The use of derivatives in corporate risk management - A value adding strategy?

Part I: *A quantitative study on the effect of currency derivatives on firm value, conducted on the European market*

Part II: *A case study on the hedging activities carried out by Porsche*

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PART I

Abstract

This study highlights the role of active risk management of currency risk exposure within large listed non-financial European firms. In the aftermath of the global pandemic and invasion of Ukraine, many firm across the global has experienced challenges in terms of sustaining stable cash flows. Euro-denominated firms was challenged with a weakened euro and highly volatile markets, which increased the importance of corporate risk management and currency risk hedging. The central hypothesis of this study is to examine if the use of currency derivatives has a significant effect on firm value, proxied by Tobin's Q. The study was conducted on 416 European firms, manually identified with currency risk exposure, and grouped into user and non-users of derivative instruments to hedge their currency risk exposure. The study was executed through regression analysis and hypothesis testing. The study also highlights fundamental financial theories in conjunction with the results obtained and challenges the classical objectives of active risk management. The results of the analysis performed, show no significant relationship between the use of currency derivatives and firm value measured by Tobin's Q.

Keywords: Europe, risk management, currency derivatives, hedging, Modigliani-Miller, regression.

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1. Introduction

Currency risk exposure through international trade has been the subject for corporate risk managers for decades. In today's open market economy and extensive outsourcing procedures applied by large corporations, the use of currency derivatives to hedge currency risk exposure has surged. This phenomenon shed light on the effective use of currency derivatives within corporation and whether this risk management tools add value to the firm.

1.1 Background

International trade and global production and distribution channels make it possible for corporation to get access to low-cost labour, materials, and processes. International trade facilitates the effective use of resources, and thus, value creation opportunities for corporations emerges. Companies are for example able to create more cost production processes by expanding their value chain cross international borders. The fundamental structure of international trade is ancrod in the highly popularized theory presented by by Adam Smith, 'The Wealth of Nations' (1779) for which underline the importance of specialization of nations. The initial theory suggest that a nation will be better off, in terms of utility, specializing in the production of goods for which the nation is relatively good at. The nation can then use international trade to export some of this production to other nations for which are relatively less effective in the production of this good (Adam Smith Institute, 2023). The nation should also take advantage of other nations relative effectiveness and import goods for which can be more effectively produced outside the nation. This theory was further exploited by David Ricardo (1817), who established the theory of comparative advantage among nations and trading partners. In short, the theory of comparative advantage suggests that even though one nation is seemingly more effective in producing all kind of goods, other countries can still have a comparative advantage with regards to the more effective nation and will thus still benefit from engaging intentional trade (CFI, 2019).

In today's economic environment, companies work under close surveillance of various market participants looking for value and return on investment. Publicly traded companies are required to publish comprehensive documentation of detailed

descriptions of the company's financial and operational standing. Often, company's margins such as gross margin, EBITDA margin, net profit margin and so forth, are closely examined by financial analyst investigating the value of the company. Revenues are analysed to describe if the company is growing, but margins are emphasized to determine if the company is profitable and can survive in the long run, which in turn will govern the firm value. Since margins act as the focal point of financial analysis and are usually the subject of interest for many investors, it may not come as a surprise that companies constantly dedicate efforts on improving margin by streamlining processes. Production processes can be effectively enhanced through global outsourcing or importing low-cost production inputs from foreign countries. Entailing lower production cost per unit of sales, for which in turn can yield higher margins, bettering the financial profile of companies. The objective of international trade is based on the fundamentals of economic trade theory and is emphasised through the value creation of improved margins (CIF, 2019).

The presence of international trade and foreign currencies publicly traded, creates a different risk dynamic for corporations for which engage a global value chain and, thus, naturally a subject for corporate risk management. One core objective of risk management is securing the cash flows of the operations and making sure that the firm can sustain the expected level of risk exposure, even though times of volatile markets. Through the lens of principal corporate finance theories, the stable cash flows will, in turn, positively affect the value of the company, which centralizes the importance of effective risk management even further. The added source of uncertainty from international trade and dynamic exchange rates becomes particularly interesting in large corporations' global operations, because it affects cash flow streams from both importing and exporting goods and services. The connection between risk management and firm value from the perspective of instinctive firm value, and during times of expansive globalization, lays the foundation for the relevance of further research of this connection and the rationale behind the main hypothesis of this paper.

1.2 Currency risk

Currency risk is the risk for which corporations face when engaging in international trade and thus being exposed to currency fluctuation when importing goods and services in other currencies but their home currency. For example, a company based in a euro-denominated country, importing raw materials from the US will face the risk that the exchange rate between EUR/USD will worsen and that the company will face monetary losses due to the negative evolution of the euro against the US dollar. In this example, it is assumed that the goods purchased from the US are purchased in US dollars. This implies that if the euro depreciate in relation to the US dollar, the real purchase price for the imported goods will be higher than expected, for which will increase the cost of goods sold and thus decrease the company's profit margins. This is because the euro has become weaker in relation to the USD, meaning that the European company need to use more euros to purchase the same amount of goods priced in dollars. This type of price increase is often less predictive, if not properly managed, than other types of changes of cost in the P&L. Increase in cost of goods sold can be due to a variety of reasons, such as new suppliers, supply and demand in the market, as well as other macroeconomic variables. While the state of the overall economy and macroeconomic factors also drives the currency exchange rate, in terms of actual cost, price increases from other factors than exchange rates, are often easier to manages and predict because many corporations have costs that varies on a contractual basis. For example, if the demand for a certain good has drastically increase during the last couple of years, and thus also the cost if this good, in line with fundamental theories for financial markets, then this will of course also affect purchase price for the companies for which uses this good as well. However, the relationship between suppliers and companies are often set by a contractual agreement and is in most cases time based, making it easier for the purchasing company to calculate the price increase and its effect on their P&L. The price increase from unfavourable movements in exchanges rates, however, does not have the same characteristics as "pure" cost of goods sold. Hence, the purpose of currency risk management can be centralized by the utilization of other markets, such as derivative markets, to create the same type of contractual basis for exchanges rates and thus mitigating the risk of price increases due to unfavourable currency movements (Berk, J. & DeMarzo, P., 2017).

1.2.1 Currency appreciation and deprecation

Currency risk within corporations comes from the uncertainty of the value of a firm's home currency, i.e., the currency for which the company uses throughout their ordinary business. As currencies are globally traded all hours of the day, the exchange rate between two currencies will dynamically evolve and be affected by macroeconomic factors and the condition of the overall economy. Foreign exchange rates are subject to a range of determining factors such as inflation, domestic interest rates and speculation, but it all boils down to basic economic theories of supply and demand. For instance, when inflation is low in one country relative to another, the competitiveness of that country's export will increase and thus the demand for that currency will also increase, leading to a currency appreciation (Pettinger, T., 2022).

Furthermore, the domestic interest rate gauge the overall capital inflow in the country. If interest rates are relatively high, all else equal, with regards to the rest of the world, market participants would seek to invest in that country to exploit the high interest rates. This will in turn lead to increased demand for the local currency and thus lead to an appreciation of that currency in relation to others. The opposite is also true, meaning that market participants will seek higher interest rates offered by foreign countries if the interest rate levels are relatively low within their operating country, which will imply capital outflows and hence currency depreciation. The exchange rates linkage to relative levels of interest rates becomes especially interesting in the current global high rates environments, where the exchange rates between countries will be determine by the relative increase in interest rates. Furthermore, the exchange rates can also be determined by other forces such as speculation. Speculation regarding the appreciation or deprecation of a certain currency can lead to movement in that currency by anticipation rather than any actual economic event. Another reason why some currencies are relatively stronger than others, can be events affecting the overall economy, such as the war in Ukraine prevalent in 2022 for instance. The Russian invasion of Ukraine created an energy shortage for larger parts of Europe. While the invasion certainly appalled the overall market, the US did not experience the same degree of negative consequences, relative to large parts of euro-denominated countries.

Thus, the US economy was perceived as strong during times of economic turbulence, which, in turn, made the US dollar perceived as safe and, thus appreciated the US dollar against the euro significantly during 2022 (Hartman, M., 2022).

1.2.2 Europe

The aftermath of the global pandemic has challenged the world economy in multiple ways. Inflation has been significantly higher than what it was for the last decades for which in turn has led the central banks all over the world to aggressively increase interest rates. The increase in interest rates are measures taken to calm down inflation and the overall activity of the economy. Interest rate are at record levels compared to the average yield on government bond during the last ten years, with 10-years US treasury yield trading at 4.20% on 8th of November 2022 which is 3.39 percentage points higher than the same time the year before, where the 10-year US treasury yield traded at 0.81%. The same hikes in interest rates are also prevalent in large part of Europe where the 10-year German Bund yield traded at 2.27% as of the same date, which is 2.55 percentage points higher than the same time the year before, where a 10-year German Bund yield traded at -0.28% (CNBC, 2022).

The high interest rates and the increasing inflation has a substantial effect on equity markets. This can partly be explained by the capital outflows from of the stock market and capital inflows to fixed income markets, due to fixed income investments becoming relatively more profitable compared to the riskier stock market. This drives down the overall stock market and increases the demand for fixed income instruments. According to fundamental economic theories, the relationship between interest rate and the stock market has historically been positive, as the inflow of capital from the stock market to fixed income drives the price up for bonds and other fixed income vehicles which in turn drives down interest rates, due to the theory of pricing mechanisms within bond markets, where bond prices and yields showcase a negative and convex relationship. This fundamental pricing theory was historically prevalent in the market, but as the market dynamic changes, as a consequence of ever evolving economies, the same evidence is not necessarily found in today's market environment. During the last years, the market has had experienced both decrease in stock market performance as well as

rapid increase in interest rate, especially observable during the year of 2022. Furthermore, the increase in interest rates combined with low stock market performance and higher risks, makes it more expensive for companies to fund their operation as both the cost of debt and cost of equity increases, which will lead to a higher weighted average cost of capital (WACC). If the instinctive value of a firm is analysed as the present value of its future cash flows, the increase in in the discounting factor as measure by WACC, will eventually lead to a lower firm value. This will in turn also negatively affect how companies are preserved by the market, driving the negative stock market performance even further (Berk. J & DeMarzo. P, 2017).

Moreover, the year of 2022 has, besides the aftermath effect of the pandemic, experienced turbulence due to the energy shortage caused by the Russian invasion of Ukraine. The issue of energy shortage originates from the European cut off from Russian gas supply, which in turns resulted in an overall supply shortage driving up energy prices significantly. This has taken its toll on households as well as companies, as the cost of energy will now take up a larger chunk of the P&L. This combined with the increase WACC has largely affected the European market for which is also a reason for the weakened euro against the historically strong dollar (Bloomberg, 2022).

The strong dollar against the euro derived from multiple factors for which some are explained above. In general, the US position in terms of the energy crisis, makes the US dollar attractive and perceived as a relatively safer investment than the euro under these stressed conditions, which has had a strengthening effect on the US dollar. Also, the Federal Reserve has been taking more aggressive measure in terms of increases in interest rates, which also make investing in the US dollar relatively more attractive everything else equal. As many large European firms engage in international trade and frequently turn to US markets to for the purpose of outsourcing and production streamlining, the weak euro against the strong dollar puts even more pressure on their P&L, as US imports become notably more expensive. The same dynamics applies to other large currencies for which are subject to international trade, and the position the euro has against those currencies (Berk, J. & DeMarzo, P., 2017).

1.3 Risk management: Currency Derivatives

For large corporations the process of risk management is a prominent part of ensuring stable cash flows. Risk management within corporation refers to the process of hedging the main line items against unexpected market movements, which will have indirect or direct consequences on the company's P&L. For instance, this can be movements in commodity prices for manufacturing companies buying raw materials as a core input into their production. If commodity price increase significantly, then the cost of goods will become larger and thus eat into the margin of company's P&L. Another situation appears when companies buy materials or other input variable from a foreign country in a foreign currency. When companies utilize the benefits of international trade, one extra source of risk is introduced in terms of exchange rate risk. This refers to the fact that the imported good will become more expensive as the foreign currency is strengthen relatively to the national currency. The presence of exchange risk creates an additional source of uncertainty that the corporate risk manager must account for in order stabilize future cash flows. To avoid the unexpected increase in prices, corporate risk managers use derivative contracts in various forms to hedge the risk of unexpected movements in their currency exposure.

Derivative contracts are defined as financial instruments which value is derived from some underlying asset. In the case of corporate risk management, multiple kinds of derivatives are often used in conjuction, where some of the most common ones are forwards and futures on e.g., commodity prices or exchange rate. Forward contracts are defined as the mutual obligation to purchase or sell a certain underlying asset at some time in the future to a predetermined price and quantity. Futures have the same structural characteristics as forwards but, are highly standardized in terms of strike price, underlying asset, and quantity. Furthermore, futures are traded on an open exchange, in contrast to forward, for which are traded on an OTC (Over the counter) market. Another common type of derivative are options, for which gives the option holder the right, but not the obligation to buy or sell a certain underlying asset to a predetermined strike price and quantity, at a future date. The option holder pays a premium for this right to the option writer, which make a profit of the option agreement if the option holder does not exercise the option. Forwards, futures, and options are commonly used to hedge exchange risk exposure of corporates, as this kind of

derivatives creates the possibility to lock in a certain exchange rate for a future date. Companies can thus use derivatives to make sure that a future delivery of imported goods will not be affected by unexpected movements in the exchange rates. Which will in turn contribute to more predictable and stable cash flows. See more detailed description of derivatives in chapter four (Berk, J. & DeMarzo, P., 2017).

While currency derivatives can be used as an effective tool to manage currency risk exposure, there are also situations when derivative contracts within risk management are not used in accordance with their initial hedging purpose. There are also situations where companies trade with financial derivatives in speculative purposed and engages in the trade of exotic instruments. The risk from using complex instruments stems from the fact that these exotic derivatives are rarely as straightforward as plain vanilla put and call options and simple futures and forwards. This makes it harder to get a comprehensive view over the true risk exposure and whether the instrument is properly used. This risk can become extensive if not properly managed and supervised and, should thus be handled with caution. Furthermore, risk management through derivatives are also associated with cost, beside from the risk exposure, in terms of premiums (applicable for options). If a company is highly exposed to long positions in options contracts, then the accumulated option premium, which the company is obligated pay to the option writer, can become significant. The cost of risk management activities must naturally be analysed in conjunction to their function and the trade-off of which they yield, otherwise this cost account could also have a negative impact on the company's financials standing. The use of currency derivatives thus becomes relevant in the light of financial analysis and its impact on the value of the company. Which in turn will gauge the interest of understanding the dynamic of how derivative contracts are utilized within corporations, for the retail investors as well as investment professionals (Berk, J. & DeMarzo, P., 2017).

1.4 Problem statement

In the light of ever evolving financial markets, the turmoil of the significant volatility experienced in the year of 2022, the aftermath of the COVID-19 outbreak and the unfortunate invasion of Ukraine, the financial health of companies becomes of particularly interest moving forward, in with, all aspects affecting the profitability of

companies, must be examined. This research paper aim to further exploit the effect of recent events on companies engaging in international trade and their exposure to currency risk and if the use of currency derivatives adds value to the firm. The problem statement concentrates on the management of currency risk, and if, the risk mitigating approach of large listed non-financial European corporations falls in line with objective of overall shareholders of maximizing return on investments. The problem statement is the following:

- Does the use of currency derivative within corporate risk management have a positive effect on firm value for large listed non-financial European companies?

This research paper aims at gaining more insight to the above stated questionary through the application of fundamental theories of financial market, risk, and different kinds of investment vehicles as well as through data analysis using econometric tools such as regression analysis.

1.5 Purpose

The purpose of this thesis is to shed light on the procedure of active risk management for currency risk exposure and its effect in companies P&L and in turn, also the value of the firm. The purpose of the research conducted is to further create a discussion around the phenomenon and challenge the choice of currency derivative for risk management and analyse this approach from different constructive angles to gain more perspective on the matter. Moreover, the research aims to offer new insights on this phenomenon in terms of European markets and add to the previous research conducted on other markets. The interest and objective of understanding the fundamental drivers of the European exchange rate exposure stems from the most recent worldwide economic events and Europe's position with regards to the rest of the world. The dynamics of the current market conditions and Europe's role as a global economy moving forward, drives the purpose this thesis and the reason for limiting the research to European companies.

1.6 Delimitations

As above stated, the research conducted in this paper is limited to listed European companies. The rationale for the limited geographical sample of companies stems from the main purpose of the paper as explained above and its relevance as a subject of interest in today's markets. Furthermore, the data for which the analysis is based on, is limited to the amount of information available regarding risk management of corporations, stated in their financial reports. The research approach of this thesis is quantitative, and the analysis made is based on a simplified measurement of the used of currency derivatives. The use of currency derivative will be translated info quantitative measure in terms of dummy variables (controlled for the different industries) included in the regression analysis performed. The readers should thus acknowledge that no distinction will be made with regards to the different kind for derivatives used by corporations. The application of different kinds of currency derivatives and their meaning as well as fundamental characteristics will be covered in this report, but the *effect* of different kinds of currency derivatives (such as futures and options) and whether the different instrument will have different effects on firm value will not be examined. The simplification of how currency derivatives are translated into an econometric setting will further limit the possible insight for which this research can yield.

1.7 Outline

All forthcoming chapters will be presented as such: The following chapter will present a selection of previous research regarding effective risk management and the used of currency derivatives in this setting. The purpose of this chapter is to provide the reader with some primary knowledge regarding the research topics of this paper and to present previous findings. This chapter will be used to deepen the understanding of the results of this paper presented in later chapters. Chapter three will introduce the hypothesis for which will be tested during the examination phase of this paper. The hypothesis is dedicated its own chapter to emphasis the central problem statement once again and to give the reader a clear understanding what the empirical study examines. Chapter four will cover all theories and models for which are applied throughout this thesis. This chapter will give the reader the fundamental tools needed

to totally comprehend the outcome of the research as well as basic financial phenomena without any prior knowledge of the subject. The following chapter will present the data for which is the basis of the analysis. This chapter will go through the process of collecting the data and how it is used to examine the problem statement. Chapter six will cover the methods of conducting the analysis in practise. This chapter will give the reader insight to the actual steps taken in terms of applying financial econometrics and data analysis to arrive to the result. Chapter seven and eight will furthermore present the result of the analysis and discuss its implication. The purpose of the discussion part of this thesis is to challenge the results and suggest possible further research on the topic. The thesis is thereafter summarized through some concluding remarks as well as a literature description and appendix.

2. Previous research

Numerous studies have been conducted on the topic of financial risk management as well as on the area of derivative use within risk management. The focal point for several research papers analysed has been to investigate the real value of applying risk management strategics through different kinds of financial derivatives. This central area of interest is based upon the belief that hedging activities should be a value creating activity, but nevertheless also imposes an additional source of risk and costs. The activity of risk managers is also put in the perspective of the classical paradigm of Modigliani and Miller and their statement regarding perfect capital markets thus the irrelevance of risk management.

2.1 Currency derivatives and firm value

The interest of derivative use within financial risk management and exchange risk hedging is growing, as it has become more relevant in today's volatile markets. There are a range of studies conducted on the topic with the objective to evaluate whether utilizing derivatives, and thus also exposing the firm to an additional source of risk and cost, is a value adding activity for firms. This research topic in the context of international trade and outsourcing procedure shed light on how effective currency derivatives are, within risk management practices. It is evident from the range of previous research available that this topic within financial markets is highly relevant.

However, previous studies show conflicting results and the statement regarding the value adding feature of currency derivative strategies within corporate risk management is ambiguous. Also, the previous research for which are highlight in this section, was focus on specific countries rather a world region, for which is the focus of this paper.

In the early 2000s, Allayannis and Weston (2001) preformed a study on sample of 720 non-financial large US firms and their use of exchange rate derivatives between the 1990-1995. The authors found that there was a positive relationship between the firm value of the US companies included in the sample and the use of currency derivatives. In line with the methodology applied in this thesis, they used the Q ratio as a proxy for firm value. The authors also found that the hedging premia was high and statistically significant for the sample data set of firms with currency risk exposure, showing that on average, the premia made up 4.87% of firm value. The basis of their study was to challenge the famous methodology presented by Modigliani and Miller and their theory of perfect capital markets, for which implies that risk management in general deemed to be irrelevant. Allayannis and Weston (2001) challenged this classical theory, in line with research conducted before them, and suggested that active risk management and exchange risk hedging should be a value adding activity. The positive results found by Allayannis and Weston (2001) was further confirmed by Clark and Mefteh (2010) for which performed a similar study concentrated on French firms. The later authors also studied the use of currency derivatives and their effect on firm value measured through the Q ratio. The French study, although conducted on a much smaller sample of firms and relating to a less widespread geographical area, found that currency derivative can be proven to be a significant determinant on firm value of French companies. Furthermore, the authors differentiated their study with regards to Allayannis and Weston (2001) in the sense that they also looked at how different degrees of foreign exchange risk exposure effected impact of currency derivatives on Tobin's Q. They found that the effect was 1.5 time higher for companies experiencing high levels of currency risk exposure. This result was even more significant for firms with exposure to euro depreciation where the effect was estimated to be 5.5 times higher relative to firms with exposure to euro appreciations.

Although both Clark and Mefteh (2010) and Allayannis and Weston (2001) found evidence of the effectiveness of currency derivatives within French and US firms respectively, Li, Visaltanachoti and Luo (2014) found no such evidence from their study conducted in New Zealand. The authors used, in line with the other researchers highlighted, Tobin's Q as a measurement of firm value and controlled for the use of currency derivatives for risk management purposes. The authors based their research with on the same logic as partitioners before them and aimed to gain insight in the true nature of the use of financial instruments and examine the risk versus reward dynamic of applying such hedging strategies. Their study showed contradicting results compared to Clark and Mefteh (2010) and Allayannis and Weston (2001), which stated that no significant relationship between the use of currency derivatives and firm value measure by Tobin's Q.

3. Hypothesis

The hypothesis of this paper aim to shed light on whether the use of currency derivatives adds significant value to a corporation exposed to exchange risk. The research topic discussed is based on the thought that using financial instrument through hedging purpose should be a value adding activity if properly utilized. Which in turns would rationalize the cost and risk associated with extensive use of derivatives in risk management practices. To examine the central research topic and fulfill the purpose of this thesis, a clear hypothesis for which act as the focal point throughout the whole paper, has been established. The aim of this thesis is to examine the following hypothesis:

H_0: The use of currency derivative within corporate risk management *has no significant effect* on firm value.
H_1: The use of currency derivative within corporate risk management *has a significant effect* on firm value.

The hypothesis will be tested on a 95% confidence level, through standard application of econometrical models and theories on a set of large listed European companies and the results will be interpreted, analyzed, and discussed thereafter.

4. Theory and models

In the light of the purpose of this paper and the topic for which it will cover, several theories and models are applied to be able to answer the central hypothesis. To gain the fundamental knowledge of risk management practices and how real-life practices may contradict classical financial theories, the set of the following theories and models have been analyzed and applied in conjunction.

4.1 Modigliani-Miller and perfect markets

4.1.1 Modigliani-Miller Theorem (proposition I and II)

One of the most important theories within the field of financial studies are the paradigm presented by Franco Modigliani and Merton Miller in 1958 and their suggestion of perfect capital markets and irrelevance of capital structure. The Modigliani-Miller (MM henceforth) theorem states that the value of a firm is independent on their choice of financing (capital structure) and should thus not play any significant role from a value creating perspective. The MM theorem was presented through two propositions for which differs in terms of assumptions made on the dynamics of the market. The MM proposition I suggest the following implications:

- All market participants are exposed to the same set of tradable securities in the market, for which are fairly prices at competitive market prices which equals the present value of future cash flows.
- Markets are frictionless i.e., there are no taxes, transaction cost, issuance cost, bankruptcy cost etc.
- Cash flows generated by the firm's activities are unaffected by their choice of financing.

Under these conditions, MM suggests that the value of a firm, as defined by their present value of future cash flows, are completely unaffected by the firm's capital structure. Meaning that the choice between debt and equity becomes irrelevant in terms of value creation, within perfect capital markets. The logic behind MM proposition I is that the cash flows generated by the firm, for which the firm value is based upon (present value

calculation of future cash flows) is independent of the choice of financing (Berk. J & DeMarzo. P, 2017).

The MM proposition II expands the fundamental idea of the establishments made in the first proposition of the MM theorem (1958) and suggest that the cost of capital will be unaffected by the choice between debt and equity. The rationale behind the second proposition is that when firms employ more leverage (for which implies lower cost of capital, as debt is considered cheaper than equity), they also increase their risk profile, which in turn will drive equity investors to demand higher expected return and that these effects are proportional to each other in perfect capital markets. This proposition stresses the statement made in the first proposition and further suggest the irrelevance of capital structure (Berk, J. & DeMarzo, P., 2017).

There are several versions of the MM Theorem for which incorporate more realistic assumptions regarding the dynamics of capital markets, such as their Proposition of Dividends (1961) as well as their Theory on Taxes (1963) for which exploits the role of dividends policy and the corporate tax shield respectively. These theories, although highly intriguing, are not further explained in this thesis due to their lack of connection of the central hypothesis of this paper.

4.1.2 Modigliani-Miller Proposition of Hedging

Extending the first two propositions, MM Proposition of Hedging highlights the role of corporate risk management in conjunction to their initial statement regarding perfect capital markets and the irrelevance of capital structure. The MM Proposition of Hedging suggest the role of active risk management and application of hedging strategies has no value creating effect for firms. Their reasoning, for which this proposition is based upon, is like the first and second proposition discussed earlier. They state that firms for which engage in hedging activities, are essentially selling the risky cash flows to the capital markets and buying the less risky ones. The hedging activity thus becomes an exchange between risky and less-risky cash flows, were the firm gives up the higher return associated with the risky cash flows for lower returns associated with less risky cash flows. Furthermore, in the perfect capital markets, due to the rational risk return trade

off, the value of the two types of cash flows is the same, and hence the firms value should stay unchanged. The MM Proposition of Hedging thus suggest that the risk management practices are irrelevant to value of a firm (Parsons, J. & Mello, A., 2011).

4.2 Firm value

4.2.1 Tobin's Q

The Q ratio, or Tobin's Q with other notation, is a simple ratio used to examine the intrinsic value of a company. The Q ratio is a widely applied concept of firm value calculation within the fields of Corporate Finance and was originally developed by Nobel prize winner James Tobin, hence the name of the ratio. However, even though the Q ratio may be frequently credited to James Tobin, it was published in academic literature by Nicholas Kaldor in 1966 and, can be encountered by other notations such as "Kaldor's V" as well (WSO, 2023). Nevertheless, the Q ratio suggest a relationship between the market value of a company and the replacement cost of its assets. The theory is based on the thought that the combined market value of all companies presented in the stock market should equal their replacement cost of their accumulated assets. The basic theory can further be used to value a single firm. The original formula of the Q ratios as proposed by Kaldor (1966) looks as follows:

$$Tobin's\ Q = \frac{Market\ Value\ of\ Firm's\ Assets}{Replacement\ cost\ of\ Firm's\ Assets} = \frac{Market\ Value\ of\ Firm's\ Equity\ and\ Debt}{Replacement\ cost\ of\ Firm's\ Assets}$$

The above stated definition of the Q measurement implies some limitations with regards to which input values are readily available. Firstly, the replacement cost of asset is often hard for financial analyst to obtain or estimate, hence the book value of asset is assumed to be a proxy of the replacement cost of asset. Secondly the market value of equity is easily observable as it is presented directly by market activity (note, only relevant for public companies), however, the market value of debt can't be directly observed in the same way as equity. The book value of debt is often used as a proxy and is in many ways considered to be a close estimate to the market value of debt (WSO,

2023). Due to these limitations, some modified version of the Q ratio has been popularized among market participants and financial analysts:

$$Tobin's\ Q = \frac{Market\ value\ of\ Equity + Book\ Value\ of\ Debt}{Book\ Value\ of\ Assets}$$

The Q ratio is superior to other valuation methodologies in the sense that it reflects a relative valuation, focusing on what the firm is worth today and comparing this value to the cost of replacing the firm. However, this conceptual advantage for which the Q ratio offers, are partly subdued by the fact that some of the input variables are proxied by book values instead of their true replacement cost. This can cause penalties in terms of accuracy in the measurement as a proper valuation (Jordan, D. et al., 2010).

Furthermore, the interpretation of the Q ratio and its application in context of analyzing firm's intrinsic value is straight forward and easily applicable. If the Q ratios is higher than one, then this means that the value of the firm's assets are valued higher by the market than its replacement cost (proxied by the book value of assets), and the firm can thus be considered as overvalued, as the market is valuing some unobservable asset, which is not present on the firm's balance sheet. When the Q ratio is lower than one, then this implies that the replacement cost (proxied by book value of assets) is higher than the value of the firm's asset as determined by the market. This indicates that the company is undervalued. Moreover, if the ratio is equal to 1, then that indicates that the firm's assets are fairly priced by the market and in line with the replacement cost (proxied by book value of assets) and thus imposes equilibrium (CFI, 2023).

4.2.2 Value creating characteristics

In accordance with previous research as well as pivotal Corporate Finance methodologies, certain financial metrices are value creating and should thus be controlled for when analyzing firm value. The financial metrices included in the regression, for the purpose of this thesis, are analyzed in conjunction with the use of currency derivative to control for their effect on Tobin's Q. The following variables were included in the fundamental analysis to gain a comprehensive overview if firm value drives:

- SIZE: To capture the effect of the size of the firm om the firm value the natural logarithm of the firm's total assets is used in line with Clark and Mefteh (2010). The size effect on firm value is not straightforward and according to previous research such as suggested by Peltzman (1977) and Allayannis and Weston (2001) there is some ambiguity on the effect of size on the value of the firm as indicated by the Q measurement. Due to the variety of research results, no prior indication of the size effect on firm value will be established.
- ROA: As a proxy for firm profitability, the ratio of return on asset is used to capture the effect of a high ROA on the value of firm. The ratio is defined as EBIT over Total Assets. The rationale of including one concrete return metrics is that the market is likely to value profitability and thus reward more profitable firms in terms of market valuation (Clark, E. & Mefteh, S. 2010).
- LEVERAGE: The use of financial leverage, as indicted by the ratio between long-term debt to total assets, may be positively correlated to firm value from different benefit, such as the corporate tax shield generated by leverage. However, simultaneously, higher leverage also increases the risk associated with firm and the expect cost of and probability of financial distress may increase using leverage, which may penalize firm value (Berk, J. & DeMarzo, P., 2017). Due to the multitude of effects for which leverage can have on a company's firm value, no prior indication of its effect can be determined.
- CAPEX: In accordance with the results from Allayannis and Weston (2001) which found a weak relationship between a firm's capital expenditure and their firm value, a component reflecting the level of capital expenditure in relation to sales (Capex/sales) is used a proxy for investment opportunities faced by firms. Due to previous research on this component and its link to firm value, a positive relationship is expected to be observed.
- DIVIDENDS: The component of dividends, measured as the dividend yield (DY), included in the analysis, in line with Allayannis and Weston (2001) and Clark and Mefteh (2010), to reflect companies' access to financial market. The rationale is based on the thought that firms for which have ample access to financial market, will more easily be able to finance new projects and thus have a lower DY. The effect for which access to financing on firm value have shown conflicting results

from previous research and thus no prior expectation on the sign of the outcome can further be established.

- CURRENCY DERIVATIVES: To control for the use of currency derivative a dummy variable was added as a regressor. There are conflicting results from previous research performed on the topic of the value creating characteristic of currency derivatives where Clark and Mefteh (2010) and Allayannis and Weston (2001) found a positive and significant relationship between the currency hedging procedure while Li et al. (2014) did not find such relationship. The expectation regarding the impact of the derivative dummy on the Q measurement will thus be unstated.

4.3 Risk management

4.3.1 Derivative contracts: Forwards, Futures and Options

A derivative contract is defined as a financial instrument which value is derived from some underlying assets. The underlying asset can be financial assets such as stocks, bonds, and currencies, but also commodities, such as gold, silver, or oil. The structure of derivative contract and, the asset which their value will be based upon, is wide ranging. Derivatives are frequently used for both for hedging within the field of risk management as well as in terms of speculation purposes. Derivative contract as a financial instrument within risk management and speculation has been growing in popularity during the last 40 some years, and thus, have also become a fundamental part of financial markets. Where derivatives contracts are traded both on standardized exchanges as well as over the counter (OTC markets). The variety of different contract types are extensive, but some of the most pivotal derivatives used within risk management are listed below (Hull C, J., 2012).

The popularity of trades in derivative instruments and their importance for financial market are proven through the significant size of the market. The OTC market of outstanding notional of derivative contract was valued at USD 632 trillion in end-June 2022, which is equivalent to a 5.7% increase from the same period the prior year. The gross market of outstanding derivative contract i.e., the sum of the positive and negative

values, was further estimated to be worth USD 18.3 trillion in end-June, led mainly by increased demand in interest rate derivatives (BIS, 2023).

Forwards: A forward contract is defined as the agreement made today between two parties to perform a certain transaction at a specified date to a predefined price at some point in the future. The forward contract is a mutual agreement between the two parties, which means that they are both obligated to perform the transaction as specified in the forward contract. The party for which are obliged to buy the underlying asset, as defined in the forward contract, is said to have the long position in the forward agreement. The party for which are obligated to sell the underlying asset is said to have the short position. Hence, the outcome of the forward contract will thus always have a winner and a loser in term of monetary gains. Moreover, forward contracts are traded over the counter (OTC market) and often tailored to meet the specific preferences of the two parties (Hull C, J., 2012).

Due to the structure of forward contract, where both parties are obligated to perform the agreed upon transaction at maturity, the value of the contract at interception will be equal to zero. However, as the contract is approach maturity the value of the contract will be equal the difference between the current spot price of the underlying asset and the strike price of the forward contract. Meaning that there is no upfront consideration for either of the parties of the forward agreement, but there will be both a downside risk and upside potential for both parties, depending on the evolution of the underlying asset in relation to the forward strike price. Hence, the value of the future contract is not known today and will fully depend on the future spot price and predetermined strike price of the contract (Hull C, J., 2012).

Both parties will be exposed to risk that the underlying asset will not evolve in favor of their position. The long position will benefit of positive evolution of the spot price in relation to the strike price, as this means that the long party will be able to purchase the underlying asset *for less* (the strike price) than the current spot price, and thus the current market value of the asset. The long position's payoff will further be the positive difference between the strike (for which is the amount that will be paid for the asset at maturity) and the current market value of the asset. The payoff is defined as:

$$Long\ position_T = S_T - K \begin{cases} > 0\ if\ S_T > K \\ < 0\ if\ S_T < K \end{cases}$$

The long position will therefore guarantee a certain purchase price for the long position, which is the rational for the use of forward contract in risk management, especially in terms of exchange rate risk. By taking a long position in a forward currency contract the risk manager will be able to lock in a certain exchange rate, hedging the risk that exchange rate will evolve above a certain threshold (Hull C, J., 2012).

The short position will naturally have the opposite exposure compared to the long position, as stated above. The short position will benefit from the forward contract if the value of the underlying asset evolves negatively in relation to the strike price. This means that the short position will be able to sell the asset *for more* than what the asset is currently worth, meaning that the short party's profit will be the positive difference between the strike price and the spot price of the asset (where in this case, the strike price is higher than the spot price). The payoff of the short position in a forward contract can naturally be explained as such:

$$Short\ position_T = K - S_T \begin{cases} > 0\ if\ S_T < K \\ < 0\ if\ S_T > K \end{cases}$$

The payoff scheme for the short position show that this party can lock in a certain selling price, hedging the risk that the value of that asset will decrease in value. As shown, the long and the short position complement each other and are thus often used in combination for risk management and hedging purposes. Furthermore, a common risk for both of the parties in the forward agreement, is the counterparty risk. The counterparty risk factor emerges from the tailored attributes in the forward contract and the fact that forwards are traded over the counter. Counterparty risk refers to the risk that the opposite party in the contractual agreement does not fulfill their obligation at maturity. Meaning, for example, that the long position does not go through with the transaction at strike, due to large negative evolution of the underlying asset for which they do have the capability to cover (Hull C, J., 2012).

Futures: Future contracts are very similar to forward contracts, which is the reason why they are often referred to in conjunction to each other. The fundamental attributes of future contracts are an agreement between two parties, one long and one short, to perform a certain transaction at a predetermined price at a predetermined date some point in the future. Unlike forwards, however, future contracts is highly standardized in terms of the underlying asset, quantity, price, and delivery date, and are traded on an exchange. This differencing feature makes it possible for the different parties not to know each other, but rather be connected through intermediaries such as banks or brokers. This creates higher liquidity, greater accessibility and eliminates parts of the counterparty risk exposure associated with forward contracts. The intermediaries give both parties a guarantee that the terms of the future contract will be honor at maturity, and thus remove the extra risk exposure obtained from counterparty risk (Hull C, J., 2012).

The intermediaries make sure that both parties will fulfill their obligations by the function of margin accounts and the requirement of the parties to *mark-the-market* or settle their position in the future contract. When the parties enter the future contract through an exchange, the exchange will require both to deposit funds to a margin account at interception, this amount is called the *initial margin*. Marking-the-market is a commonly used term within the world of derivative trading and refers the procedure of settling the margin account at the end of the trading day to reflect the trades gains or losses. The exchange can also make a so-called *margin call,* which happens if the balance of the margin account (as defined by the evolution of the underlying asset and the daily settlements) goes below the *maintenance margin,* which is a predetermined level, set often slightly below the initial margin. The margin call requires the party with a balance too low, to insert more funds into the margin account. All in favor of making sure that the obligations in the future contract are honored. Since future contracts are traded on an exchange and have standardized terms i.e., standardized asset, strike price and maturity, movements in future prices of a certain asset can be readily observed through broker site and exchanges (like common stock) and used for analysis the future expectation of price evolvement of some asset, such as currencies, metals, stocks, bonds, or rates to name a few (Hull C, J., 2012).

Options: Option contracts provide the option holder (the buyer) the right but not the obligation to buy or sell a certain asset at a predetermined price at some point in the future. The other party of the option contract is said to be the option writer (the seller), for which is the party that agrees to take on the obligation to perform the transaction as stated in the option contract upon the request of the option holder. The option contract is thus not inferring a mutual obligation on the contract parties, and the structure and payoff scheme for the option holder compared to the option writer can look vastly different. Since the option writer agrees to perform the transaction at the request of the option holder, the option writer is exposed to risk that the option will be exercised (since this will only happen if exercising the option will benefit the option holder) and for this risk the option writer must be compensated through an option premium. The option premium is the price paid by the option holder i.e., the buyer, to the option writer. The option premium will be the profit that the option writer makes on the trade in case that the option is not exercised. Options can be of two different styles, for which implies different conditions for when the option holder can exercise the option. American style options refer to the type of option for which can be exercised at any time during the duration of the contract. While European style options can only be exercise at maturity. Furthermore, there are four fundamental positions for which can be taken through plain vanilla option contracts, which are explained in the following segment (Hull C, J., 2012).

Long a put option: A long position in a put contract means buying an option contract that gives the buyer the right to sell the underlying asset a predetermined price and quantity at some point in the future. The maximum loss for this position will be the option premium paid at interception and the upside potential is defined by the strike price and the spot price of the underlying asset. A long position in a put option will profit when spot price is below the strike price. The payoff scheme looks as follows:

$$Long\ put = \max(K - S^T, 0)$$

Long a call option: A long position in a call contract means buying the right to buy a certain asset at a predetermined price and quantity at some point in the future. The maximum loss of this position is the option premium paid at interception and the

potential payoff is defined by the strike price in relation to the spot price of the underlying asset. The long call option will profit when the strike price is below the spot price. The payoff scheme looks as follows:

$$Long\ call = \max(S^T - K, 0)$$

Note, that the profit for the long position will not be at par with the payoff due to the option premium paid by the option holder, for which is the case in both the call and the put option.

Short a put option: A short position in a put option refers to the process of issuing an option (i.e., selling or writing the option with other notation), giving the option buyer the right to sell underlying asset. This means that the short put creates the obligation for the option writer to *buy* the underlying asset if the option holder wishes to exerciser her option in the future. Since the option holder will only exercise her option if the price of the underlying asset goes below the strike price, the maximum loss for the option writer and the short put will be the strike price. Since prices cannot take negative prices (naturally) the minimum price of the underlying asset will be equal to zero. If this happens, the option holder is forced to buy the underlying asset, for which is worthless, for the predetermined strike price. The short put will profit when the option is not exercised, and the profit will be the option premium paid at interception.

Short a call option: A short position in a call option means writing an option that gives the buyer the right to buy the underlying asset, meaning the option writer will have the obligation to sell the underlying asset if the option holder wishes to exercise their option. In return for this future, non-mutual obligation, the option writer earns an option premium paid by the option buyer. The maximum loss for a short call is theoretically unlimited and, are thus considered to yield significant risk exposure for the option writer. Since the long call will exercise the option only if the price of the underlying asset exceeds the strike price, and since there is theoretically no limit to price of the underlying asset, the option writer could be obligated to sell the underlying asset at a price that is well below its actual value. The short call will profit if the option

is not exercised, and the profit will be equal to the option premium paid at interception (Hull C, J., 2012).

Option premium: There are several ways of valuing options and some of the most popular ways of determining the option premia is through Binominal trees and the Black and Scholes option pricing formula, which are to some extend the limit to the Binominal tree pricing fundamentals (Cox C, J. Ross A, S. & Rubinstein, M., 1979). The connection of the Black and Scholes (BS hereafter) and the limit of the binomial tree is beyond the scope of this thesis and will not be explained further.

An overview of the fundamental steps of obtaining the Black and Scholes pricing formula: The BS pricing formula for options is a fundamental tool when it comes to understanding the dynamics of option prices and what pivotal input variables drive changes in option prices. The model is based on a series of assumptions and the pricing formula is dynamic in relation to the various assumptions underlying the input variables and will therefore change in accordance with these inputs. The BS formula is based upon the put-call parity and the way that put and call options can be used to replicate the payoff scheme of other financial instruments. In the following section the underlying asset of the options will be assumed to be publicly traded stock if not otherwise stated. The put-call parity explains the relationship between the price of a put option and the price of a call option (with the same underlying asset) and the replication features of options. The put-call parity implies the following relationship:

$$S + P = B + C \rightarrow P - C = B - S$$

Where:
S = stock price
B = bond price
P = put option
C = call option

By rearranging the above stated expression, the price of a call option can be express in terms of the following relationship:

$$C = P - B + S$$

The above expression can furthermore be expanded to incorporate the pricing of the bond and the stock. Note that the following derivation will be based on continuous discounting factors. If implementing the definition of bond and stock prices, the following definition of the put-call parity can be stated (Tebaldi, C., 2019):

$$p_t - c_t = Ke^{-r(T-t)} - S_t e^{-q(T-t)}$$

Where:
K = face value of the bond and the strike price of the option
S_t = stock price at time t
q = dividends
T = maturity
t = present time
r = risk-free rate
p_t = put price at time t
c_t= call price at time t

Furthermore, this relationship can be expressed in terms of forwards prices F as such:

$$F_t^T = Forward\ price\ of\ S\ at\ time\ t\ with\ maturity\ T$$

$$F_t^T = S_t e^{(r-q)(T-t)}$$

The intuition of the forward price is bringing the current stock price forward with the risk-free rate minus the discounting factor of the dividend yield. If this definition of the forward price is used in the put-call parity, then the relationship will look as follows:

$$p_t - c_t = e^{-r(T-t)}(K - F_t^T)$$

A *naïve* approach of option valuation through the BS framework would be using historical risk measures (defined as the historical mean). In this case the *only historical*

data is used to measure the risk of the stock. Note that this is considered naïve as it is not possible to predict the future only based one historical measure. If this measure is used, the expected return of the stock will be the historical mean μ, and the BS formula would thus look like (Tebaldi, C., 2019):

$$C_t^{naïve} = e^{-r(T-t)} S_t e^{\mu - r} N\left(d_1^{\mu}\right) - K e^{-r(T-t)} N\left(d_2^{\mu}\right)$$

Where:

$e^{-r(T-t)} S_t e^{\mu - r}$ = the stock price brought forward and then discounted back to present

$N\left(d_1^{\mu}\right)$ = portion of the portfolio that's invested in the risky asset

$K e^{-r(T-t)}$= price of the bond

$N\left(d_2^{\mu}\right)$= portion of the portfolio invested in the bond

This expression of the BS formula can be plugged into the definition of the put-call parity as follows:

$$p_t^{naive} - c_t^{naive} = e^{-r(T-t)} K - e^{(\mu - r)(T-t)} S_t \neq e^{-r(T-t)} (K - F_t^T)$$

Unless $\mu = r$ an *arbitrage opportunity* will appear. Furthermore, assuming that the expected value of the stock would be the same as the risk-free rate is also naïve as it is known that investors in general are considered risk averse. This paradox is resolved within the BS framework and further assumptions made (Tebaldi, C., 2019).

Continuing, the price of the stock can be proxied by the evolution of the stock market index, which evolves dynamically according to a continuous time stochastic (random) process described by an SDE (Stochastic Differential Equation):

$$dS_t = \mu(S_t, t)dt + \sigma(S_t, t)dW_t$$

Where:

dS_t = evolution of the index over time

$\mu(S_t, t)dt$ = the drift term i.e., some expected value of the index at t

$\sigma(S_t, t)dW_t$ = the diffusion term i.e., some random shock defined by a stochastic process, where W is the classic Brownian motion

Further, under the assumption that the riskless asset is a bond with face value K and with price B, the dynamics of the risk-free asset will thus be according to the following notion (note, the risk-free asset, the bond, will always be discounted with the risk-free rate):

$$\frac{dB_t}{dt} = rB_t \rightarrow dB_t = rB_t dt$$

Where the solution to this ODE (Ordinary Differential Equation) is defined by:

$$B_t = B_0 e^{r*(t-0)}$$

As previously stated, the payoff of a long position in the call and the put option can be described as:

$$c_T = \max(S_T - K, 0)$$

$$p_T = \max(K - S_t, 0)$$

The above stated derivation summarizes the basic argument of the BS framework for which are the following:

- The market is free from arbitrage
- The market is perfectly liquid
- There are no constraints (such as margin requirements)
- The market is driven by one single source of randomness

In addition, the BS framework states the following replication arguments which is based on the flexible features of plain vanilla put and call options. The BS replication argument implies taking a long position in one call option and a short position *delta* unit of the stock market index for which creates the portfolio Π (Tebaldi, C., 2019):

$$\Pi_t = c_t - \Delta_t S_t$$

The evolution of the portfolio according to time can be described as follows:

$$d\Pi_t = dc_t - \Delta_t dS_t$$

Note that it is assumed that the allocation to each asset is known an instant before the price evolve randomly. By applying Ito's calculus, we get:

$$d\Pi_t = dc_t - \Delta_t dS_t$$

$$= \left[\frac{\partial c_t}{\partial S_t} + \left(\frac{\partial c_t}{\partial S_t} - \Delta_t\right)\mu S_t + \frac{1}{2}\frac{\partial^2 c_t}{\partial S_t^2}\sigma_t^2 S_t^2\right]dt + \sigma_\Pi dW_t$$

$$\sigma_\Pi = \left(\frac{\partial c_t}{\partial S_t} - \Delta_t\right)\sigma S_t$$

$$\Delta_t = \frac{\partial c_t}{\partial S_t}$$

Where delta is the amount needed to immunise portfolio Π i.e., choosing the amount invested in the risky asset, which is assumed in this case to be the stock market index (the short position) the makes for zero volatility $\sigma_\Pi = 0$.

Since portfolio Π has zero volatility, then according to the law of one price it must be possible to replicate it only using the riskless asset such as cash or T-bills to avoid arbitrage. The evolution of the riskless portfolio must then be equivalent to:

$$d\Pi_t = r\Pi_t dt$$

Since the definition of $d\Pi_t$ is known (see definition above) and the definition of delta under the BS framework is equal to $\Delta_t = \frac{\partial c_t}{\partial S_t}$, and imposing that the portfolio volatility must be equal to zero, $\sigma_\Pi = 0$, then the definition of $d\Pi_t$ can be expanded and be expressed as such:

$$d\Pi_t = \left[\frac{\partial c_t}{\partial t} + \left(\frac{\partial c_t}{\partial S_t} - \frac{\partial c_t}{\partial S_t}\right)\mu S_t + \frac{1}{2}\frac{\partial^2 c_t}{\partial S_t^2}\sigma_t^2 S_t^2\right]dt + \sigma_\Pi dW_t$$

The parenthesis inside the brackets cancels out, and the product of the last term is equal to zero, which will result in:

$$d\Pi_t = \left[\frac{\partial c_t}{\partial t} + \frac{1}{2}\frac{\partial^2 c_t}{\partial S_t^2}\sigma_t^2 S_t^2\right]dt = r\Pi_t dt$$

$$\left[\frac{\partial c_t}{\partial t} + \frac{1}{2}\frac{\partial^2 c_t}{\partial S_t^2}\sigma_t^2 S_t^2\right]dt - r\Pi_t dt = 0$$

Since the expression is linear in dt, the equation can be rewritten as follows:

$$\left[\frac{\partial c_t}{\partial t} + \frac{1}{2}\frac{\partial^2 c_t}{\partial S_t^2}\sigma_t^2 S_t^2\right] - r\Pi_t = 0$$

Since portfolio Π is defined as the long position in the call option and the short stock position:

$$\Pi_t = c_t - \Delta_t S_t$$

Plugging this into the above stated differential equation will result in:

$$\left[\frac{\partial c_t}{\partial t} + \frac{1}{2}\frac{\partial^2 c_t}{\partial S_t^2}\sigma_t^2 S_t^2\right] - r(c_t - \Delta_t S_t) = 0$$

$$\left[\frac{\partial c_t}{\partial S_t} + \frac{1}{2}\frac{\partial^2 c_t}{\partial S_t^2}\sigma_t^2 S_t^2\right] - r\left(c_t - \frac{\partial c_t}{\partial S_t}S_t\right) = 0$$

$$0 = \frac{\partial c_t}{\partial t} + r\frac{\partial c_t}{\partial S_t}S_t + \frac{1}{2}\frac{\partial^2 c_t}{\partial S_t^2}\sigma_t^2 S_t^2 - rc_t \quad (1)$$

With the condition that the call option at maturity will be worth:

$$c_T = \max(S_T - K, 0) \ \ or\ with\ other\ notation\ c_T = (S_T - K)^+ \qquad (2)$$

The solution formula of the PDE (Partial Differential Equation) (1) and the boundary condition (2) will uniquely price the call option within the BS framework (Tebaldi, C., 2019).

PDE with the boundary condition continues to hold also when volatility is a deterministic function of the asset price, such as $\sigma(S_t, t)$. Under this hypothesis, the Feynman-Kac theorem tells us that the value of the option contract can be expressed as a conditional expectation such as:

$$c_t = e^{-r(T-t)}\mathbb{E}^{\mathbb{Q}}[(S_t - K)^+]$$

Where the measurement of $\mathbb{Q}$ is not the historical one (note, the measurement of $\mathbb{Q}$ is what market partitioners base their expectations on), it is the measure that is defined by the stochastic representation of the PDE solution. $\mathbb{Q}$ can be explained as such:

$\mathbb{Q}$ = The probability of each event (price) which is implicit in the quoted prices of the risky asset in the absent of arbitrage

$\mathbb{Q}\ probaility\ of\ event\ A$: $\mathbb{Q}(A)$ = Market undiscounted price of a bet that pays off in the event of A

Furthermore, the BS formula is defined as the closed form expression of the conditional expectation under $\mathbb{Q}$ (Feynman-Kac) which is the solution to the PDE stated above.

$$Characteristic\ PDE: \ 0 = \frac{\partial c_t}{\partial t} + r\frac{\partial c_t}{\partial S_t}S_t + \frac{1}{2}\frac{\partial^2 c_t}{\partial S_t^2}\sigma_t^2 S_t^2 - \ rc_t$$

$$Feynman - Kac, solution\ under\ \mathbb{Q}: c_t = e^{-r(T-t)}\mathbb{E}^{\mathbb{Q}}[(S_t - K)^+]$$

$$Closed\ form\ expression: c_{BS}(r, q, T, S_t, K, \sigma) = S_t N(d_1^r) - Ke^{-r(T-t)}N(d_2^r)$$

The PDE solved by the BS formula rationalizes the selection of the risk-free discounting using the replication argument as stated above, and thus solves the paradox discussed earlier. I.e., solving the PDE under $\mathbb{Q}$ instead of the historical $\mathbb{P}$ (as in the naïve BS) the issue of needing $\mu = r$ to avoid arbitrage is resolved. The risk neutral measure of volatility is the one obtains through the solution of the PDE under $\mathbb{Q}$ and this measure is generally different from the historical one (Tebaldi, C., 2019).

4.4 Regression analysis

4.4.1 Basic concept

The procedure of conducting a regression analysis within the subject of financial analysis is a widely accepted method of examining the relationship between one variable with other factors, and whether some of the movements in that variable can be partly or fully explained by the included factors. The research variable, the variable for which researchers tries to gain more knowledge about, are often referred to as the *endogenous variable*. The term refers to the fact that this variable is determine inside the model and are thus dependent on the values of the factors, or *exogenous variables* for which are included in the model regression. The exogenous variables, often also referred to as the independent variables, are determined independently, or outside of the model. Hence, the exogenous variables are external factors for which are included in the model with the incentive of hopefully explaining some of the movements in the endogenous variables, for which are the central focus of the regression. Within financial econometrics, regression analysis is often utilized to explain movements in different types of values to gain deeper understanding of the drivers of for example growth, firm value, stock prices and so forth (Chatterjee, S. & Simonoff S, J., 2013).

The simplest form of regression analysis is examining if there is a linear relationship between the dependent and the independent variables. A linear relationship implies that the dependent variable, in many situations denoted by y, can be explained as a linear combination of some intercept (alpha) and the explanatory variables, often denoted by x, scaled by their impact on the dependent variable (beta), plus some error term. The following expression illustrated the simplest form of a linear regression:

$$y_i = \alpha + \beta x_i + \varepsilon_i$$

In this simple example of a cross sectional regression (note, different from time-series regression), it is assumed that y can be explained by only one explanatory variable x over a sample set of observations ranging from *i = 1…n.* This very simplistic representation of a regression analysis is far from comprehensive enough to capture the more general case of application when there is multiple explanatory variables and a dataset of n observations. A general representation of k explanatory variables can look as follows:

$$y_i = \alpha + \beta_1 x_{1,i} + \cdots + \beta_k x_{k,i} + \varepsilon_i$$

Note, a linear model refers to a model for which is linear in its parameters, meaning that one can specify a quadratic model which are still a linear regression if it satisfies linearity in parameters. One could for example specify the following:

$$y_i = \alpha + \beta_1 x_i + \beta_2 x_i^2 + \varepsilon_i$$

The model is still linear since x and x^2 are just different versions of x_1 and x_2 and can thus be easily transformed. The interpretation of the parameters in this simple linear regression model is straightforward. The intercept, denoted by the Greek letter alpha in this case, can be interpreted as the expected value of the research variable when all explanatory variables are equal to zero. Furthermore, the beta parameters, can be interpreted as the change in the research variable by one unit change in the explanatory variable. Lastly, the error term, represented by the Greek letter epsilon, is the part of the research variable for which cannot be explained by the explanatory variables (Chatterjee, S. & Simonoff S, J., 2013).

4.4.2 OLS Estimation

As previously stated, the aim of the regression analysis is to explain a relationship between variables. Important to know, however, is that the relationship derived from the model will be an estimated relationship and will thus differ from the true values presented in the data set. The goal of the regression procedure is therefore to find the

relationship coefficients, the betas, for which yield estimated values that are the closest to the real true values of the data set. This can be done by applying an Ordinary Least Square, or OLS, estimation. OLS refers to the process of finding the beta parameters for which will minimize the distance between the true relationship (true regression) and the estimated one. The following operation is performed to find the OLS estimates for the beta parameters in the regression:

$$\min \sum_{1=i}^{n} [y_i - \hat{y_i}]^2 \; = \; \min \sum_{1=i}^{n} \left[y_i - \left(\alpha + \beta_1 x_{1,i} + \cdots + \beta_k x_{k,i}\right)\right]^2$$

The estimated values, or the fitted values with other notation, is denoted by $\hat{y}$ and are represented by the explanatory variables plus the intercept as indicated by the above stated equation. The fitted values will be the output of the OLS estimation and thus represent the value for which satisfy condition of minimum distance to the true value. The fitted values can be expressed as follows:

$$\hat{y_i} = \; \hat{\alpha} + \; \hat{\beta}_1 x_{1,i} + \cdots + \hat{\beta}_k x_{k,i}$$

The difference between the true value y_i and the fitted value, is called the residual, and it represent the part if the dependent variable for which cannot be explained by the explanatory variables included in the regression. The objective of the OLS estimation is thus to minimize the squared residual and produce parameter estimates for which can describe the dependent variable with the highest accuracy (Chatterjee, S. & Simonoff S, J., 2013).

4.4.3 Multiple linear regression

In the case where there are multiple explanatory variables, i.e., whenever k > 1, the representation of a linear regression model can become rather extensive. In this case, the relationship can no longer be explained by a two-dimensional plane as in the case with k =1. If there are two explanatory variables, the relationship exists in a three-dimensional room, and it is thus appropriate to convert the simple relationship into matrix notation to make the illustration and computation easier (this is of course true

also for even higher orders of parameters). The linear regression can be written in terms of matrix notion as such:

$$y = \beta X + \varepsilon$$

$$X = \begin{pmatrix} 1 & x_{1,1} & \cdots & x_{k,1} \\ \vdots & \vdots & \vdots & \vdots \\ 1 & x_{1,n} & \dots & x_{k,n} \end{pmatrix} \quad y = \begin{pmatrix} y_1 \\ \vdots \\ y_n \end{pmatrix} \quad \beta = \begin{pmatrix} \beta_0 \\ \beta_1 \\ \vdots \\ \beta_k \end{pmatrix} \quad \varepsilon = \begin{pmatrix} \varepsilon_1 \\ \vdots \\ \varepsilon_n \end{pmatrix}$$

Note, beta$_0$ represent the intercept for which were earlier denoted by alpha.

With this representation of the linear relationship between the dependent variable and the independent variables, the minimization procedure now takes the shape of the following multivariate equation, for which can be solved using matric algebra:

$$\hat{\beta} = (X'X)^{-1}X'y$$

Which implies the following representation of the fitted values:

$$\hat{y} = X\hat{\beta} = X(X'X)^{-1}X'y$$

Following the residuals can thus be stated as:

$$\varepsilon = y - \hat{y} = y - X(X'X)^{-1}X'y = (\mathbb{I} - X(X'X)^{-1}X')y$$

Where $\mathbb{I}$ is the identity matrix (Guidolin, M. & Pedio, M., 2018).

4.4.4 Assumptions

Furthermore, to correctly specify and analysis a potential relationship between the endogenous variable and the exogenous variables, one must make some necessary assumptions regarding the data set for which the analysis will be based on. The following assumption must be satisfied:

- Linearity: While conducting the linear regression in its simplest form, one is assuming that the true relationship between the dependent variable and the explanatory variables are in fact linear (meaning that we are excluding the possibility of another type of relationship such as an exponential relationship for example).
- Zero mean error terms: The expected value for the errors should be equal to zero, $E[\varepsilon_i] = 0$. Meaning, that on average, the estimated fitted values are equal to the true values, i.e., there are no systematic under or overvalued observations.
- Homoscedasticity: Homoscedasticity implies that all error terms are considered random variables and have the same variance across all observations (time or cross sectional). That is, $Var(\varepsilon_i) = \sigma^2$.
- Zero cross sectional or serial correlation: No cross sectional or serial correlation among error terms. Meaning that the error terms are not correlated with each other (cross sectional) or its own past (serial). That is, $Cov[\varepsilon_i, \varepsilon_j] = E[\varepsilon_i \varepsilon_j] = 0, where\ i \neq j$.
- Normally distributed errors: Assuming that the error terms are normally distributed are necessary when analyzing the level of significance of the estimated coefficients. It is necessary to correctly specify critical values and preform hypothesis testing.

The above stated assumptions are needed to correctly specify the relationship between the research variable and the explanatory variables and will play an essential role in the validity of the output from the regression and final analysis (Chatterjee, S. & Simonoff S, J., 2013).

4.4.5 Hypothesis testing

A central discussion within application of regression analysis and the interpretation of the output estimates, are whether the estimates as obtained by OLS, have a significant effect on the research variable. Or to put it differently, whether the estimates coefficients, are significantly different from zero. This can be tested by applying either a t-test separately on each estimated parameter, or a joint F-test on the parameters all together. A t-test is conducted by calculating a t-statistic for each of the estimated

parameters individually and then comparing the obtained individual t-statistic with a critical value from the t-distribution, which will further depend on the chosen level of significance and the corresponding confidence level. The hypothesis of a t-test can be stated as such:

$$H_0: \beta_j = 0$$
$$H_1: \beta_j \neq 0$$

The null hypothesis claims that the j^{th} beta parameter is equal to zero (not statistically different from zero) and the alternative hypothesis claims that there is a significant difference between the estimated beta parameter and zero (Chatterjee, S. & Simonoff S, J., 2013).

The t-statistic is calculated as follows:

$$t_j = \frac{\widehat{\beta_j}}{\widehat{SE}(\widehat{\beta_j})}$$

Where SE is the standard error of the estimator for which is defined as:

$$\widehat{SE}(\widehat{\beta_j}) = (X'X)^{-1}\hat{\sigma}^2$$

Which is the squared root of the diagonal elements of the estimated beta matrix, where $\hat{\sigma}^2$ is equal to residual mean square defined as:

$$\hat{\sigma}^2 = \frac{\sum_{i=1}^{n}(y_i - \hat{y}_i)^2}{n - k - 1}$$

A 95% confidence interval (which is a standard range applied in this context) implies a 5% level of significance and means that there is a 5% risk that the null hypothesis is rejected when there is in fact no true difference. If a narrower confidence interval is chosen, say 99%, then this means that the risk of rejecting the null when the null is in fact true, decreases (Chatterjee, S. & Simonoff S, J., 2013).

Furthermore, when testing if all the parameters, simultaneously, are significantly different from zero, one can conduct a F-test. The F-test share the same logic as the t-test but imply a different point of comparison. The F-test examine the following hypothesis:

$$H_0: \beta_1 = \cdots = \beta_k = 0$$
$$H_1: \ some\ \beta_j \neq 0, for\ j = 1, \ldots, k$$

Where the test variable is computed from the model output, and is obtained through the following formula:

$$F = \frac{Regression\ MS}{Residual\ MS} = \frac{Regresson\ SS/k}{Residual\ SS/(k-n-1)}$$

Meaning that the F-test examine if any of the dependent variables included in the model have any significant explanatory power. To conduct the hypothesis testing, a F value is calculated and then compared to the relevant critical values of the F distribution on (k, k -n-1) degree of freedom (Chatterjee, S. & Simonoff S, J., 2013).

5. Data

The central discussion of this thesis is focused on large listed non-financial European companies and whether the use of currency derivatives within corporate risk management have a significant effect on firm value measured through Tobin's Q. The data collection was thus focused on finding a large enough sample of non-financial firms, listed on a European exchange and for which are headquartered in Europe. The selection of firms for which this thesis central analysis is based upon, was manually selected, and checked to make sure that all the critical firm characteristics was captured (i.e., publicly trade, non-financial and so forth). All data was downloaded through the FactSet add-in function in Excel in conjunction with the continuous sanity checks against the FactSet Terminal, to circumvent any misleading datapoints. The data was further analyzed through application of basic econometric models and R code through the software package R studio.

5.1 European non-financial firms

The basis of the data collection was the STOXX Europe 600 Index. The rationale behind choosing a European index as the starting point for the data collection was that a stock market index gives a comprehensive overview of the large, listed companies active in the relevant market. Since the purpose of this paper is to examine the European market and the most active firms within it, it was natural to look at one of the largest indices published in Europe to reflect the activity of the European stock market. The STOXX Europe 600 Index is derived from the STOXX 1800 Index for which aim to reflect the stock market activity in three different world regions, Europe, North America, and Asia/Pacific i.e., with 600 companies each, representing that world region in the total index. Hence, the STOXX Europe 600 Index represent the European part of the total index and is analyzed separately as well as in conjunction with the total index. The STOXX Europe 600 index is well-diversified within different sectors comprising the overall stock market and the weights applied to the index components (companies) are based upon the free-float market cap. The free-float market cap is also the matric used to determine which companies to include in the top 600 list for which the index reflect. The list show only the largest European firms as measured by their free-float market cap (Qotingo, 2023).

The full list of companies included in the STOXX Europe 600 Index was found through MarketScanner (2023) and manually inserted into Excel. Once the full list of companies was presented in Excel, the list was analyzed in conjunction with the FactSet Terminal and the Factset representation of each company ticker. The FactSet (FS hereafter) representation of the ticker was needed to easily work with the sample set of companies and obtain the financial matrices from the companies' P/L and balance sheet needed to calculate Tobin's Q.

Since the starting point, as stated above, was a comprehensive stock market index, some modification to the sample of companies was needed in order to not violate the guidelines of the sample needed to perform the analysis in line with the purpose of this thesis. First, the delimitation of excluding financial firms was made since financial firms in general have a significantly different capital structure compared to non-financial firm which makes them not directly comparable. Furthermore, the use of derivative

instrument may differ from the purpose they serve within non-financial firms, and it can be difficult to directly compare how derivative instruments are accounted for within financial reports without further analyzing the capital structure of financial versus non-financial firms, which is beyond the scope of this thesis. To determine which firms was classified as financial firms, the FS sector grouping and classification was applied to the raw sample of companies. The FS add-in in Excel was utilized to simultaneously obtain the FS industry grouping for each company. When the raw sample of 600 companies each had their FS industry grouping, the companies defined as financial firms based on the FS definition were deleted from the sample set.

Secondly, the sample set of companies was further reduced based on exchange risk exposure and availability of data, which is further discussed later in this chapter. The final data set, for which the fundamental analysis of this paper is based upon, was reduced from 600 companies as included in the STOXX Europe 600 Index to a total of 416 companies. The following table summarized some of the key statistics over the data set utilized to examine the central hypothesis.

Table 5.1 Summary statistic: Sample data set

MEUR	Number	Mean	Median	SD	10th percentile	90th percentile
Input Statistics						
Market cap	416	23550	9200	42591	2585	53396
BV Equity	416	9416	3791	16082	857	23125
Revenue	416	16046	5652	28634	981	39715
EBIT	416	1867	606	3940	84	4645
Assets	416	30154	11354	55187	2481	76444
Long term debt	416	7135	2593	14141	252	16903
Capital expenditure	416	1108	300	2502	41	2551
Research Statistics						
Use of FX derivatives	416	0,83	1,00	0,37	0,00	1,00
Tobin's Q	416	2,05	1,48	1,63	0,93	3,78
Regressor Statistics						
SIZE	416	9,40	9,34	1,35	7,82	11,24
ROA	416	7,74%	6,99%	7,69%	1,08%	16,63%
LEVERAGE	416	0,23	0,22	0,14	0,07	0,42
CAPEX	416	0,09	0,05	0,13	0,01	0,20
DY	416	2,37%	1,92%	2,18%	0,00%	5,26%

Table 5.2 Industry diversification overview

Total Index	600		
*Lapse**	*184*		
Total Sample	416		
Derivative users	346		
Non-users	70		
#Industries	19	#Companies	416
Aerospace & Defense	19	Pharmaceuticals	22
Automotive Manufacturing	24	Real Estate Development	17
Chemicals	19	Retail	26
Engineering & Construction	10	Services	34
Entertainment	8	Technology	29
Food & Beverages	34	Telecommunications	19
Industrials	47	Tobacco	3
Medical	25	Transportation & Distribution	11
Metals	15	Utilities	33
Oil &Gas	21		

**Lapse due to missing data, financial firm, or no FX exposure.*

5.1.1 Sector division and control variables

As the raw sample set of companies was based on an ample list of European companies, which was well-diversified based on exposure to different sectors, some attention was needed on this aspect of the set of companies and the effect of sectoral differences on the analysis. Since different sectors have different exposures to market movements the effect of sectoral difference among companies and their relative performance may be significant. In general, as a simplified categorization, sectors can be defined as being cyclical or defensive, and of course a range of different levels of cyclically and defensiveness. The nature of the sector, being either cyclical or defensive, will influence companies' exposure to market risk and thus, in turn, also their market value (Berk, J. & DeMarzo, P., 2017). It is thus important to incorporate sector belonging of each of the companies within the sample to make a proper analysis of the firm value. The sector division within the sample set of companies was first determined based on FS industry definition and grouping as explained above. To simplify the sector division among the sample set, the FS defined industry belonging for each company was then manually analyzed in conjunction with information obtained through company websites, and further refinement was made to make the industry classification less detailed. The final

set of industries for which each company in the sample set could be divided into was 19 industries.

Furthermore, these industries were then acknowledged in the regression analysis using dummy variables for each industry. Meaning that if company *i* belongs to industry *j*, the dummy variable (further denoted as D*j*) will take the value of 1, the rest of the dummy variables included in the regression will thus take the value if 0 (for simplicity, it is further assumed that companies cannot belong to more than one industry). The interpretation of the coefficient obtained through running the regression with the industry control variables is the effect that a certain industry has on the firm value measured through the Q measurement.

5.2 Value creating characteristics

Since the central analysis is based of Tobin's Q as a measure of firm value, the availability of the components needed to calculate the Q measure and the financial matrices for which was analyzed on their effect on the Q measure, for each company was crucial. The sample set of companies, after filtering for only non-financial firms, was thus further reduced based on the level of available data among the companies included in the sample set. As previously mentioned, the data was collected using FS code through the FS add-in function in Excel, where the program pulls information, as specified by the code itself, regarding the companies from the FS Terminal and imports it directly into Excel. Since this was the most effective way to collect information from companies' financial statements, the data collection was limited to the information available on the FS terminal. If the code couldn't pull the data or if the data for some companies seemed deviating, each data point for those companies was manually check through their profile in the FS terminal as well as their own financial reports as presented on their websites and was later hardcoded into the dataset in excel.

5.2.1 Tobin's Q framework

As stated in chapter four, the endogenous variable in the regression analysis preformed was the firm value of the company measured through Tobin's Q, or the Q measure with other notation (for more details regarding this measure and application of regression

analysis, please see chapter four). The exogenous variables are defined as the financial matrices, chosen to reflect some characteristic of the firm for which may influence the Q measure (for more details, see chapter four). The coefficients obtained through the regression analysis will thus reflect the impact of a certain financial characteristic on the firm value as measured by the Q ratio. To obtain the necessary building blocks and the input variables needed to calculate each financial matrices, the FS tickers and FS coded was utilized through the FS add-in function in excel. Based on the information gathered through the FS pull, the Tobin's Q measurement was calculated for each company in the sample set as well as all the relevant input variables used in the regression analysis.

5.2.2 Use of currency derivatives

The information needed to determine each company's risk management strategy and their use of currency derivatives was not as straightforward and readily available as the above stated data points. The information regarding active risk management and the potential use of currency derivative for hedging purposes was not available on the FS terminal and the use of FS code was not applicable on the data collection for this specific input variable. As the use of currency derivative is the subject of interest in this paper, significant effort was put into incorporating qualitive data found in annual reports, into the regression analysis preformed. For each company, the latest annual report was analyzed and information regarding their exchange risk exposure and hedging strategy was obtained through the notes of the financial statements. If the company did not state in the annual report that they were exposed to exchange risk during the latest year, then that company was excluded from the sample set. Meaning that the sample set only includes companies that actively stated, in their latest annual report, that they have an exchange rate risk exposure. Moreover, each company's risk management section, displayed in the notes of the annual reports, was closely examined to determine which risk management approach was applied and whether currency derivatives were utilized within the risk management of exchange risk exposure. If the company actively stated that currency derivatives were used, and if this was in line with accounts presented on their balance sheet, then this company was categorized as *currency derivative user*. The companies that actively stated that they did not use currency derivatives within exchange risk management were categorized as *non-users*. Companies for which did not

present any information regarding if currency derivatives were used or not, were excluded from the sample due to ambiguity.

Furthermore, the grouping of users and non-users were later translated into a binary division, where users were granted the value of 1 and non-users the value of 0. This was later incorporate into the full regression through an additional dummy variable, which took the value of 1 if the company actively uses currency derivatives to hedge their exchange risk exposure, and 0 if no such financial instruments is used. The interpretation of the coefficient obtained through the regression analysis, can thus be interpreted as the effect of the usage currency derivatives on the value of the firm. Note, for simplicity, a distinction between different type of derivatives used within currency risk management was not made, as it is beyond the scope of the thesis (see chapter eight for further discussion on this topic).

6. Method

To test the central hypothesis of this thesis, a comprehensive regression analysis was preformed, with the firm value measured through the Q ratio as the dependent variable. The purpose of the regression analysis was to evaluate what financial matrices significantly contribute to the value of a firm, and especially the use of currency derivatives in exchange risk management within corporations. The use of currency derivatives within the sample set of 416 large European listed companies was included in the regression as a dummy variable, for which took the value of 1 if the company uses currency derivatives for hedging purposes, and 0 if not. Also included in the regression were 19 control variables, controlling for sectoral differences within the data sample set. The regression analysis was preformed using the software package R and R studio, by running the cross-sectional regression in matrix notation. The raw data, as collected through the FS add-in function in excel as well as manually (see chapter five for more details) was inserted into the packaged software. Thereafter, the relevant variable vectors were formed by creating a subset of each column containing the exogenous variables and generating column vectors. The same procedure was performed for the endogenous variable, the Q measure as well as the control variables. After the data was structured in the appropriate notation, the following regression was preformed:

$$Q_i = \alpha + \beta_1 SIZE + \beta_2 ROA + \beta_3 LEV + \beta_4 CAPEX + \beta_5 DY + \gamma_1 DERV + \gamma_2 ID_1 + \cdots + \gamma_{20} ID_{19}$$

Where beta represent the coefficients connected to the exogenous variables as financial matrices, and gamma represent the coefficients connected to the control variables, including the dummy variable controlling for the use of currency derivatives. The final regression output was then summarized in a summary table to easily analyze the meaning of each estimated coefficient obtained through the OLS estimation. Each exogenous variable included in the analysis as well as the intercept (alpha) was listed according to their presence in the regression and analyzed thereafter (see chapter seven for presentation of results).

6.1 Testing for significance

The output of the regression i.e., the estimated beta and gamma coefficients obtain through the OLS estimation of the above stated regression, was view from the perspective of explanatory power of the endogenous variable, the firm value. The central hypothesis of this thesis is to the test the effect of actively using currency derivatives to hedge exchange risk within corporations, while also controlling for other value creating factors. The coefficients obtained through the regression is the unit change of the firm value, measured through Tobin's Q, by a unit change of the independent variables. The level for which each variable included in regression affect the value of a firm, differs depending on the nature of the that specific variable. To determine if the coefficients significantly impact the firm value, individual test of significance was performed on each of the estimated coefficients and presented in the output table. The first step of testing the level of explanatory power of the included variables was to calculate the corresponding t-statistic. The t-statistic was generated in conjunction with the rest of the variable output when applying the *lm* call (R code for comprehensive regression output) in the R studio software and is thus readily available to analyzed together with the rest of the output (see chapter four for more details around the econometric theories supporting the calculation of the t-statistic). The t-statistic for each of the estimated coefficients are compared to the critical values of the t-distribution at the level of significance stated in the initial hypothesis. As discussed,

and stated in chapter three of this paper, the central hypothesis will be analyzed on 95% confidence interval, meaning that the critical values for which the t-statistic are compared against will represent the 5% likelihood of obtaining a t-statistic for which lies in the 2.5% tails of the t-distribution. The t-statistic can be analyzed on a standalone basis (in comparison to the critical values) or through its corresponding p-value. The p-value will showcase the probability of obtaining a t-statistic for which is at least as extreme as the result observed, assuming that the null-hypothesis is correct. This means that if the p-value of the t-statistic for each estimated coefficient is less than the level of significance (in this case 5%) respectively, then the null hypothesis can be rejected and it is possible to state that the coefficient is significantly different from zero on a 95% confidence level. The result from the above tests is presented in the table in the following chapter and will show the t-statistic and the p-value. Furthermore, the last column of the output table will show indications of whether the estimated coefficient is statistically significant or not with the asterisk symbol noted.

7. Results

The following table will present the result from the performed regression analysis. The result is presented in a logical order, representing the order for which the exogenous and control variables was included in regression as it was executed. As the central hypothesis and research topic of this paper is to evaluate the effect of using currency derivatives within exchange risk management, the result from including this as a control (dummy) variable is highlighted in the table.

Table: 7.1

Residuals:					
Min	1Q	Median	3Q	Max	
-2.566	-0.598	-0.159	0.394	6.823	
Coefficients: (2 not defined because of singularities)					
	Estimate	Std. Error	T-stat	Pr(>|t|)	Significance
(Intercept)	3.4639	0.5811	5.96	5.6e-09	***
SIZE	-0.1763	0.0500	-3.53	0.00047	***
ROA	13.1150	0.8926	14.69	< 2e-16	***
LEVERAGE	-1.0667	0.4519	-2.36	0.01876	*
CAPEX	1.9765	0.4762	4.15	4.1e-05	***

DIVIDENDS	-20.8552	3.1427	-6.64	1.1e-10	***
DERIVATIVE	0.0286	0.1558	-0.18	0.85432	
ID_matD2	-0.4497	0.3499	-1.29	0.19947	
ID_matD3	-0.1646	0.3746	-0.44	0.66067	
ID_matD4	0.0391	0.4432	0.09	0.92981	
ID_matD5	0.3637	0.4858	0.75	0.45447	
ID_matD6	-0.2740	0.3283	-0.83	0.40433	
ID_matD7	-0.1776	0.3214	-0.55	0.58086	
ID_matD8	0.0537	0.3526	0.15	0.87894	
ID_matD9	-1.6239	0.4139	-3.92	0.00010	***
ID_matD10	-0.4108	0.3658	-1.12	0.26222	
ID_matD11	0.6897	0.3613	1.91	0.05701	
ID_matD12	-0.2979	0.3897	-0.76	0.44518	
ID_matD13	-0.3269	0.3520	-0.93	0.35352	
ID_matD14	-0.1235	0.3311	-0.37	0.70922	
ID_matD15	-0.3054	0.3484	-0.88	0.38115	
ID_matD16	-0.0953	0.3880	-0.25	0.80602	
ID_matD17	1.8029	0.7385	2.44	0.01508	*
ID_matD18	-0.2274	0.4396	-0.52	0.60530	
ID_matD19	-0.1040	0.3301	-0.32	0.75283	
Residual standrad error: 1.13 on 391 degrees of freedom					
Multiple R-squared	0.549				
Adjusted R-squared	0.522				
F-statistic: (on 24 and 391 DF)	19.9				
P-value:	< 2e-16				

Note, the first dummy variable is the ID_1 matrix, i.e., the first sector identification matrix, was excluded from the regression analysis in order to circumvent multicollinearity problems within the dummy variables and the dummy variable trap.

7.1 Currency derivatives and firm value

Table 7.1 presents the final output from the regression performed on the data set of 416 large listed European companies as of December 2022. As the table indicates by the last column and the seventh row, the derivative dummy included to control for the use of currency derivatives, is not significant on any level of significance (10%, 5% or 1% level). This result can be derived from Table 7.1 by analyzing the p-values and the corresponding asterisks as noted in the *significance* column. The output table shows that some of the included variables have significant effects on the Q measure, which is

natural based on the nature of the financial matrices included in the analysis. Size, ROA, Leverage, Capex, and Dividends yield are all estimated to have significant coefficients on at least a 10% significance level. Furthermore, all variable as previously listed, except for Leverage, are also significant on a 5% level, which was the relevant level of significant throughout this paper.

As shown by the output table, the derivative dummy is missing any significance (indicated by the lack of asterisks corresponding to its p-value). This result is fundamental, as it answer the central hypothesis of this paper. According to the chosen sample set of large listed European companies and the regression analysis preformed (including the choice of explanatory variables), the use of currency derivatives within risk management and hedging purposes for exchange risk is not significantly impacting firm value measured through the Q measure. The null hypothesis as stated in chapter three, cannot be rejected, and the coefficient obtain through the regression analysis is not significantly different from zero.

8. Discussion and conclusion

The results obtained through the application of fundamental econometric models has been analyzed in conjunction to previous research and relevant financial theories as presented in chapter four. The rationale behind the following discussion is to critically evaluate the result form the performed analysis, to comprehend the economic meaning of the results and what insight the study yields in the field of financial risk management and firm value. The previous research as present by chapter two, will act as benchmark comparison for the result to grasp the limits and the insight of this study.

8.1 Discussion: Results

The result presented in chapter seven show that the null hypothesis for which tests the impact of the use of currency derivatives on firm value, cannot be rejected on a 5% level of significance. The output table also show that the null is not rejected on any of the most widely adopted levels of significance i.e., neither on a 1% nor 10% level. The results obtain through previous research show ambiguous signs of the effect of currency derivatives on firm value within the US, France, and New Zealand market. However, the

results from the study present in this paper, is in line with the results of Li, Visaltanachoti and Luo (2014) for which concluded that it was not possible to confirm a statistically significant relationship between Tobin's Q of New Zealand firms and the use of currency derivative within risk management of exchange risk exposure. It is not possible to state an overall conclusion with regards to the various results obtain through the study as well as previous research, as the research differs when it comes to execution as well as geographical location of the study. Nonetheless, the conflicting results are intriguing and should be analysed in conjunction to the fundamental reasons for risk management practices and the purpose of hedging. The results found by Allayannis and Weston (2001) on the US market, and by Clark and Mefteh (2010) on the French market, somewhat goes against the famous theorem of Modigliani-Miller of efficient capital markets and their Hedging Proposition, stating that the hedging procedure and the use of derivative instrument to stabilize cash flows, do influence firm value. This result is contradicting the Efficient Market Theorem and Hedging Proposition (Parson, J. & Mello, A., 2011), but at the same time confirming the rationale of the use of hedging instruments. As discussed in chapter four, the use of hedging instruments in the form of different derivatives, comes either in the form of pure cost, such as option premiums, or indirect in the form of increase risks. The rational of using currency derivatives, for any reasonable risk manager, should be to lower the firms risk exposure and to secure future cash flow, in line with profit maximization and increased firm value. The results obtain from Allayannis and Weston (2001) and Clark and Mefteh (2010) confirms this rationale, where their studies create an incentive for risk managers to actively hedge their currency risk exposure.

Nevertheless, the result obtained in this study, and the research conducted by Li, Visaltanachoti and Luo (2014), present another perspective more in line Modigliani-Miller and their world of efficient capital markets. Where the result in this study confirms that there is no significant relationship with the use of currency derivatives on firm value. However, this perspective questions the rationale for active risk management and the use of currency derivatives. This result is interesting in the sense that it challenges the fact that active risk management of currency exposure within international corporations is a widely adopted practice and shed lights on the effective use of derivatives. The results in this study suggest that the trade-off between increased

risk and high cost through derivative positions, with the benefits these positions yield in form of hedging currency risk, may not be as straightforward as implied by the rationale of derivatives as presented by classical financial theory.

8.2 Discussion: Delimitation in the results

The result of study carried out in this research paper has been affected by the scope of the study and its implications of the depth of the analysis. Firstly, the sample size of the data set used to examine the central hypothesis was limited to the data available both through FactSet and annual reports. The information regarding the main research variable, was obtain through the availability of data in each firm's latest annual report, where it is necessary to note that the latest report was either from 2021 or 2022. This implies that information on the use of currency derivative and each firm's exposure to currency risk, will be more or less relevant in time depending on the which year the latest annual report was published. This can in turn have effects on the outcome of the study, for which is not captured by the analysis of this research. Furthermore, the qualitative part of the data collection procedure was limited to the binary division of the sample set of firms. Meaning that the information obtained through this step was whether the firms could be classified as users (i.e., active users off currency derivatives) or non-users (no active hedging through financial instruments). Furthermore, this simplified classification ignores the variety of derivative instruments available, and the number of derivatives for which are stated on the balance sheet of each firm. Since the selection of companies included in the data set different from a multitude of aspects, the amount and type of derivative within each risk management department, are very likely to differ inside the sample. The effect of this aspect on the firm value was not covered by the research conducted in this paper but may produce significantly different output if recognized. The interpretation of the result and the economic meaning is therefore limited to the simplified categorization of users versus non-users and lacks insight of the effects of different level and characteristics of the range of hedging instruments available. The research of this paper was also conducted looking at a snapshoot of the firm value, since the analysis was performed on a cross-sectional basis rather than using panel data (incorporating a time-series perspective), which limits the flexibility of the result.

8.3 Improvements and suggested future research

The study conducted in this research paper have some natural limitations due to the availability of data and the scope of the study. These limitations could further be explored and the scoped could be extended to analyze the effects of these limitations and investigate if the economic insight would be different from the results presented in this paper. One of the most intriguing improvements that could be carried out in future research is the effect of different kinds of hedging instruments, and the level of on balance sheet currency derivative positions with respect to the size of the firm, on firm value. This type of research would require a wider scope and a more in-depth analysis of the financial statement accounts, seeking to get a more comprehensive picture of risk management practices and whether the different choices of hedging strategies would lead to bigger (smaller) impact on firm value. Another perspective for which could be interesting to further investigate would also be to examine the same hypothesis through a time-series perspective. As mentioned previously, the study conducted in this paper is limited to a snapshot view and the application on cross-sectional data from one date in time. Further research could incorporate the effect of time and market dynamics by studying the same research variables but over a certain time frame. This approach would be in line with the research carried out by Allayannis and Weston (2001) for which studies US firms from 1990 to 1995. Future research could thus yield new insights into the previous result, for which may more accurately depict the market dynamics of the latest decade.

8.4 Conclusion

The result of the study carried out in this paper showed no significant relationship between the use of currency derivatives and firm value as measured by Tobin's Q for non-financial large listed European firms. The result is partially in line with previous research on the related topic, but there are however some ambiguities with other results conducted on other geographical locations. The result from this study implies that the famous Modigliani-Miller Theorem of efficient capital markets and their Hedging Proposition, applies, and that companies cannot obtain higher firm value by changing the dynamics of their future cash flows through hedging activities. The central hypothesis of this paper was confirmed as the null hypothesis was not rejected, implying that the estimated coefficient related the derivative control variable was not

significantly different from zero. The result of this thesis should be interpreted with caution and in conjunction to the limitation discussed. Nonetheless, the results give way to further analyzing the topic and challenges the widely adopted rationale of extensive use of derivatives for currency hedging, and the idea the this is a value adding activity.

9. Biography

9.1 Literature

Allayannis, G., & Weston, J. (2001). The Use of Foreign Currency Derivatives and Firm Market Value. Review of Financial Studies, 14, 243-276.

Berk, J., & DeMarzo, P. (2017). Corporate Finance (4th ed.). Pearson. Pages 376, 524-531, 674-678, 756, 1062-1065, 1092-1096.

Chatterjee, S., & Simonoff, J. S. (2013). Handbook of Regression Analysis. John Wiley & Sons. Pages 1-9.

Clark, E., & Mefteh-Wali, S. (2010). Foreign Currency Derivatives Use, Firm Value and the Effect of the Exposure Profile: Evidence from France. International Journal of Business, 15(2), 183-196.

Cox, J. C., Ross, S. A., & Rubinstein, M. (1979). Option Pricing: A Simplified Approach. Journal of Financial Economics, 7(3), 229-263.

Guidolin, M., & Pedio, M. (2018). Essentials of Time Series for Financial Applications (1st ed.). Academic Press.

Hull, C. J. (2012). Options, Futures, and Other Derivatives (8th ed.). Pearson Education. Pages 5-12, 29-30.

Jordan, B. D., Ross, S. A., & Westerfield, R. W. (2010). Fundamentals of Corporate Finance (11th ed.). McGraw-Hill Education.

Peltzman, S. (1977). The Gains and Losses from Industrial Concentration. University of Chicago, Booth School of Business; National Bureau of Economic Research (NBER).

Tebali, C. (2019) Advanced Derivatives: Lecture Notes. Bocconi University, Department of Finance. Pages 13-31.

9.2 Online sources

Adam Smith Institute. (n.d.). The Wealth of Nations. [Online]. Available at: https://www.adamsmith.org/the-wealth-of-nations (Accessed: 15/11/2022).

Bank for International Settlements. (n.d.). OTC Derivatives Statistics at end-December 2020. [Online]. Available at: https://www.bis.org/publ/otc_hy2211.pdf (Accessed: 15/11/2022).

Bloomberg. (2022, November 8). EU Energy Crisis Sparked by Ukraine War to Create Blackouts in Poor Countries. [Online]. Available at: https://www.bloomberg.com/news/articles/2022-11-08/eu-energy-crisis-sparked-by-ukraine-war-to-create-blackouts-in-poor-countries#:~:text=The%20center%20of%20the%20issue,available%20for%20short%2Dnotice%20delivery (Accessed: 12/11/2022).

Britannica. (n.d.). International Trade. The New Mercantilism. [Online]. Available at: https://www.britannica.com/topic/international-trade/The-new-mercantilism (Accessed: 12/11/2022).

CNBC. (n.d.). US 10 Year Treasury Yield. [Online]. Available at: https://www.cnbc.com/quotes/US10Y (Accessed: 08/11/2022).

CNN Money. (n.d.). Europe Markets. [Online]. Available at: https://money.cnn.com/data/world_markets/europe/ (Accessed: 08/11/2022).

Corporate Finance Institute. (n.d.). Comparative Advantage. [Online]. Available at: https://corporatefinanceinstitute.com/resources/economics/comparative-advantage/ (Accessed: 12/11/2022).

Corporate Finance Institute. (n.d.). Q Ratio. [Online]. Available at: https://corporatefinanceinstitute.com/resources/valuation/q-ratio/ (Accessed: 17/12/2022).

Economics Help. (n.d.). Factors Influencing Exchange Rates. [Online]. Available at: https://www.economicshelp.org/macroeconomics/exchangerate/factors-influencing/ (Accessed: 01/12/2022).

HDFC Bank. (n.d.). What is Currency Derivatives and Its Types? [Online]. Available at: https://www.hdfcbank.com/personal/resources/learning-centre/invest/what-is-currency-derivatives-and-its-types#:~:text=What%20are%20Currency%20Derivatives%3F,pre%2Dspecified%20date%20and%20rate. (Accessed: 12/11/2022).

Marketplace. (2022, August 29). Why the US dollar is strong. [Online]. Available at: https://www.marketplace.org/2022/08/29/why-us-dollar-is-strong/ (Accessed: 08/11/2022).

MarketScreener. (n.d.). STOXX Europe 600 EUR Index Components. [Online]. Available at: https://www.marketscreener.com/quote/index/STOXX-EUROPE-600-EUR-7477/components/ (Accessed: 07/11/2022).

Parsons, J. & Mello, A. (2011). The M-M Proposition of Hedging. [Online]. Available at: https://bettingthebusiness.com/2011/07/26/the-m-m-proposition-of-hedging-2/ (Accessed: 17/12/2022).

STOXX. (n.d.). STOXX Europe 600 EUR Index - Current Factsheet. [Online]. Available at: https://www.stoxx.com/document/Bookmarks/CurrentFactsheets/SXXGR.pdf (Accessed: 07/11/2022).

The Wall Street Journal. (n.d.). BX/TMBMKGB-10Y Bonds. [Online]. Available at: https://www.wsj.com/market-data/quotes/bond/BX/TMBMKGB-10Y (Accessed: 08/11/2022).

Wall Street Oasis. (n.d.). Valuation - Q Ratio. [Online]. Available at: https://www.wallstreetoasis.com/resources/skills/valuation/q-ratio (Accessed: 17/12/2022).

10. Appendix

The below table presents the full sample set of European companies included in the study.

A.P. Moller - Maersk A/S	E.ON SE	Kerry Group Plc Class A	Schneider Electric SE
A2A S.p.A.	EDP-Energias de Portugal SA	Kesko Oyj Class B	Scout24 SE
AAK AB	Electricite de France SA	KGHM Polska Miedz S.A.	Securitas AB Class B
Aalberts N.V.	Elekta AB Class B	Kingfisher Plc	Severn Trent Plc
AB Sagax Class B	Elia Group SA/NV	Kingspan Group Plc	SGS SA
ABB Ltd.	Elis SA	KION GROUP AG	Shell Plc
Accor SA	Elisa Oyj Class A	Knorr-Bremse AG	Siemens Healthineers AG
Ackermans & van Haaren NV	EMS-CHEMIE HOLDING AG	Kojamo Oyj	SIG Group AG
Actividades de Construccion	Enagas SA	Kone Oyj Class B	Signify NV
Adecco Group AG	Endesa S.A.	Koninklijke DSM N.V.	Sika AG
adidas AG	Enel SpA	Koninklijke Philips N.V.	Siltronic AG
ADLER Group SA	ENGIE SA.	Kuehne & Nagel International AG	SimCorp A/S
Aena SME SA	Eni S.p.A.	L'Oreal S.A.	Skanska AB Class B
Aeroports de Paris ADP	Entain PLC	Lagardere SA	SKF AB Class B
AFRY AB Class B	Epiroc AB Class A	LANXESS AG	Smith & Nephew plc
Ahold Delhaize N.V.	Equinor ASA	LEG Immobilien SE	Smiths Group Plc
Air France-KLM SA	Ericsson Nikola Tesla d.d.	Legrand SA	Smurfit Kappa Group Plc
Air Liquide SA	EssilorLuxottica SA	Leonardo SpA	Snam S.p.A.
Airbus SE	Essity AB Class B	Linde plc	Sodexo SA
Aker BP ASA	Etablissementen Franz Colruyt N.V.	Logitech International S.A.	SoftwareONE Holding Ltd.
Alcon AG	Eurofins Scientific Societe Europeenne	Lonza Group AG	Soitec SA
Alfa Laval AB	Eutelsat Communications SA	LVMH Moet Hennessy Louis Vuitton SE	Solvay SA
Ambu A/S Class B	Evolution AB	Marks and Spencer Group plc	Sonova Holding AG
Amplifon S.p.A.	Evonik Industries AG	Melrose Industries PLC	Sopra Steria Group SA
ams-OSRAM AG	Evotec SE	Merck KGaA	Spectris plc
ANDRITZ AG	Experian PLC	METRO AG	SPIE SA
Anglo American plc	Fabege AB	Moncler SpA	Spirax-Sarco Engineering PLC
Anheuser-Busch InBev SA/NV	Fastighets AB Balder Class B	Mondi plc	SSE plc
Antofagasta plc	Faurecia Societe europeenne	MorphoSys AG	SSP Group Plc
ArcelorMittal SA	Ferguson Plc	Mowi ASA	Stadler Rail AG
arGEN-X SE	Ferrari NV	MTU Aero Engines AG	Stellantis N.V.
Arkema SA	Ferrovial, S.A.	National Grid plc	STMicroelectronics NV
Aroundtown SA	Flutter Entertainment Plc	Naturgy Energy Group, S.A.	Stora Enso Oyj Class R
ASM International N.V.	Fortum Oyj	NEL ASA	Straumann Holding AG
ASML Holding NV	freenet AG	Nemetschek SE	Subsea 7 S.A.
ASSA ABLOY AB Class B	Fresenius SE & Co. KGaA	Neste Corporation	Svenska Cellulosa AB SCA Class B
Associated British Foods plc	Fuchs Petrolub SE Pref	Nestle S.A.	Swatch Group Ltd. Bearer
AstraZeneca PLC	Galapagos NV	Nexi S.p.A.	Swedish Match AB
Atlantia S.p.A	Galenica AG	Next plc	Swedish Orphan Biovitrum AB
Atlas Copco AB Class B	Galp Energia, SGPS S.A. Class B	NIBE Industrier AB Class B	Swiss Prime Site AG
Auto Trader Group PLC	GEA Group Aktiengesellschaft	Nokia Oyj	Swisscom AG

AVEVA Group plc
BAE Systems plc
Barry Callebaut AG
BASF SE
Bayer AG
Bayerische Motoren Werke AG
Bechtle AG
Beiersdorf AG
Beijer Ref AB Class B
BELIMO Holding AG
BHP Group Ltd
bioMerieux SA
Boliden AB
Bouygues SA
BP p.l.c.
Brenntag Societas Europaea
British American Tobacco p.l.c.
Britvic plc
BT Group plc
Bunzl plc
Burberry Group plc
Capgemini SE
Carl Zeiss Meditec AG
Carlsberg AS Class B
Carrefour SA
Castellum AB
CD Projekt S.A.
Cellnex Telecom S.A.
Centrica plc
Chocoladefabriken Lindt
Chr. Hansen Holding A/S
Cie Generale des Etablissements
Cineworld Group plc
Clariant AG
Coloplast A/S Class B
Compagnie de Saint-Gobain SA
Compagnie Financiere Richemont SA
Compass Group PLC
Continental AG
ConvaTec Group Plc
Corbion NV
Covestro AG
CRH Plc
Croda International Plc
CTS Eventim AG & Co. KGaA
Geberit AG
Genmab A/S
Georg Fischer AG
Getinge AB Class B
Getlink SE
Givaudan SA
Glanbia Plc
Glencore plc
GN Store Nord A/S
Grand City Properties SA
Grifols, S.A. Class A
GSK plc
H&M Hennes & Mauritz AB Class B
Halma plc
Hays plc
HeidelbergCement AG
Heineken NV
HELLA GmbH & Co. KGaA
HelloFresh SE
Henkel AG & Co. KGaA
Hera S.p.A.
Hermes International SCA
Hexagon AB Class B
HEXPOL AB Class B
Hikma Pharmaceuticals Plc
Holcim Ltd
Holmen AB Class B
Howden Joinery Group PLC
HUGO BOSS AG
Huhtamaki Oyj
Husqvarna AB Class B
Iberdrola SA
Icade SA
IMCD N.V.
IMI plc
IMMOFINANZ AG
Imperial Brands PLC
Inchcape plc
Industria de Diseno Textil, S.A.
Indutrade AB
Infineon Technologies AG
Informa Plc
Infrastrutture Wireless Italiane S.p.A.
InterContinental Hotels Group PLC
International Consolidated Airlines
Nokian Renkaat Oyj
Norsk Hydro ASA
Novartis AG
Novo Nordisk A/S Class B
Novozymes A/S Class B
OC Oerlikon Corporation AG
Ocado Group PLC
OMV AG
Orange SA
Orion Oyj Class B
Orkla ASA
Orpea SA
Orsted
Pandora A/S
Pearson PLC
Pennon Group Plc
Pernod Ricard SA
Persimmon Plc
Pirelli & C. S.p.A.
Polski Koncern Naftowy ORLEN S.A.
Polymetal International Plc
Porsche AG
ProSiebenSat.1 Media SE
Prosus N.V. Class N
Proximus SA de droit public
Prysmian S.p.A.
Publicis Groupe SA
PUMA SE
QIAGEN NV
Randstad NV
Reckitt Benckiser Group plc
Recordati Industria
Red Electrica Corp. SA
RELX PLC
Remy Cointreau SA
Renault SA
Rentokil Initial plc
Repsol SA
Rexel SA
Rheinmetall AG
Rio Tinto plc
Roche Holding Ltd
Rolls-Royce Holdings plc
Rotork plc
Royal Unibrew A/S
Symrise AG
TAG Immobilien AG
Tate & Lyle PLC
Taylor Wimpey plc
Tecan Group AG
TechnipFMC plc
Tele2 AB Class B
Telecom Italia S.p.A.
Telefonica SA
Telenet Group Holding NV
Telenor ASA
Teleperformance SA
Telia Company AB
Temenos AG
Tenaris S.A.
Terna S.p.A.
Tesco PLC
Thales SA
thyssenkrupp AG
TOMRA Systems ASA
TotalEnergies SE
Travis Perkins plc
Trelleborg AB Class B
TUI AG
Tullow Oil plc
Ubisoft Entertainment SA
UCB S.A.
Umicore
Unibail-Rodamco-Westfield SE
Unilever PLC
Uniper SE
UNITE Group plc
United Internet AG
United Utilities Group PLC
UPM-Kymmene Oyj
Valeo SE
Valmet Corp
Varta AG
VAT Group AG
Veolia Environnement SA
VERBUND AG Class A
Vestas Wind Systems A/S
Viaplay Group AB Class B
Victrex plc
Vifor Pharma AG

Daimler Truck Holding AG	International Distributions Services plc	Royal Vopak NV	VINCI SA
Danone SA	Interpump Group S.p.A.	RS Group PLC	Vivendi SE
Dassault Aviation SA	Intertek Group plc	Rubis SCA	Vodafone Group Plc
Dassault Systemes SA	Ipsen SA	RWE AG	voestalpine AG
Davide Campari-Milano N.V.	ISS A/S	Saab AB Class B	Volkswagen AG Unsponsored ADR
DCC Plc	Italgas SpA	Safran S.A.	Volvo AB Class B
Dechra Pharmaceuticals PLC	ITV PLC	Saipem S.p.A.	Vonovia SE
Delivery Hero SE	IWG Plc	SalMar ASA	Warehouses De Pauw SCA
Demant A/S	J Sainsbury plc	Sandvik AB	Wartsila Oyj Abp
Deutsche Lufthansa AG	JCDecaux SE	Sanofi	Weir Group PLC
Deutsche Post AG	JD Sports Fashion Plc	SAP SE	WH Smith PLC
Deutsche Telekom AG	JDE Peet's NV	Sartorius AG	Whitbread PLC
Diageo plc	Jeronimo Martins, SGPS S.A.	Sartorius Stedim Biotech SA	Wienerberger AG
DiaSorin S.p.A.	John Wood Group PLC	SBM Offshore NV	Wolters Kluwer NV
Dometic Group AB	Johnson Matthey Plc	Scandinavian Enviro Systems AB	Worldline SA
DS Smith Plc	Just Eat Takeaway.com N.V.	Scatec ASA	WPP Plc
DSV A/S	K+S AG	Schibsted Asa Class A	Yara International ASA
Dufry AG	Kering SA	Schindler Holding AG	Zalando SE

PART II

Abstract

The global economy and highly volatile markets creates the need for international corporation to engage in risk management to withstand financial turbulence. It is thus common that companies turn to financial markets to hedge different market risk factors efficiently through the use of derivative contracts. Hedging activities may be an effective way to hedge e.g., currency or interest rate risk to a certain extent. However, derivatives are rarely free, and are often associated with costs either in terms of premiums or in terms of risk. This paper will foster a critical discussion around the extensive use of derivatives within corporate risk management in non-financial firms. The discussion is anchored in a case study conducted on Porsche and their hedging strategies in 2007, for which highlights the upside potential of using currency derivatives and stock options. The purpose of the discussion is to question hedging strategies centred around derivatives and the appropriateness of said strategies within non-financial firms. The discussion and conclusion of this paper will govern a more qualitative view on corporate risk management, which will complement the finding presented in part I of this thesis.

Keywords: Risk management, financial derivatives, options, hedging, Porsche.

Table of Contents

1 Introduction

In the current state of the world economy, and in today's dynamic and uncertain market environment, corporations face challenges beyond the scope of their ordinary line of business. Volatile markets create several new aspects of risk, and the role of corporate risk management strengthens. For example, unfavourable foreign exchange movement could significantly subdue top-line growth for international corporation, which in turn could negatively affect overall profitability. Furthermore, increasing interest rates makes it more expensive for companies to fund their operations, which may also limit growth prospects. However, risk associated with the state of the market can generally be circumvented trough clever use of different hedging strategies. Risk managers can turn to financial markets to position themselves in derivative contracts to create a hedge against e.g., a depreciating home currency or increasing interest rates. The use of derivative instruments for hedging purposes within active risk management is a widely employed strategy (Hull. J.C., 2015). However, it does come at a price, both in terms of cost, such as e.g., option premiums, and in terms of risk. Depending on the positions, derivative contracts can become riskier than expected, and should therefore be used with caution. The fact the hedging activities could results in adverse results in terms of growth and profitability, creates room for discussion: Are hedging activities always a value adding strategy? What risks can be associated with these activities, and to what extent is it appropriate for non-financial firms to engage in derivative trading? As an extension to the research findings in part I of this Thesis, part II will focus on a more qualitative discussion of the central problem statement through a case study conducted on Porsche and their hedging strategy in 2007.

1.1 Background to research topic

Derivative instruments can be used for many purposes and are commonly known in conjunction with the operation of hedge funds. However, the use of derivative

instruments often plays an import role for non-financial firms through corporate risk management (Mackay. P & Moeller. S, 2007). The use of derivative contracts opens the possibly for corporation to enter positions for which locks in a certain derisible price or quantity for input variables necessary in their value chain. This central aspect of derivative contracts makes them a valuable tool for corporations, especially in volatile market. It creates a sense of control over variable markets factors for which are outside the normal course of business. Corporations can utilize derivative contracts such as options, futures and forwards, swaps and, credit derivatives to hedge their exposure to market movements in e.g., foreign exchange (FX) markets, credit markets and commodity market. (Kozarevic. E, et al., 2012). The use of derivatives has a clear upside, but it also creates an additional source of risk for non-financial firms for which should be highlighted. Options, for example, come at a cost in terms of an option premium for which is paid to the option writer. This premium may seem neglectable when the position is small but can become quite substantial at scale. The option premium is the maximum loss for which the long position can incur. However, if the option premium is substantially large, and if the option position didn't yield any profits, the cost of the hedge could negatively affect margins. The risk profile of non-financial firms will also change through aggressive use of derivative instruments. Plain vanilla put and call options and, forwards and futures are straightforward, and the downside risk is usually limited (note, not for the short party in option contract). Nevertheless, there are a multitude of exotic derivatives that are far more complex. The risk associated with the company's position in derivative instruments is thus not always clearcut (Brooks. R & Chance. D, 2019).

The different aspect of derivatives and their risk bearing characteristics are intriguing in terms of non-financial firms. The fact that hedging activities should, from the perspective of a rational risk manager, be a value adding activity. The purpose of hedging is to secure a certain outcome, e.g., in terms of revenue streams in a foreign currency or in terms of interest rate cost. The role for which derivative instruments play in risk management should also be highlighted in terms different hedging strategies. Even though hedging through derivatives is generally common among large international corporation, far from all companies employ this strategy (Kozarevic. E, et al., 2012). International companies also have the possibility to create a natural hedge

throughout their value chain. A natural hedge is created by matching the amount of cost exposed in a certain currency, with the level of revenues for which are exposed to the same currency. Through this strategy, if the home currency depreciates, the negative effect of the foreign exchange on revenues, will simultaneously be matched by lower cost. This matching of cost and revenues in a foreign currency will create a natural hedge thus subdue the effect of undesirable movements in the currency exposure and keep profit margins more stable (CIF, 2023).

1.2 Connection between part I and part II

The purpose of the case study carried out in part II of this thesis is to conduct a more qualitative discussion around corporate risk management. The case study is analysed to connect real-life events to theoretical aspects of risk management and the use of derivative instruments. Part I of this thesis focused on the quantitative analysis of derivatives and its relation to firm value. Part I however focused solely on the use of currency derivatives. In this part, the discussion is extended to incorporate all kinds of derivatives. The discussion and research will be anchored in the case study of Porsche in 2007 and their choice of risk management strategy with extensive use of derivative instruments. Since Porsche is German car manufacture, the research and discussion will be kept within the limitations set out in part I, i.e., conducting the study on the European market.

2 Methodology

The methodology for which was employed in this paper is based on one case study for which highlight Porsche in 2007 and their risk management strategy. The purpose of the chosen case study was to foster a further discussion and gain insight into the central problem statement of this paper. Furthermore, the case for which act as the focal point of the discussion and analysis aim to complement the research conducted in part I of this thesis. The analysis of actual events in conjunction with the research carried out in part I will add colour to the overall discussion and insights.

2.1 Empirical methodology

For the qualitative purpose of this paper, the case study research method was employed. The case study approach focuses on a real-life event to gain deeper understanding about economic phenomenon and help to answer the question around why certain situation appears and the events that follows. According to Yin (2014) the case study approach is appropriate when researching the building blocks of real-life events and gain understanding around the driving factors and what causes can be attributable to the observed outcome. The author further states that the case study approach pertains to the collection of actual events where researchers may have limited control. Furthermore, the case study method facilitates in-depth and multi-faceted explorations of highly complex issues and gives room for analysis in a real-life setting, which can yield valuable qualitative insight, complementing quantitative facts and data (Crowe et al., 2011).

According to Creswell (2014), the case study methodology for research is designed as a qualitative tool for which enables researcher to explore a program, event, individuals, or activity in detail, to gain in depth insight to the research topic. The author defines a case as bounded by time and activity, and the research around the case should be conducted as a collection of detailed information obtained from a wide range of different sources of data. Furthermore, there are three core types of the case study method for which embodies the most important part of this research tool i) Descriptive: A descriptive case study aim to, in detail, describe a real-life phenomenon to gain knowledge around the event understanding the most crucial details surrounding it. Descriptive case studies are commonly found in research areas such as sociology and anthropology. ii) Explanatory: A explanatory case study research puts emphasis on the causal factors to explain a real-life event. The central questions in an explanatory case study are “how” and “why”. The objective is to understand the driving factors of a phenomenon and how a certain sequence of events came about. Researchers go into details around the explanatory factors for which can be discussed in relation to the actual event. iii) Exploratory: A exploratory case study are cantered around the exploring possible outcomes of a real-life phenomenon and identifying new research questions and ideas. The purpose of an exploratory case study is to explore new ways of analysing the actual event and suggest future research for which can be anchored in the questions produced by the explanatory case study. (Yin. R, 2014)

2.2 Data

The primary source of data and information used for the purpose of this study was different literature and online resources. As the research carried out was centred around one case study, the focus of the data collection process was to gather as much quantifiable information regarding the case as possible. Academic publications and past course literature was utilized in conjunction to the case study details, to support the discussion further. As the purpose of the case study research was to gain insight into corporate risk management and the use of derivative instruments, the case details were analysed jointly with fundamental financial theories. Hence, the use of academic publication and physical and digital literature. Additionally, online resources were further employed to support case facts and statements made around case events.

Furthermore, company specific information found in the financial statements and annual reports of Porsche was analysed in-depth. The case study is focused on Porsche and their risk management strategy during their 2006/2007 fiscal year, which make their financial statement and appurtenant notes central for the case study. Furthermore, as an additional reference point and point of discussion, Porsche financial standing and strategy was analysed as of their latest reporting period, hence information obtained from their 2022 annual report was also utilized extensively. Porsche financial information was found through their financial publication, which were readily available on their website. Moreover, for the purpose of illustrating the use of currency derivatives for hedging purposes, an analysis of historical EURO/dollar exchange rates was carried out. The data for this analysis was found through open data sources, i.e., Investing.com.

2.3 Evaluation and delimitations

The quality of the data and information gathered for the purpose of this thesis was limited to the availability of data sources. Meaning that the case details and facts where limited by availability of past interviews, discussions, previous case studies, previous financial information and so forth. The research and discussion carried out in this paper is also limited to the scope of the thesis. The data and information were collected from written sources, meaning that no new and additional interviews were conducted

for the purpose of this paper. Interviews with industry professional or company related persons would have given some additional depth to the analysis, and thus the discussion and conclusion will be limited due to this aspect. Nevertheless, the quality of the information gathered from written sources was selected carefully, and as stated in previous section, a significant portion of the analysis and discussion will be based on company specific information.

3 Problem statement and purpose

3.1 Purpose

The purpose of this paper is to foster a more qualitative discussion around active corporate risk management and the use of derivative instruments in this setting. The central discussion will be anchored to part I of this thesis, where part I provided a quantitative research study on the effect of currency derivatives on firm value of European corporations. This paper will add to the findings presented in part I but will focus the discussion on an actual event and conduct a case study on Porsche and their risk management strategy in 2007. The case study examined in this paper aim present a real-life perspective of risk management and extensive use of derivative instruments for hedging purposes (see chapter 5 for case description). Furthermore, the qualitative discussion and case research carried out, aim at providing deeper understanding of derivative use and the potential risk and rewards associated with active risk management centred around this kind of hedging strategies.

3.2 Problem statement

The case study research conducted on Porsche, and their hedging strategy and risk management in 2007, will act as a focal point throughout this paper. The research was structed around on main questionnaire composed of three sub questions. The central questionnaire was clearly defined to shape to the final discussion and to make sure that the research carried out in this paper fulfil the purpose stated in the previous section. The problem statement is divided into three central discussion topics, which are the following:

Central questionnaire: *What is the effect of derivative use on the market perception of a non-financial corporation, and what are the risk and rewards associated with this risk management strategy?*

> **Sub question 1***: Were the astonishing results presented by Porsche in 2007 due to well thought out risk management and clever use of derivative instruments, or was it pure luck and particularly beneficial market conditions?*
>
> **Sub question 2:** *What would have been the market feedback if the results were the opposite, would the extensive use of derivative instruments be praised or analysed with more caution?*
>
> **Sub question 2:** *How does extensive use of derivative instruments change the risk profile of a non-financial corporation, and are these activities appropriate even though beyond the scope of their ordinary business?*

4 Background

The following section will highlight a case study on Porsche in 2007 and their use of financial derivatives and risk management strategy throughout. Porsche fiscal year 2006/2007 is particularly interesting for the purpose of this paper as it showcases the upside potential of extensive use of derivative in a non-financial firm. The case facts subsequently provided will be analysed for the purpose of this upside perspective, as well as to foster discussion around the risk for which can be associated with said strategy.

4.1 Porsche overview

Porsche is a German automotive manufacturer, with a prestigious history within the industry. The company was founded in 1931 by Ferdinand Porsche and have since then established themselves in the market through precision engineering, luxury profile, and performance throughout the years. Their differentiating characteristics lies within their ability to consistently exemplify innovation and design excellence within the field of luxury sports cars. Porsche's product portfolio consists of famous model such as the 911 and the Cayman. Due to their outstanding profile and strong market presence, the

company has yielded significant success within the core business for selling and manufacturing cars. (Mueller. S, 2020) However, Porsche's history is far from clearcut, and the company has faced both headwinds and tailwinds during the last couple of decades. For example, the company faced serious financial struggles in the early 1990 but managed to make a turnaround through new leadership and strategies. The company also showcased skills beyond the scope of their usual line of business, as they presented substantial gains from positions in derivative instruments in 2007. The fact the Porsche could generate such substantial amounts of profits from activities outside their natural course of producing cars made people talk, and critics questioned whether this was appropriate. (WDI, 2015) To lay the foundation for the central discussion the following section will highlight the most important fact regarding Porsche and their risk management strategic.

4.1.1 Historical financial standing

During the early 1990s faced substantial headwinds from several macro variables which significantly affect Porsche financial standing at that time. The global recession was one of the key drivers which hit Porsche's sales hard, due to its profound impact on the automotive industry. Car manufacturers were faced with overall reduced customer spendings as a natural response to lower economic activity. Furthermore, demand faltered due to overall economic uncertainty which in turn led to a sharp decline in need for high-end luxury goods, and the common customer prioritized spending on necessities. (National Research Council, 1992) Moreover, Porsche had implemented an aggressive expansion strategy during the year leading up to the early 1990s, which were heavily dependent on a single model, the Porsche 911. This narrow expansion strategy made the company highly sensitive to market movements, as the sole focus on high-performance sport cars made them sensitive to changing customer preferences and wide-spread macro-economic conditions. The declining demand from changing customer preference, coupled with wide-spread and stressed economic conditions drove Porsche's sales to unprecedented low. Porsche reported a drop in unit sales of cars from 50,000 units to 14,000 units in 1993, compared to the prior fiscal period, which reflect a -72% decline in unit sales. (Porsche, 1993) Additionally, Porsche was also struggling to maintain healthy margins, as their costs were also negatively affected.

The escalating cost were mainly associated to the production and development cost of their cars. Investments in R&D, accompanied by significant manufacturing expenses, stretched their margin even further. A large part of the Porsche's financial turbulence cloud be traced back to macro events and challenging economic circumstances. However, the company's lack of adaptability and thin product portfolio stands as one of the core issues for which almost drove the company to bankruptcy. Porsche financial struggles during this time was a turning point for the company, and a signal that the organization was in need for as structural change in order to withstands though market conditions in the future. (Nash. N, 1996)

4.1.2 Change in leadership

Following the turbulence of declining sales figures and high uncertainty around Porsche's financial standing in the early 1990s, the company chose to make a substantial change. As a steppingstone to turn around the business, Wendelin Wiedeking was appointed the new CEO of Porsche in 1993. Wiedeking was brought onto the organization in order to present a fresh perspective and lead Porsche in a new strategic direction, with the objective of making the company profitable again with a more stable business model. Wiedeking had substantial experience within finance and management, with a well know reputation and great ability to turn around struggling companies. His prominent background and strong sense for companies in need of a strategic shift, made him a great fit for the financial challenges for which Porsche faced. Wiedeking's primary focus was on revitalizing Porsche's financial standing and reposition the brand in the market with a new wider product portfolio. (EuropeanCEO, 2017)

Wiekeking's initiatives under his new leadership role, was focused on operational efficiency and cost control. These areas were in particular interest for improvements as they were identified as some of the driving factors behind Porsche financial struggles previous years. Wiedeking implemented several measures to streamline production processes and optimize the utilization of resources to improve the company's overall operational effectiveness. These measures were instrumental at the time, and the focus was on increasing margins and ensuring profitability. Furthermore, Wiedeking also

recognized the importance of innovation and product development within the automotive industry, which posed strong competition. Hence, significant efforts and attention was invested in the research and development of new cutting-edge technologies and design elements for Porsche product portfolio. The strengthen focused on R&D increased the need for new engineers and former Toyota employees from Japan was brought on to support the new strategic direction that Porsche were implementing under the Wiedeking leadership. (WDI, 2015) The commitment to innovation would differentiate Porsche towards their competitors and enable the creation of a broader product portfolio. Under the new rain, Porsche Boxster was introduced as a new cheaper vehicle, appropriate for first-time buyers. A costumer group for which was previously out of reach. The new model played a pivotal role in diversifying Porsche product offering as it created a new customer group through a more diversified offering. (Bell. L, 2016)

4.1.3 EURO dollar exposure

Two of the most important market for Porsche in 2007 was the German and US automotive markets. As a German company, Porsche had since their inception established a central role as a leading player in the market for luxury vehicles in German. Porsche was, and still are, headquartered in Stuttgart, Germany where their primary operations was located, and production processes centred. In 2007, the German automotive market was characterized by a robust manufacturing sector and an ample reputation for engineering excellence. The characteristic of the German market made this the perfect hub for Porsche to excel within and fostered a natural environment for innovation and product development. (Porsche, 2007)

However, Porsche had also established themselves within the US automotive market, yielding significant sales in the US in 2007. At the time, the US market was characterized by a diverse landscape with a mixture of both domestic and foreign manufactures, for which Porsche utilized the demand for the latter substantially. Porsche market exposure to the US was highly influenced by the demand for luxury and performance vehicles. The company was strategic in their market position as a foreign player in the US market, where they strategically positioned their Porsche 911 and Cayenne models

to obtain and capture a discerning consumer segment in the US (Porsche, 2007). The substantial exposure and established market present in the US became prevalent in terms of sales generated in US dollar. However, the increase of non-domestic sales (i.e., sales generated in a different currency to Porsche home currency, for which was EURO), increased currency risk exposure. In their fiscal year of 2006/2007, Porsche exported sales amounted to 82% of their revenue (Porsche, 2007). The company's prominent exposure to the US market made Porsche sensitive EURO/dollar exchange movements, where they risked tangible losses due to the US dollar deprecating against EURO. Furthermore, the currency market, as any other financial or non-financial market, can be highly unpredictable. In fact, the EURO/dollar exchange rate experienced some substantial fluctuations during 2007. The exchange rate (dollar to EURO) started at approximately 0.77 in the beginning of the year and reached a year low at 0.67 in November 2007 (see appendix for historical EURO/dollar exchange evolution over time). For Porsche, the weakened dollar against the EURO, meant that for every sale generated in US dollar, less EURO sales would be accounted for (if not hedged) on the company's P/L. (Investing, 2024)

4.1.4 Hedging activities

As Porsche established a global market presence, such as their position as a German car manufacturer in the US, the company's exposure to foreign exchange risk naturally increased. Porsche had, as previously stated, a significant amount of sales generated in US dollar, which meant that they were sensitive to the EURO dollar exchange rate. In 2007, the company were primarily exposed to US dollar, pound sterling and Japanese yen (Porsche, 2007). For example, a weak dollar would mean that the company would experience monetary losses due to the conversion of US sales to EURO, which would effectively impact their P/L negatively. At Porsche, the foreign exchange risk was actively managed using currency derivatives, in particular foreign exchange options. Porsche implemented a hedging strategy using options to create a desired floor (i.e., the lowest dollar to EURO rate for which Porsche would have to face) for the exchange rate and locked this rate for a foreseeable future. The exchange rate floor was created through long put option contracts. A long put gives the option holder the right to sell a predetermined quantity of dollar to a predetermined price (US dollar to EURO exchange rate). Furthermore, Porsche's strategy was centred around using at-the-money (i.e.,

options where the strike price is equal to the current spot price) currency options to secure the current spot rate at that time. The company also implemented a structured strategy in terms of purchasing different maturities of the currency options. They designed the hedging program on a rolling basis and over a three-year forecasting period. This meant that the company forecasted sales for the coming three years, and structured a long (i.e., Porsche held the right to exercises the options) portfolio of at-the-money currency options. The option portfolio was encompassed of maturities ranging from a couple of months up to three years, and it was rolled on a continuous basis (Risk, 2006). Rolling options refers to the process of closing out existing positions in the contracts, and simultaneously entering new positions with different expiration dates. The purpose of rolling options is to dynamically manage the currency risk exposure and to respond to changing market conditions or extend the duration of the positions (Russell. D, 2022).

4.1.5 Ownership

Porsche was in 2007 essentially a privately held company, with a capital structure comprised of two different types of shares. The first class of shares was ordinary shares with voting rights for which were held privately. The second class of shares was preferred non-voting shares which were at free float on the stock exchanges and were thus publicly traded. The preference shares offered no voting right, i.e., no control, but offered instead an established preferred dividend yield. Even though the preferred non-voting shares were traded on public markets, the company was still considered privately held as the voting rights and control was not at public dispense (AFX, 2006). The number of ordinary shares outstanding with voting rights equalled 8.75 million in for the fiscal year of 2006/2006 and the non-voting publicly traded preference shares also amounted 8.75 million (Porsche, 2007). The ordinary voting-shares were to its entirety held by the Piech and Porsche families, keeping the control private and within the longstanding family name. While the non-voting preferred shares were, mostly held by institutional investors (AFX, 2006)

As of today, Porsche is a public company as they completed an IPO on the midst of 2022. Porsche was listed on the Frankfurt Stock Exchange on the 29th of September in 2022,

and the total share outstanding amounted to 114 million. The shares were listed to the public at a price of 76.5-82.5 Euros per share and a Market Capitalization of 75 billion EUROs (Dhawan. S, 2022).

4.2 Case facts

As a prominent German manufacturer of luxury sport cars, Porsche had a well-established brand and substantial market presence across serval geographies which permeated their financial performance for the fiscal year of 2006/2007. However, discussion emerged around Porsche and their choice of risk management strategy, as the annual report 2007 recorded sizable profits from other operations rather than solely from Porsche core business which was manufacturing and selling cars. The following section will highlight the most important details for basis of further discussion on the topic around hedging activities, currency risk exposure and the use of financial derivatives in a non-financial firm.

4.2.1 Porsche performance

In 2007, Porsche announced their outstanding financial performance and presented, yet again, record unit sales which represented financial health and growth for the company. During the year, Porsche well-established Cayenne series had undergone model changes, but despite this, Porsche still managed to increase unit sales which grew 0.7% to above 97,000 vehicles in the 2006/2007 fiscal year. The company stated that the classic Porsche 911 series was one of the main drives for continued growth over the period. The model sales presented an 8.8% increase, closing the period with above 37,000 vehicles sold across market, which represent approximately 38% of total unit sales. Some growth was also attributable to the second generation of the sporty all-terrain vehicle, Porsche Cayenne, which was positively received by customers throughout their core geographies. (Porsche, 2007)

The demand across market was high and beneficial for Porsche and their niche product offering of luxury sports cars and all-terrain vehicles. In the reporting period, Porsche announced that North America (The US and Canada) remained their largest single market with substantial parts of sales attributable to this region. Moreover, the

company also showcased growth in the Middle East, Latin America as well as southern and eastern Europe. In total, unit sales on exports markets excluding North America, rose by 9.2%, and closed at above 49,000 for the fiscal period. Furthermore, the German market posed some headwinds for Porsche. The overall German automotive industry struggled throughout the period, as an effect of the increased VAT in 2007. However, Porsche managed to present unit sales growth, despite this. German sales increased with 2.8% to approximately 14,000 vehicles, mainly driven by a 14.8% upswing of Porsche 911 model sales. Furthermore, Porsche reaped the benefits of a wide product mix, as sales revenue growth outpaced unit sales during the reporting period. Porsche recorded top-line revenue at approximately €7.40 billion end period, which represent a 3.4% increase from previous year. The more substantial revenue growth numbers, compared to unit sales for which rose only by 0.7%, was generated by Porsche product mixture, and price range of their model series. (Porsche, 2007)

Furthermore, Porsche recorded substantial profits, with an EBT (earning before tax) amounting to €5.9 billion which represent a 181% increase compared to the previous period. The sharp increase in profits for the company was mainly driven by substantial increase in other operating income (Exhibit 1). In this case, other operating income as reported on Porsche's Profit and Loss account, represent gains made through stock option trades attributable to their positions in stock option on Volkswagen shares following their acquisition of a minority stake in 2005. The recorded income from stock options was around €6.9 billion for the 2006/2007 fiscal year, which was nine times bigger than the preceding period. Furthermore, the stock option positions held by Porsche during the year generated considerable profit of €3.6 billion. The strong performance in stock option on Volkswagen, was accompanied by Porsche share of Volkswagen profits which amounted to around €1.2 billion for the reporting period. (Porsche, 2007)

4.2.2 Porsche risk management strategies

The striking financial results presented by Porsche in 2007 for their fiscal year of 2006/2007 showcased stable profits generated from their ordinary operations, i.e., producing and selling luxury vehicles. However, what was even more striking was the

portion of their bottom-line for which was not attributed to their ordinary business, but rather to positions in financial instruments. For a non-financial firm, the amount of profit generated through these positions was substantial, hence, the public interest for Porsche risk management strategies increased. (WDI, 2015)

The risk management policy prevalent in 2007, had been strongly influenced by the turbulence of financial instability in 1990, and the policy for which was implement was grounded in lessons learned from this period. The initial strategy focused on low leverage and a cushion of cash and cash equivalence to foster ample liquidity. At the time, Porsche balance sheet reflected this and showed considerably little long-term debt, which was comprised of mostly bank loans and bonds (Exhibit 2). Their financial liabilities accounted for a small fraction of their total asset. Their liquid asset was also strong and amounted to more than 2bn EURO. It was prevalent that the company was reluctant to rely on credit lines, and instead was focused on maintaining as healthy cash balance. This prudent approach to leverage was tightly connected to the struggles in 1990s and the limitation posed by unexpended credits lines. (Porsche, 2007)

Porsche also had a clear objective to hedge their position against the US dollar. The motivation for this was linked to the monetary losses incurred during the 1990 recession, as the dollar was significantly weakened. Porsche approach to their foreign exchange risk exposure was to use FX options on the US dollar, securing a certain FX rate. Porsche had long positions on the exchange rate, meaning that the company had the right but not the obligation to exercise the option if profitable. For the flexibility and upside potential, the company incurred the option premium as a cost. (WDI, 2015)

Their option strategy was focused on the purchase of at-the-money FX options to lock in the current spot exchange rate between the EURO and the dollar. This strategy created a floor for the EURO dollar exchange rate, meaning that Porsche created a minimum amount of EUROs received for every dollar revenue earned. This further stabilized Porsche's top-line revenue generated in the US. The company had set up a clear schedule for buying and rolling over put options on the EURO dollar exchange rate, and their objective was to have forecasted sales fully hedged against undesirable movements in the FX rate for the next three years. Porsche bought and rolled put

options (giving them the right to sell dollars against a predetermined amounts of EURO) with various maturities capped at three years. On July 31, 2007, Porsche currency derivative exposure was estimated as a notional value of 12bn EURO and a market value of around 0.5bn EURO. (Porsche, 2007)

The market value of Porsche's option positions reflected the value of the contracts at the time, and the notional depict the total value of underlying asset (currency rate) of their cumulative position. The 12bn EURO notional further means that Porsche had the possibility to sell 12bn EUROs worth of US dollar to the pre-determined exchange rate as stated in the option contract (at the strike price). In relation to Porsche's annual sales from operations outside of Europe, the notional of their option position was roughly three times as large. (WDI, 2015) Another fundamental part of Porsche currency risk hedging strategy was that they carried out said strategy irrespectively of the current view of the EURO dollar exchange development. The rationale behind this approach was to eliminate the impact of human emotion and adverse effects of the behavioural finance biases. The behavioural finance biases depict the phenomenon of human emotion in non-emotional decisions, and can take the shape of e.g., overconfidence of a certain outcome based on subjective beliefs (Nofsinger. J, 2023). Porsche circumvented these traps by carrying out their hedging strategy regardless of further exchange rate prospects and under the belief that it is not possible to beat the market (Risk, 2006).

4.2.3 The acquisition of Volkswagen

Porsche announced their plan to acquire a 20% stake on one of Europe's biggest car manufactures, Volkswagen, on the 26th of September 2005. The market was stunned upon the announcement as Porsche was a small player in relation to their acquisition target Volkswagen. Volkswagen was at that time a mass producer or automotives but was struggling in terms of their profitability. While Porsche was a luxury niche car manufacturer, show to be highly profitable. Volkswagen operated under their own brand name as well as under several other names such as the Skoda and Audi brand. (Porsche, 2005)

The profiles of Porsche and Volkswagen posed many differences in both in terms of financial standing and profit profiles, and in terms of size and business strategy. At the time of the acquisition, Volkswagen reported top-line revenues of nearly 100bn EUROs, representing 5 bn unit sales. Porsche on the other hand sold about 90,000 vehicles during the same period, representing about 7 bn EUROs in sales. However, the acquisition was far from arbitrary, and Porsche had a clear rationale behind their decision of acquiring a significant stake in Volkswagen. Due to their weakened position and financial standing, Volkswagen was viewed as target for potential hostile takeovers and the risk of Volkswagen being sold as parts followed. Furthermore, Volkswagen was a good part of Porsches value chain and accounted for 30% of components used in the production of Porsche cars. The fact the Volkswagen and Porsche were already closely knitted in terms om their respective value chains posed a motive for Porsche to prevent the breakup of Volkswagen, and thus laid the foundation for the proposed acquisition. Another argument for the transactions was anchored in the fact the Porsche, as a small car manufacturer, had faced difficulties obtaining economies of scale. Porsche argued that the acquisition of Volkswagen could help with achieving this and that breakup of Volkswagen would hamper their own production and effectiveness. (Muller. J, 2007)

Volkswagens business profile in 2005 was weak and this was mainly due to thin profit margins. There were mixed views on the reason for this inability to obtain and maintain satisfactory levels of profitability, but many analysts believed that this was largely due to inefficiencies throughout their production processes. It was particularly interesting how the profitability differed across subsidiaries, where e.g., Audi was perceived as highly profitable, while other subsidiaries posed a much weaker profile. The case for a takeover and a breakup of Volkswagen was thus evident, as it seemed like the sum of each separate value of Volkswagens business components was higher than the value of the combined entity. (The Economist, 2005)

At the time, however, a German Law (the Volkswagen act of 1960) was prevalent which limited any current or potential shareholder to acquire more than a 20% stake of the company. The act also governed regional government seats on the Volkswagen supervisory board. This legislative act naturally protected Volkswagen from hostile takeover bids historically. Nevertheless, the act was soon to be disregarded. In 2005 the

European Court was expected to mandate Germany to annul the Volkswagen act. The basis on the annulment was found in the argument that such law out to go against the rules of European Single Market and the free movements of capital. In 2007 the law was amended which made it possible for Porsche to make another strategic move and increase their stake in Volkswagen. In October 2006, Porsche further announced their plan to acquire additional stakes in Volkswagen, which was also accompanied by an extensive amount of call options on Volkswagen ordinary share. The new acquisition amounted to 3.9% of the company, while the options gave Porsche the right to purchase an additional 3.6%. On the 26th of March 2007, Porsche announced that they had exercised their call options which increased their total ownership to 30.9%. (WDI, 2015)

Porsche final stake in Volkswagen in 2007 was above the threshold of 30%. The above 30% ownership stake triggered a requirement (set out by law) for Porsche to make a mandatory offer for the remaining Volkswagen shares. However, Porsche made the bid the lowest price allowed by law, which was at that time 14% lower than the Volkswagens current trading, resulting in a grossly undersubscribed bid. The bid later lapsed, and Porsche was again able to freely decide on their level of desired ownership in Volkswagen. Overall, Porsche had used an extensive amount of call options to increase their stake in Volkswagen since their initial acquisition. The call options used gave Porsche the right to buy additional shares in Volkswagen to a pre-determined price. The company argued that the use of said financial instruments assessed the risk that the Volkswagen share price would increase upon their announcement to acquire more shares. (WDI, 2015)

4.2.4 Outcome

When Porsche announced their end-year results of 2006/2007, their accomplishments in terms of top-line revenues and substantial profit margins was widely appraised by the market. Porsche reported sales of above €7.4 billion and profits of €5.9 billion, which reflect a 181% increase in profits compared to the year before which reported a €2.1bn EBT. The astonishing profit margin had been significantly affected by Porsche's positions in derivative instruments, where €3.6 billion came from stock option

proceeds (accompanied by an additional €1.2 bn which was attributable to Porsche's claim on the Volkswagen's profit). (Porsche, 2007) Furthermore, Porsche's positions in currency derivatives, in particular foreign exchange option contract on the EURO dollar exchange rate, had generated around €250 million in profits during the period (WDI, 2015). This meant that Porsche's position in derivative instruments comprised around 65% of the €5.9 billion bottom line profit, with share of associates profits contributing with 20 %, leaving only around €0.9 billion, or 15%, of profit that could be attributed to Porsche's ordinary business of producing and selling luxury cars.

The fact the that such substantial amount of Porsche's profits was linked to their use of derivative instruments raised debates. As Porsche closed the fiscal year of 2006/2007 it was prevalent that their position had generated great value accompanied by strong results in their core business, however, what had been the consequence of such intense use of derivative instruments in the case that out had been unfavourable? Porsche reported a cost of stock options to be above €3.3 billion. (Porsche, 2007) The stock option cost is associated with the option premium for which Porsche paid to acquire the call option in Volkswagens shares. This cost would occurred regardless of if the potions were exercised or not. This means that instead of boosting the bottom-line, the derivative positions could have just as easily subdued reported profits. The strong profit margins reported could thus be pure luck rather than skills. Some could argue that Porsche and their risk management team had above average skills in selecting their derivative positions. While others stated that the extensive deviation from Porsche ordinary business profiled the company in a different light and that company operated almost like a hedge fund. (WDI, 2015)

5 Porsche today

Porsche has managed to maintain their well-established market position as a prominent luxury and sports car manufacturer, with a good reputation and diversified product portfolio. The company has still a wide-ranging reach with established customer groups worldwide. However, the group's risk management strategy has evolved during the latest decades as the company adapted to dynamic markets and everchanging risk factors. With the global challenges and turbulent macro environment which has permeated all aspects of the global economy, Porsche has changed the focus of their risk

management strategy to hedge the most crucial risk factors. Nevertheless, the objective of active hedges remains the same, and Porsche aim to stabilized earnings and foster liquidity and continuous to use derivative instruments as a core element of their risk management strategy. (Porsche, 2023)

5.1 Market exposure to hedging instrument

Porsche has managed to continue their international establishment and reported sale generated from several world regions in their 2022 annual report. In 2022, revenue sales were primarily generated in Europe and Asia-Pacific, for which encompassed around 80% of sales for the group. The remaining global market for which generated the outstanding 20% were North and South America, which indicate a shift in global market significance for Porsche in relation to their establishment in 2007 (see section 5.1.2). Nevertheless, Porsche profile as an international player is still prevalent today, and their exposure to foreign exchange remains but to another extent. Porsche continues to state currency risk, interest rate risk and stock price risk as the key market risks for which fall under risk management programs. However, in contrast to the extensive use of currency derivatives in 2007, Porsche stated in their 2022 annual report that the company had no significant exposure to exchanges rate fluctuations in their operating activities, and thus did not actively hedge this risk during the reporting period. (Porsche, 2023)

Nonetheless, the aftermath of the global pandemic and the invasion of Ukraine posed unprecedented challenges for the overall economic environment, ultimately effecting interest level across global markets. Porsche reported rigorous use of interest rate derivatives and the active management of this risk component in 2022. The strategic objective of Porsche's interest rate hedge is to achieve a balanced reduction in uncertainty and risk surrounding liquidity and earnings stemming from variable interest payments related to interest bearing debt. During the reporting period, Porsche experienced an incline in interest rate risk from increased variable-rate debt on their balance sheet. The interest-bearing debt is contingent on the relevant EURIBOR plus margin during the reporting period. Porsche is thus exposed to changes in the variable component of their interest rate structure (i.e., EURIBOR level), meaning that Porsche risk monetary losses from increasing interest rates, for which would lead to more

expensive financing/re-financing and interest payments. The interest rate hedge carried out during the fiscal year of 2022, was implemented through swap contracts. Interest rate swaps are structured to swap floating interest payments for fixed. Porsche held, for the purpose of their interest rate hedge, the fixed leg, meaning that they received the floating and paid a fixed rate determined in the swap contract. The floating rate received through swap contracts were thus used to cover the interest rates obligations related to Porsche capital structure. The swap contract hedges the variable-rate fluctuation and locked in a fixed rate around 2.47% during the reporting period and with terms lasting up to five years. (Porsche, 2023)

5.2 Evolution over time

It is prevalent that Porsche maintains a significant focus on hedging activities and active risk management, however, their structure and use of financial instruments has evolved and adapted to new challenges and risk factors. Porsche's risk management strategy in 2007 was mainly comprised of currency derivatives (foreign exchange options) and stock options on Volkswagen shares. The currency risk exposure for which Porsche faced, was hedged through a variation of long positions in FX options on exchange rate such as the EURO/dollar rate (Porsche, 2007). Porsche's extensive positions in FX options was related to cost associated to the option premium paid for the long position in the contract. On the contrary, in their latest report, Porsche stated that they were not significantly exposed to FX risk to the same extent, and thus did not hold any positions in currency derivatives during the latest reporting period. However, the company instead noted a substantial risk exposure to variable-rates on interest bearing debt, for which their exposure amplified during the economic turbulence and an overall high-interest rate environment in 2022 (ECB, 2023). Furthermore, the interest rate risk was hedged through interest rate swaps rather than option contract. Swaps are commonly used for the purpose of interest rate risk hedging. As with any financial instrument there are risk associated with the fair value appreciation or depreciation and the risk a particular position poses in relation to market evolution and conditions. However, swap contract is not associated with any upfront payment, as opposed to options and the associated option premium (Hull. J.C., 2015). The cost associated with swap contract could instead be an implicit fee on the swap rate, or risk of monetary losses due to non-

beneficial market movements in the underlying asset (Elsen. P, 2023). Porsche risk management strategy still implies a certain risk exposure from potential monetary losses associated with their positions. However, the risk profile of said positions has changed, as the company utilized swaps instead of options during their latest reporting period, and as the primary risk factors has shifted from currency risk to interest rate risk as defined by the company. (Porsche, 2023).

6 Discussion

The case of Porsche performance during the 2006/2007 fiscal year, and their risk strategy related thereto, fosters further discussion around the use of derivatives instruments within non-financial firms. Porsche choice of risk management strategy can be compared to other approached such as natural hedges, and the suitability for a car manufacturer to use stock options to amplify profits and be criticized and analysed from a shareholder perspective.

6.1 Hedging strategies

Against the backdrop of decades of dynamic markets globally and overall economic turbulence, the importance of corporate risk management becomes essential for large corporations. The choice of active risk management becomes central in terms of the risk profile associated with the corporation overall. Financial analysis of companies is conducted in relation to the type of firm for which the business model in question establishes. Meaning that the benchmark for which companies' risks are compared, differs among different type of business models and industries. The purpose of hedging is often to foster liquidity or stabilized cash flows, but extensive use of derivative instruments presents an additional risk factor due to the risky nature of derivatives. Monetary losses for which will affect the company's financial standing and profitability may occur in case of unfavourable market conditions and this risk may not be directly observable by the market. Nonetheless, hedging activities and active risk management through the use of derivative instruments is a common practice within large corporations and may be analysed against other risk management approaches. To create a natural hedge is another way of hedging against currency risk for example. A natural hedge is created through matching of cost and revenue components for which are generated in the same currency. This hedging structure implies that an

unfavourable movement in currency affecting revenue stream will be partly or wholly offset by an equivalent movement in cost, and thus not affecting profits. This type of hedge can therefore enable stabilization of cash flows and foster liquidity without changing the risk profile of the company by using derivative instruments. However, natural hedges are dependent on the possibility to transfer production processes to the country for which revenue stream are generated in a different currency. This aspect of a natural hedge makes this hedging strategy rigid and associated with high cost. There is a strong dependency on assets and production facilities in the country for which currency movements needs to be hedged, and there is no guarantee that the production components needed are readily available. Moreover, the cost of transferring a production facility or establishing new ones could become very high, and the cost of such establishment must be analysed in relation to the natural hedge and its upside potential. Utilizing financial markets and derivative instruments can thus be a more accessible strategy for hedging foreign exchange risk. Risk management through derivative contact is also more flexible to specific risk factors. In the case of Porsche, the primary focus of their hedging strategy was mitigating their risk exposure to foreign currencies, which stemmed from their establishment as a German car manufacturer and seller in the US. Generating substantial revenue streams in US dollar, while reporting in EURO. However, as highlighted in chapter five of this paper, Porsche focus shifted over time, and as of their latest report, their core objective of their risk management strategy was to hedge and mitigate interest rate risk. The change in focus is a natural response to the changes in the overall economy and the dynamics of capital structure. Additionally, the wide range of different types of derivative contract available, such as forwards and futures, options and, swap, make the utilization of these instruments flexible to changing market conditions. This aspect of derivatives makes them suitable for risk management within corporations for which are closely connected to the state of the economy and sensitive to macro-economic factors.

6.2 Derivatives instruments within non-financial firms

The utilization of derivative instruments for corporate risk management is, as previously stated, a widely employed strategy to mitigate various risk factors. The objective for setting up this kind of hedging strategy is clear, and a rational risk manager

wants to hedge risk factors affecting cash flows and liquidity, to the lowest cost and risk possible. The risk for which is associated with the nature of derivatives contracts must be considered in relation to the potential upside of the hedge and the rational risk manager should continuously make sure that the hedging procedures carried out does in fact mitigate risks and not amplify the overall risk associated with the company. Extensive use of derivatives contract may give rise to significant gains and the upside potential may be substantial depending on what type of contracts are utilized. There is a risk of deviation from the objective of risk management and hedging when the amount and complexity of derivatives increase. In the case of plain vanilla puts and calls for example, the risk associated with positions in these contracts is relatively straight forward and easy to assess. However, more exotic contracts may be structurally very complex, which make it harder for the risk manager as well as the company's shareholders, to analyse and assess the implied risk. Furthermore, considerable amounts of financial instruments in a non-financial firm may raise questions regarding the purpose of the firm and whether it is appropriate to engage in trading with derivative instruments if it deviates too much for the primary business. In the case of Porsche, the company was praised for their financial engineering skills and ability to generate revenue from their position in stock options and FX options. However, at the time, market conditions were favourable, and Porsche reaped the benefits from the overall state of the economy in 2007. The discussion may have been angled differently if Porsche had not managed to produce stable profits and year on year growth. The payoff from the stock options in Volkswagen, for which contributed significantly to the Porsche bottom-line in 2007, was not guaranteed. The result of this position as well as their cash flow hedge through foreign exchange options could have subdued profits rather than amplify them, which was a risk that Porsche accepted when they entered their positions. The fact that 65% of Porsche EBT margin was generated though their stock options in Volkswagen and FX hedge, is intriguing from a perspective of an unfavourable market. The substantial amounts of proceeds from derivatives are naturally celebrated when there is an obvious profit, but what would the critique have been if the same positions generated losses? Even though there are clear benefits from hedging, one could argue that the focus should remain on the ordinary business of the company, for which is, in the case of Porsche, to produce and sell vehicles. From a shareholder perspective, the analysis performed to evaluate the risk associated with a

non-financial firm is usually centred around e.g., financial matrices, profitability, growth, and industry belonging. The risk associated with hedging strategies and positions in derivative instruments may be harder to assess and not readily available. This could become problematic when a sizable portion of profits are attributable to these positions rather than the company's ordinary course of business.

7 Conclusion

The research and case study analysis for which was carried out for the purpose of this paper stress the fact that there are multiple aspects of corporate risk management within large international corporations, and that the choice of strategy ultimately comes down to internal and external factors. The case study conducted on Porsche showed that the international car manufacturer was able to deviate from their ordinary course of business and create shareholder value by increasing profits through options. The results presented by Porsche were indeed impressive, but there is no absolute evidence that the results were due to cleaver risk management. There is an additional perspective to the case for which needs to be highlighted in order to foster a comprehensive discussion around the appropriateness of extensive use of derivative instruments. The nature of derivatives creates an additional risk factor related to the firm. Furthermore, hedging instruments are rarely free, and substantial use of derivatives can accumulate large cost over time. There is also an aspect of shareholder understanding and insight. Risk management policies with large positions in derivatives, plain or exotic, can make it difficult for shareholders to comprehend the real risk exposure which in turn can lead to a misrepresentation of the risk associated with the firm. This aspect of corporate risk management creates concerns around the appropriateness of extensive and complex use of derivatives within non-financial firms. As hedging procedure often deviates from the core business of non-financial firms, one can argue that the primary focus of any company shouldn't be on trading in derivatives, but rather the ordinary business. Furthermore, the case study on Porsche from 2007 illustrated that praise and acknowledgement were given in time of success. However, if the results were reversed, there is a risk that the market wouldn't not have been as forgiving.

In conclusion, the choice of using derivative instruments for hedging purposes can in many situations be the most suitable strategy. There is ample upside potential if used in coherence with the core objective of mitigating market risk. There is a factor of flexibility and a diversity of instruments for which companies can utilized to hedge specific risks and which make it possible to adapt to everchanging markets and the dynamics of the economy. In relation to a natural hedge, derivatives instruments are more flexible in terms of duration and ability to hedge a wide variety of risk factors. However, due to the overall risky nature and cost associated with derivatives, non-financial firm should be cautious not to deviate to much from their core business. Focusing vast amounts of company resources on risk management rather than the company's initial purpose can eventually change the risk profile of the firm and may create operational inefficiencies over time.

8 Biography

8.1 Literature

Brooks, R., & Chance, R. (2009). An Introduction to Derivatives and Risk Management (8th ed.). Ohio, US: South-Western College Pub.

Crowe, S., et al. (2011). The case study approach. PMC PubMed Central Ltd. (pp. 1-2).

Hull, J. C. (2015). Options, Futures, and Other Derivatives (9th ed.). (pp. 11, 152-160).

Kozarevic, et al. (2012). The Usage of Derivatives in Financial Risk Management by Companies in Bosnia and Herzegovina. Kiel, Germany: Journal of Economics and Business. Kiel, Germany. (pp. 59-63).

Mackay, P., & Moeller, S. (2007). "The Value of Corporate Risk Management." Journal of Finance 62. (pp. 1379-1419).

National Research Council. (1992). Automotive Fuel Economy: How Far Can We Go? The Washington DC, US: National Academies Press. (pp. 90-95).

Nofsinger, J. R. (2023). The Psychology of Investing (7th ed.). New York, US: Routledge. (pp. 4-9).

Porsche SE. (1993). Porsche Annual Report 1993. Stuttgart, Germany. (pp. 72-75).

Porsche SE. (2007). Porsche Annual Report 2007. Stuttgart, Germany. (pp. 17-18, 59, 123-131, 136, 146, 167).

Porsche SE. (2022). Porsche Annual Report 2022 Stuttgart, Germany. (pp. 233-240).

WDI Publishing. (2015). Hedging at Porsche. Michigan, US: Michigan Ross School of Business.

Yin, R. (2014). Case Study Research and Applications: Design and Methods (6th ed.). Los Angeles, US: SAGE Publications

8.2 Online sources

AFX News (2006) 'Porsche to ask shareholders to approve motion to create reserve capital' [online] Available at: https://www.finanznachrichten.de/nachrichten-2006-12/7422271-porsche-to-ask-shareholders-to-approve-motion-to-create-reserve-share-capital-020.htm (Accessed: 7 January 2024)

Autonews. (2022) 'VW and Porsche's Relationship Highlighted Timeline', [online] Available at: https://europe.autonews.com/automakers/vw-and-porsches-relationship-highlighted-timeline (Accessed: 8 January 2024)

Bell, L. (2016) 'A Look Back at the Car That Saved Porsche: 20 Years of the Boxster', Road and Track, [online] Available at: https://www.roadandtrack.com/car-culture/car-design/a28621/a-look-back-at-the-car-that-saved-porsche-20-years-of-the-boxster/ (Accessed: 23 November 2023)

Corporate Finance Institute. (2023) 'Natural Hedge', [online] Available at: https://corporatefinanceinstitute.com/resources/capital-markets/natural-hedge/ (Accessed: 2 December 2023)

Dhawan, S. (2022) 'Porsche Goes Public, Listing on Frankfurt Stock Exchange', [online] Available at: https://www.financialexpress.com/business/investing-abroad-porsche-goes-public-listing-on-frankfurt-stock-exchange-check-price-ticker-2694879/ (Accessed: 7 January 2024)

ECB (European Central Bank) [online] Available at: https://www.ecb.europa.eu/stats/policy_and_exchange_rates/key_ecb_interest_rates/html/index.en.html (Accessed: 7 December 2023)

Elsen, P. (2023) 'The Real Estate Swap Cost', [online] Available at: https://www.chathamfinancial.com/insights/real-estate-swap-cost#:~:text=Borrowers%20choose%20to%20purchase%20swaps,cost%20if%20not%20negotiated%20carefully (Accessed: 7 December 2023)

EuropeanCEO. (2013) 'Wendelin Wiedeking: Porsche', [online] Available at: https://www.europeanceo.com/profiles/wendelin-wiedeking-porsche/ (Accessed: 23 November 2023)

Forbes, Muller Joann. (2007) 'Porsche VW Merger', [online] Available at: https://www.forbes.com/2007/01/09/porsche-vw-merger-biz-cz_jm_0110porsche.html?sh=2be98d75acf4 (Accessed: 8 January 2024)

Investing.com (2024) [online] Available at: https://www.investing.com/currencies/usd-eur-historical-data (Accessed: 5 January 2024)

'Cautious Porsche' (2006) Risk.net, [online] Available at: https://www.risk.net/derivatives/1526319/cautious-porsche (Accessed: 7 January 2024)

'Keeping it in the Family' (2005) The Economist, [online] Available at: https://www.economist.com/business/2005/09/29/keeping-it-in-the-family (Accessed: 7 December 2023)

Mueller, S. (2020) 'Success Stories: Ferdinand Porsche', Planet of Success, [online] Available at: https://www.planetofsuccess.com/blog/success-stories-ferdinant-porsche/ (Accessed: 7 December 2023)

Nash, N. (1996) 'Putting Porsche in the Pink', The New York Times Achieves, [online] Available at: https://www.nytimes.com/1996/01/20/business/putting-porsche-in-the-pink.html (Accessed: 23 November 2023)

Porsche Press Release (2005) 'Porsche AG Acquires Stake in Volkswagen', [online] Available at: https://www.porsche.com/usa/aboutporsche/pressreleases/pag/?id=2005-09-28&pool=international-de#:~:text=Porsche%20AG%2C%20Stuttgart%2C%20acquired%20a,cent%20in%20VW's%20voting%20capital (Accessed: 8 January 2024)

Russell, D. (2022) 'Rolling Options: Key Things for Traders to Know', Market Insight, [online] Available at: https://www.tradestation.com/insights/2022/12/31/rolling-options-key-things-for-traders-to-know-2/#:~:text=Rolling%20options%20is%20the%20practice,(ETF)%20remains%20the%20same.) (Accessed: 5 January 2024)

9 Appendix

Exhibit 1: Porsche Profit and Loss accounts 2007

Consolidated Income Statement of the Porsche Group
for the Period from August 1, 2006 of July 31, 2007

	Notes	2006/07 T€	2005/06 T€
Continuing operations			
Sales	(1)	**7,367,876**	7,122,667
Changes in inventories and other own work capitalized	(2)	162,217	172,967
Total operating performance		**7,530,093**	7,295,634
Other operating income	(3)	7,264,416	1,045,127
Cost of materials	(4)	– 3,659,520	– 3,273,507
Personnel expenses	(5)	– 1,264,325	– 1,037,475
Amortization and depreciation	(15), (16), (18)	– 531,712	– 488,758
Other operating expenses	(6)	– 4,600,099	– 1,709,318
Profit before financial income		**4,738,853**	1,831,703
Share of profit of associates	(7)	1,223,164	203,357
Financial expenses	(8)	– 272,232	– 198,916 *
Financial income	(9)	167,215	192,053 *
Financial result		**1,118,147**	196,494
Profit from ordinary activities of continuing operations		5,857,000	2,028,197
Profit from ordinary activities of discontinued operations		0	81,803
Profit from ordinary activities		**5,857,000**	2,110,000
Income taxes from continuing operations	(10)	– 1,615,000	– 713,578
Income taxes from discontinued operations	(10)	0	– 3,422
Income taxes	(10)	– 1,615,000	– 717,000
Net profit from continuing operations		4,242,000	1,314,619
Net profit from discontinued operations	(11)	0	78,381
Net profit		**4,242,000**	1,393,000
thereof profit allocable to minority shareholders	(12)	– 10,519	– 3,445
thereof profit allocable to hybrid capital investors	(13)	55,556	28,451
thereof profit allocable to shareholders of Porsche AG	(13)	4,196,963	1,367,994
Earnings per ordinary share from continiung operations (diluted and basic)	(13)	**239.80**	73.66
Earnings per ordinary share from discontinued operations (diluted and basic)	(13)	**0.00**	4.44
Earnings per preference share from continiung operations (diluted and basic)	(13)	**239.86**	73.72
Earnings per preference share from discontinued operations (diluted and basic)	(13)	**0.00**	4.50

* adjusted

Source: Porsche Annual Report 2007

Exbibit 2 Porsche Balance Sheet 2007

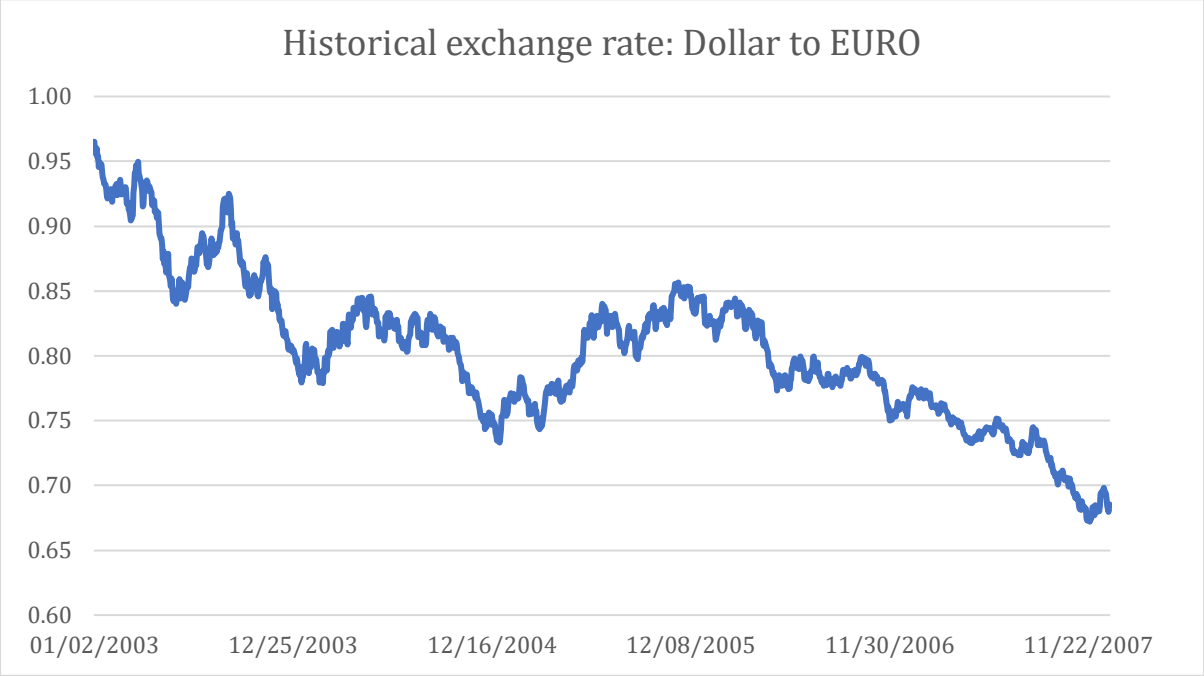
Consolidated Balance Sheet of the Porsche Group as of July 31, 2007

		Notes	July 31, 2007 T€	July 31, 2006 T€
Assets	Intangible assets	(15)	263,526	250,295
	Property, plant and equipment	(16)	1,378,435	1,178,352
	Investments in associates	(17)	7,059,333	3,263,733
	Other financial assets	(17)	67,584	27,755
	Leased assets	(18)	990,979	960,650
	Trade receivables	(20)	20,772	1,990
	Receivables from financial services	(21)	1,321,635	1,248,750
	Other receivables and assets	(22)	285,662	172,659
	Receivables of taxes on income	(23)	63,598	0
	Securities	(24)	1,014,573	713,072
	Deferred tax assets	(10)	75,114	152,930 *
Non-current assets			**12,541,211**	**7,970,186** *
	Inventories	(19)	625,209	594,080
	Trade receivables	(20)	245,136	202,981
	Receivables from financial services	(21)	459,879	434,889
	Other receivables and assets	(22)	5,604,442	1,399,988 *
	Receivables of taxes on income	(23)	27,262	1,306 *
	Securities	(24)	1,419,185	2,048,521
	Cash and cash equivalents	(25)	2,410,066	1,988,550
Current assets			**10,791,179**	**6,670,315**
			23,332,390	14,640,501 *
Equity and liabilities	Subscribed capital	(26)	45,500	45,500
	Capital reserves	(26)	121,969	121,969
	Revenue reserves	(26)	8,507,292	4,362,342 *
	Translation differences	(26)	– 3,712	– 1,821
Capital allocable to shareholders			8,671,049	4,527,990 *
	Hybrid capital	(26)	809,977	809,977
	Minority interests	(26)	0	0 *
Equity			**9,481,026**	**5,337,967** *
	Pension provisions	(27)	719,476	658,743
	Other provisions	(28)	624,234	628,512
	Deferred tax liabilities	(10)	612,826	181,764
	Financial liabilities	(29)	3,539,237	3,529,650
	Trade payables	(30)	7,480	3,875
	Other liabilities	(31)	67,007	51,219
Non-current provisions and liabilities			**5,570,260**	**5,053,763**
	Tax provisions	(28)	896,643	238,026
	Other provisions	(28)	1,161,098	1,012,522
	Financial liabilities	(29)	3,010,024	1,280,342 *
	Trade payables	(30)	505,183	478,942
	Other liabilities	(31)	2,708,156	1,238,939
Current provisions and liabilities			**8,281,104**	**4,248,771** *
			23,332,390	14,640,501 *

* adjusted

Source: Porsche Annual Report 2007

Exhibit 3: Dollar/EURO exchange rate



Source: Investing.com