlying assets, changes in the value of those assets affect the value of options on them.
- variance in value of the underlying asset – the greater the variance in the value of underlying assets, the greater the value of options on them.

- ❖ dividends paid on the underlying asset (relevant for financial assets) – the value of the underlying asset may decrease if dividends are paid, resulting in the decrease in the option's value.
- ❖ strike price of the option – key characteristic used to describe the value of the option; depending on the type of option (call or put), the increase in strike price may increase or decrease the value of the option.
- ❖ time to expiration of the option – options are more valuable the greater the time to expiration.
- ❖ riskless interest rate corresponding to life of the option – increases in the interest rate will increase the value of call options and decrease the value of put options.

The theoretical ground covered in this section, namely options, their varieties, types, etc., will be used further in the next chapters when speaking about a specific case and choosing a real option for the model.

This chapter has covered some theoretical aspects relevant to the goal of this paper, it mentioned and analyzed the empirical studies of other researchers and explained the approach that is going to be put in the foundation of the methodology.

3. METHODOLOGY

As methodology, this paper will use the two-model approach, which is the combination of two valuation models, namely the combination of DCF and real options approach. When speaking of the latter, there are several methods to estimate options' value: Cox-Ross-Rubinstein (CRR) (binomial model), trinomial model, the Black-Scholes model, and others. This paper is going to use the Cox-Ross-Rubinstein option valuation model, because the Black-Scholes model is more appropriate for calculating the value of financial options, since it uses continuous-time variables, which means that one can enter or exit the project at any time. While this might pose no problems for financial options, it may be a problem for real options since some of them may not be as "liquid". The trinomial model, compared to the CRR model, is more complex although it may assess the value of an option more accurately if fewer steps are modeled (Josheski and Apostolov, 2020). However, Cox et al. (1979) recommended the CRR model as a much simpler yet effective way to evaluate American options (which are used in this paper). Furthermore, Copeland and Tufano (HBR, 2004), in their article "A Real-World Way to Manage Real Options" claimed that binomial models (the CRR option pricing model included) are ideally suited to real-option valuation. In addition, they noted that using Black-Scholes-Merton model for real-option valuation is inappropriate and misguided. Hull J. (2011) says in his book that binomial trees are useful and extremely popular technique for pricing options and notes that it is widely used for valuing American options in particular. The approach to binomial trees that the author was promoting was claimed to be similar to that of Cox, Ross, and Rubinstein (1979). The Cox-Ross-Rubinstein model coupled with DCF model will help assess the effectiveness of the M&A deals in the oil & gas industry and prove that this approach is better than single-model approach and may be used in oil & gas industry.

The novelty of this approach is explained by the fact that synergy evaluations that are based on only one evaluation model (DCF) do not take into account the value of managerial flexibility of the new firm. This might be fixed and considered by using real options. The methodology suggested in this paper takes that managerial flexibility into account by combining the discounted cash flow model with a real option and proves that this approach can be used in oil and gas industry. Furthermore, this paper uses a different type of real option – the growth option, which is an option on option (this will be explained in next chapters).

There are several reasons for choosing this methodology, which have been mentioned previously:

1. each M&A deal is a strategic investment with uncertain outcome that requires as accurate assessment as possible to make the right decisions, and according to van Putten and MacMillan (2004), this approach should bear more precise results than any DCF or real options approach conducted alone;
2. this approach has been used by other researchers and proved its applicability in other industries;
3. the chosen methodology minimizes subjectivity factor which may be inherent for other valuation approaches;
4. this approach may be simpler, which may allow valuators to assess and compare more potential M&A deals and may help management make decisions faster.

3.1. Criteria and sampling

To test the methodology and achieve the research goal, a case of a merger between Wintershall and DEA Deutsche Erdoel, two German-based firms, has been chosen. The deal happened in 2019 and was assessed at $7.18 billion.

There are certain criteria that have been dictated by the requirements of the models and the goal of this paper and have been used to choose the appropriate case for the sample:

1. both firms should operate in the oil and gas industry;
2. both firms should be international (in that operate in various countries) and public if possible;
3. both firms should have published financial statements for at least two years prior and two years after the M&A deal;
4. the merger should happen in 2018-2019, to give some time for the synergy to reveal itself.
5. the M&A deal should be big enough – with value of at least $2 billion.

Although there is only one case in the sample, its representativeness might be explained if the case is proven to be typical for the oil and gas industry. An M&A deal might be considered typical for the oil and gas industry if it involves the merger or the acquisition of one firm by another, often with the goal of expanding operations, gaining access to new markets, or consolidating industry players. The deal can involve both upstream (exploration and production) and downstream (refining and marketing) companies and can involve joint ventures or partnerships where companies combine their resources to develop new projects or explore new areas. The size of such a deal can vary greatly, from small acquisitions of individual wells or fields to multi-billion dollar mergers between major oil and gas companies.

In case of the merger of Wintershall and DEA, the goal of the merger was to create a leading independent European exploration and production company increasing its daily production from 590,000 barrels of oil equivalent per day to 750,000-800,000 barrels of oil equivalent, which implies operations expansion. Moreover, the newly formed company must have gained access to new assets (those of DEA) in various countries, meaning that the new firm might have gained access to new markets, for instance Mexico – in 2018 DEA acquired Sierra Oil & Gas which had interests in six exploration and appraisal blocks in Mexico (Offshore Technology, 2018). Furthermore, Wintershall DEA also expected to realize synergies of at least €200 million per year as of the third year following the closing of transaction (Wintershall DEA, 2019).

3.2. Discounted Cash Flow valuation

Discounted Cash Flows (DCF) is the fundamental model which is used by majority of, if not all, investment banks. The idea of DCF is based around the present value of cash flows that the asset – the possible investment – will generate in the future. The core formula of DCF that illustrates this idea is as in formula (1) below.

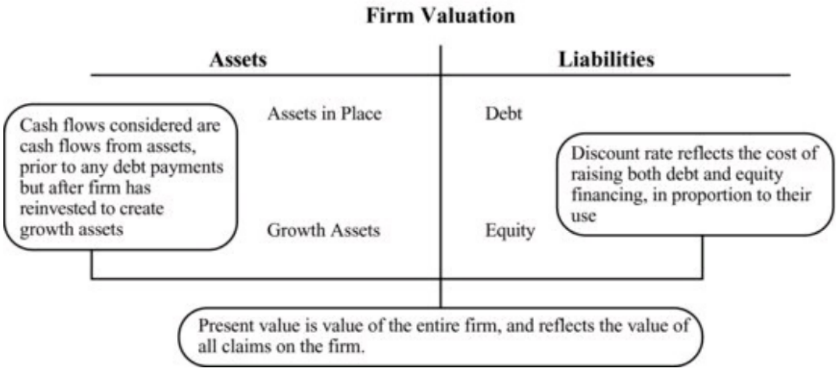
$$Value = \sum_{t=1}^{t=n} \frac{CF_t}{(1+r)^t}, \tag{1}$$

where n – life of the asset, CF_t – cash flow in period t, r – discount rate reflecting the level of risk of the expected cash flows.

The cash flows may vary in sources, for example they may represent proceeds from stock dividends, coupons and face value of bonds, and/or after-tax cash flows for a real project. Depending on the nature of cash flows, the discount rate will be different, as it is a function of the riskiness the incoming cash flows, hence it should reflect the risk. In this way, when receiving cash flows from obligations, a discount rate will be different (lower in this case) from that when receiving equity, or cash flows from a project.

DCF approach has two ways to value a business, in that one is through equity valuation and the other is through firm valuation. The choice affects the cash flows and the discount rate used in the main model. This paper will use the firm valuation approach. DCF approach through firm valuation suggests valuing the entire business, including not only equity but also other claimholders of the firm, e.g., bondholders, preferred stockholders. The illustration below shows the concept of this approach in a clearer manner.

Fig. 1. *DCF approach through firm valuation*



Source: Damodaran, Investment valuation, 2012

The firm valuation approach takes into account cash flows from both equity and debt financing. For this paper, it is most appropriate approach because evaluating the synergy of an M&A deal implies defining the values of firms, and when one speaks about firms, especially big corporations like ones in oil & gas industry, one must understand that these firms are funded not only by equity but by debt as well, which implies that it might be expected that some cash flows are created by debt financing. Therefore, it is important to take both sources into account.

In the case of firm valuation, expected cash flows to the firm, that is the residual cash flows after meeting all operating expenses, reinvestment needs, and tax obligations, but prior to any payments to either debt or equity holders, are discounted at the weighted average cost of capital (WACC), which serves as the cost of different funding sources used by the company, weighted by their market value proportions. The formula for the firm valuation approach is illustrated below.

$$Value = \sum_{t=1}^{t=n} \frac{CF\ to\ firm_t}{(1+WACC)^t}, \qquad (2)$$

where n – life of the asset, CF to $firm_t$ – cash flow to the firm in period t, WACC – weighted average cost of capital (formula shown below).

WACC is calculated as formula (3) below suggests.

$$WACC = k_e \times \frac{Equity}{Debt + Equity} + k_d \times \frac{Debt}{Debt + Equity}, \tag{3}$$

where k_e – cost of equity, k_d – cost of debt.

To calculate the cost of equity, the capital asset pricing model (CAPM) is used:

$$k_e = R_f + \beta \times (R_m - R_f). \tag{4}$$

where R_f – risk-free rate of return, R_m – expected market rate of return.

The risk-free rate of return has been taken from statistical sources (Statista, 2022) for the years taken as the beginning of the valuation period.

In the CAPM model, beta (β) refers to the degree of volatility or systematic risk that a security or portfolio exhibits in comparison to the overall market, typically represented by the S&P 500 (for U.S. stocks). Beta can be of two types, levered and unlevered. The former (levered) indicates that the coefficient takes into account financial leverage, while the latter (unlevered) does not. In this paper, the levered beta is used since firms are usually financially leveraged. The levered beta coefficient is calculated as following:

$$\beta_l = \beta_u \times (1 + ((1 - Tax\ rate) \times (Total\ debt/Equity))), \tag{5}$$

where β_l – levered beta, β_u – unlevered beta.

The unlevered beta is taken from the Damodaran's database (Damodaran Online) for the oil and gas industry and for the years taken as the beginning of the valuation period (2016 – for Wintershall Holding and DEA Deutsche Erdoel, and 2019 – for Wintershall DEA). All indicators in the database have been calculated by Damodaran personally.

As shown in formula (4), the risk premium might be found by subtracting the risk-free rate from the expected market rate, which in turn is based on the historical rate of return of an index (e.g., S&P 500, Nasdaq, etc.) and can be calculated by taking the average of historical returns of the index and using it as the projected return for the upcoming investment period.

However, in this paper, the value of the risk premium is taken from the Damodaran's database (Damodaran Online) for the respective country and for the years taken as the beginning of the valuation period.

The cost of debt is calculated by using the formula:

$$k_d = \ Pretax\ cost\ of\ debt \times (1 - Tax\ rate). \tag{6}$$

Since the DCF model is going to be used to measure the value of firms, in addition to formula (2), it is important to calculate the terminal value of those firms, as it might be reasonable to assume that they will continue not only operating but also growing. For that purpose, the growing perpetuity formula (7) is used.

$$Terminal\ Value = \frac{CF\ to\ firm}{WACC - g}, \tag{7}$$

where CF – expected cash flows, WACC – discount rate, g – expected growth rate.

Just as it is the case with unlevered beta and risk premium, the growth rate is taken from the Damodaran's database (Damodaran Online) and is represented by the average value of CAGRs in net income in the oil and gas industry for Western Europe from 2018 to 2022 (see appendices 16 and 17), which are calculated based on the 5-year period prior to the date.

Combining formulae (2) and (7), the full formula for DCF valuation is received:

$$Value = \sum_{t=1}^{t=n} \frac{CF\ to\ firm_t}{(1 + WACC)^t} + \frac{CF\ to\ firm}{WACC - g}, \tag{8}$$

where n – life of the asset, CF to firm$_t$ – cash flow to the firm in period t, WACC – weighted average cost of capital (discount rate), g – expected growth rate.

There is a limitation to DCF valuation model, in that it does not take into account the managerial flexibility of the firm. As a result, the model may show negative results for some investments, however it does not necessarily mean that they should not be made, since the value of the managerial flexibility may make a difference (Kulik and Savina, 2020). Therefore, to value potential investments correctly including managerial flexibility, the real options approach is used in addition to DCF (described further in the paper).

DCF valuation approach has some advantages (Kulik and Savina, 2020), which include:

- it allows to value assets quickly;
- DCF model is easier to build compared to other models;
- it focuses on the main property of the firm, which is the ability to generate free cash flows;
- DCF valuation is widely used and can be universally used in different organizations around the world.

Despite its advantages, there are some disadvantages to DCF valuation as well (Kulik and Savina, 2020):

- forecasting for long periods of time might be complicated due to numerous variables that appear over time;
- DCF model may be sensitive to growth rate, post-forecast growth rate of free cash flows, financial indicators (e.g., EBITDA, CAPEX, revenue), and multipliers;
- valuing assets and firms that do not generate positive cash flows might be impossible.

3.3. Real Options and Cox-Ross-Rubinstein option pricing model

As it was mentioned in the beginning of this section, for the real options approach, Cox-Ross-Rubinstein binomial option pricing model is going to be used.

This model is useful for estimating the value of American style options and has the iterative structure (Cox et al., 1979). The idea of the binomial model is based on the creation of the asset price process in which the asset, over any given period, can move in two possible directions meaning the increase or decrease in price (Damodaran, 2012). In general, the binomial asset price process looks as following:

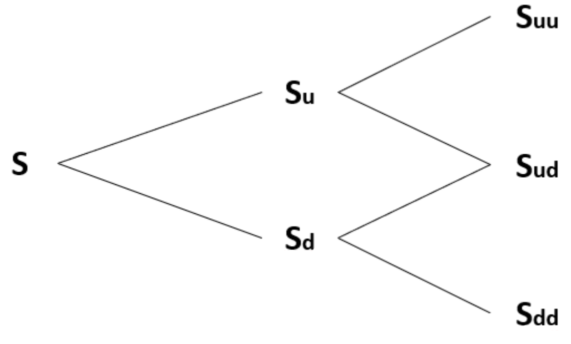


Fig. 2. *The binomial asset price process*

Source: Constructed by the author

In the figure above, S refers to the price of the underlying asset, S_u denotes a price increase in the first period (e.g., in one year) with growth coefficient u, while S_d denotes a price decrease in the first period with decrease coefficient d. S_{uu} is used to indicate the price increase in the second period (e.g., in two years). S_{ud} may show either the price increase in the first period and the price decrease in the second period or the price decrease in the first period and the price increase in second. S_{dd} shows the price decrease in both periods.

According to Rogers (2002), to calculate the value of the option via CRR model, one needs two trees – the underlying asset's price tree and the option's price tree. Firstly, all the values in the underlying asset's price tree need to be calculated by using the formulae as shown in figure 3 below. After that all the values in the option's price tree are calculated by using the formulae as shown in figure 4 below and as a result the value of the option is found. The crucial thing to note is that when calculating the values in the underlying asset's price tree, one should move from the base year to the last year, while when calculating the values in the option's price tree, the calculations need to be done in the opposite direction starting from the last year.

The increase coefficient «u» is calculated via formula below:

$$u = e^{\sigma\sqrt{\Delta t}}\,. \tag{9}$$

For the standard deviation in formula above, the relative standard deviation is used, which is basically the same standard deviation but in percentage and therefore can also be used as the estimate of volatility. Δt is calculated as the number of years divided by the number of steps (periods) in the tree.

The decrease coefficient is calculated by using formula (10).

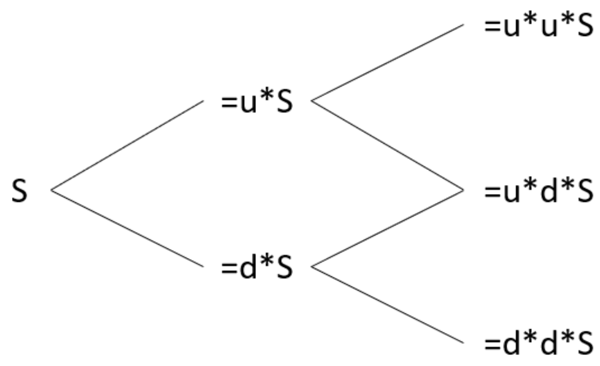
$$d = \frac{1}{u}\,. \tag{10}$$

Probability of price increase is found via the following formula:

$$p = \frac{(1+r)^{\Delta t} - d}{u - d}, \tag{11}$$

where r – discount rate.

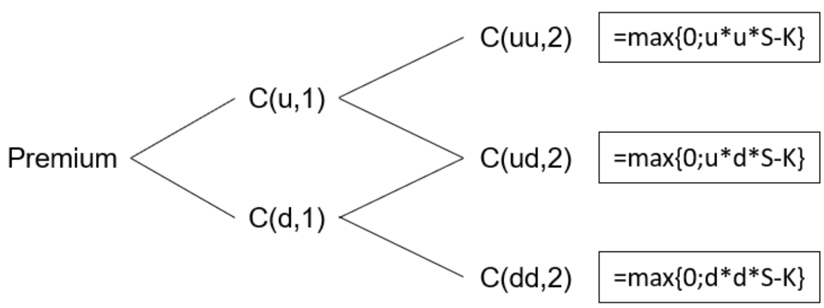
Fig. 3. *The binomial underlying asset's price tree*



Source: Constructed by the author

u – the increase coefficient; d – the decrease coefficient; S – the price of the underlying asset.

Fig. 4. *The binomial option's price tree*



Source: Constructed by the author

Premium – the current value of the option; C – the option's price; K – the strike price; S – the underlying asset's price.

Risk-free rate of return is used as the discount rate in formula (11), because the CRR model assumes agents' risk-neutrality.

In the option's price tree, to find C(u,1), C(d,1), and Premium (C_0), the following formulae are used:

$$C_{u,1} = \frac{1}{(1+r)^{\Delta t}} \times \left[p_u \times C_{uu,2} + p_d \times C_{ud,2}\right]; \quad (12)$$

$$C_{d,1} = \frac{1}{(1+r)^{\Delta t}} \times \left[p_d \times C_{dd,2} + p_u \times C_{ud,2}\right]; \quad (13)$$

$$Premium = C_0 = \frac{1}{(1+r)^{\Delta t}} \times \left[p_u \times C_{u,1} + p_d \times C_{d,1}\right], \quad (14)$$

where r – discount rate, p_u – probability of the price increase, p_d – probability of the price decrease.

However, when using the CRR model, several assumptions should be considered:

- agents' risk neutrality;
- perfect efficiency of the market, implying no arbitrage opportunities;
- only two possibilities for the price dynamics – up or down – at each point in time.

One of benefits of this model is that it considers uncertainty and a number of managerial decisions that may be taken, which get reflected in the options' value.

4. MARKET AND FIRMS DESCRIPTION

4.1. Market description

In 2019, the global oil and gas exploration and production market was estimated at around $3 trillion with global crude oil demand of 99.7 million barrels per day (ibisworld, zippia). The oil market seemed to be recovering from the 2014 downturn. Oil prices recovered from the $40 annual average WTI price low of 2016. In 2017, the price breached the mark of $50, and it averaged at around $67 through September 2018, although in some regions like Canada the prices were yet a bit lower. This recovery was due to various factors, namely sustained success of the production restraint agreement between OPEC and non-OPEC countries in force since 2017, lower oil supply from producers that were challenged, and continued strong global growth in demand for oil (Energy Information Administration estimated it at about 1.6 million b/d in 2018). All these factors combined contributed to the decrease in the global oil inventory by more than 175 million since 2016 and pushed up prices. Due to these signals, there was another year of impressive growth for US crude oil and natural gas liquids (NGL) production, adding approximately $2 million b/d in 2018. Tendencies in the natural gas industry were a bit different however. The gas prices in the US for example were constant at around $3, while abundant low-cost US supply continued meeting growing demand in both domestic and export markets. The oil and gas trade between the US and other countries continued growing, bolstering activity. Upstream capital expenditures did not recover in the same proportions as prices in 2018 due to firms remaining cautious. At that time, companies seemed to be focused more on demonstrating returns rather than investing to get growth (Deloitte, 2019).

According to Deloitte’s annual survey, in 2019 as compared to 2018, experts were growing more confident in the oil and gas market recovery, expecting increased economic growth, commodity prices, and investment. The market indicators of 2019 seemed to support this view – the global economy was showing big growth, energy demand in the oil and gas sector was increasing at levels above average, supply risks were persisting only from a few key exporting countries.

Overall, the picture of the oil and gas industry in 2019 appeared to be healthy – the unemployment was low, business investment was increasing, and prices were stable. Although there were some incentives for the industry growth, the industry still posed some risks due to vulnerability to tariffs and supply chain disruptions. Sustainability was no longer an issue for energy firms, since it became the central point of their strategy and investment decisions. For example, oil firms were making investments into renewable energy, gas producers were increasing their concentration on reducing methane emissions, etc. Some countries increased their efforts to bring down the environmental and carbon footprints of their industrial and energy sectors. That especially relates to China, which took big steps to close down polluting factories and switch to cleaner energy. Technology was not standing still either, enabling firms to focus their decision making around growth for low-carbon energy, electric vehicles, energy efficiency, and distributed energy (Deloitte, 2019).

In 2019, there were several evident trends relevant for the oil and gas industry all over the world, including the German market (Deloitte, 2019):

1. Although the recovery in cash flows and commodity prices in 2018 was good news for the industry, keeping the sustainable profitability and returns in the future was expected to be challenging. Some costs were expected to rise, therefore to keep the same level of operating efficiency, cost containment, and generate acceptable returns, firms were advised to adopt a disciplined approach to capital investments and increase capital productivity by leveraging digital technologies.
2. As production was increasing, the existing infrastructure (pipelines, processing facilities, import and export terminals, storage facilities, etc.) became insufficient to handle the volumes, resulting in depressed prices for producers. Therefore, building new infrastructure was expected to be vital for the industry.
3. Natural gas was continuing to grow as a source of lower-carbon power generation. The US became a major player in global LNG markets, which was expected to shape global prices, trade flows, and business models.
4. Although sustainability agenda had been present in energy firms for some years by 2019, due to increasing consumer awareness of environmental and climate issues and societal expectations, more energy firms needed to embrace sustainability as a central part of their business strategy, rather than just an add-on activity.
5. Opportunities coming from digital technologies became increasingly evident, having the potential to unlock new value. Many sectors were turning their attention to those opportunities. As a result, an increasing number of firms were looking for ways to deploy artificial intelligence, robotics, analytics, and blockchain to boost efficiency, reliability, predictability of operations, and productivity. Those that succeeded could be well-equipped to thrive and handle external factors.

4.2. Wintershall Holding Gmbh description

Wintershall Holding Gmbh was founded in 1894 and was the biggest producer of crude oil and natural gas in Germany. The firm had German roots and was headquartered in Kassel, Germany, which gave the firm a good location not only in the center of Germany, but in the center of Europe as well. The firm had global scope, in that it employed more than 2,500 people from over 40 countries, in which it was represented. Besides that, the firm sought crude oil and natural gas in many regions all over the world, including South America, North Africa, Middle East, Caspian See, Russia, and Europe (BASF).

Before the merger, Wintershall Holding Gmbh was fully owned by BASF, the German multinational and largest chemical producer in the world with headquarters in Ludwigshafen.

Wintershall Holding Gmbh was focused on exploration and production in the regions rich with oil and gas. The company also handled natural gas transportation in Europe (Crunchbase), gas storage, and its realization. Wintershall had more than 2000 km of pipeline system in Germany, and its key business activity was sale of gas in Germany and other countries of Western Europe.

4.3. DEA Deutsche Erdoel AG description

DEA Deutsche Erdoel AG was founded in 1899 in Hamburg, Germany, and was a natural gas and crude oil exploration and production company operating with 1150 employees internationally. It was represented in 12 countries and owned stakes in oil and gas licenses in different countries. The firm served the purpose of secure, sustainable, and environmentally friendly crude oil and natural gas production as well as its storage. Besides the production of crude oil and natural gas and operation of high-volume underground storage facilities for natural gas, the firm specialized in crude oil and natural gas exploration.

DEA Deutsche Erdoel AG had long-standing experience along the whole value chain of the upstream business. Before the merger, the firm was owned by LetterOne, the international investment business headquartered in Luxemburg and founded by Russian oligarch, Mikhail Fridman (Crunchbase).

4.4. Wintershall DEA AG description

Wintershall DEA AG is a new organization that has been formed in May 2019 as a result of the merger of Wintershall Holding Gmbh and DEA Deutsche Erdoel AG. The merger has created Europe's leading independent oil and gas company, which holds concessions worldwide, has around 3,000 employees globally from more than 60 countries, and produces combined at least 575,000 barrels of oil equivalent a day. Wintesrhall DEA has a mission, which is to offer solutions to meet the challenges of the future, especially the global growing need for energy, and climate change. The firm has its headquarters in Kassel and Hamburg, Germany. Currently, the company is operating in 11 countries, namely Mexico, Argentina, Algeria, Libya, Egypt, the UAE, the UK, Netherlands, Denmark, Norway, and Germany. Until recently, the firm also operated in Russia, however due to the ongoing geopolitical conflict, it decided to quit the Russian market in January 2023 (Winetshall DEA, 2023).

The operations of Wintershall DEA are based around searching and producing natural gas and crude oil worldwide. A more precise list of business operations of the firm includes exploration of natural gas and crude oil, gas transportation, development projects worldwide, and production of natural gas and crude oil with the last being the core business of the company. The strategy of the firm might be described in two words – valuable growth. The company's strategy focuses on a gas-weighted portfolio and selected regions to deliver profitable growth. At the same time, the oil and gas giant contributes to affordable and lower-carbon energy for the economies and societies it serves (Wintershall DEA, 2023).

The Chief Executive Officer (CEO) of the firm is Mario Mehren, who is responsible for such areas within the firm as Human Resources, Corporate Communications, General Council, Strategy and M&A, and Investor Relations. The Chief Operating Officer (COO) is Dawn Summers, who is also a member of the Board. She is responsible for Business Units Germany, Norway, the Netherlands, UK and Denmark, Egypt, Libya, Algeria, and UAE. Thilo Wieland is a member of the Board and is the lead of Business Units Russia, Achimgaz, Argentina, Mexico, and Midstream. Other board members include H. Dijkgraaf (CTO), P. Smith (CFO), Hans-Ulrich Engel (Chairman), M. Heinz, K. Scharpwinkel, F. Sommer, D. Elvermann, T. Summers, M. Lievonen, S. Nyquist, B. Böl, K. da Luz-Berlin, G. Prien, and M. Winkler.

Right after the merger, the ownership of Wintershall DEA was divided between two companies, BASF and LetterOne – BASF received around 67% of the shares, while LetterOne received the remaining 33%. Currently, the ownership structure has change a little. The firm is still owned by BASF and LetterOne, however 72.7% belongs to BASF and the remaining 27.3% belongs to LetterOne (Wintershall DEA, 2023). Moreover, the major owner of the firm intended to make an IPO a couple of times, but both times it was postponed (Wintershall DEA, 2021). Nevertheless, BASF still keeps its intention to sell its stake in Wintershall DEA in an IPO, but it has been lately out of the question due to the ongoing conflict in Ukraine (Euronews, 2023).

5. VALUATION PROCESS AND RESULTS

To estimate the value of the firms, the discounted cash flow (DCF) model has been used. As shown by the empirical study analysis in this paper, this approach is widely popular among both researchers and valuation specialists, when it comes to firm valuations. As a matter of fact, major investment banks as Deutsche Bank AG, Credit Suisse, JP Morgan, etc. use the DCF model as a standard approach to firm valuation, especially if dealing with large firms, and WACC as a discount rate (Brotherson et al., 2014). As described in the methodology, since the object of valuation is a firm, which is financed both by equity and debt, the DCF model that is used here discounts cash flows to firm, which take into account both debt and equity, and therefore WACC is used as a discount rate. The valuation period has been chosen as three years prior to the merger and three years after the merger, that is from 2016 to 2018 (for Wintershall Holding Gmbh and DEA Deutsche Erdoel AG) and from 2019 to 2021 (for Wintershall DEA AG), because the firms (Wintershall and DEA) had its financial statements disclosed only from 2017, and 3 years are usually enough for the synergy to reveal itself (Corporate Finance Institute, 2022). Furthermore, Wintershall claimed that it expected to realize synergies in 3 years after the merger (Wintershall Dea, 2019).

To build the DCF model, two components were required the discount rate (WACC) and the cash flows. As for the WACC, since the starting year in the valuation model is 2016, it has been decided to calculate WACC as of 2016. To calculate WACC, one required such components as: the total debt and equity of the firm, applicable tax rate, pre-tax cost of debt (to calculate the cost of debt), unlevered beta (to calculate the levered beta), risk-free rate of return, and risk premium.

5.1. Wintershall Holding Gmbh valuation

To calculate the total debt and equity of the firm, the appropriate financial statement line items have been selected from the balance sheet and summarized. These line items as well as calculated total debt and equity can be seen in table 1. Financial indebtedness in the table refers to liabilities to credit institutions, while other liabilities refer to the loan and interest liabilities and liabilities to BASF group of companies (Wintershall took loans via the group companies).

Table 1. Wintershall's total debt and equity and financial line items from the balance sheet relevant for their calculation as of 2016

€, m	**2016**
Non-current liabilities	
Non-current financial indebtedness	1,473
Other non-current liabilities	1,407
Current liabilities	
Current financial indebtedness	137
Other current liabilities	3,516
Equity	
Share capital	105
Capital surplus	15
Retained earnings and unappropriated net profit	3,796
Other comprehensive income	(745)
Minority interests	(42)
Total Equity	3,129
Total Debt	6,533

30% tax rate has been chosen for the calculation of WACC since it is the average corporate tax rate in Germany, and it is the tax rate that the firm used for its own calculations. Pre-tax cost of debt is 5.38%, which has been taken from the Damodaran's database (Damodaran Online). This value had been calculated (by Damodaran) specifically for 2016 and specifically for the oil and gas industry in Western Europe. Having the tax rate and pre-tax cost of debt, the after-tax cost of debt has been calculated and is equal to 3.77%.

The unlevered beta is 0.74% and has been taken from the Damodaran's database (Damodaran Online) for 2016 for the oil and gas industry in Western Europe. Having known tax rate (30%), equity (€3,129m), and total debt (€6,533m), the levered beta has been calculated and is equal to 1.82.

The risk-free rate for WACC is 1.4% and has been taken from Statista for 2016 for Germany. The risk premium is 6.25% and has been taken from the Damodaran's database (Damodaran Online) for 2016 for Germany.

Having calculated all the necessary components, the cost of equity has been calculated and is equal to 12.78% (see table 2).

Table 2. Calculation of cost of debt and cost of equity for Wintershall as of 2016

	2016
Cost of equity	12.78%
Risk premium	6.25%
Risk-free rate	1.40%
Levered beta	1.82
Unlevered beta	0.74
Tax rate	30%
Equity (m)	3,129
Total Debt (m)	6,533
Cost of debt	3.77%
Pre-tax cost of debt	5.38%
Tax rate	30%

Finally, to calculate WACC, besides the calculated cost of debt and cost of equity, the proportion of equity in the firm's financing as well as the proportion of debt has been required. Given the total debt and equity, these values have also been easily calculated with the proportion of equity being 32.38% and the proportion of debt being 67.62%. Therefore, WACC has been calculated and is 6.69% (as shown in table 3).

Table 3. Calculation of WACC for Wintershall as of 2016

	2016
WACC	6.69%
Cost of equity	12.78%
Cost of debt	3.77%
E/(D+E)	32.38%
D/(D+E)	67.62%

To find cash flows to firm, four financial statement line items have been taken from the income statement and the statement of cash flows, these are operating profit less taxes (EBIT*(1-T)), depreciation, amortization, impairment losses, etc., changes in working capital, and capital expenditure. The base for perpetuity value has been taken the last year in the valuation period (that is 2018) and it has been assumed that the firm will grow with the growth rate of 2.34%. This value has been calculated as the average value of 5-year CAGRs (in net income) calculated for 2018, 2019, 2020, 2021, and 2022 (see table 4). The CAGRs have been taken from the Damodaran's database (Damodaran Online) and they are relevant for the "integrated" oil and gas industry in Western Europe, which includes oil and gas production, exploration, and gas transportation. The period from 2018 to 2022 has been chosen for CAGRs because perpetuity in this DCF model starts from 2019. Normally, evaluators would estimate the plausible future growth rate (i.e., growth rate from 2019 onwards) and use it as the terminal growth rate for the model, but since the current model is built in the retrospective, the future growth rates are known to some extent (up to 2022). Furthermore, since the CAGRs differ from each other from year to year, to have a more realistic terminal growth rate, the average value of those CAGRs (from 2018 to 2022) has been taken. As mentioned before, as a result of this approach, the value of 2.34% has been acquired as the terminal growth rate for Wintershall Holding. That means that the firm is assumed to grow (in net income) each year by 2.34%. All the cash flows (discounted and non-discounted) are presented in table 5. As might be drawn from that table, the enterprise value of Wintershall Holding Gmbh is around €27 billion.

Table 4. CAGR in net income in the "integrated" oil and gas industry in Western Europe, in %

	2018	2019	2020	2021	2022
CAGR in net income	-1.22	9.23	6.33	-13.33	10.67
Average CAGR					**2.34**

Table 5. Calculation of the enterprise value for Wintershall

€, m	2016	2017	2018	Perpetuity
EBIT*(1-T)	343	653	905	905
Depreciation, Ammortisation, Impairment losses, etc.	1,101	1,024	1,080	1,080
Changes in working capital	8	(13)	(52)	(52)
Capital expenditure	(1,007)	(890)	(621)	(621)
Cash flow to firm	445	774	1,312	1,312
Terminal value				30,187
WACC	6.69%	6.69%	6.69%	6.69%
Terminal growth rate				2.34%
Period	1	2	3	3
Discount factor	0.94	0.88	0.82	0.82
Present value	417	680	1,081	24,859
Enterprise value				**27,037**

5.2. DEA Deutsche Erdoel AG valuation

To calculate the value of DEA Deutsche Erdoel AG, absolutely identical approach as to the valuation of Witnershall Holding Gmbh has been used. To calculate the total debt and equity, the relevant financial statement line items have been identified and summed up. They might be found in table 6, together with the values for total debt and equity. To clarify, financial debt in the table refers to the debt to related firms, which implies interest expenses.

Table 6. DEA's total debt and equity and financial line items from the balance sheet relevant for their calculation as of 2016

€, m	**2016**
Non-current liabilities	
Debt to banks	1,494
Financial debt	1,018
Current liabilities	
Debt to banks	3
Financial debt	16
Equity	
Shareholders' equity	1,900
Non-controlling interests	4
Total Equity	1,904
Total Debt	2,531

30.55% tax rate has been chosen for the company because it is the tax rate that the firm expected at that time (in 2016). Pre-tax cost of debt is 5.38% and has been taken from the Damodaran's database (Damodaran Online) for the oil and gas industry in Western Europe for 2016. After-tax cost of debt has been calculated and equals to 3.74%.

The unlevered beta is 0.74 and has been taken from the Damodaran's database (Damodaran Online) for the oil and gas industry in Western Europe for 2016. Having the tax rate (30.55%), equity (€1,904m), and total debt (€2,531m), the levered beta has been calculated at 1.42.

Risk-free rate has been taken from Statista for Germany for 2016. Risk premium has been taken from the Damodaran's database (Damodaran Online) for Germany for 2016 and is equal to 6.25%. Having all the necessary components, the cost of equity for the firm has been calculated and is 10.29% (see table 7).

Table 7. Calculation of cost of debt and cost of equity for DEA as of 2016

	2016
Cost of equity	10.29%
Risk premium	6.25%
Risk-free rate	1.40%
Levered beta	1.42
Unlevered beta	0.74
Tax rate	30.55%
Equity (m)	1,904
Total Debt (m)	2,531
Cost of debt	3.74%
Pre-tax cost of debt	5.38%
Tax rate	30.55%

For WACC calculation, the proportions of equity and debt in the firm's financing have been calculated and equal to 42.93% and 57.07% respectively. Given the costs of equity and debt as well as the proportions of debt and equity, WACC has been calculated and is equal to 6.55% (see table 8).

Table 8. Calculation of WACC for DEA as of 2016

	2016
WACC	6.55%
Cost of equity	10.29%
Cost of debt	3.74%
E/(D+E)	42.93%
D/(D+E)	57.07%

For calculating cash flows to firm, financial statement line items like operating profit less taxes (EBIT*(1-T)), depreciation, impairment losses, etc., changes in working capital, and capital expenditure have been taken from the income statement and the statement of cash flows. The base for perpetuity has been taken the last year in the valuation period (which is 2018) and it has been assumed that the firm will continue growing at the rate of 5.3%. This value has been calculated in the same manner as the terminal growth rate for Wintershall Holding (see chapter

5.1). However, DEA Deutsche Erdoel has a different value because instead of taking CAGRs relevant for the "integrated" oil and gas industry in Western Europe the CAGRs relevant for only production and exploration in the oil and gas industry (in Western Europe) have been taken for calculations (see table 9). Therefore, the values differ a little. There is a reason for such a choice, namely DEA Deutsche Erdoel, unlike Wintershall Holding, did not provide gas transportation services, therefore could not be considered as belonging to the "integrated" oil and gas industry. All the cash flows (discounted and non-discounted) can be observed in table 9. From the table follows that the enterprise value of DEA Deutsche Erdoel AG is around €4.46 billion.

Table 9. CAGR in net income in the "production and exploration" oil and gas industry in Western Europe, in %

	2018	**2019**	**2020**	**2021**	**2022**
CAGR in net income	-4.52	10.6	1.03	-5.33	15.66
Average CAGR					**5.30**

Table 10. Calculation of the enterprise value for DEA

€, m	**2016**	**2017**	**2018**	**Perpetuity**
EBIT*(1-T)	31	246	507	507
Depreciation, Impairment losses, etc.	570	389	486	486
Changes in working capital	46	110	23	23
Capital expenditure	(656)	(829)	(948)	(948)
Cash flow to firm	(9)	(84)	68	68
Terminal value				5,430
WACC	6.55%	6.55%	6.55%	6.55%
Terminal growth rate				5.30%
Period	1	2	3	3
Discount factor	0.94	0.88	0.83	0.83
Present value	(9)	(74)	56	4,489
Enterprise value				**4,462**

5.3. Real option valuation

To calculate the real option value, first it has been required to identify the real option and type of the real option. The key requirement for the real option has been that it should be integral for the M&A deal (i.e., an important and inevitable part or result of the deal) and should provide the merged firm with new opportunities that were and would be unavailable to either of the firms if there was no merger. This is the description of growth options, therefore the type of the real option that has been used in this case is the growth option. Growth option implies an inter-project compound option, which means an option on option. Hence, two real options had to be identified. The M&A deal between the firms has been chosen to be the initial option, since it is fundamental to the merger and it opens new doors for the firm. Wintershall DEA (2019) claimed that after merger they have become big enough to be a relevant partner for the state-owned oil and gas firms, and at the same time independent and flexible enough to tackle complex tasks, which illustrates just one of the opportunities that has become available to the new firm. However, to be the second option, another new opportunity disclosed in one of the firm's reports has been chosen. Wintershall DEA claimed that after the merger the firm would hit the ground running with a pipeline that would deliver market-leading growth in the upcoming years. They talked about the Nord Stream 2 pipeline. The project would not be possible without the merger, and it provided the firm (Wintershall DEA) with access to new pumping stations and yet new opportunities that firms before the merger (Wintershall Holding and DEA Deutsche Erdoel) could not have gotten otherwise. Moreover, the pipeline was expected to bring Germany $2 billion (around €1.78 billion with 2019 exchange rate) a year as transit fees to transport gas to Eastern and Southern Europe (Atlantic Council, 2021). Moreover, as Kulik and Savina (2020) mentioned, the real options in the oil and gas industry might be related to entering or exiting an exploration field, production, R&D projects, drilling, etc. The Nord Stream 2 project fits this description, therefore, for this reason and the reasons mentioned prior, it has been chosen as the second real option.

The initial option is the American call option to grow (growth option), as was already mentioned. The option to grow means that its underlying value is the value of the second option's premium (Hussain and Khan, 2020), and the American call option means that the firm can implement the deal at any time prior to the expiration date. The second option is an American call option – the firm could invest into the pipeline at any date prior to the expiration date. Therefore, the case presented in this paper gives an example of a call-call compound option.

The valuation period for the CRR model (real options) has been chosen 3 years for both options because that is the time period in which Wintershall expected to realize the synergy (Wintershall Dea, 2019). The starting year has been set at 2019, since this is the year when the merger was completed and the investment into the Nord Stream 2 was planned to be made. The discounted present value of all the expected cash flows from the Nord Stream 2 pipeline has been chosen as the underlying asset price of the second option. To calculate this discounted present value, two components have been required – cash flows and the discount rate. Speaking about the cash flows, as mentioned previously, Germany expected to receive €1.78 billion a year once the pipeline construction has been finished. However, there are two German firms that operate in Germany and that have invested into Nord Stream 2, and each has financed 10% of the project (Reuters, 2017) – these are Wintershall DEA and Uniper. Both of these firms are transporting gas, therefore it has been assumed that half of €1.78 billion will be earned by Wintershall DEA, and the other half will be earned by Uniper. Hence, the incoming cash flows shown in the DCF model of Nord Stream 2 are €890 million a year, starting from the year of 2022, because the Nord Stream 2 pipeline was planned to be finished in 2021. Moreover, it has been assumed that these cash flows would continue to come in, therefore the perpetuity formula (without growth) has been used to calculate the terminal value. As for the discount rate, the project has been financed by debt (Reuters, 2017), therefore the cost of debt of Wintershall DEA as of 2019 has been used as the discount rate. As a result, the underlying value of €17,551 million has been derived. The strike price for the second option has been chosen to be €950 million, since it is the amount that Wintershall DEA agreed to invest into Nord Stream 2 (Reuters, 2017) (Wintershall DEA, 2022). The discount rate for the second real option has been taken as the risk-free rate of return in Germany for 2019 due to agents' risk-neutrality assumption of the model. Volatility has been taken as the relative standard deviation which has been calculated based on the historical gas prices in Europe from 2010 to 2018 (Trading Economics, 2023) (see table 11), since Nord Stream 2 is linked to gas. The increase coefficient (u) has been calculated at 1.19, while the decrease coefficient (d) has been calculated at 0.84. Knowing these two coefficients, the probability of increase has been calculated and is equal to 48.8%, then the decrease probability is 51.2%. The second option premium has been calculated by solving the underlying asset's price tree and the option's price tree (as shown in table 12). As table 12 suggests, the premium is €16.632 billion.

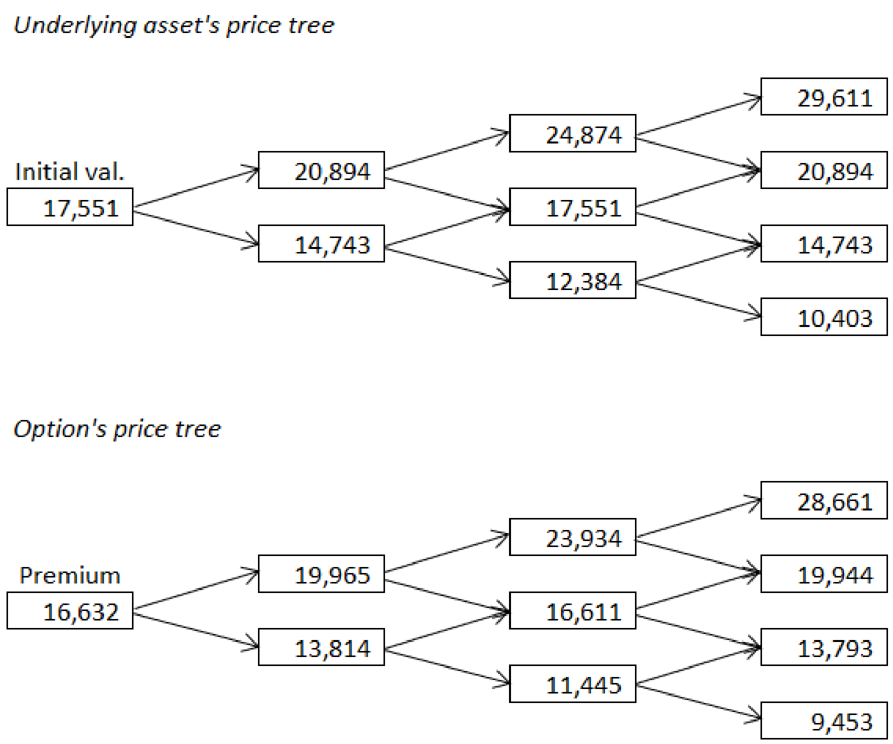
The underlying value of the initial option, as mentioned before, is the premium of the second option – that is €16.632 billion. As for the strike price, it has been set at €6.39 billion, since it is the estimated value of the deal (Kommersant, 2019). The discount rate has been chosen as the risk-free rate for Germany in 2019, and the same volatility has been chosen as in the second option, since DEA's assets are related to gas operations. Since volatility and the discount rate are the same in both the first and the second options, the increase (u) and decrease (d) coefficients are also the same – namely, 1.19 and 0.84 respectively. The probability of

Table 11. Calculation of volatility for real option

Year	Gas price (€, MWh)	Mean	Deviation	Sqr. Deviation	Variance	St. deviation	RSD
2010	18.43		-2.53	6.40			
2011	23.63		2.67	7.13			
2012	25.17		4.21	17.72			
2013	26.61		5.65	31.92			
2014	21.48	20.96	0.52	0.27	13.35	3.65	17.4%
2015	19.61		-1.35	1.82			
2016	14.62		-6.34	40.20			
2017	17.23		-3.73	13.91			
2018	21.86		0.9	0.81			
				120.19			

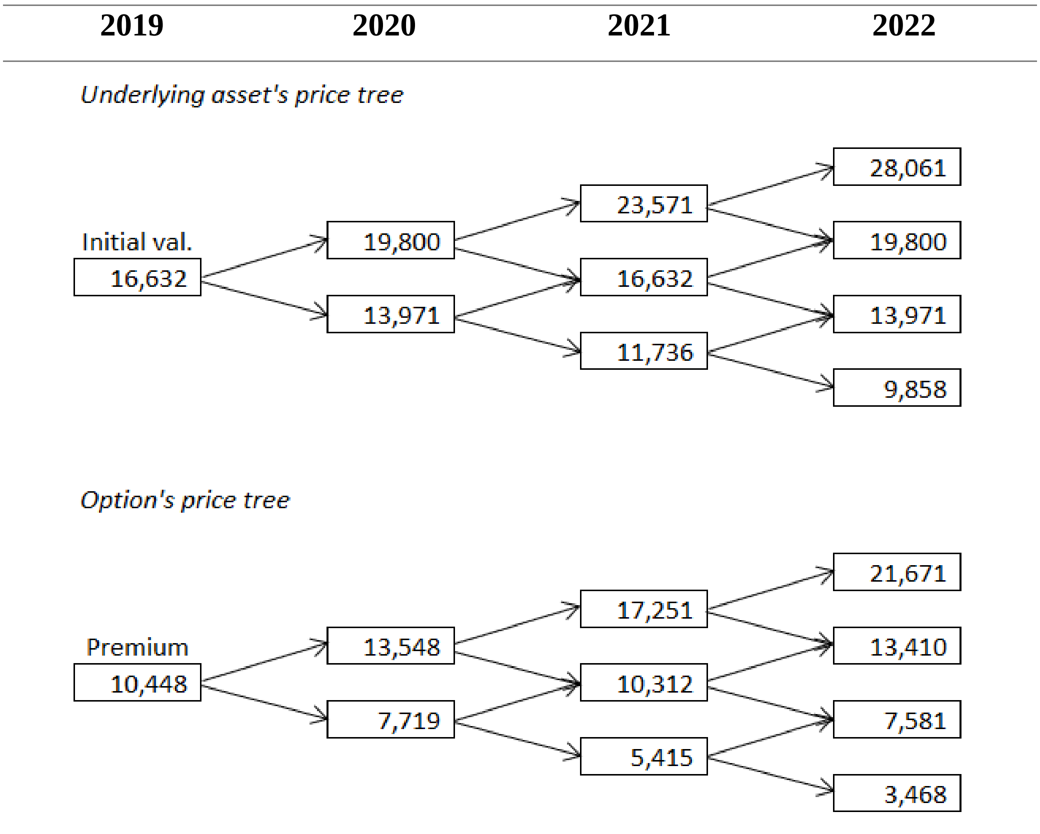
Table 12. Calculation of second option premium with 3-year valuation period

2019	2020	2021	2022



increase has been calculated and is equal to 48.8%, while the decrease probability is 51.2%. By solving the underlying asset's price tree and the option's price tree (as shown in table 13), the initial option premium, which can be translated into the value of managerial flexibility, has been calculated and is equal to €10.448 billion.

Table 13. Calculation of initial option premium with 3-year valuation period



5.4. Wintershall DEA AG valuation

To calculate the total debt and equity of the firm necessary for finding WACC, the appropriate financial statement line items have been selected from the balance sheet of the firm for 2019 and summed up. The line items coupled with calculated total debt and equity can be observed in table 14. It might be worth stressing that the financial debt in table 14 refers primarily to bonds and debt to banks.

Tax rate that has been chosen to calculate WACC is 30% for the same reasons that have been mentioned, namely it is the average tax rate in Germany, and it is the tax rate that Wintershall DEA used for its own calculations. Pre-tax cost of debt is 6.36%, which has been taken from the Damodaran’s database (Damodaran Online). Its value is different from the pre-tax cost of debt for the previous firms because, when calculating WACC for those firms, the data have been taken as of 2016, while when calculating WACC for Wintershall DEA, the data have been taken as of 2019. Hence, some components like unlevered beta, pre-tax cost of debt, risk-free rate, etc. might be different. Returning to pre-tax cost of debt, its value had been calculated specifically for the oil and gas industry in Western Europe. The after-tax cost of debt has been calculated and equals to 4.45%

Table 14. Wintershall DEA's total debt and equity and financial line items from the balance sheet relevant for their calculation as of 2019

€, m	2019
Non-current liabilities	
Financial debt	6,028
Current liabilities	
Financial debt	576
Equity	
Share capital	189
Capital reserve	6,152
Retained earnings and other comprehensive income	1,948
Non-controlling interests	-
Total Equity	8,289
Total Debt	6,604

The unlevered beta is 0.82 and has been taken from the Damodaran's database (Damodaran Online) for 2019 for the oil and gas industry in Western Europe. Knowing the tax rate (30%), equity (€8,289), and total debt (€6,604), the levered beta has been calculated and equals to 1.28.

The risk-free rate for WACC has been taken from Statista for 2019 for Germany and is equal to 1.1%. The risk premium has been taken from the Damodaran's database (Damodaran Online) for 2019 for Germany and equals to 5.96%.

Having the risk premium, risk-free rate, and levered beta, the cost of equity has been calculated and it equals to 8.71%. It might be observed in table 15.

Lastly, as mentioned before, to calculate WACC, all what has been required is calculated cost of debt with cost of equity, proportion of equity in the firm's financing, and proportion of debt in the firm's financing. Having calculated the total debt and equity, the proportions of equity and debt in the firm's financing have been easily found – equity takes up 55.66%, while debt does 44.34%. As a result, WACC has been calculated and is equal to 6.82% (see table 16).

Table 15. Calculation of cost of debt and cost of equity for Wintershall DEA as of 2019

	2019
Cost of equity	8.71%
Risk premium	5.96%
Risk-free rate	1.10%
Levered beta	1.28
Unlevered beta	0.82
Tax rate	30%
Equity (m)	8,289
Total Debt (m)	6,604
Cost of debt	4,45%
Pre-tax cost of debt	6.36%
Tax rate	30%

Table 16. Calculation of WACC for Wintershall DEA as of 2019

	2019
WACC	6.82%
Cost of equity	8.71%
Cost of debt	4.45%
E/(D+E)	55.66%
D/(D+E)	44.34%

For finding cash flows to firm, four accounts have been taken from the income statement and the statement of cash flows. They include operating profit less taxes (EBIT*(1-T)), depreciation, amortization, impairment losses, etc., changes in working capital, and capital expenditure. The base for perpetuity value has been taken 2021, which is the last year in the valuation period, and it has been assumed that Wintershall DEA will continue growing with the growth rate equal to 2.34%. This value is identical to that used for Wintershall Holding and it has been calculated in the same way as well (see chapter 5.1), because that is the most recent information available. The discount factors and cash flows, both discounted and non-discounted, can be found in table 17. As might be concluded from the appendix, the enterprise value of Wintershall DEA is around €27.8 billion.

Table 17. Calculation of the enterprise value for Wintershall DEA

€, m	**2019**	**2020**	**2021**	**Perpetuity**
EBIT*(1-T)	519	(1,133)	1,375	1,375
Depreciation, Ammortisation, Impairment losses, etc.	1,378	2,631	1,592	1,592
Changes in working capital	51	(143)	(504)	(504)
Capital expenditure	(1,164)	(1,268)	(1,050)	(1,050)
Cash flow to firm	784	87	1,413	1,413
Terminal value				31,512
WACC	6.82%	6.82%	6.82%	6.82%
Terminal growth rate				2.34%
Period	1	2	3	3
Discount factor	0.94	0.88	0.82	0.82
Present value	734	76	1,159	25,851
Enterprise value				**27,819**

6. RESULTS DISCUSSION

To illustrate the difference between one-model valuation approach (which uses only DCF model) and two-model valuation approach (which uses DCF model coupled with a real option), the results described in the previous section will be now compared to each other and discussed.

6.1. Comparative analysis of the results and inferences

The discounted cash flow models for the chosen firms have shown that the enterprise value of Wintershall Holding Gmbh is €27.037 billion and the enterprise value of DEA Deutsche Erdoel AG is €4.462 billion, which means that the combined value of firms before the merger is around €31.5 billion.

According to the one-model valuation approach, the value of Wintershall DEA AG, the firm after the M&A deal, is €27.819 billion. When this value is compared to the combined value of firms before the merger, it might be seen that the value of the newly merged firm is less than the combined value of pre-merger firms, namely by €3.68 billion. Therefore, following the one-model valuation approach, it could be concluded that the M&A deal instead of creating value did the opposite – destroyed some value. As a result, the M&A deal could be classified as ineffective, because the firm failed to create synergetic value whatsoever and meet its goals regarding synergy generation.

According to the two-model valuation approach, the value of Wintershall DEA AG, as calculated via DCF model, remains unchanged – €27.819 billion. However, to that value, the value of the real option premium is added, which, as calculated via CRR model, equals to €10.448 billion. As mentioned in previous sections of the paper, one of the disadvantages of DCF model is the fact that it does not take into account the managerial flexibility of the firm, that is the ability of the management to take various decisions based on the external and internal environments – the situation on the market and within the firm. The real option allows to address this problem; therefore, the values of the firm and the real option premium should be summed up. Indeed, if the premium is added to the enterprise value of Wintershall DEA AG, the overall value of the firm (considering the managerial flexibility) is equal to €38.267 billion. When this number is compared to the combined value of pre-merger firms, it may be seen that the value of the newly merged firm is greater than the value of firms before merger taken together. Hence, following two-model valuation approach, it may be concluded that the M&A deal has created synergetic value equal to approximately €6.768 billion (see table 18). Considering the fact that the firm has put for itself a goal of creating synergies of at least €200 million per year as of the third year after the M&A deal (Wintershall DEA, 2019) – that is at least €600 million in three years after the M&A deal – the deal might be considered as effective since €6.768 billion exceeds the expected value. However, firms' announced synergy goals are often smaller than really expected by the firm, which is due to a buffer that firms strive to have, as Jeff Rudnicki, the global lead of McKinsey's M&A strategy service line, explains. This buffer is usually around 50% of the announced number (e.g., if €600 million has been announced, the firm may expect €900 million), but it may also be several hundred percent (McKinsey, 2020). Nevertheless, if the actual synergetic goals of Wintershall DEA are greater than €600 million, the calculated synergy is still greater, implying an effective deal. This can be further backed up by the claim of the firm itself. According to Wintershall DEA themselves (2020), the merger was successful – already by the end of 2019, the firm managed to produce synergies worth more than €100 million, which was more than expected. To get the full picture, the merger was done in May 2019, which means that synergies worth of more than €100 million were created in just half a year.

Table 18. Results obtained by using one-model valuation and two-model valuation approaches

€ m	**One-model valuation approach**	**Two-model valuation approach**
Wintershall Holding	27,037	27,037
DEA Deutsche Erdoel	4,462	4,462
Combined value of firms	**31,499**	**31,499**
Real option	-	10,448
Wintershall DEA	27,819	27,819
Wintershall DEA (with managerial flexibility)	**27,819**	**38,267**
Synergy	**-3,680**	**6,768**

The comparative analysis of the results has shown that using the two-model valuation approach produces more reliable, in that more plausible, results, compared to the one-model valuation approach, which means that the goal of the paper has been reached – methodology has been developed and it has proved its applicability in the oil and gas industry.

As once mentioned before, the novelty of this approach is explained by the fact that the two-model valuation approach (combination of DCF model and real option) takes into account managerial flexibility of the new firm, which is not considered in the one-model valuation approach (DCF model) (as shown in table 18). This stands in line with van Putten and MacMillan (2004), Li Destri, Picone, and Mina (2012), Loukianova, Nikulin, and Vedernikov (2017), Kulik and Savina (2020), and others. Furthermore, this paper uses a different type of real option – the growth option, which is an option on option.

6.2. Theoretical and practical implications

Based on the results and inferences mentioned in the previous paragraph, there are several practical recommendations that might be made (for business valuation management). The first recommendation is that when evaluating the effectiveness of an M&A deal in retrospective, it is recommended to use more than one model, namely two – the discounted cash flow model combined with a real option – this approach may give more plausible results that could be relied on. Moreover, management can use this two-model valuation approach to assess the effectiveness of a potential M&A deal if, when calculating the enterprise value of the merged firm and the real option premium, historical values in the models are replaced by forecasted values. The second practical recommendation is connected to the goals of M&A deals. Whenever there is a need to evaluate the effectiveness of an M&A deal, it is recommended to consider the goals of the deal and keep in mind that this approach is only applicable for M&A deals that have synergetic goals, and it evaluates the effectiveness of those deals only in this regard. The third recommendation is related to the choice of the real option. Whenever choosing a project for the real option, it is recommended to pick up a project or a deal which is, firstly, integral for the merger or acquisition (i.e., an important and inevitable part or result of the deal) and, secondly, provides the merged firm or the acquirer with new opportunities that were unavailable to either of the firms before the M&A because it is the opportunities that create the value for managerial flexibility. In other words, it is recommended to choose projects or deals suitable for growth options. As an example, managers can consider a new pipeline or the M&A deal itself as real call options, as shown in this paper, since each one of them may provide the firm with new opportunities. Another recommendation is connected to the selection of the valuation periods for DCF and CRR models. When selecting the period for valuation, it is advisable to pay attention to the merging firm's goals and expectations, however if that information is unavailable two-three years might be enough to reveal the synergy, as mentioned before. The last recommendation might be rather general and intuitive, nevertheless it is connected to the inputs or data used in the models. It is recommended to use firm-specific data compared to industry-related data, when possible, especially when it comes to, for example, unlevered beta, pre-tax cost of debt, and terminal value, since these elements might have the most influence on the results of the models.

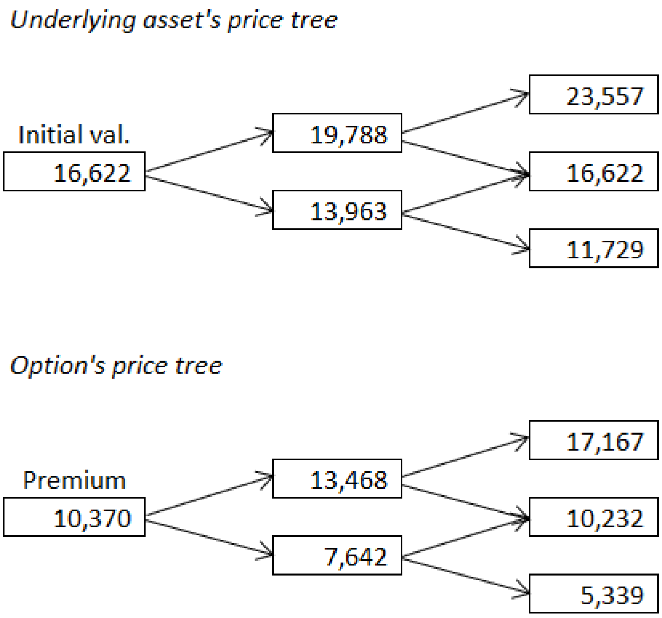
The theoretical contribution of this paper is reflected in the fact that this paper provides a better way of estimating M&A deals effectiveness in the oil and gas industry in terms of synergy generation, in that it introduces the two-model valuation approach implying the combination of the discounted cash flow model and a real option, which helps to take into account the value of managerial flexibility unlike the one-model valuation approach consisting solely of the discounted cash flow model. Moreover, this paper contributes to previous research done by Kulik and Savina (2020), in that it confirms the conclusions reached by the researchers – the correct market value of a firm in the oil and gas industry may be found by using the real options method, that is by combining the discounted cash flow model with a real option. Furthermore, this paper illustrates how to use growth option as the real option and combine it with the discounted cash flow model to find the true value of synergy.

6.3. Limitations of the paper and future research suggestions

Considering the complexity of the topic, this paper has certain limitations that should be taken into account. First of all, it should be noted that due to the lack of information, some elements in the discounted cash flow model have been taken as industry-specific rather than firm-specific, which might affect the calculations a little. Namely, these elements are unlevered beta, pre-tax cost of debt, and terminal growth rate of the firms. The results of the discounted cash flow model seem to be more sensitive to the latter than to the other elements. The second limitation that should be considered is the choice of the project for the real options. In the case of the merger of Wintershall Holding and DEA Deutsche Erdoel, the Nord Stream 2 project has been chosen as the second real option. However, everyone might be now aware that as a result of today's complex geopolitical situation in the world and following tensions the Nord Stream 2 pipeline has been put out of action for indefinite amount of time. This might put the real option and the calculated value of managerial flexibility into question, however there are other facts that should be noted as well. Firstly, the managerial flexibility might be calculated by using other projects for real options that could provide new opportunities for the merged firm, which means that the managerial flexibility would be present in any case. Secondly, the time period of the real option in the model is up to 2022 now, however when reducing it up to 2021, the result does not change much (see table 19) – only by €78 million. Considering this fact and the fact that the Nord Stream 2 incident happened in 2022, the results obtained from the CRR model may still be valid because in the second case (when the valuation period is up to 2021) the Nord Stream 2 incident happened after the valuation period used in the CRR model. Moreover, such events may be considered as black swans, therefore they cannot possibly be taken into account by the management when looking in perspective (e.g., when building forecasts and evaluating possible M&A deals), and they do not occur often. Thirdly, the future is still uncertain, which means the Nord Stream 2 project might be yet restored. The third limitation might be related to the sample. The results are drawn based on one case, although it has been explained previously that the case of the merger of Wintershall Holding and DEA Deutsche Erdoel might be representative, and one industry – the oil and gas – which implies that this paper might not guarantee the same results for other industries.

Table 19. Calculation of initial option premium with 2-year valuation period

2019	2020	2021



The future research may take another case of a synergy-oriented M&A deal in the oil and gas industry, possibly in another market (not Germany), with a clearly sustainable well-functioning project taken as the real growth option and with input data calculated specifically for the researched firms to get more precise results. Another idea for future research is to take an M&A deal with a different type of real option (e.g., put option to abandon) and see if the results will still hold true.

7. CONCLUSION

This paper was aimed at developing a more precise methodology for evaluating the effectiveness of M&A deals in the oil and gas industry. To reach the intended goal, a number of various research in the fields of M&A deals effectiveness evaluation and synergy evaluation have been analyzed. As a result, a two-model valuation approach has been introduced, which is a methodology for assessing the effectiveness of M&A deals in the oil and gas industry which combines the discounted cash flow model with a real option and gives more plausible results compared to the one-model valuation approach, which implies using solely the discounted cash flow model. To prove this point, both approaches have been used on the case of the M&A deal of Wintershall Holding and DEA Deutsche Erdoel, which led to subsequent formation of Wintershall DEA, to calculate the effectiveness of the deal in terms of created synergies. The results have shown that when using the one-model valuation approach the sum of values of the firms before the merger, namely Wintershall Holding and DEA Deutsche Erdoel, is greater than the value of the merged firm, Wintershall DEA, implying that the deal led to value destruction instead of creation. However, when using the two-model valuation approach the value of the merged firm, Wintershall DEA, is greater than the sum of values of the firms before the M&A deal, namely Wintershall Holding and DEA Deutsche Erdoel. That is due to the managerial flexibility being considered, which does not happen when using the one-model valuation approach. Moreover, the value of created synergy exceeded the expectations of the new firm, indicating that the M&A deal was effective. Considering the fact that Wintershall DEA themselves reported that the merger was successful, because already by the end of 2019 (in only 5-6 months after the merger), the firm managed to produce synergies worth more than €100 million, which was more than expected, it may be indeed claimed that the two-model valuation approach produces more plausible and more reliable results compared to the one-model valuation approach.

Having tested the valuation approaches, the following recommendations regarding the evaluation of M&A deals effectiveness have been developed. Firstly, managers are recommended to use the combination of two models – the discounted cash flow model and a real option (e.g., the CRR model) – when evaluating the effectiveness of past M&A deals, since this approach may give more plausible results. Moreover, managers could use this approach to assess the effectiveness of potential M&A deals if, when calculating the enterprise value of the merged firm and the real option premium, historical values in the models were replaced by forecasted values. Secondly, when evaluating the effectiveness of M&A deals, managers are advised to consider the goals of the deal and keep in mind that this approach is only applicable for M&A deals that have synergetic goals, and it evaluates the effectiveness of those deals only in this regard. Thirdly, when choosing a project for the real option, it is recommended that managers pick up a project or a deal which is, firstly, integral for the merger or acquisition (i.e., an important and inevitable part or result of the deal) and, secondly, provides the merged firm or the acquirer with new opportunities that were and would have been unavailable to either of the firms without the M&A deal. Fourthly, when selecting the period for valuation in the models, managers are advised to pay attention to the goals and expectations of the merging or acquiring firm in regard of synergy realization, however if that information is unavailable two-three years might be enough to let synergy reveal itself. Finally, when building models, managers are recommended to use firm-specific data compared to industry-related data, when possible, especially when it comes to unlevered beta, pre-tax cost of debt, and terminal value, since the valuation models are most sensible to these elements.

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APPENDICES

Appendix 1. Wintershall Holding Gmbh Group Balance Sheet for 2016-2017

€ thousand	2017	2016
Non-current assets	**11,969,190**	**12,671,418**
Intangible assets	2,307,787	2,832,792
Property, plant, and equipment	6,360,832	6,675,316
Equity-accounted investments	2,556,542	2,581,398
Other financial assets	73,492	71,456
Deferred tax assets	152,611	192,156
Other assets	517,926	318,300
Current assets	**979,920**	**989,073**
Inventories	84,359	76,197
Trade receivables	502,106	493,935
Other receivables and other assets	283,129	326,222
Cash and cash deposits	110,326	92,719
Assets	**12,949,110**	**13,660,491**

Equity	**3,213,450**	**3,129,744**
Share capital	105,000	105,000
Capital surplus	415,543	15,543
Retained Earnings and unappropriated net profit	3,693,020	3,796,944
Other comprehensive income	-1,071,791	-745,137
Minority interests	71,678	-42,606
Non-current liabilities	**4,778,690**	**6,114,598**
Pension provisions	312,680	323,266
Other provisions	1,289,406	1,259,430
Deferred tax liabilities	1,294,782	1,626,214
Non-current financial indebtedness	501,459	1,473,799
Other non-current liabilities	1,380,363	1,431,889
Current liabilities	**4,956,970**	**4,416,149**
Trade payables	286,756	242,739
Provisions	131,800	109,311
Tax liabilities	133,877	181,871
Current financial indebtedness	100,150	137,832
Other current liabilities	4,304,387	3,744,396
Equity and liabilities	**12,949,110**	**13,660,491**

Appendix 2. DEA Deutsche Erdoel AG Consolidated Balance Sheet for 2016-2017

€ m	**2017**	**2016**
Non-current assets	**5,764**	**5,487**
Intangible assets	588	567
Property, plant, and equipment	2,952	2,527
Investment property	2	3
Financial investments	4	1
Financial receivables	2,021	2,209
Other receivables and other assets	81	95
Deferred tax assets	116	85
Current assets	**580**	**684**
Inventories	83	90
Financial receivables	22	0
Trade accounts receivables	279	336
Other receivables and other assets	69	156
Income tax assets	11	1
Cash and cash deposits	116	101
Assets	**6,344**	**6,171**

Equity	**1,818**	**1,904**
Shareholders' equity	1,813	1,900
Non-controlling interests	5	4
Non-current liabilities	**3,642**	**3,599**
Provisions	728	616
Debt to banks	1,334	1,494
Financial debt	1,013	1,018
Income tax liabilities	26	26
Other liabilities	15	14
Deferred tax liabilities	526	431
Current liabilities	**884**	**668**
Provisions	208	209
Debt to banks	0	3
Financial debt	116	16
Trade accounts payable	304	308
Income tax liabilities	24	32
Other liabilities	232	100
Equity and liabilities	**6,344**	**6,171**

Appendix 3. Wintershall DEA AG Consolidated Balance Sheet for 2019-2020

€ m	**2020**	**2019**
Non-current assets	**18,518**	**21,071**
Goodwill	2,298	2,580
Exploration assets	642	1,577
Other intangible assets	2,689	2,925
Property, plant, and equipment and investment property	8,776	9,932
Equity-accounted investments	2,671	2,685
Other financial assets	16	5
Financial receivables	1,127	1,064
Derivative instruments	121	72
Other receivables	38	135
Deferred tax assets	140	96
Current assets	**2,459**	**2,589**
Inventories	201	227
Financial receivables	141	181
Trade and other receivables	908	1,227
Derivative instruments	92	57
Income tax assets	296	83
Cash and cash deposits	821	814
Total assets	**20,977**	**23,660**

Equity	**6,435**	**8,289**
Subscribed capital	189	189
Capital reserve	1,161	6,152
Retained earnings and other comprehensive income	5,085	1,948
Non-current liabilities	**12,574**	**13,194**
Pension provisions	631	579
Decommissioning provisions	2,607	2,815
Other provisions	89	230
Financial debt	5,886	6,028
Derivative instruments	62	22
Income tax liabilities	18	8
Other liabilities	31	35
Deferred tax liabilities	3,250	3,477
Current liabilities	**1,968**	**2,177**
Decommissioning provisions	167	58
Other provisions	270	317
Financial debt	471	576
Trade and other payables	766	1,096
Derivative instruments	258	51
Income tax liabilities	36	79
Equity and liabilities	**20,977**	**23,660**