UNIVERSITY OF TWENTE.

Derivative usage in low and high tech industries

Master thesis

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Acknowledgements

This thesis is the final part of the master Business Administration, where I followed the specialisation track Financial Management at the University of Twente. I would like to give my gratitude to a number of people that kept supporting me during the time I wrote it.

First of all I want to express my gratitude to my first supervisor Prof. Dr. R. Kabir, who kept on giving me constructive guidance and support throughout the whole process of writing the thesis. Moreover, I am grateful for the detailed and helpful feedback of my second supervisor Dr. X. Huang. It helped me stay motivated even though there were some struggles during the process. Finally, I want to take the opportunity to thank my family and my girlfriend for their unconditional support and encouragement during the study.

Abstract:

This research examines 141 companies from the United Kingdom in high and low tech industries. It is the first study that analyses the impact of firm factors on derivatives in comparison with high and low tech industries. The study finds that companies in low tech industries make more use of derivatives than companies in high tech industries. It might be the result of the negative impact of ownership concentration. Another finding is that companies in low tech industries are more impacted by debt maturity on derivatives usage than companies in high tech industries. Also, for general derivatives, foreign exchange derivatives and interest rate derivatives, companies in high and low tech industries are equally minimally impacted by size. According to the sample size used by this research, a difference in impact of growth opportunity (market-to-book ratio) on derivative usage cannot be predicted, a priori. Moreover, this thesis finds that companies in low tech industries are more impacted on derivative usage by international operation than are companies in high tech industries. It seems that companies in high tech industries are positively related on general derivative usage from international operations and companies in low tech industries negatively.

Keywords: Derivative, foreign exchange derivative, interest rate derivative, commodity price derivative, debt maturity, leverage, ownership concentration, international operations, executive stock options, United Kingdom.

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1. Introduction

1.1 Introduction

Firms are getting more professionalised every day and this is also the case in managing risk. More techniques are available and can be used. In this matter there is a separation of risk management techniques that might be applicable in certain circumstances. The distinction can be made between operational risk management techniques and financial risk management techniques. Operational risk management techniques are for example diversification or relocating production facilities. Other strategies that companies consider are financial policies as for example keeping leverage low (in order to reduce the risk of not being able to pay interests in the future). This research focusses on financial risk management techniques, instead of operational risk management techniques or financial policies. The focus on the financial part of risk management, or financial hedging is because of the growing interest in relatively new financial hedging techniques in the last few decades. Examples of the financial hedging technique derivatives and its underlying asset: foreign exchange derivatives (or currency derivative), interest rate derivatives and commodity price derivatives.

1.2. Prior research

Prior research by Bartram, Brown and Fehle (2009) suggest that there is some inconsistency between theory and literature that is in need of more research, thus there is significant room for research to be done on this subject. For instance, the financial distress costs theory suggests that firms with higher profitability should have less financial distress and for that reason are less likely to hedge. This is in contrast with research that show results of general derivative users that have higher Return on Assets (Bartram et al., 2009).

Prior studies in derivative usage of firms mainly focused on the influence of country specific factors on derivatives usage (Bodnar, Jong, & Macrae, 2003) and the influence firm specific factors such as firm value on derivative usage (Jin & Jorion, 2006; Fauver & Naranjo, 2010; Khediri, 2010) or the influence of firm performance on derivative usage (Allayanis & Weston, 2001). In addition, Bartram et al. (2009)

combined firm specific factors with specific factors as an influence on derivative usage (Bartram et al., 2009). It is yet to be researched whether companies in low tech and high tech industries are different in derivative usage and if this research could shed some light on whether this is the case, companies in low or high tech industries could use this information to better understand certain business behaviour in extreme industries. The companies could adapt their business strategy to attain competitive advantage.

1.3. Goal of the research

The goal of this research is to find out whether derivative usage is different between companies in low and high tech industries and if the impact of firm factors on derivative usage is different between companies of the two extreme industries. More specifically, whether the impact of firm factors on the usage of certain derivatives is different across companies in high tech industries compared to companies in low tech industries.

1.4. Possible outcomes

It might for instance be the case that there is less financial risk in certain industries which leads to less likely use of derivatives in that particular industry, where as for other industries there might be more financial risk that leads to more likely use of derivatives. Furthermore, there could be different determinants that will influence derivative usage between companies from low and high tech industries. A reason behind this difference could be the reward system of executives in high tech industries. According to Balkin, Markman and Gomez-Mejia (2000), especially in high tech industries executives are often rewarded for innovation-related activities such as R&D projects or patents, rather than of financial outcomes (Balkin, Markman, & Gomez-Meijia, 2000, p. 1126). When executives are prone to these kind of measurements it would be plausible that companies in these high tech industries are affected by external financial outcomes. An example here could be a high risk project in a different country with the risk of foreign currency fluctuations. To compensate for the financial risk and to reduce it, derivatives could be the solution.

A different way to predict derivative usage in an industry is to look at the simple needs of a regular company in a high tech or low tech industry. Bartram et al. (2009) mention in their paper that companies that use foreign exchange derivatives have higher proportions of foreign assets, sales, and income and that for example companies that use interest rate derivatives have higher leverage than companies that do not use derivatives (Bartram et al., 2009, p. 2). If companies in high tech industries would have more foreign assets, sales, and income, and/or more leverage than companies in low tech industries, logical sense would suspect that these firms in high tech industries are more likely to use (foreign exchange and interest rate) derivatives. Surprisingly, Wang, Hsu and Fang (2008) argue that for Taiwan high technology companies, R&D intensity has a strongly negative impact on internationalisation, likely because firms need to make the decision between internal growth strategies with relatively high R&D intensities and external growth strategies including internationalisation (Wang, Hsu, & Fang, 2008, p. 1392). This indicates that high tech companies are likely to have less foreign assets, sales and income and therefore, according to Bartram et al. (2009) less likely to use foreign exchange derivatives. Additionally, Hall and Lerner (2009) argue that R&D-intensive firms have considerably less leverage than other firms. This is mainly because debtholders prefer tangible assets to secure the loan, instead of R&D project investments (Hall & Lerner, 2009, p. 13). The finding of Hall and Lerner (2009) indicates high technology firms are less leveraged than low technology firms. This suggests that, according to Bartram et al. (2009), high technology firms are less likely to use interest rate derivatives. Moreover, following some theories in order to predict derivative usage. As chapter 2.3 will explain, financial distress, underinvestment, managerial risk aversion, and multinational operations of companies will probably have a positive relationship with derivative usage, whereas agency costs and hedging substitutes might have a negative relationship with derivative usage. Especially financial distress and multinational operations are hypothesised to make a difference between high and low tech industries on derivative usage.

1.5. Contribution

Prior research did not include the variable of a high or low tech industry into the equation of predicting derivative usage. For example, the study of Bodnar and Gebhardt (1999) distinguishes 11 industries and the derivative usage in those industries, but not whether those industries are high or low tech. Furthermore, Géczy, Minton and Schrand (1997) mention in their paper that companies that are involved in long-term R&D projects often try to find overseas revenue when domestic R&D

financing is too costly. When R&D decisions are centralised, there is a mismatch between domestic costs and foreign revenues. This can be mitigated by derivatives to secure cash for future investments. This research is aimed to investigate whether there is a difference in derivative usage and whether there is a differential impact of firm factors on derivative usage between companies from low and high tech industries. The contribution of this paper lies in the angle on which the research is based on. Previous literature does not investigate the technology factor in prospecting or reasoning derivative usage in an industry. Even though R&D might not be the number one driver in predicting derivative usage, it could be that it still has an influence on hedging behaviour. To my knowledge further research on this topic is lacking and could therefore be interesting to investigate and create some new light on financial hedging of firms in order to reduce risk.

1.6. Research questions

Having all the aforementioned in mind a few research questions arise: Are companies in high tech industries more (or less) likely use derivatives than companies in low tech industries? Are there differences in the impact of firm factors on the kind of derivatives (with underlying asset) that are used by companies between the two extreme industries (e.g. foreign exchange derivatives, interest rate derivatives or commodity price derivatives). If there is a difference, what is the difference and why is this present?

1.7. Overview

The remainder of this paper is organised as follows. Chapter 2 summarises relevant existing literature on derivatives, hedging and the technology intensity of an industry. The hypotheses and its explanation are included in chapter 3. Chapter 4 contains the research method, the sample and the variable explanation. Followed by the results, and conclusion in chapters 5 and 6 respectively.

2. Literature review

This chapter gives a brief summary of existing literature on the subject of derivatives, hedging and theories behind it.

2.1. Derivatives

Risk management is an important aspect of a company to survive and to keep its overall business strategy going. The usage of derivatives can be an aspect of the risk management strategy. A definition given by Grinblatt, Hiller and Titman (2011) is the following: "*A derivative is a financial instrument whose value today or at some future date is derived entirely form the value of another asset (or group of other assets), known as the underlying asset (or assets)"* (Grinblatt, Hiller, & Titman, 2011, p. 202). Financial derivatives are a mean of managing risks and to face other corporations. The most regular underlying assets of derivatives include currency, interest rate, and commodity derivatives (Guay & Kothari, 2003, p. 424). Currency or foreign exchange rate derivatives are used by companies to protect themselves against unpredicted changes in foreign exchange rates. The derivative depends on two or more currencies. Interest rate derivatives depend on movements of interest rates and as the name already says it, commodity price derivatives depend on the price of commodities. For instance, Pindyck (2001) mentions in his article that commodity prices tend to be volatile, even over time (Pindyck, 2001). In order to protect itself against these volatile commodity prices, companies can use commodity price derivatives.

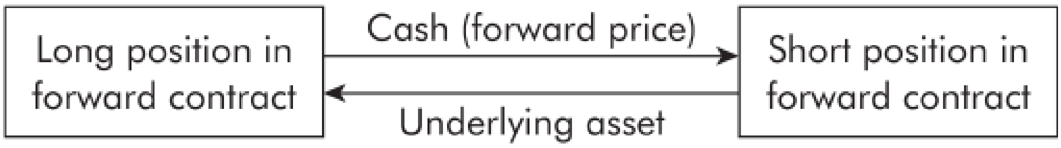
Examples of (common) derivatives are forwards, futures, options, swaps, mortgage-backed securities, and structured notes (Grinblatt et al., 2011, p. 202).

In order to offer a more thorough explanation of the examples of derivatives, the view of the long position (this case the buyer of the contract) is explained, instead of the view of the short position (this case the seller of the contract).

2.1.1. Forwards, futures, swaps and options

Forward contracts include the obligation to buy a security or commodity at a pre specified date in the future. At the maturity date, the forward price will be paid to the person or company with the short position in the contract and the underlying asset of the forward contract will go to the person or company with the long position. The concept of the forward contract is graphically viewed in figure 1. Moreover, when forwards can be traded on an organised exchange (future markets) they are often called futures.

Figure 1 – exchange of an asset in a forward contract at maturity (Grinblatt et al., 2011, p. 203)



Another illustration of a financial derivative is a swap. In short, a swap is an agreement between two persons or companies on the exchange of one's cash flow for the other's. For instance between a fixed-rate bond and a floating-rate bond. The cash flows of swaps are applicable for multiple forms, examples are interest rate swaps and currency swaps. According to Longstaff et al. (2005) the credit default swap is the most common type of credit derivative. It works as follows, there is a buying party that buys protection in terms of a fixed premium per period from the selling party until either default arises or the swap contract matures. On the other hand, when the underlying firm defaults on its debt, the selling party is obligated to buy back the defaulted bond at its par value (Longstaff, Mithal, & Neis, 2005, p. 2214), which is the face value of a bond.

Furthermore, there is a popular derivative called options. In contradiction to a forward contract, options, as the name says it already, gives a person or company the right (instead of the obligation) to buy or sell an underlying security for a certain price (strike price) already stated in the contract. Normally, options have a limited exercise time at which the right ends to buy or sell an underlying security for the strike price. There is a distinction between American and European options. American options can be exercised at any given moment between the beginning of the contract and the expiration date, whereas European options can only be exercised at the expiration date. Options are present in many forms, examples are swap options, bond options, equity options, interest rate options (caps and floors) (Grinblatt et al., 2011, p. 207). Some terminology that is used in the options area that can be handy when actually working with options is the following. Call options are the rights to buy something (for example an underlying asset) and put options are the rights to sell something. In the money means when the current price is higher than the strike price of a call option, out of the money is the opposite, when the current price is below the strike price of the call option, which in the end means that the call option will not be exercised. At the money is when the strike price is the same as the current price of the underlying asset (Grinblatt et al. 2011, p. 209).

2.1.2. Hedging and derivative usage

The terms hedging and derivative usage are often used as synonyms but this is not totally correct, when derivatives are used as a risk-reduction technique (basically a contract to buy or sell a certain asset) it is known as hedging. Consequently, when financial risks are reduced with the use of financial transactions it is called hedging and this can be in the form of derivatives. Speculating on the other hand is taking risk in order to gain the possibility of a future income.

Companies hedge for different reasons, there are several perspectives to consider. From a commercial environment perspective the reason to hedge lies in the contractual framework of the company (Pennings & Leuthold, 2000, p. 881). When the company has a contractual relationship with another company, the commercial aspect of the relationship can influence the decision to hedge. Risk might affect both companies and therefore it can be the case that a futures contract for one particular firm is needed because it also affects another company. When the other company has any influence on that particular firm it can make the hedge happen using its power (e.g. threaten to end the contract).

2.2. Firm's reasons for derivate usage

Firms make use of derivatives for two main reasons: in order to obtain new profit opportunities and in order to reduce the company's risk (Tanha & Dempsey, 2017, p. 170). Thus, there is a difference between speculation and hedging. Speculation is betting on the direction of which an asset will move in the future and hedging is to exclude volatility of risk related to price changes in the price of securities. Because companies are more interested in risk aversion and to secure their business, hedging is a more secure strategy. According to Nguyen and Faff (2010), the main motive behind financial derivatives is financial derivatives is hedging. Their research concluded that the (moderate) use of derivatives is related to risk reduction, instead of increasing risk. Therefore, the focus of this research is on hedging. Chernenko and Faulkender (2011) then found evidence that the reasons to use derivatives are because of hedging when it is endured more over time and it is speculating when the derivative usage is just over a short period (Chernenko & Faulkender, 2013). Hedging mainly include derivatives with a few underlying assets: currency derivatives, interest rate derivatives and commodity price derivatives. Research in the hedge fund industry explain that companies that use derivatives do on average have less risk, especially lower fund risks, which is market risk, downside risk, and event risk (Chen, 2011, p. 1073). Moreover, financially constrained firms are more likely to hedge, which is driven by asset substitution motives (Adam, Fernando, and Salas, 2015). This means that these firms hedge so they can take higher-risk investments to get a higher potential outcome. In the subject of selective hedging over time, Fabling and Grimes (2010) state that exporters change their hedging behaviour in currency derivatives when the currency rate differs largely from historical averages (Fabling & Grimes, 2010). Furthermore, Bodnar, Consolandi, Gabbi and Jaiswal-Dale (2013) analysed Italian firms and came to the conclusion that international trade, access to capital markets and the educational level of managers are positively related to foreign currency derivatives. Moreover, when the derivative options is compared to holding stock, Tufano (1996) shows that in the North American gold mining industry managers that hold more options manage less price risk compared to managers that hold stock (Tufano, 1996).

According to Bodnar and Gebhardt (1999) the main reason of using or not using derivitives is because of the risk of currency fluctuations in certain industries. Some industries do operate more on an international platform and others more on a national one. Industries as the construction, consumer goods retail and services are less involved in international operations and are therefore less prone to currency risks. Companies in these industries are therefore less in need of currency derivatives than companies that operate in the chemical, machinery, electro, or metals industry (Bodnar & Gebhardt, 1999, p. 7). The article stated that most companies that did not make use of derivatives do so, because they simply think that exposure is not that big. Subsequently, other popular reasons for not using derivatives are managing risk with other means, i.e. other operation strategies, and simply the lack of knowledge of the manager in derivatives.

2.3. Theories explaining derivatives usage

Several theories are explained in existing literature to investigate the derivative behaviour of companies, therefore (probably) most influential theories are explained and analysed to further understand why companies would use derivatives. An overview of the theories and its predicted relationships with derivatives usage and the distinction between companies in low and high tech industries can be seen in table 2.

2.3.1. Financial distress costs

Financial distress costs arises when a company has not sufficient liquid means to pay fixed obligations in time, as for instance wages and interest payments. Hedging in the form of derivatives then can be a tool of financial risk management to reduce the probability of a company to default and thus for that matter lower the expected value of costs that are connected to the financial distress (Bartram et al., 2009). Therefore, the financial distress costs theory predicts that firms with higher leverage, shorter debt maturity, lower interest coverage and less liquidity are more likely to use derivatives. Furthermore, financial distress has also to do with size. For instance, Nguyen and Faff (2002) use size as a part of the financial distress costs determinant. Smaller firms are more prone to default risk and are therefore more likely to use derivatives. Contradictory, larger companies have bigger means to set up such a hedging program, therefore, there is a positive relationship expected between size and the decision to use derivatives but a negative relationships expected between size and the extent of derivative usage (Nguyen & Faff, 2002). In this research the decision to use derivatives for companies is investigated and therefore a positive relationship is expected between size (of a company) and derivative usage. Furthermore, Lee and Sung (2005) argue that the relationship between size and R&D is greater when there are rapidly changing technology opportunities (Lee & Sung, 2005). This is the case for companies in high tech industries and therefore it can be expected that companies in high tech industries might be more impacted by the firm factor size.

Next, Hall and Lerner (2009) argue that R&D-intensive firms have considerably less leverage than other firms, mainly because debtholders prefer tangible assets to secure the loan, instead of R&D project investments. Thus indicating that high technology firms are less leveraged than low technology firms. Furthermore, Bartram et al. (2009) state that companies that use interest rate derivatives are more leveraged than companies that do not use derivatives (Bartram et al., 2009). This indicates that, companies that use interest rate derivatives have higher leverage than companies that do not use derivatives and therefore that companies in high tech industries are less likely to use (interest rate) derivatives than companies in low tech industries. Additionally, Bartram et al. (2009) argue that, according to the financial distress costs theory, shorter debt maturity leads likely to more derivative usage. But, when debt maturity is examined on its own and its influence on derivative usage there is a positive relationship expected between the two. Jalilvand (1999) found that companies that use derivatives have longer maturity of debt that nonusers. He argues that these companies make use of derivatives in order to reduce the adverse effects of wealth transfers between shareholders and debtholders.

2.3.2. Underinvestment

Interests of shareholders and debtholders are not always aligned, it might for example be the case that shareholders prefer high-risk investment in order to increase their share value. This in contradiction to debtholders, who only want a safe return of the loan and therefore might prefer low-risk investments. Highly leveraged companies are therefore most common with this agency problem. Underinvestment is in this matter the decisision of shareholders not investing in profitable low-risk projects.

Table 1 The expected relationships of firm factors with derivative usage

Leverage	+
Debt maturity	+
Interest coverage	-
Liquidity (quick ratio)	-
Size	+
Market-to-book ratio	+
Closely held (shares)	+
Stock options	-
International operations	-

Risk management can then mitigate the underinvestment costs (for instance costs for not choosing the profitable low-risk investment) by decreasing the volatility of firm value by using derivatives (Bartram et al., 2009). Therefore, companies that are prone to underinvestment would be more likely to be involved in derivative usage. Furthermore, the underinvestment problem might even be more likely when the company has significant growth and investment opportunities. The interests of shareholders and debtholder can be even more apart then. This is supported by Géczy et al. (1997) who argues that firms that are highly leveraged and have significant growth opportunities are more likely to have underinvestment problems. The underinvestment problem can be acknowledged with the market-to-book ratio combined with leverage, which should both be expected to be positively related to derivative usage. This is supported by the study by Graham and Rogers (2002), who argue that to minimise underinvestment problems, firms have a positive relation between hedging and debt and market-to-book ratios. This indicates that when firms have growth opportunities they are more likely to hedge, when there is an underinvestment problem (Graham & Rogers, 2002). Next, the influence of the underinvestment problem needs to be theorised on its influence on derivative usage for companies in low- and high tech industries. Gay and Nam (1998) argue that the relationship between R&D expenses and derivative usage could be driven by agency problems. In this case ‘good’ managers do not have the incentive to hide their true quality to make the best investments, when external financeing is difficult to get these managers know that hedging could be a way te get sufficient financing for the needed investements. On the other hand, ‘poor’ managers may try to hide their true quality by investing in long term R&D investments or copying hedging strategies of ‘good’ managers. Both ways, the relationship of the level of R&D and derivatives is positive. Even though for well managed firms R&D might be a proxy for investment opportunities, whereas for poor managed firms it is the result of agency problems (Gay & Nam, 1998). In this case, because of the agency problem, it is expected that companies in high tech industries would be more likely to use derivatives than companies in low tech industries.

2.3.3. Management incentives

Risk management is mainly based on decisions of managers to reduce the risk of (increasing) costs. Risk management then in the form of derivatives can be interesting for managers. This would especially be the case when managers have their own wealth invested in the company, for instance managers that have a large proportion of shares might have more incentives to hedge (Nguyen & Faff, 2002). Therefore, it is expected that managerial risk aversion is positively related to derivatives usage. To calculate whether managers have their own wealth invested in the company, the closely held shares can be analysed. Therefore, a positive relationship is expected between closely held shares and derivative usage, which is also done by Bartram et al. (2009). Agency costs are the costs incurred by asymmetric information within the company or conflicts of interest between managers and shareholders. Derivatives can then be used as a mititigation tool of all opinions. Though, Fauver and Naranjo (2010) mention in their paper that derivative usage has a negative influence on firm value for companies with greater agency and monitoring problems. Therefore, it might be preferred by companies to look at their agency and monitoring problems when derivative usage is involved. If the company is prone to these agency and monitoring problems, derivatives might not be the worthwhile. Another example of getting the right incentive of the manager is to link managers' pay to the stock price of the firm (Bartram et al., 2009). Executive stock options would reduce the risk aversion of a manager and therefore increase the need to use derivatives. Next, the relationship between management incentives and derivative usage for companies in low- and high tech industries needs to be theorised. Guay (1999) argues that R&D is positively related to CEOs' wealth to equity risk. This indicates that because there is a positive relationship expected between derivative usage and managers' wealth invested in the copmany, companies in high tech industries would be more likely to use derivatives than companies in low tech industries.

2.4. Prior studies concerning derivatives

2.4.1. Derivative usage in different industries

Bartram et al. (2009) included data of over 7000 non-financial firms across 48 countries, showed that 59.8% of the companies use derivatives in general and currency derivatives was with 43.6% the most common derivative. The study by bodnar and Gebhardt (1999) shows that German non-financial companies are more likely to use derivatives than non-financial companies from the United States, 78% against 57% (Bodnar & Gebhardt, 1999). The authors separated several industries and looked at the derivative usage within these industries, examples are utilities industry, service industry, retail, and so on. There are differences and similarities between the US and Germany in certain industries. The total usage of derivatives among the industries in these two countries can be seen in figure 2.

Figure 2 – derivative usage in multiple industries in the USA and in Germany (Bodnar & Gebhardt, 1999, p. 7)

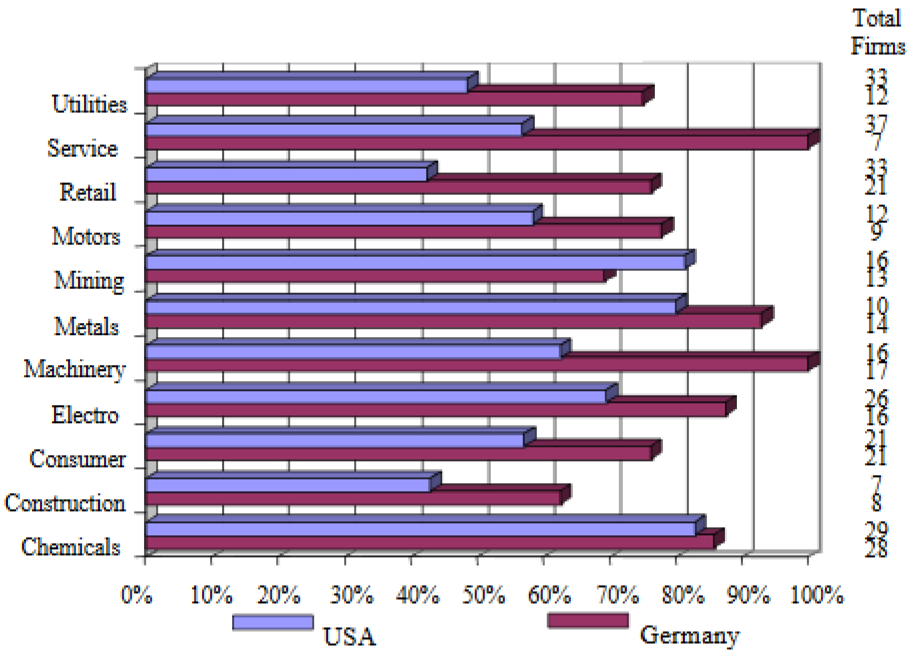


Figure 2 shows that derivative usage in the service industry in Germany is close to 100% of the sample where in the US this is around 55% of the sample. Though this is a large difference, the overall pattern is that within industries the derivative usage is broadly the same between the two countries. This implies that country-specific factors as for instance the kind of government of developed or developing economies might not be ultimately influential for the amount of derivative usage.

2.4.2. Firm factors and derivative usage

Firm specific factors such as firm value were analysed by prior research (Jin & Jorion, 2006; Fauver & Naranjo, 2010; Khediri, 2010). It seems that firm value is not directly positively related by derivative usage, Fauver and Naranjo (2010) even mention a negative relation for firms with greater agency and monitoring problems.

Allayanis and Weston (2001) on the other hand found a positive relation between firm value and the use of foreign currency derivatives (Allayanis & Weston, 2001). Furthermore, Bartram et al. (2009) combined firm specific factors (for instance leverage, coverage, quick ratio, debt maturity, size and so on) with country specific factors (for instance the rank of derivatives market, OECD membership, shareholder rights, creditor rights and so on) as an influence on derivative usage. The paper especially argues a positive relationship of firm value and interest rate derivatives. Moreover, Nguyen and Faff (2002) analysed the determinants of derivative usage of Australian companies. It seems that leverage, size and liquidity are the most important factors in the decision to use derivatives. This is in line with the financial distress theory. The paper by Afza and Alam (2011) supports the financial distress theory as well. This Pakistan research of determinants of financial derivative usage show that firms with higher debt are more likely to use derivatives.

2.4.3. Derivative usage in different countries

Prior studies in derivative usage are from all across the world, it might be the case that these country specific factors have influence on the behaviour of derivative usage in these certain countries. For instance, Bodnar et al. (2003) compare the US to the Netherlands in influence of institutional differences on risk management practices. They argue that firms from the Netherlands hedge more financial risk than firms from the US. The difference is because of an institutional nature, the Netherlands have a more open economy and are therefore more prone to foreign exchange exposure and hedge more currency risk. Though, it seems that Dutch firms almost solely rely on over-the-counter transactions, where US firms are more oriented on derivatives. As mentioned before, the paper by Bartram et al. (2009) does also compare the derivative usage of companies between countries. The (only significant) most important factor that the study found in predicting derivative usage across countries is the size of the local derivative market. Furthermore, Allayanis, Lel and Miller (2012) examined the impact of corporate governance on the use of foreign currency derivatives. They had a sample of companies across 39 countries and found that companies with strong internal or external corporate governance are significantly more likely to use foreign currency derivatives. So it could be the case that in countries where quality governance is not an exception, it would be less problematic to up hedging strategies. Then, there are also papers that investigate derivative usage in emerging countries.

For instance, Martin, Rojas, Eráusquin, Yupanqui and Vera (2009) examined this in Peru. It seems that the use of derivatives in this country is minimal and the most important factors influencing this are the degree of training in derivatives and the market regulation. Because these two factors are not improving derivative usage in this country, it can be concluded that it matters what country the company originates in.

3. Hypotheses

This chapter is divided into two parts. The first section includes the hypothesis of whether companies in low- or high tech industries would be more likely to use derivatives and the second part includes the impact of firm factors on derivative usage of companies in low- and high tech industries. Because multiple theories predict certain risk management tools and in this case derivative usage, only those who are most cited are examined in this thesis. Table 2 gives an overview of the prediction of the theories on derivative usage and table 3 gives an overview of the hypothesised relationships and impacts of firm factors with derivative usage.

3.1. The derivative usage hypothesis

The theories of chapter 2.3. can be used in order to predict the derivative behaviour of companies in both low- and high tech industries. Firstly, the financial distress cost theory. This has to do with the trade-off theory, which is a trade-off between tax advantages and financial distress costs. Managers want to reach the optimum capital structure, which is the way that the company is financed, with debt or equity. Higher amounts of debt indicate tax benefit but higher amounts of debt also lead to financial distress costs. The tax benefit of debt is that the interest that accrues from debt is tax deductible and could therefore lead to a tax advantage. Financial distress costs on the other hand could be increased with debt and could lead to direct and indirect costs. An example of a direct cost is bankruptcy costs and examples of indirect costs are managers making only short-term decisions, customer/suppliers losing faith in the company and therefore leaving the company. The financial distress costs theory predicts that firms with higher leverage, shorter debt maturity, lower interest coverage and less liquidity should have more financial distress and therefore are more likely to use derivatives (Bartram et al., 2009). The financial distress costs is mainly based on the determinant leverage and because, according to Hall and Lerner (2009), R&D intensive firms are less leveraged, it is expected that companies in high tech industries would be less likely to use derivatives than companies in low tech industries.

Other problems that could be evolving by the trade-off are agency costs. Stockholders would for instance be risk seeking, where bondholders would be risk averse. Monitoring these problems would result in more costs. This could lead to the second theory investigated by this paper, namely the underinvestment problem. An underinvestment problem arises when a manager chooses to ignore certain valuable investment opportunities because debtholders would get the larger proportion of the investment, instead of the shareholders. The manager acts on behalf of the shareholders and because the return for the shareholders is insufficient the manager will let the opportunity pass. Because the investment would have increased value for the film but it did not happen, it is a problem. The problem could especially occur when the firm is highly leveraged. It is predicted that highly leveraged firms with great growth opportunities would be more likely to have underinvestment problems, therefore it is expected that market-to-book ratio and leverage is positively related to derivative usage (Géczy et al., 1997). Furthermore, the agency problem can conclude for ‘good’ managers and ‘bad’ managers, both ways, the relationship of the level of R&D and derivatives is positive. Even though for well managed firms R&D might be a proxy for investment opportunities, whereas for poor managed firms it is the result of agency problems (Gay & Nam, 1998). Either way, companies in high tech industries would be more likely to use derivativers than companies in low tech industries.

Table 2 – The theories and their prediction in the difference in derivative usage for companies in low and high tech industries

Theory (or reasoning)	Prediction
Financial distress costs	Companies in **high** tech industries are less likely to use derivatives than companies in low tech industries
Underinvestment	Companies in **high** tech industries are more likely to use derivatives than companies in low tech industries
Management incentives	Companies in **high** tech industries are more likely to use derivatives than companies in low tech industries
(international operations)	Cannot be predicted, a piori

The third theory is about management incentives. Management incentives entails whether the management team has its own money invested in the company.

When a manager is for instance also a large shareholder of the company it is expected that the manager is more risk averse and therefor is more likely to be interested in risk management tools as for example derivatives. It is expected that managers that have their wealth invested in the copmany are more risk averse and are therefore more likely to use derivatives (Nguyen & Faff, 2002). Additionally, to mitigate the agency costs (which could be higher when the wealth of a manager is invested in the company), derivatives can be a tool. Guay (1999) argues then that CEOs' wealth to equity risk is positively related to R&D. This suggests that companies in high tech industries would be more likely to use derivatives than companies in low tech industries. Moreover, as mentioned in the introduction, Balkin et al. (2000) argue that in high tech industries executives are often rewarded for R&D projects and patents instead of financial outcomes. Higher risks of projects could then be protected by derivatives.

Furthermore, the international operations of a company. When a company has expanded its business across borders, there will change a lot. The business environment will change and on multiple levels, political, economic, regulatory and so on. Risk management should therefore also be handled differently. For instance, currency fluctuations could influence the business, in this matter derivatives could be a tool that reduces the risk of these fluctuations. For example, Bodnar and Gebhardt (1999) argue that industries as the chemical industry or the electro industry are more prone to price risks as a result of international operations. Both these examples of industries are high tech industries so it could be the case that companies in these industries are more likely to use derivatives because of the price risk in operating in a high tech industry. Other industries as construction or consumer goods retail are less prone to this price risk of international operations (and might be low tech industries), and might therefore be less likely to make use of derivatives. These findings indirectly conclude that companies in high tech industries are more prone to price risk, and executives being paid for R&D projects guides to the hypothesis that these companies are more likely to use derivatives than companies in low tech industries. In contradiction with this finding, Bartram et al. (2009) argue that companies that use foreign exchange derivatives have higher proportions of foreign assets, sales, and income (Bartram et al., 2009, p. 2). This is supported by Bodnar et al. (2013), who mentioned that companies that are involved in international trade are more likely to use foreign currency derivatives. Moreover, Wang et al. (2008) argue that for Taiwan high technology companies, R&D intensity has a strongly negative impact on internationalisation, this indicates that high tech companies have less foreign assets, sales and income and therefore, according to Bartram et al. (2009) use less foreign exchange derivatives.

As can been seen, the theories give some contradicting predictions. The financial distresss costs theory predicts that companies in low tech industries would be more likely to use derivatives than companies in high tech industries. Contradicting, the underinvestment and management incentives theories predict that companies in high tech industries would be more likely to use derivatives than companies in low tech industries. It is therefore unclear whether companies in low tech industries would be more (or less) likely to use derivatives than companies in high tech industries, but nevertheless the theories give explanations in different kind of derivatives usage between the two industries. Thus the first hypothesis is: **Differences in derivative usage between companies in low and high tech industries cannot be predicted, a priori.**

3.2. Impact of firm factors

This section includes firm factors and their relationship with derivative behaviour of companies. Not all firm factors have a clear influence on all kind of (currency, interest rate and commodity price) derivatives, as for example possibly the relationship between leverage and interest rate derivatives. The theories point out a few firm factors that could be influential in derivative usage. Financial distress costs suggests a relationship between derivative usage and leverage, debt maturity, interest coverage, liquidity and size. Underinvestment problems suggest relationships between derivative usage and market-to-book ratio combined with closely held shares. Moreover, the management incentives theory suggests a relationship between derivative usage and stock options. Furthermore, it can be expected that foreign exchange derivatives are related to international operations. An overview of the relationships of these firm factors with derivative usage can been seen in table 1. An explanation of each firm factor and its possible relationship with derivative behaviour follows below. Afterwards in table 3 are the firm factors and their relationships with derivative usage and the impact on the distinction between companies in high and low tech industries.

3.2.1. Impact of firm factors and financial distress costs

Hall and Lerner (2009) argue that R&D-intensive firms have considerably less leverage than other firms, mainly because debtholders prefer tangible assets to secure the loan, instead of R&D project investments. Thus indicating that high technology firms are less leveraged than low technology firms. Furthermore, Bartram et al. (2009) state that companies that use interest rate derivatives are more leveraged than companies that do not use derivatives (Bartram et al., 2009). This indicates that, companies that use interest rate derivatives probably have higher leverage than companies that do not use derivatives and therefore that firms in high tech industries are less likely to use interest rate derivatives. Also, the financial distress costs theory suggests that more leveraged firms are more likely to use derivatives than less leveraged firms. Thus, when companies in low tech industries are more leveraged than companies in high tech industries, the financial distress is already higher and they would therefore probably already be using derivatives. It is then expected that the impact of leverage on companies in high tech industries on their derivative behaviour would likely be larger.

Bartram et al. (2009) argue that derivatives have a negative impact on debt maturity when the whole financial distress costs theory is investigated. But, when only the maturity of debt is examined, the results differ. Jalilvand (1999) found that companies that use derivatives have longer maturity of debt that nonusers. He argues that these companies make use of derivatives in order to reduce the adverse effects of wealth transfers between shareholders and debtholders. This means that companies with more long-term debt are more likely to use derivatives. According to Bah and Dumontier (2001) R&D intensive firms would have shorter debt maturity than non-R&D firms (Bah & Dumontier, 2001). Which indicates when companies in high tech industries have shorter debt maturity, they are less likely to use derivatives. It also suggests that companies in high tech industries would be more impacted by a change in debt maturity in terms of derivative usage, compared to companies in low tech industries. The results of Afza and Alam (2011) show that interest coverage has a negative relationship with derivative usage, which means that companies that can more easily pay their interest expenses of outstanding debt are less likely to use derivatives. Because companies in high tech industries have shorter debt maturity (Bah & Dumontier, 2001) and are less leveraged than companies in low tech industries (Hall & Lerner, 2009), it can be expected that these firms could more easily change their capital structure. Therefore, when companies in high tech industries can more easily change their capital structure and therefore also change the interest coverage, their derivative usage would also be more fluctuating. Therefore it is expected that these companies in high tech industries would be more impacted by interest coverage. The relationship of liquidity and derivatives is the same as for instance interest coverage. Firms with higher liquidity (liquid current assets/total current liabilities) are less likely to default. Therefore is a negative relationship expected between the two variables, which is supported by the research of Bartram et al. (2007). Additionally, when the companies in high tech industries can more easily change their capital structure and therefore their liquidity, risk management tools as for instance derivative usage will also be faster and more efficient altered.

The impact on derivative usage of the four firm factors resulting out of the financial distress costs theory are related to each other and correlated. All four factors are predicted to have more impact on derivative usage of companies in high tech industries instead of low tech. Though, not all combinations can be used in the regression because this factor is rather correlated to the other three (table 8 and 9). This leads to the second hypothesis: **The impact of debt maturity on derivative usage is more likely to be stronger for companies in high tech industries than for companies in low tech industries.**

3.2.2. Size

Nguyen and Faff (2002) argue that because of the financial distress costs theory smaller firms are more likely to default and in terms of risk management are more likely to use derivatives. Though, larger companies have bigger means to set up a derivative program and are therefore also likely to use derivatives. A difference here is between the decision to use derivatives and the extent of derivatives. A positive relationship is expected between the decision to use derivatives and size, and a negative relationship is expected between the extent of derivative usage and size. This research is focused on the decision to use derivatives and thus is a positive relationship expected. Furthermore, Lee and Sung (2005) argue that the relationship between size and R&D is greater when there are rapidly changing technology opportunities (Lee & Sung, 2005). The technology is more rapidly changing for companies in high tech industries and therefore it is also expected that these firms are more impacted by size. Size should then also have more impact on derivative usage and therefore the third hypothesis is: **The impact of size on derivative usage is more likely to be stronger for companies in high tech industries than for companies in low tech industries.**

3.2.3. Impact of firm factors and underinvestment problems

3.2.3.1. Growth opportunity

Growth opportunity is calculated with the market-to-book ratio. The market-to-book ratio can be analysed combining with leverage, which should both be expected to be positively related to derivative usage. Graham and Rogers (2002) argue that to minimise underinvestment problems, firms have a positive relation between hedging and debt and market-to-book ratios. This is contradicting to the research of Bartram et al. (2007), they argue a negative coefficient between market-to-book ratio and derivative usage. It could be the case that firms with fewer growth opportunities hedge more in order to secure future income. Furthermore, Nguyen and Faff (2002) argue that hedgers have significantly less market-to-book value than nonhedgers. This is also in contradiction to the theory of the underinvestment problem. Because the theory and the two outcomes of studies are different it is too difficult to predict this firm factor. Therefore, the fourth hypothesis is: **A difference in impact of growth opportunity on derivative usage for companies in high and low tech industries cannot be predicted, a priori.**

3.2.3.2. Ownership concentration

Ownership concentration entails whether the company's stock is owned by individual investors or by large shareholders, shareholders that own at least 5 percent of the equity of the firm. A closely held company is then a company where the ownership is concentrated. Closely held firms include more effective monitoring, with less shareholder diversification of opinions and therefore with more desire to hedge with derivatives (Bartram et al., 2009). Di Vito, Luarin and Bozec (2010) show that highly concentrated ownership structures negatively affects R&D intensity and R&D outcomes of Canadian firms (Di Vito, Luarin, & Bozec, 2010). This suggests that R&D intensive firms would be less closely held and companies in low tech industries are more likely closely held. When companies in high tech industries are less likely to be closely held, the impact of a change in ownership would then be more gravely in derivative usage because of the positive relationship. Therefore, the fifth hypothesis is: **The impact of ownership concentration on derivative usage would likely to be stronger for companies in high tech industries than companies in low tech industries.**

3.2.3.3. Executive stock options

Bartram et al. (2009) argue that stock options can be used to get the right incentive of the manager, linking managers' pay to the stock price of the firm. Executive stock options would reduce the risk aversion of a manager and therefore lower the need to use derivatives. Therefore a negative relationships is expected between stock options and derivative usage. Furthermore, Wu and Tu (2007) argue that R&D spending and stock options are positively related to eachother in R&D intesnsive industries, especially when loose resources are available, or when performance is high (Wu & Tu, 2007), this means that investment opportunities with incentive compensation is positively related. It is therefore expected that companies in high tech industries would have more incentive compensation programs and therefore stock options and with this make less use of derivatives. This would suggest that companies in low tech industries make less use of stock options and are therefore more impacted in derivative usage when a change in executive stock options occurs. The sixth hypothesis is then: **The impact of executive stock options on derivative usage would likely to be stronger for companies in low tech industries than companies in high tech industries.**

3.2.4. International operations

Bartram et al. (2009) argue that companies that use foreign exchange derivatives have higher proportions of foreign assets, sales, and income (Bartram et al., 2009, p. 2) and Bodnar et al. (2013) mention that companies that are involved in international trade are more likely to use foreign currency derivatives. Moreover, Wang et al. (2008) argue that for Taiwan high technology companies, R&D intensity has a strongly negative impact on internationalisation. This means if companies would increase their R&D intensity, they are more likely less involved in international operations. It would indicate that high tech companies have less foreign assets, sales and income and therefore, according to Bartram et al. (2009) use less foreign exchange derivatives. This suggests that a difference in internationalisation would impact companies in high tech industries more than companies in low tech industries. Therefore, the seventh hypothesis is: **The impact of international operations on derivative usage would likely to be stronger for companies in high tech industries than companies in low tech industries.**

Table 3 - The hypothesised relationships and impacts of firm factors with derivative usage

Firm factor	**Relationship with derivative usage**	**Impact is stronger on derivative usage for (companies in low or high tech industries)**
Leverage	+	high
Size	+	high
Debt maturity	+	high
Interest coverage	-	high
Liquidity (quick ratio)	-	high
Growth opportunity	+	?
Ownership concentration	+	high
Executive stock options	-	low
International operations	+	high

4. Research method

This chapter starts with the research design of prior studies in derivative usage. Thereafter the research design of this research. The section ends with the variable description, the sample description, and the data collection method.

4.1. Research design of prior research in derivative usage

According to Tanha and Dempsey (2017), who made a comprehensive review of prior studies in derivative use, prior studies in derivative usage generally relied on surveys (Tanha & Dempsey, 2017 pp. 171, 172). A different study from New Zeeland by Berkman, Bradbury and Magan (1997) also did a survey to investigate the derivative use of New Zealand companies compared to the American derivative use and used percentages to compare the two countries with each other (Berkman, Bradbury, & Magan, 2009). Nugyen and Faff (2002) show that this kind of research can also be done by looking at the financial reports of the companies (Nguyen & Faff, 2002). The research by Bartram et al. (2009) in derivative usage is as well done by analysing annual reports, these annual reports can be looked up on the companies' websites or on general websites of annual reports as the Global Reports database[1]. Another study by Afza and Alam (2011) follows the structure of Nguyen and Faff (2002) and uses financial reports to analyse the derivative use in Pakistan (Afza & Alam, 2011). Furthermore, studies by Charumathi and Kota (2012) analyse the derivative use of Indian companies and do so by studying annual reports of Indian companies (Charumathi & Kota, 2012).

In order to analyse the determinants of derivative usage in high tech industries and low tech industries, information given by the annual reports (as for instance, leverage and international operations) needs to be modelled. Various prior papers in analysing derivative usage mention the use of logit models (Bartram et al., 2009; Tanha & Dempsey, 2017). Some authors use both logit and tobit models (Nguyen & Faff, 2002), and others only use the tobit model (Afza & Alam, 2011) or the linear multiple regression model (Charumathi & Kota, 2012). Géczy et al. (1997) investigated what the reasons of companies might be behind different hedging behaviour, for instance why firms would use currency derivatives. Their research

[1] http://database.globalreporting.org/ - global database with various reports (including annual reports) of organisations around the world

included a multinomial logit model to examine reasons behind the different hedging strategies in currency derivatives. Thus, why managers chose currency swaps, currency forwards or no currency instrument at all (Géczy et al., 1997). Additionally, Clark and Judge (2009) also include the multinomial logit in their analysis to determine foreign currency derivatives choices (Clark & Judge, 2009).

4.2. Models

The abovementioned articles mention 5 different kind of models: logit, multinomial logit, probit, tobit, and linear regression models.

4.2.1. Logit model

Logit models can be used when the dependent variable of the study is binary, it needs to be computed as 0 and 1. The logit model is then a predictive model of multiple independent variables in order to predict the binary dependent variable. It is used to calculate the probability of a certain outcome, using the independent variables. The multinational logit model is an extension of the logit model. The dependent variable of a multinomial logit model can take more values than only two as in the logit model. The dependent variable is then categorically distributed.

4.2.2. Probit model

Just like the logit model, the probit model has a dependent variable which can take only two outcomes. The difference between the probit and logit model is that the logit model uses the cumulative distribution function of the logistic distribution and the probit model uses the cumulative distribution function of the standard normal distribution. The difference is in when models are used, probit models are mostly used in deeper theoretical models by for instance economists.

4.2.3. Tobit model

The tobit model includes a dependent variable that has a maximum or minimum outcome, the outcomes below the minimum or above the maximum are censored from the research. The goal of the tobit model is to describe how the relationship is built between a dependent variable (that cannot be negative) and an independent variable. The latent variable is then depending on the parameter (independent variable).

4.2.4. The Linear regression model

The linear regression model is the most commonly used regression in predictive analysis. It can include multiple independent variables in order to predict one scalable quantitative dependent variable. It attempts to find a fitting linear equation between the variables, using the observed data. The equation is in the form of Y = a + bX, where X is the independent variable and Y the dependent variable. The ordinary least squares is a linear regression that includes a dependent variable that is continuous and could have an infinite number of possible values.

4.3. Model used in this study

In this research the dependent variable is dichotomous, whether a company uses derivatives or not. The multinomial logit model can be used for a model with a nominal dependent variable of two or more, it is comparable with the logit model but then instead of a dependent variable of two outcomes, it has three or more outcomes, which is also not needed for this research. More than 2 outcomes would be applicable when for example the determinants of the three kind of derivatives are investigated. Foreign currency derivative, interest rate derivative and commodity derivative would then be modelled as the dependent variable, but the downside of the multinomial logit model is that it can deal with only one outcome. It is therefore not suited for a combination of the three (or 4 if no derivatives is included) outcomes. The aim of this research is to discover the impact of determinants of certain companies to use derivatives. In this matter the dependent variable is dichotomous (0 if no derivative usage, 1 if the company uses derivatives). Logit and probit models are suited for this kind of predictive analysis. The tobit model is an extension of the probit model and includes a dependent variable which is censored and not needed in this research. The probit and the logit model are similar but the probit model is used by a comparable study (Bartram et al., 2009), and is therefore used (more than once).

Two types of probit models are used, the single-equation probit model with general derivative usage as dependent variable and the multivariate probit model to see a distinction in the dependent variable in terms of foreign exchange derivatives, interest rate derivatives and commodity price derivatives. With the multivariate probit model it is possible to simultaneously estimate several multiple correlated dependent variables and is therefore perfect for this research.

4.4. The model

As earlier mentioned, two single-equation probit models and two multivariate probit models are used in this study, this is comparable to the study of Bartram et al. (2009), where the same models are used.

Two single-equation probit models that include data of only companies in low tech industries ór data of only companies in high tech industries:

$Y^* = X\beta + \varepsilon$

$Pr(Y = 1 \mid X) = \phi(X\beta)$

This means that there it is a function with a dependent variable containing a success (1 if certain derivative) or a failure (0 if no certain derivative usage) and that the response variables are not identically distributed.

The function has the following variables:

$Y^* = \Sigma factor + \Sigma control + error$

$Y^* = \beta_0 + \beta_1 x_{1_i} + \beta_2 x_{2_i} + \beta_3 x_{3_i} + \beta_4 x_{4_i} + \beta_5 x_{5_i} + \beta_6 x_{6_i} + \beta_7 x_{7_i} + \beta_8 x_{8_i} + \beta_9 x_{9_i} + \beta_{10} x_{10_i} + \beta_{11} x_{11_i} + \varepsilon_i$

$Y^* =$ 1 if $Y^* > 0$,

0 otherwise

(there can be no number in between, 1 for certain derivative usage, 0 if not)

where $_i$ is a particular company and where:

Y^* = The latent variable of the decision to use derivatives

β_0 = Constant

x_{1_i} = Leverage

x_{2_i} = Debt maturity

x_{3_i} = Interest coverage

x_{4_i} = Liquidity

x_{5_i} = Size

x_{6_i} = Growth opportunity

x_{7_i} = Ownership concentration

x_{8_i} = Stock options

x_{9_i} = International operations

The two control variables are:

x_{10i} = Foreign debt

x_{11i} = Foreign listing

ε_i = Statistical error

The multivariate probit models are then used in order to simultaneously estimate multiple correlated dependent variables. In case of the two multivariate probit models there are three latent variables and thus:

Y_1^* = 1 if $Y_1^* > 0$,
0 otherwise

Y_2^* = 1 if $Y_2^* > 0$,
0 otherwise

Y_3^* = 1 if $Y_3^* > 0$,
0 otherwise

Where Y_1 counts for foreign exchange derivative usage, Y_2 interest rate derivative usage and Y_3 commodity price derivative usage.

The two single-equation probit models test the impact of firm factors on general derivative usage and two multivariate probit models estimate the impact of the firm factors on the choice of using a kind of derivative, namely whether the company makes use of foreign exchange derivatives, interest rate derivatives or commodity price derivatives. This is also done by Bartram et al. (2009).

The two single-equation probit models examine the influence of the nine independent variables on one dependent variable (general derivative usage). The two multivariate probit models examine the influence of the nine independent variables on all three kinds of derivatives. A comparison then can be made between the two single-equation probit models and between the two multivariate probit models. Both kind of models include one model that only includes data of companies in low tech industries and one model that only includes data of companies in high tech industries. This way, the impact of the firm factors on general derivative usage can be compared between companies in high and low tech industries, and the impact of the firm factors with the kind of underlying assets of the derivatives usage for companies in high and low tech industries can be compared.

Furthermore, in order to test the hypotheses the results of the models are analysed. For the first hypotheses the descriptive statistics gives sufficient information. A two proportion z-test test for comparing proportions can be conducted to accept or reject the hypothesis. For the other six hypothesis the results from the probit models in SPSS need to be investigated. The coefficients of the independent variables give information about the impact of that independent variable on derivative usage (for the single equation probit model on general derivative usage and for the multivariate probit models on all three kinds of derivative usage). Other studies as for instance the research in derivative usage in Australia from Nguyen and Faff (2002) did a comprehensive study for percentages of derivative usage per industry (Nguyen & Faff, 2002). Interesting is whether the impact of the firm factors on derivative usage is significantly different between companies in high tech industries and companies in low tech industries. Testing whether the impact is different between the two extreme industries is done by looking at the significance level of both models and especially the coefficients.

As a robustness check, multiple different combinations of explanatory variables in the same regression are run in SPSS. The regressions with combinations with most significance levels can be analysed. The comparison is between the coefficients of the companies in low tech industries versus high tech industries. For instance whether the impact of debt maturity is stronger for companies in high or low tech industries. An additional robustness check is the multivariate model, this way it can be examined whether the impact of certain independent variables is different among the three types (foreign exchange, interest rate or commodity price) of derivatives. It could be that the impact is solely because of one type of the derivatives.

4.5. Variables

This research includes several variables: nine independent variables and one or three dependent variables, depending on whether general derivative usage is investigated or underlying asset of the derivative. The nine independent variables do all have a connection to predict derivative usage in different ways. Table 3 gives an overview of the predicted relationship of the dependent variables (the firm factors) and the prediction of different impacts on derivative usage of companies in high and low tech industries. Table 4 then gives a total overview of the independent variables, how they are calculated, theories' predicted relationships with derivative usage and the

Table 4 – The independent variables of this research and their calculation, prediction and impact

Independent variable	**Measured by (year 2016)**	**Prediction for relationship with derivative usage**	**Predicted impact on derivative usage is larger for companies in low/high tech industries**
Leverage (LEV)	Total debt/total assets	+	High
Debt maturity (DM)	Total long term debt/total debt	-	High
Interest coverage (IC)	EBIT/interest over liabilities (3 year average 2014/2015/2016)	-	High
Liquidity (LIQ)	Quick ratio: liquid current assets/total current liabilities (3 year average 2014/2015/2016)	-	High
Size (SIZE)	Operating revenue (turnover)	+	High
Growth opportunity (GO)	Share price/ net book value per share	+	?
Ownership concentration (OWN)	Closely held shares/ common shares	+	Low
Executive stock options (ESO)	Dummy variable: 1 if executives have stock options, 0 if not	-	Low
International operations (INT)	International assets/ total assets	+	High

predicted impact of the independent variables on derivatives usage for companies in low and high tech industries. All the data that are used is from of the year 2016, except interest coverage, which is a 3-year average (which is also done by Bartram et al. (2009).

4.5.1. Dependent variables

The two single-equation probit models (of companies in high and low tech industries) do only have on dependent variable: general derivative usage (GD). This is 1 when the company mentions any kind of derivatives in their annual report and 0 if not. There was also the option to go for the notional amount of derivates as the dependent variable but then it is unclear whether the derivatives have a long or short position, for convenience only the decision to use derivatives is therefore used in this study. For the other two multivariate probit models it is the same but now the dependent variable is divided in different classes of derivatives: foreign exchange derivatives (FXD), interest rate derivatives (IRD) or commodity price derivatives (CPD). They should all be mentioned in the annual reports otherwise it is expected that there is no such derivatives usage. Each variable can then be put into a probit model and see whether it explains the derivative usage in low tech industries or in high tech industries.

4.5.2. Independent variables

The first independent variable is leverage (LEV), it can be calculated by dividing the total debt by the total assets, if available from the year 2017. Bartram et al. (2009) mention a positive relationship with derivatives usage and the predicted impact would be larger for companies in high tech industries. The second independent variable is debt maturity (DM), that can be calculated by dividing total long term liabilities by total liabilities. Jalilvand (1999) explain a positve relationship of debt maturity with derivative usage and the hypothesised impact would be larger for companies in high tech industries. The third independent variable is interest coverage (IC), that can be calculated by dividing Earnings Before Interest and Tax (EBIT) by interest over liabilities, in a 3 year average. Afza and Alam (2011) show a negative relationship of interest coverage with derivative usage and the hypothesised impact would be larger for companies in high tech industries. The fourth independent is liquidity (LIQ), which can be calculated with the quick ratio: liquid current assets divided by total current liabilities. Bartram et al. (2009) predict a negative relationship of liquidity with derivative usage and the hypothesised impact would be larger for companies in tech industries. The fifth independent variable is size (SIZE), which is the operating revenue (turnover). Nguyen and Faff (2002) argue that there is a positive relationship of size with derivative usage and the hypothesised impact would be larger for companies in high tech industries. The sixth independent variable is growth opportunity (GO) that is calculated with the market-to-book ratio, dividing the share price by the net book value per share. Graham and Rogers (2002) show a positive relationship of the market-to-book ratio with derivative usage. Furthermore, outcomes this research of the impact of the market-to-book ratio on derivative usage is contradicting, the difference of impact on derivative usage of companies in low and high tech industries is not clear. The seventh independent variable is ownership concentration (OWN), that can be calculated by dividing the total amount of closely held shares by common shares. Bartram et al. (2009) predict a positive relationship of closely held shares with derivative usage and the hypothesised impact would be larger for companies in low tech industries. The eighth independent variable is stock options (ESO), which is a dummy variable that is 1 if executives have stock options and 0 of executives do not have stock options. Bartram et al. (2009) predict a negative relationship of stock options with derivative usage and the hypothesised impact would be larger for companies in low tech industries. The ninth and last independent variable is international operations (INT), which can be calculated by dividing foreign sales by total sales. Bartram et al. (2009) and Bodnar et al (2013) predict a positive relationship between international operations and derivatives usage and the hypothesised impact would be larger for companies in high tech industries.

Table 5 – Explanation of control and dependent variables

Control variable	**Explanation**
Foreign debt (FOD)	Dummy variable: 1 if the company has foreign debt, 0 if not
Foreign listing (FOL)	Dummy variable: 1 if the company has foreign listing (ADR or GDR), 0 if not
Dependent variable	
General derivatives (GD)	Dummy variable: 1 if the company uses any kind of derivatives, 0 if not
Foreign exchange derivatives (FXD)	Dummy variable: 1 if the company uses foreign exchange derivatives, 0 if not
Interest rate derivatives (IRD)	Dummy variable: 1 if the company uses interest rate derivatives, 0 if not
Commodity price derivatives (CPD)	Dummy variable: 1 if the company commodity price derivatives, 0 if not

4.5.3. Control variables

To control the model a few control variables are introduced. In the research there are already a few proxies for exposures, the international operations is already a proxy for foreign exchange exposure and leverage is the proxy for interest rate exposure. Bartram et al. (2009) argue that foreign debt could be a hedging tool that is complement to derivatives, or even a substitute for derivatives, therefore foreign debt (FOD) is a control variable in this study. Furthermore, companies that have foreign listings (FOD) (either American Depositary Receipts (ADR) or Global Depositary Receipts (GDR)) are more likely to be involved in more stringent reporting requirements and are therefore more likely to hedge (Bartram et al., 2009). Foreign debt acts as a dummy variable with a value of 1 if the company makes use of foreign debt and value of 0 if not. Foreign listing is also a dummy variable with a value of 1 if the company makes use of either ADR or GDR and a value of 0 if not.

4.6. Data

In order to find out whether high tech industries are more likely to use derivatives than low tech industries, the annual reports of the companies are investigated. Using ORBIS, a selection of companies is made. These companies need to be: from the United Kingdom, listed and operate in an extreme industry (the extreme industries are explained in section 4.7.2.) Due to the fact that not all annual reports of the companies provided sufficient information that is needed for this research, the sample is reduced to 141. The sample of 141 includes 102 firms in high tech industries and 39 firms in low tech industries. The reduced sample is especially lower for companies in low tech industries because a significant amount of these firms were limited. Limited companies are private companies where the owners are legally responsible for the debt only to the extent of capital that they invested. These firms tend to share less information online and are therefore mostly removed from this research. A substantial amount of firms are categorised as PLC, this means that the firms are ‘public limited companies’. These PLC’s tend to show the sufficient information and can in a large part be used in this study. The annual reports can be looked up online on the companies’ websites or on general annual report websites as the Global Reports database. The data from annual reports is analysed and put into four probit models.

4.7. Sample description

For this research it needs to be clear what kind of companies are included, namely companies in high and low tech industries. With the classification of the OECD, industries can be titled as ‘high tech’ or ‘low tech’. With this information a research in derivative usage in the high tech sector and low tech sector can be conducted. More specifically, to do so, companies and whole industries need to be placed in the distinguished quadrants. Then analysing the companies’ derivatives usage and subsequently at (underlying assets of) the kind of derivatives the companies in these specific industries use, i.e. foreign currency, interest rate and/or commodity prices. To conduct this research in derivatives usage the database of ORBIS is used. ORBIS is an international database with large and listed firms and their company information. ORBIS has a search engine where it is possible to include specific industries in the search for companies. The industries that are included in the search are the ones that are distinguished by the OECD as high tech or low tech. Table 6 shows the industries that are included in the search for high tech industries and for low tech industries.

The selection of the industries is based on the NACE Rev. 2 code from the NACE (European Classification of Economic Activities), the NACE Rev. 2 is the European industry coding system. The coding system places companies in industries, containing four digits. The first two digits include the sections and divisions, and last two digits include the groups and classes. The total list of industries and their codes can be examined on Eurostat[2]. The NACE Rev. 2 codes are included in the table. For convenience there is also an American coding system for industries included in the company list, this is the US SIC (United States Standard Industrial Classification) code. The SIC is also a four-digit code and is comparable to the NACE Rev. 2 code. For the SIC code, the major industry group is identified by the first two digits, the third digit explains the industry group and the fourth digit is the industry. The SIC codes can be examined at siccode.com.[3] All companies in both extreme industries have to be active, have an ultimate owner and are originated in the United Kingdom. The United Kingdom is chosen because prior studies often chose for example the United States as sample. The united Kingdom is still a large economy and this way there is no country control variable needed.

If there is not sufficient information in the annual report or not even an annual report available, the company is excluded from the research. Furthermore, explanation in derivative use by companies in their annual report is often used by companies to ensure safe commerce and to attract stakeholders. Therefore, it can be expected when there is no mentioning of derivatives in the annual report, the financial instrument is not used by that particular company. On top of that, the Financial Accounting Standards (FAS) state in No. 133, that already was issued in 1998, all derivatives need

[2] http://ec.europa.eu/eurostat/documents/3859598/5902521/KS-RA-07-015-EN.PDF - pages 53-90 give the full structure of the classification of the industries, using the NACE Rev. 2 coding system
[3] https://siccode.com/en/siccode/list/directory - SIC code directory

to be recognised as either assets or liabilities at their fair value.[4] Thus, when a company uses derivatives it is stated in their annual/financial report. The information for the independent variables that is needed from the annual reports of 2016 can be found in table 4.

4.7.1. Multiple classifications high tech and low tech industries

There are several definitions for a high tech industry or a low tech industry, these definitions might differ somewhat from each other but overall the idea is more or less the same. Though, for reasons of clarification it needs to be clear what exactly in this research is meant by a high tech industry and by a low tech industry. For instance Cortright and Mayer (2001) include only the computer, electronics, instruments and software industry in the high tech sector. Their classification of a high tech industry differs from other classifications in the case that it is more focused on the cluster of firms that share similar technologies, labour force demands and markets (Cortright & Mayer, 2001, p. 9). Other classifications are more focused on the research and development intensity of a sole company, as is the classification of the OECD. Because the focus of this research is on individual companies (that are in the database of ORBIS) and their derivative use, the classification of the OECD suits the research and therefore there is a bit more explained.

4.7.2. OECD classification

The OECD bases the classification of high or low tech industries both in direct R&D intensity and R&D embodied in intermediate and investment goods (OECD, 2011). The OECD includes the industry classification index ISIC Rev. 3. (ISIC Rev. 4 is most recent United Nations classification) It is the classification of industries from the United States, where NACE Rev. 1 (NACE Rev. 2 is the most recent industry classification for Europe) is the comparable classification for Europe. ISIC Rev. 2 based the classification on only direct R&D intensity and R&D embodied in intermediate and investment goods, the ISIC Rev. 3 also includes the indirect R&D intensities were also included. The OECD mentions that because the technological effort is critical in productivity growth and international competitiveness and not widely spread across an economy, it would be helpful to analyse the industry on

[4] http://www.fasb.org/st/summary/stsum133.shtml - summary of SFAS No. 133

technological criteria. The previous version, based on ISIC Rev. 2 included three indicators of technology intensity: R&D expenditures divided by value added, R&D expenditures divided by production, and R&D expenditures plus technology embodied in intermediate and investment goods divided by production (OECD, 2011). In the newest version with ISIC Rev. 3 only the first two indicators could be calculated, because of an outdated ISIC Rev. 3 input-output table. Having this classification in mind the OECD came up with four quadrants with multiple industries.

As can been seen in figure 3 on the next page, the four quadrants are High-tech industries, medium-high-tech industries, medium-low-tech industries and low-tech industries. Then, the OECD placed the four industries with the highest amount of both direct R&D intensity as R&D embodied in intermediate and investments goods in the highest quadrant and the lowest amount of both indicators in the lowest quadrant. This means that (as can be seen in figure 3) indicators as R&D divided by production of above 5 and R&D divided by value added of above 10 are considered as high tech. On the other end are indicators as R&D divided by production of below 0.6 and R&D divided by value added of below 1.5 are considered as low tech. Examples of industries placed in the highest quadrant are pharmaceutical and aircraft/spacecraft industries, examples of industries placed in the lowest quadrant are textile industries and food production industries. The industry classification codes that the OECD used is the ISIC Rev. 3., but because the ORBIS database (thas is used for this research) is only updated until ISIC Rev. 2., the ISIC Rev. 2. is used.

As the OECD itself also mentions, the classification is not perfect. For instance, some industries involve a variety of products, high tech and low tech, but can only be put in one quadrant. Also, it could be the case that a high tech company is operating in a low tech industry or the other way around. These problems are limitations for the research. Furthermore, countries other than within the OECD might have slightly different classifications.

Figure 3 – the four quadrants of industries based on R&D intensities and R&D embodied in intermediate and investments goods (OECD, 2011)

	ISIC Rev. 3	1999			
		R&D divided by production		R&D divided by value added	
		Aggregate intensity[2]	Median intensity	Aggregate intensity[2]	Median intensity
High-technology industries					
Aircraft and spacecraft	353	10.3	10.4	29.1	27.5
Pharmaceuticals	2423	10.5	10.1	22.3	25.8
Office, accounting and computing machinery	30	7.2	4.6	25.8	15.1
Radio, TV and communciations equipment	32	7.4	7.6	17.9	22.4
Medical, precision and optical instruments	33	9.7	5.6	24.6	11.9
Medium-high-technology industries					
Electrical machinery and apparatus, n.e.c.	31	3.6	2.3	9.1	6.7
Motor vehicles, trailers and semi-trailers	34	3.5	2.8	13.3	11.7
Chemicals excluding pharmaceuticals	24 excl. 2423	2.9	2.2	8.3	7.1
Railroad equipment and transport equipment, n.e.c.	352 + 359	3.1	2.8	8.7	7.9
Machinery and equipment, n.e.c.	29	2.2	2.1	5.8	5.3
Medium-low-technology industries					
Building and repairing of ships and boats	351	1.0	1.0	3.1	2.9
Rubber and plastics products	25	1.0	1.1	2.7	3.0
Coke, refined petroleum products and nuclear fuel	23	0.4	0.3	1.9	2.7
Other non-metallic mineral products	26	0.8	0.6	1.9	1.3
Basic metals and fabricated metal products	27-28	0.6	0.5	1.6	1.4
Low-technology industries					
Manufacturing, n.e.c.; Recycling	36-37	0.5	0.5	1.3	1.2
Wood, pulp, paper, paper products, printing and publishing	20-22	0.4	0.1	1.0	0.3
Food products, beverages and tobacco	15-16	0.3	0.3	1.1	1.0
Textiles, textile products, leather and footwear	17-19	0.3	0.4	0.8	1.0
Total manufacturing	15-37	2.6	2.2	7.2	6.5

Table 6 – industries that are included in the ORBIS search for both extreme quadrants

Low tech industries	**NACE Rev. 2 Primary code**	**High tech industries**	**NACE Rev. 2 Primary code**
manufacture of food products	10	manufacture of basic pharmaceutical products and pharmaceutical preparations	21
manufacture of tobacco products	12	manufacture of computer, electronic and optical products	26
manufacture of textiles	13	manufacture of air and spacecraft machinery	303
manufacture of leather and related products	15	Repair and maintenance of aircraft and spacecraft	3316
manufacture of wood and of products of wood and cork	16	manufacture of medical and dental instruments and supplies	325
manufacture of paper and paper products	17		
Manufacture of fabricated metal products, except machinery and equipment	25		

5. Results

5.1. Univariate analysis

Several variables as for instance interest coverage, size and growth opportunity are influenced by outliers. In order to get rid of these outliers, winsorization is applied, which is also done by Giraldo-Prieto, Uribe, Bermejo and Herrera (2017), who researched the impact of derivatives on the market value of Colombian companies. For companies in low tech industries interest coverage, size and growth opportunity are winsorized at 10%, and liquidity is winsorized at 5%. For companies in high tech industries interest coverage and size are winsorized at 10%, liquidity and growth opportunity are winsorized at 5%, and leverage is winsorized at 1%. This way of winsorization, with different winsorization levels is for instance also done by Li (2006). With this winsorization technique all (extreme) outliers that are defined as 3 IQRs (interquartile range) below the first quartile or above the third quartile are readjusted. Table 7 gives an overview of the descriptive statistics, table 8 and 9 give the correlations within the samples.

5.1.1. Descriptive statistics

Table 7 illustrates the descriptive statistics. It includes all variables, with their sample N, minimum, maximum, mean, standard deviation and median. Also the difference between the two samples are presented by paired t tests for means, two proportion z tests and Wilcoxon tests for abnormal distributions. Abbreviations used in the model: GD = general derivatives; FXD = foreign exchange derivatives; IRD = interest rate derivatives; CPD = commodity price derivatives; IC = interest coverage; LEV = leverage; DM = debt maturity; LIQ = liquidity; SIZE = size of the company; GO = growth opportunity; OWN = ownership concentration; ESO = executive stock options; INT = international operations; FOD = foreign debt; FOL = foreign debt. The way these variables are calculated can be seen in table 4 and 5.

Table 7 – Descriptive statistics

Variable	N	Minimum	Maximum	Mean	Std. Deviation	Median
Panel A. Low tech industries						
Dependent variables						
GD	39	0	1	0.74	0.44	1
FXD	39	0	1	0.67	0.48	1
IRD	39	0	1	0.51	0.51	1
CPD	39	0	1	0.18	0.39	0
Independent variables						
IC	37	1.32	15.15	7.04	4.51	6.81
LEV	39	0.09	0.94	0.54	0.21	0.57
DM	39	0	0.61	0.29	0.18	0.28
LIQ	39	0.49	2.38	1.02	0.54	0.83
SIZE (x1000)	39	18.97	4507.1	1034.26	1585.96	197.76
GO	39	0.55	6.63	2.69	1.90	2.16
OWN	39	0	0.70	0.33	0.21	0.36
ESO	39	0	1	0.85	0.37	1
INT	39	0	1	0.48	0.37	0.51
Control variables						
FOD	39	0	1	0.49	0.51	0
FOL	39	0	1	0.13	0.34	0
Panel B. High tech industries						
Dependent variables						
GD	102	0	1	0.33	0.47	0
FXD	102	0	1	0.30	0.46	0
IRD	102	0	1	0.21	0.41	0
CPD	102	0	1	0.03	0.17	0
Independent variables						
IC	79	-25.34	67.63	8.14	26.60	3.08
LEV	102	0.05	1.24	0.45	0.28	0.43
DM	102	0	0.80	0.18	0.22	0.05
LIQ	102	0.67	11.25	3.18	3.09	1.71
SIZE (x1000)	102	6.78	1732	393.64	614.14	56.68
GO	102	0.59	10.61	3.42	2.88	2.57
OWN	102	0	0.93	0.39	0.24	0.40
ESO	102	0	1	0.96	0.20	1
INT	102	0	1	0.70	0.33	0.86
Control variables						
FOD	102	0	1	0.59	0.50	1
FOL	102	0	1	0.14	0.35	0

Table 7 – Descriptive statistics continued

Panel C. Mean & Median differences

	Mean low tech industries	Mean high tech industries	Significance level of P
Dependent variables			
GD	0.74	0.33	0.00
FXD	0.67	0.30	0.00
IRD	0.51	0.21	0.00
CPD	0.18	0.03	0.00
Independent variables			
IC	7.04	8.14	0.80
LEV	0.54	0.45	0.34
DM	0.29	0.18	0.15
LIQ	1.02	3.18	0.00
SIZE (x1000)	1034.26	393.64	0.00
GO	2.69	3.42	0.15
OWN	0.33	0.39	0.51
ESO	0.85	0.96	0.02
INT	0.48	0.70	0.02
Control variables			
FOD	0.49	0.59	0.29
FOL	0.13	0.14	0.88
	Median low tech industries	**Median high tech industries**	**Wilcoxon p-value**
Dependent variables			
GD	1	0	0.53
FXD	1	0	1
IRD	1	0	0.53
CPD	0	0	0.21
Independent variables			
IC	6.81	3.08	0.97
LEV	0.57	0.43	0.96
DM	0.29	0.05	0.34
LIQ	0.83	1.71	0.01
SIZE (x1000)	197.76	56.684	0.13
GO	2.16	2.57	0.49
OWN	0.36	0.40	0.09
ESO	1	1	0.06
INT	0.51	0.86	0.00
Control variables			
FOD	0	1	0.00
FOL	0	0	0.01

Derivative usage shows a significant difference for companies in low tech industries compared to companies in high tech industries. On average the companies in low tech industries are substantially more involved in general derivative usage than companies in high tech industries, 0.74 versus 0.33. Most of these derivatives are foreign exchange derivatives, 67% percent of companies in low tech industries use them and of the 30% of the companies in high tech industries. Close to half of the firms of low tech industries use interest rate derivatives, and 18% percent of them use commodity price derivatives. For firms in high tech industries these numbers are only 20% and 3%. All these kinds of derivatives are significantly different in means between the two extreme industries.

Interest coverage is calculated by the EBIT divided by the interest expenses. Some firms do not have long term debt and with this no interest costs, therefore the calculation is divided by zero, hence not possible for all firms. Looking at the minimum values for both extreme industries, some values seem negative, if the IC is negative the company is making a loss. The variable could then be highly negative because of small interest expenses or because of large negative earnings (Blume, Lim and Mackinlay, 1998). Though, the firms that are included in the calculation do not give a significant difference in mean and neither in median. Furthermore, table 7 shows that companies in low tech industries are more leveraged than companies in high tech industries, 54% against 45%, though the difference is not significant.

For debt maturity it is comparable only with the exception that the difference between low and high tech is significant. Mean debt maturity is larger for companies in low tech industries than it is for companies in high tech industries, 0.29 against 0.18. It might suggest that it is easier for companies in low tech industries to attract long term investors, because debtholders prefer tangible assets to secure the loan, which is more present with companies in low tech industries, as is supported by the research of Hall and Lerner (2009).

Moreover, liquidity numbers show that companies in low tech industries are substantially less liquid than companies in high tech industries, 1.02 versus 3.18, and also significant.

On average, bigger companies in low tech industries are used, compared to the companies in high tech industries, 1034.26 versus 383.64, the table shows a significant difference in means but not in the Wilcoxon p-value of difference in medians.

Growth opportunity is slightly smaller for companies in low tech industries than high tech, 2.69 versus 3.42, which indicates that the companies that are used in high tech industries are higher valued, compared to the book value. That high tech firms would have more growth opportunities than low tech firms is supported by the research of Chan, Kensinger Keown and Martin (1997). Subsequently, ownership concentration is also slightly more present in high tech industries, 0.39 versus 0.33. What points out here is that the minimum is zero, this would suggest that ownership is not concentrated in that particular firm. This is partly true, it only means that there is no party that owns more than 5% of the firm, there could be parties that own up to 4.99%, but not more. Though, growth opportunity and ownership concentration are not significantly different from each other (high versus low). Almost all the firms in high tech industries included executive stock options (96%), where for low tech industries this was 85%. It seems that the high tech industries are more international, as the companies' revenue are for 70% from abroad, where for the companies in low tech industries, the revenue is originated almost half from other countries (48%). Both stock options and international operations are significantly different in terms of means (high versus low). Foreign debt and foreign listing are probably more present in companies from high tech industries because of the international operations. Foreign debt is slightly higher with means of 0.59 versus 0.49 and foreign listing is 0.14 versus 0.13, but are both not significant in terms of means, the Wilcoxon p-value shows on the other hand a significant difference of medians.

The financial distress costs theory (Bartram et al., 2009) could explain why the companies in low tech industries would be more leveraged and less liquid and therefore would make more use of derivatives. This would also explain why debt maturity is longer for companies in low tech industries compared to companies in high tech industries. Also, according to the financial distress theory larger companies have bigger means to set up a hedging program and therefore is a positive relationship expected between size and the decision to use derivatives (Nguyen & Faff, 2002). This could also be the case in this research where bigger companies in low tech industries are on average more invested in derivative usage than companies in high tech industries. To minimise underinvestment problems it is predicted that firms with higher leverage and larger market-to-book ratios are more likely to be involved in derivative usage (Graham and Rogers, 2002). On the contrary, the descriptive statistics of this research show that companies in low tech industries are more leveraged but have a smaller market to book ratio, compared to companies in high tech industries. Though, these companies in low tech industries make more use of derivative usage. Guay (1999) argues that R&D is positively related to CEOs' wealth to equity risk. This would indicate that executives of companies in high tech industries would be more likely to have stock options, this is also the case for the UK sample. In contradiction, it is expected that companies with more international operations would be more involved in (at least foreign exchange) derivative usage. The averages of the table 7 do not show this relationship, because the companies in high tech industries in the UK are more international but are less involved in derivative usage on average. Though, it could be the case that later on the model shows that it is different for companies on itself.

5.1.2. Correlation matrices

As can be seen in the correlation matrix in table 8 and 9, there are a few independent variables that are correlated to each other, also multiple independent variables with dependent variables which indicates that there is some kind of relationship between the independent and dependent variables. The significance value of p of the correlation is two-tailed. If a * is behind a value the correlation is significant at the 0.05 level and if ** is behind a value the correlation is significant at the 0.01 level. Examples of moderately strong correlated independent variables in low tech industries are leverage with debt maturity (0.561**), leverage with liquidity (-0.579**) and leverage with growth opportunity (0.530**), and another example is debt maturity with liquidity (-0.432**) and debt maturity with growth opportunity (0.449**). Other moderately strong to strong correlated independent variables are size with international operations (0.506**) and size with both the control variables foreign debt and foreign listing (0.457** and 0.766**). Additionally, growth opportunity with ownership concentration (-0.421**), growth opportunity with control variable foreign listing (0.441**), and international operations with both control variables foreign debt and foreign listing(0.720** and 0.461**).

For high tech industries it is comparable with the exception of the correlation with growth opportunity. For instance leverage and liquidity (-0.592**) and debt maturity with size (0.469**). Though, companies in high tech industries also include correlations for ownership concentration with size (-0.422**). Thus, as expected, debt maturity cannot can be used in the regression for instance with a combination with leverage or size, as other moderately to strong correlated combinations. Furthermore, size is correlated with almost all other independent variables. For companies in low tech industries especially with international operations (0.506**), ownership concentration (-0.414*), leverage (0.383*), debt maturity (0.392*), liquidity (0.375*) and growth opportunity (0.368*). This indicates that it might be difficult to include size in a lot of combinations in the regression. For companies in high tech industries size is also highly correlated with the abovementioned independent variables, with the exception of growth opportunity.

Moreover, the dependent variables foreign exchange derivatives, interest rate derivatives and commodity price derivatives values of correlation with each other, especially in low tech industries foreign exchange derivatives with interest rate derivatives (0.508**). In high tech industries this is the same case for foreign exchange derivatives with interest rate derivatives (0.612**). The strong correlation between foreign exchange derivatives and interest rate derivatives is supported by Bartram et al. (2009) that show that foreign exchange derivatives are correlated with interest rate derivatives with the value of 0.41**. The correlation between general derivatives with the different types of derivatives can be ignored, because these correlations just explain the type of general derivative that is used most often.

Table 8 - Correlations of the variables in high tech industries

	IC	LEV	DM	LIQ	SIZE	GO	OWN	ESO	INT	FOD	FOL	GD	FXD	IRD	CPD
IC	1														
LEV	-0.070	1													
DM	-0.177	0.389**	1												
LIQ	-0.186	-0.592**	-0.292**	1											
SIZE	0.069	0.274**	0.469**	-0.346**	1										
GO	-0.181	0.185	0.091	0.074	-0.024	1									
OWN	-0.154	-0.247*	-0.222*	0.281**	-0.422**	0.025	1								
ESO	-0.214	0.017	0.055	0.008	0.079	-0.104	-0.011	1							
INT	-0.034	0.015	0.098	-0.029	0.314**	-0.068	-0.173	-0.036	1						
FOD	-0.132	0.212*	0.345**	-0.334**	0.481**	-0.161	-0.213*	-0.066	0.435**	1					
FOL	0.062	0.373**	0.142	-0.188	0.467**	-0.030	-0.281**	0.081	0.165	0.276**	1				
GD	0.153	0.240*	0.489**	-0.378**	0.712**	0.015	-0.387**	0.036	0.201*	0.380**	0.262**	1			
FXD	0.163	0.199*	0.376**	-0.344**	0.751**	-0.040	-0.391**	0.024	0.310**	0.423**	0.294**	0.934**	1		
IRD	-0.068	0.317**	0.556**	-0.338**	0.704**	0.073	-0.314**	0.103	0.090	0.327**	0.361**	0.720**	0.612**	1	
CPD	-0.029	0.146	0.196*	-0.104	0.256**	0.040	-0.175	0.035	0.108	0.146	0.099	0.246*	0.263**	0.055	1

Note: IC = interest coverage; LEV = leverage; DM = debt maturity; LIQ = liquidity; SIZE = size of the company; GO = growth opportunity; OWN = ownership concentration; ESO = executive stock options; INT = international operations; FOD = foreign debt; FOL = foreign debt; GD = general derivatives; FXD = foreign exchange derivatives; IRD = interest rate derivatives; CPD = commodity price derivatives. The way these variables are calculated is presented in table 4 and 5.
**Significant at the 0.01 level.
*Significant at the 0.05 level.

Table 9 - Correlations of the variables in low tech industries

	IC	LEV	DM	LIQ	SIZE	GO	OWN	ESO	INT	FOD	FOL	GD	FXD	IRD	CPD
IC	1														
LEV	-0.251	1													
DM	-0.342*	.561**	1												
LIQ	0.099	-0.579**	-0.432**	1											
SIZE	-0.029	0.383*	0.392*	-0.375*	1										
GO	-0.121	0.530**	0.449**	-0.259	0.368*	1									
OWN	0.037	-0.318*	-0.147	0.228	-0.414	-0.421**	1								
ESO	-0.085	-0.023	0.009	0.116	0.203	0.256	-0.250	1							
INT	0.088	-0.053	0.205	0.111	0.506**	0.032	-0.167	0.041	1						
FOD	-0.064	-0.033	0.243	0.083	0.457**	-0.021	-0.053	-0.011	0.720**	1					
FOL	0.036	0.304	0.277	-0.247	0.766**	0.441**	-0.360*	0.164	0.461**	0.393*	1				
GD	0.246	0.379*	0.581**	-0.387*	0.371*	0.391*	-0.155	0.075	-0.037	0.102	0.225	1			
FXD	0.219	0.261	0.485**	-0.325*	0.382*	0.306	0.106	0.000	0.024	0.254	0.271	0.830**	1		
IRD	-0.074	0.241	0.507**	-0.306	0.568**	0.170	-0.176	0.011	0.255	0.232	0.374*	0.602**	0.508**	1	
CPD	-0.128	0.125	0.158	-0.025	0.469**	-0.132	-0.139	0.199	0.148	0.213	0.220	0.275	0.189	0.322*	1

Note: IC = interest coverage; LEV = leverage; DM = debt maturity; LIQ = liquidity; SIZE = size of the company; GO = growth opportunity; OWN = ownership concentration; ESO = executive stock options; INT = international operations; FOD = foreign debt; FOL = foreign debt; GD = general derivatives; FXD = foreign exchange derivatives; IRD = interest rate derivatives; CPD = commodity price derivatives. The way these variables are calculated is presented in table 4 and 5.

**Significant at the 0.01 level.

*Significant at the 0.05 level.

5.2. Regression results

In order to test the relationships between derivative usage and several firm factors the probit models are performed in the statistical program SPSS, the outcomes of these models are presented in table 10 and 11. Table 10 presents the parameter estimates of the coefficients of companies in high tech industries and table 11 presents the same estimates of the companies in low tech industries. The tables include the firm factors that had the most influence with the most significant combinations on derivative usage without multicollinearity. The stars in the tables present the level of significance and the numbers in parentheses are the standard errors. Chapter 3 explains all seven hypotheses that are included in this paper. This section contributes to the outcomes of these hypotheses. An overview of the hypotheses and the outcomes are in table 12. The paragraphs will start with the hypothesis and will follow with the answer to the hypothesis using its belonging variables.

H1: Differences in derivative usage between companies in low and high tech industries cannot be predicted, a priori. Table 7 can be used to examine this hypothesis. The table presents there is actually a difference between the two extreme industries in derivative usage. Companies in low tech industries are significantly using more derivatives than companies in high tech industries (74% against 33%). The financial distress costs is supports this outcome, because the theory is mainly based on the determinant leverage and because, according to Hall and Lerner (2009), R&D intensive firms are less leveraged, it is expected that companies in high tech industries would be less likely to use derivatives than companies in low tech industries. Furthermore, table 7 shows that companies in high tech industries are indeed slightly less leveraged so that could be the underlying reason. Though, a larger sample size might give more straightforward solutions. On the other hand for companies in high tech industries firms that are more closely held (ownership concentration) are less likely to use derivatives so it might be the case that this is an influential variable, but then again it cannot be compared to the variable for companies in low tech industries, because only foreign exchange derivatives show small values of positive relations for companies in low tech industries.

H2: The impact of debt maturity on derivative usage is more likely to be stronger for companies in high tech industries than for companies in low tech industries. In order to examine this hypothesis, table 10 and table 11 can be looked at. For companies in high tech industries debt maturity show significant positive relations

Table 10 – Probit estimations companies in high tech industries

	Single-equation models (GD)					Multivariate models					
	1	2	3	4	5	6			7		
Independent variables						FXD	IRD	CPD	FXD	IRD	CPD
DM	2.49***		2.54***	2.59***	2.95***	0.60***	0.89***	0.12			
	(0.71)		(0.66)	(0.68)	(0.63)	(0.18)	(0.15)	(0.08)			
SIZE		0.00***							0.00***	0.00***	0.00**
		(0.00)							(0.00)	(0.00)	(0.00)
GO	0.00			-0.00							
	(0.06)			(0.06)							
OWN	-1.93***					-0.53***	-0.23	-0.09			
	(0.68)					(0.18)	(0.14)	(0.07)			
ESO											
INT	0.20		0.40	0.47	0.96*				0.09	-0.20**	0.01
	(0.58)		(0.57)	(0.57)	(0.51)				(0.10)	(0.10)	(0.06)
Control variables											
FOD	0.72*	0.09	0.64*	0.73**					0.06	0.03	0.01
	(0.39)	(0.38)	(0.37)	(0.37)					(0.08)	(0.07)	(0.04)
FOL		-0.88	0.56			0.23*	0.30***	0.02	-0.11	0.05	-0.01
		(0.77)	(0.41)			(0.12)	(0.10)	(0.05)	(0.10)	(0.10)	(0.06)
Adj. R^2	0.32	0.50	0.29	0.27	0.25	0.25	0.39	0.03	0.56	0.50	0.03
F-stat.	41.43***	61.40***	34.54***	32.66***	28.44***		96.79***			45.93***	
Obs.	102	102	102	102	102	102	102	102	102	102	102

Note: The thesis includes two types of models: single-equation probit models with general derivatives as the dependent variable (model 1, 2, 3, 4 and 5) and two multivariate probit models (model 6 and 7) with foreign exchange derivatives, interest rate derivatives and commodity price derivatives as dependent variables. GD = general derivatives; FXD = foreign exchange derivatives; IRD = interest rate derivatives; CPD = commodity price derivatives; DM = debt maturity; SIZE = size of the company; GO = growth opportunity; OWN = ownership concentration; ESO = executive stock options; INT = international operations; FOD = foreign debt; FOL = foreign debt. The way these variables are calculated is presented in table 4 and 5. F-stat is the F-statistic. Figures in parentheses represent the standard error.
***Significant at the 0.01 level; **Significant at the 0.05 level; *Significant at the 0.10 level.

Table 11 – Probit estimations companies in low tech industries

	Single-equation models (GD)					Multivariate models					
	1	2	3	4	5	6			7		
Independent variables						FXD	IRD	CPD	FXD	IRD	CPD
DM	21.64*		7.58***	10.57**	8.12***	1.19***	1.20***	0.21			
	(21.64)		(2.68)	(4.28)	(2.64)	(0.38)	(0.40)	(0.36)			
SIZE		0.00**							0.00*	0.00***	0.00***
		(0.00)							0.00	0.00	0.00
GO	2.24*			1.06**							
	(1.32)			(0.51)							
OWN	4.89					0.60*	-0.06	-0.12			
	(3.52)					(0.35)	(0.37)	(0.33)			
ESO											
INT	-6.32*		-2.39*	-3.07*	-1.47				-0.64**	-0.03	-0.17
	(3.70)		(1.44)	(1.77)	(0.92)				(0.29)	(0.29)	(0.23)
Control variables											
FOD	2.01	0.08	0.68	0.85					0.38*	-0.02	0.09
	(1.52)	(0.71)	(0.96)	(1.09)					(0.20)	(0.29)	(0.16)
FOL		-37.30	5,90			0.33	0.37	0.19	-0.01	-0.22	-0.37
		(14964)	(11625)			(0.22)	(0.23)	(0.21)	(0.33)	(0.33)	(0.26)
Adj. R^2	0.31	0.08	0.32	0.33	0.33	0.26	0.26	-0.02	0.18	0.26	0.19
F-stat.	28.90***	23.81***	20.43***	26.10***	18.71***		6.69			8.22	
Obs.	39	39	39	39	39	39	39	39	39	39	39

Note: The thesis includes two types of models: single-equation probit models with general derivatives as the dependent variable (model 1, 2, 3, 4 and 5) and two multivariate probit models (model 6 and 7) with foreign exchange derivatives, interest rate derivatives and commodity price derivatives as dependent variables. GD = general derivatives; FXD = foreign exchange derivatives; IRD = interest rate derivatives; CPD = commodity price derivatives; DM = debt maturity; SIZE = size of the company; GO = growth opportunity; OWN = ownership concentration; ESO = executive stock options; INT = international operations; FOD = foreign debt; FOL = foreign debt. The way these variables are calculated is presented in table 4 and 5. F-stat is the F-statistic. Figures in parentheses represent the standard error. ***Significant at the 0.01 level; **Significant at the 0.05 level; *Significant at the 0.10 level.

with derivative usage, with coefficients around 2.5. Thus it seems that companies that have more long term debt are more likely to use derivatives, especially interest rate derivatives with the high the highest coefficient out of the three types of derivatives with 0.89***. The coefficients for companies in low tech industries on general derivative usage are even larger (around 10), so a stronger more positive impact of debt maturity on derivative usage. Also the impact on foreign exchange derivatives and interest rate derivatives is for companies in low tech industries higher with values of 1.19*** and 1.20*** where these values are 0.60*** and 0.89*** for companies in high tech industries. The positive relationships of debt maturity with derivative usage is supported by Jalilvand (1999), who argues that these companies make use of derivatives in order to reduce the adverse effects of wealth transfers between shareholders and debtholders. The debt maturity coefficient for the single-equation models does show higher values for companies in low tech industries than for companies in high tech industries, with coefficients around 10 for low tech industries and around 2.5 for high tech industries. So it seems that the hypothesis needs to be rejected, because it is the other way around. Companies in low tech industries are more impacted by debt maturity than companies in high tech industries.

H3: The impact of size on derivative usage is more likely to be stronger for companies in high tech industries than for companies in low tech industries. Size shows highly significant numbers in both samples, but the coefficients on derivative usage is in both samples 0.00***, which means that the impact significant but is minimal. The multivariate models show the same effect for companies in high and low tech industries. In this case there is no clear difference between the two extreme industries and the hypothesis can therefore be rejected. Nguyen and Faff (2002) had the same kind of results, they could also not predict the explanatory variable size and the outcome was also 0.00.

H4: A difference in impact of growth opportunity on derivative usage for companies in high and low tech industries cannot be predicted, a priori. When growth opportunity is investigated, it points out that only companies in low tech industries are slightly more likely to use derivatives when the market-to-book ratio (growth opportunity) is higher, with a coefficient of 2.24* and 1.06**. The positive relationship is supported by Graham and Rogers (2002), who argue that to minimise underinvestment problems, firms have a positive relation between hedging and debt and market-to-book ratios. Though, for companies in high tech industries growth opportunity does not show any significant impact. Therefore, with the information available, it cannot be predicted, a priori.

H5: The impact of ownership concentration on derivative usage would likely to be stronger for companies in high tech industries than companies in low tech industries. It seems that companies that are owned by just a few investors are less likely to use derivatives (-1.93***), especially because they are less likely to use foreign exchange derivatives (-0.53***). For companies in low tech industries there is a slightly opposite relationship. It is the case that these more concentrated owned firms are more (slightly) more likely to use foreign exchange derivatives (0.60*). A prior study explains that firms that are more closely held include more effective monitoring, with less shareholder diversification of opinions and therefore with more desire to hedge with derivatives (Bartram et al., 2009). For this paper this is the case for foreign exchange derivatives for companies in low tech industries, but not for companies in high tech industries, these more concentrated companies are less likely to use derivatives. Because the impact on general derivatives is more than one point stronger and highly significant for companies in high tech industries it seems that the hypothesis is correct, companies in high tech industries are more impacted by ownership concentration and is because of this accepted.

H6: The impact of executive stock options on derivative usage would likely to be stronger for companies in low tech industries than companies in high tech industries. Sadly, when executive stock options was included in several regressions, it did not show any significant impact, it only made the regressions less significant. A significant difference could be extracted when the sample would be larger, which means that the relation might be there but it needs to be investigated more thoroughly in order to get real evidence for it.

H7: The impact of international operations on derivative usage would likely to be stronger for companies in high tech industries than companies in low tech industries. For general derivatives both values point in a different direction. Companies in high tech industries tend to be more likely to use derivatives (0.96*) and companies in low tech industries tend to be less likely to use derivatives (between -2.39* and -6.32*) when they have more international operations. Moreover, a coefficient of -0.64** presents that companies in low tech industries are less likely to use foreign exchange derivatives, when they are more international. The companies in high tech industries do show a negative relationship between international operations and general derivative usage with a coefficient of -0.20** with interest rate derivatives. The negative relationship is the opposite of what one would expect because these international companies are more prone to for example currency risks. Also argued by Bodnar et al. (2013), who explain that companies that are involved in international trade are more likely to use foreign currency derivatives. It would indicate some space for a more thorough investigation behind this relationship and would therefore be interesting to be explored more in future research. Nevertheless, because the companies in low tech industries tend to be more (negatively) impacted by international operations, the hypothesis needs to be rejected.

Subsequently, significant positive values of the control factors (foreign debt and foreign listing) show that foreign debt and foreign listings indeed increase foreign risk and is therefore related to likely more derivative usage.

As table 10 and 11 show, not all factors are significant, this could be the result of the smaller sample (especially for the companies in low tech industries), but also because there might simply not be a significant effect of the factor on derivative usage. Especially for the independent variable growth opportunity for high tech industries and for executive stock options for both extreme industries.

Furthermore, the adjusted R-squared is included in the model, this means that the R-squared has been adjusted for the number of predictors in this probit model. The number further explains the variability of the response data around the mean. The adjusted R-squared number of 0.32 means that 32% of the variance of the dependent variable is explained by the independent variables. The adjusted R-squared of the models are mostly around 30% which indicates a relatively good explanation of the variance of the dependent variable compared to prior studies. For instance the comparable study by Bartram et al. presents an adjusted R-squared of around 22% and the study by Nguyen and Faff (2002) of only 13%. When the multivariate models are compared in terms of adjusted R-squared, it stands out that commodity price derivatives are in most models not explained by the independent variables. This could be the case because of the small number of companies that uses commodity price derivatives. Furthermore, in multivariate model 6 for companies in low tech industries the adjusted R-squared is even negative, this number can be interpreted as zero, as the explanatory variables in this case are insignificant.

Table 12 - The hypothesises and the outcomes

	Hypothesis	Accepted or rejected
H1	Differences in derivative usage between companies in low and high tech industries cannot be predicted, a priori	Rejected, more use of derivatives in low tech
H2	The impact of debt maturity on derivative usage is more likely to be stronger for companies in high tech industries than for companies in low tech industries	Rejected
H3	The impact of size on derivative usage is more likely to be stronger for companies in high tech industries than for companies in low tech industries	Rejected
H4	A difference in impact of growth opportunity on derivative usage for companies in high and low tech industries cannot be predicted, a priori	Accepted
H5	The impact of ownership concentration on derivative usage would likely to be stronger for companies in high tech industries than companies in low tech industries	Accepted
H6	The impact of executive stock options on derivative usage would likely to be stronger for companies in low tech industries than companies in high tech industries	Not enough evidence
H7	The impact of international operations on derivative usage would likely to be stronger for companies in high tech industries than companies in low tech industries	Rejected

6. Conclusions

6.1. Conclusion

In this thesis 141 companies from the United Kingdom are examined in terms of firm factors, derivative usage and the impact of these firm factors on derivative usage. It is the first study that investigates whether several firm factors have different impact on derivative usage for companies in high and low tech industries. 102 of these companies operate in high tech industries and 39 companies operate in low tech industries. Sadly, probably because of the smaller sample not all regression results were significant and could be interpreted and be used as evidence for certain hypotheses.

The first finding of this research is that companies in low tech industries make more use of derivatives than companies from high tech industries. It looks like ownership concentration is an influential variable for this finding, but more research is needed on this subject. Furthermore, a finding of this research is that companies in low tech industries are more impacted by debt maturity. This means that companies in low tech industries are relatively more impacted by the long-term debt/total debt ratio than companies in high tech industries in terms of derivative usage. Another finding is that the impact of size on general derivatives is comparably close to zero. The same counts for all three types of derivatives either in low tech industries as in high tech industries.

Other hypotheses that this research included is that the difference of impact of growth opportunity on derivative usage for companies in high and low tech industries cannot be predicted, a priori. Which indeed could not be predicted, because the data was lacking statistical power for companies in high tech industries. It seems that companies in low tech industries are positively impacted by the market-to-book ratio in terms of derivative usage, but this cannot be compared to companies in high tech industries, because of lack in statistical power.

Additionally, this paper presents that companies in low tech industries are more impacted on derivative usage by international operation than are companies in high tech industries. Though, it shows that international companies in low tech industries are less likely to use general derivatives, the same counts for foreign exchange derivatives. Why there is a negative relation with general derivatives, is unknown. This finding is contradicting to the theory and should therefore be investigated in future research.

6.2. Limitations & recommendations

The findings give a new view on theory and on predicted signs of firm factors on derivative usage. This way some new movements are broad to light, it is for instance interesting to investigate why actually are companies in low tech industries more impacted by international operations on derivative usage than companies in high tech industries. And why is there a negative relationship between international operations and general derivative usage in low tech industries? This thesis shows these findings but does not exactly show why these findings are present, future research should investigate this more.

Additionally, hypothesis 6 did not present enough significant power and could therefore not be accepted or declined. This should be building stone for future research because it might be possible to find differences in impact of certain firm factors on derivatives usage in low and high tech industries, but the sample size of this research would not allow it. Also, maybe if more countries would be included in the research the sample size increases and certain relationships would be more visible.

Another improvement of this study could be looking at the technology per firm, instead of looking at extreme industries like this study does. It might get a different outcome because this study could for instance also include a high tech firm that is operating in a low tech industry. It is a different way for looking at the research.

Moreover, not every independent variable possible is used in this research, it could be that certain independent variables are influential in the decision making of using derivatives but are not used in this study. An example here could be taxes, it was expected that it was not influential because there is no comparison made between different countries with different rules for taxes. But if multiple countries would be included in this research, also different (control) variables should be used.

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