IUL School of Social Sciences

Department of Political Economy

The impact of credit implied volatility on long term financial investments

Dissertation submitted as partial requirement for the conferral of Master in Monetary and Financial Economics

By

Kelly Luiana Sulissa Ferreira

Supervisor:
Prof. Dr. Diptes Chandrakante Prabhudas Bhimjee,
Invited Assistant Professor, ISCTE-IUL Business School,
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Resumo

O objetivo desta Dissertação é evidenciar as diferenças entre a volatilidade a curto prazo e a longo prazo.

A volatilidade é um instrumento essencial para o mundo financeiro,a mais utilizada é calculada a partir do mercado de equities. O problema desta volatilidade é que o mercado de *equities* é na sua grande maioria a curto prazo, logo uma volatilidade calculada a partir deste mercado transmitiria a perceção do mercado a curto prazo. As preocupações, inquietaçõs e prioridades de um investidor a curto prazo são diferentes das de um investidor a longo prazo, logo ambos não deveriam utilizar a mesma volatilidade.

De modo a encontrar a volatilidade a longo prazo, foi utilizado o mercado de *credit default swaps* (CDS), que possui na sua maioria maturidades iguais ou superiores a 5 anos. Ao comparar a volatilidade presente no mercado de *equities* com a do mercado de *credit*, foi possível verificar que para a mesma empresa, no mesmo periodo de tempo, ambas as volatilidades não tinham o mesmo comportamento.

A volatilidade a longo prazo é menos sensível a mudanças no mercado que a volatilidade a curto prazo. Igualmente, a volatilidade a longo prazo é superior em empresas com elevada dívida e, tende a reagir mais fortemente com essas empresas do que com empresas financeiramente estáveis.

Palavras chave: Volatilidade a longo prazo, Volatilidade a curto prazo, *Credit Graders*, Credit Default Swa

Abstract

The goal of this dissertation is to expose how the short and long term volatilities are different from one another.

Volatility is an essential instrument in the financial world, the most frequently used volatility is calculated though the equity market. The volatility calculated this way has a short term perspective, since the equity market is composed, by a large majority, of products with shorter maturities. The worries and priorities of short term investors are very different from the ones of long term investors., therefore they shouldn't use the same volatility.

In order to find the volatility in the long term, the market for credit default swaps (CDS) was used, since it's mainly composed of swaps with maturities between 5 years and 10 years. By comparing the credit implied volatility with the equity implied volatility. It was possible to conclude that for the same company in the same time period, both volatilities had very different behaviors.

The credit implied volatility is less sensitive to changes in the market then the equity implied volatility. Also, the credit implied volatility is higher on companies with higher debt, having stronger reactions on these companies than on the ones which are financially stable.

Keywords: Equity implied volatility, Credit Implied Volatility, *Credit Graders*, Credit Default Swap

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Chapter I: Introduction

Volatility is a significant parameter in the financial world. Firstly, it is according to the current and expected market volatility that traders decide which strategy to adopt, for example if there's a high expected volatility a trader usually won't implement a short straddle, which is only profitable when a lower volatility is experienced. Secondly, it's essential in pricing derivatives, considering the price will depend on the fluctuation of the underlying asset during the life of the trade (Poon & Granger, 2003). Furthermore, the ability of an investor to correctly estimate future volatility will determine how efficient its hedging strategy and risk management will be in protecting the trading book from future losses. (Brenner, Ou, & Zhang, 2006)

Currently the two most accurate methods used to estimate future volatility are historical volatility and Black-Scholes implied volatility (Poon & Granger, 2003).

Historical volatility is usually calculated by horizontally matching periods, meaning, it will estimate that the volatility for the first trimester of 2019 will be the same to that of the first trimester of 2018, as this method is accepted by the Financial Accounting Standard Board for companies to account for the employee stock options on balance sheets (Byström, 2015). Despite being widely used, it still presents multiple issues. What happened in the past may not necessarily happen in the future, especially when there are still European countries that are recovering from the 2012 crisis, even though they're now presenting positive values their past volatility that will continue to be higher than what the market is expecting for the future. (Romei, 2018).

The Black-Scholes implied volatility is found by backing up the Black-Scholes Method (Merton, 1974) to calculate the standard deviation. Since the model results in the premium of an equity option, this volatility will translate into the expectation of the equity market for the future of the underlying asset. Taking into account that more than 50% of equity derivatives have a maturity lower than five years (Bank for International Settlements, 2018) it can also be concluded that this implied volatility only covers the short term. The volatility implied in the Black-Scholes model can only be used to price and manage short term investments and products.

The issue lies with investments containing maturities longer than 5 year, as neither one of the above traditional volatilities can be used for risk management or pricing these type of products. In the past couple of years there has been an increase on the number of long term investments (Byström, 2015) that have created an urging need to have a volatility that covers these types of products specifically.

Employee stock options programs are being extensively used in the Euro Zone. For example, in Portugal, Banco Português de Investimento has created a program for its top management employees (BPI, 2002), and usually the employees covered under this program stay in the company for longer than 1 year. For risk management purposes, the short term volatility is useless, as there is a need for volatility metrics that can estimate 5 or even 10 years ahead, since it's usually the time employees will stay at a company and, consequently, the time the bank will have the product on its trading book.

Credit derivatives allow market participants to be exposed to the debt of the underlying company. The buyer of this instrument will pay a premium to the seller and, in case the underlying company defaults on its obligation, it will be the seller who's responsible to cover the debt position to the buyer (Elmahdaoui and Dugas, 2009). Besides offering protection in case of default, these financial products are packaged with maturities ranging from 1 to 30 years (Byström, 2015). The volatility calculated though this product will generate the financial market's expectation for a certain company in the next 5, 10, 20 or 30 years, depending on the maturity used, which, accordingly, will be associated with longer term volatility (Byström, 2015).

This paper will analyze the role of long term volatility on 18 European companies, in order to find out the following:

i) **How credit implied volatility will impact long term investments?**
ii) Is there a large difference between the market short term volatility and the credit implied long term volatility?
iii) Will the long term volatility be more optimist or pessimist than the short term, for the same company?
iv) Are financial firms more, less or equally impacted by the differences in the long- short volatiles than non- financial?
v) Are certain countries more, less or equally impacted by the differences in the long-short volatiles than others?
vi) Is the credit market able to forecast a crisis?
vii) What factors influence more each of these markets?

The volatility forecasting issue has been studied multiple times.

The article Byström (2015) aims to specify how credit implied volatility can be useful for risk management and derivatives pricing of long term investment and the construction of credit fear gauges. Even though there is quite a large literature on forecasting volatility, very few focus on the long term volatility, as neither GARCH, stochastic or regime switching models provide long term volatility results, which are essential in the credit markets. In order to create credit fear gauges, Byström (2015) uses stock prices, credit default swaps spreads and debt to equity ratios to calculate the daily credit implied volatilities by resolving the *Credit Graders* model backwards.

On another hand Poon & Granger (2003) review 93 articles on volatility forecast methods in order to find out if volatility is forecastable and which method is the most accurate. From this article it can be concluded that the volatility backed out from equity options is the most accurate, followed by historical volatility, and, lastly the ARCH method. No relevant research was identified for Stochastic Volatility.

In order to cover the market need for long term volatility, the credit implied volatility was calculated similarly to the Black-Scholes implied volatility, but while the latter is generated by backing up an equity premium, the long term volatility is used by backing the Credit Grader's CDS spread formula in order to find the implied credit market's volatility, and comparing it with the at-the-money European put option implied volatility available in Datastream, which is the most frequently used

volatility in hedging and trading, in order to conclude whether the investments are over or under valuated in the long term perspective.

To calculate the implied volatility, the present dissertation uses daily mid quote senior unsecured CDS spread with 10 year maturities on 18 companies in Eurostoxx 50, 1st quarter debt levels withdrawn from each company quarterly result report, the outstanding number of shares from Reuters, and at-the-money European put implied volatility from Datastream. The data has a time period between 10th November 2009 and 2nd September 2019, so it would reflect the time before, during and after the sovereign debt crisis.

The present Dissertation's main findings suggest that the biggest discrepancies between the long and short term volatilities always come during times of opposing news coming out. Since the two markets have different views and priorities when confronted with specific news, they'll have different reactions as well.

The equity market is concerned about variables that can alter the ability of a company to pay dividends, with a large focus on revenues and all factors that could lead to the decrease of revenues for the company, even if they are temporary. While the credit market worries the level in debt of the company has changed or if they're not taking actions to decrease high levels of debt, whether there is a change in the strategy followed by the client, or even Merger and Acquisitions, all information that seem to impact their debt trajectory within the next 10 years, but ignores changes that seem to be temporary.

The credit market has a higher volatility, on companies with higher debt. Since a credit default swap is a synthetic exposure to a company's or government's debt, it's only natural to be a special focus of the market

This Dissertation will be divided into five Chapters: The First Chapter discloses the definitions of volatility and credit default swaps, while exposing the incapability of using short term volatility on long term investments. Chapter Two follows the current state-of-the-art literature regarding the long term investments, the differences between the credit and equity markets and the study of volatility. Chapter Three addresses the data and methodology used to calculate the credit implied volatility, while Chapter Four displays our main findings, reviewing the differences between the equity and the credit implied volatility for the 18 companies studied, lastly, Chapter Five concludes.

Chapter II: Literature Revision

In order to provide a comprehensive overview of what the state-of-the-art literature states on this fundamental topic, the present section reviews ten articles, which were comprised into three main groups, according to the following sub-topics: i) volatility between credit derivatives and equity derivatives market; ii) long term investments; and iii) the accurate forecasting of share prices.

Volatility between the credit derivatives and the equity derivatives market

Byström (2015) aims to specify how the credit implied volatility can be useful for risk management and derivatives pricing of long term investment and the computation of credit fear gauges. Even though there is quite a large literature on forecasting volatility, very few articles focus on long term volatility, which is essential to the credit markets. In order to find the long term volatility measure, the author estimates the *Credit Graders* model backwards, the outcome being the credit implied volatility of the 30 biggest European banks.

Through the implied volatility thus computed, the author is able to create a country fear index (CIVX). Currently there are other fear gauges in the market; one of the most used is the VIX, which is backed down from equity options on the S&P 500 companies with one month's maturity. Although both fear gauges present very different dimensions and geographic coverage, they had a similar performance, except that the VIX only peaked during the 2008 Lehman brothers crisis while the CVIX peaked both at the Lehman brothers and the 2010 sovereign debt crisis, a distinction which is caused by their separate geographic coverage. After building the fear gauges for Sweden, Switzerland, France, Germany, Italy, and the United Kingdom, the author was able to point out that all the countries reached a peak in June 2007, except for Sweden. Furthermore, France, Germany, and Italy reached a second peak in their corresponding fear gauge in 2012, unlike the rest of the Countries addressed. Lastly, the fear gauge of Italy still remains higher than the pre-crisis level, which can be translated on the credit market's disbelief in this country's economic recovery.

Unlike the above-mentioned author, who observed that credit default swaps constituted the best forecast method, **Poon and Granger (2003)** review 93 articles on volatility forecast methods in order to find out which method is the most accurate. The article divides the different types of methods into four large groups.

The first group of methods is the Historical Price Volatility Models which consists of methods based on past fluctuations, such as the Random Walk (also known as horizontal matching), the Simple Regression method, and the historical average methods which consist of the Moving Average, Exponential Smoothing, and the Exponentially Weighted Moving Average methods.

The second group, the ARCH models, though its parameter "h", can forecast "h" periods into the future. The author states that this model has been proven to be quite an effective predicator on short horizons.

The third group, the Stochastic Volatility models do not present a large body of studies in comparison with the other three methods, and, in result of its complex nature, this model isn't very used.

Lastly, the fourth group, which encompasses the options implied volatility method, consists of the volatility backed out of the Black-Scholes model.

By collecting the datasets of the 93 papers, the author is able to point out that: i) 22 articles find the historical price volatility models a more accurate model than the ARCH models; ii) 26 articles find that options implied volatility method is more accurate than historical price volatility models; and iii) 17 articles identify options implied volatility as a more accurate method than ARCH models. From this survey it can be concluded that the volatility backed out from equity options constitutes the most accurate method, followed by historical volatility, and, lastly, the ARCH method. No relevant research is advanced for the Stochastic Volatility models.

Cao, et al. (2011) also uses the Credit Grader's model, but this time to conclude whether historical or option-implied volatility produce the best fitting credit default swap spreads. The author expects, to a certain extent, for the equity and credit markets to have a structural connection, which would lead to more realistic CDS spreads.

The author finds the *Credit Graders* model the most suited for this study. Even though at the time there were other methods available that would be able to calculate the CDS spreads, Cao, et al. (2011) highlights that this model is more frequently used for the main goal of this study, in result of its customization of the uncertainty rate which will enable the existence of tailored results depending on the maturity of the CDS or the type of companies in the sample, while, lastly, presenting a simpler formula.

By replacing the volatility in the *Credit Graders* models by the historical volatility and then by the option-implied volatility, two different sets of credit spreads are estimated. Comparing the credit spreads calculated with the market's spreads, the implied volatility based spreads had a based root-mean-square pricing error (RMSE) of 105.76 bps, while the historical volatility based spreads presented a RMSE of 131.54 bps.

Though this method, Cao, et al. (2011) shows that historical volatilities don't have relevant explanatory power on CDS spread changes, while the use of implied volatility on the Credit Grader's model provides more reliable results and improves the model altogether.

Long term investments

Bodie (1991) considers the challenges that pension funds face when hedging their portfolios Overall, these type of funds own portfolios with longer maturities, and hedging these type of portfolios in itself is quite a challenge. The author considers that the equity market, unlike popular practice followed by portfolio managers, shouldn't be a good market for portfolio managers to invest or hedge, since the high volatility of the market and the long maturity of the portfolio won't match.

The most used justification for using equity products in this type of portfolios is related to the onset of inflation risk. For managers, since the equity market is linked to a physical share, it shouldn't be impacted by inflation. The author rebukes this theory by point out that even though equities might protect stock returns from inflation risk, it exposes the portfolios to market risk, which is, in general, much higher.

The article also points out that using equities in hedging strategies should only be done by very experienced managers, since it will significantly increase the volatility of the portfolio. Although this strategy might also provide higher returns, the length the manager will have to go to hedge the portfolio's position may not compensate the shareholder of the pension fund in the longer run. It is nevertheless important to note that as time goes by the cost of hedging will increase, therefore a volatility strategy will typically translate into a higher cost.

Gürkaynak, Sack, and Swanson, (2005) also address financial products with longer timelines, but through interest rates. The article is set to test whether long term cycles behave the same way that most macroeconomic models assumptions suggest. Overall, these models treat long term levels as constant over time.

The article concludes that, whenever unexpected news hit the short term interest rates, the effect is very significant in the moment, but decreases within one year. In order to scrutinize how it behaves over longer horizons, the authors also address forward rates between January 1990 and December 2002.

Gürkaynak, Sack, and Swanson (2005) find that not only are these forward rates more sensitive to macroeconomic and monetary policy changes, but the impact of the news persists up to 15 years. The news at the moment of its release, indeed, generate a smaller variation on long term forward rates than on one year spot rates, but the difference isn't as significant as the models usually suggest it is.

Therefore the most notable difference between the two resides in the fact that the impact of the news is transitory on short term interest rates, while it's persistent on long term interest rates. The most significant finding of the article resides in the fact that long term forward rates are very sensitive to news, unlike other models' assumptions which usually treats this parameter as a constant.

The accurate forecasting of share prices

Yu (2006), also uses the Credit Grader's model in order to estimate the theoretical spreads of the credit default swaps, investigating the riskiness and profitability of a capital structure arbitrage strategy.

Both the equity and the credit derivatives refer to the same company, therefore their prices should be connected. If one market is under or over valuated in comparison with the other, a capital structure arbitrage strategy can be used to take advantage of the mispricing. These mispricings are usually temporary as, eventually, the markets will converge in price. So the investor can forecast, that in the near future, the under valuated market will rise in price and the over valuated will fall. The

investor should take a short position on the over valuated market and long on the under valuated. But the prices don't converge while the investor is pursuing this strategy, its portfolio will endure financial losses, since the entire strategy is based on the premise that mispricings are temporary.

The author performs a case study on Altria Group during the first semester of 2003. On this date, the group was ordered by a judge to post $12 billion guarantee; as a result of this news the conglomerate credit rate was downgraded from A2 to Baa. The author calculates the CDS spreads using the Credit Grader's model, provided by a correlation between equity prices and credit spreads of -0.25 during this period. The author notes that on March 31st, while the market spread rose 89bps, the theoretical spread only rose 11bp; 4 days later the market spread rose again by 171bp and the theoretical only 8bp, meaning the credit market was undervalued. If implemented, a capital structure arbitrage strategy would have been successful since share prices were falling but the credit market spread was rising exponentially higher than its theoretical price. Eventually, both markets converged, and the investor should have liquidated the position in that moment. If the credit markets spread had continued to rise at a higher speed, the investor would only have suffered losses.

The Altria case study would only have produced negative returns if the group had bankrupted or lost access to the CDS market, which would bring about either of these results as a continuous increase in the credit market spread; but since that wasn't the market reality, the markets eventually converged to a strategy that was predisposed to be profitable.

Moreover, Yu (2006) also addresses the case of North American companies CDS in order to further test in which cases would the strategy be profitable and in which cases it wouldn't.

Accordingly, the article divides the sample into three categories, as follows.

The first group includes companies such as AT&T, McDonalds, and ToysRUs, where the market spread temporarily increases, but shortly after it goes back to its previous level. This group would produce positive returns if a capital structure strategy were applied, as the credit market occasionally raises some concerns on the company, but it eventually calms down.

The second group includes companies such as AMRCorp, Delta Airlines, and WorldCom, and the market and theoretical spreads were very close until a date where they significantly diverged. This group is composed of companies that filed for bankruptcy or legal protection against creditors. For this group, an arbitrage strategy wouldn't be successfully implemented.

The third group includes companies such as Agilent Technologies, Phelps Dodge, and Staples. They start with converging prices (like the second group), but their prices disperse quicker. Also, there are no arbitrage opportunities in the group.

Since there wasn't a very clear standing either in favor or against the strategy at the time this article was published, this exhaustive research nevertheless ended up supporting the case that a longer holding period of the strategy would open the investor to positive returns, although the strategy only works if the divergence is temporary. Lastly, the correlation between the two markets is highest on the lowest credit rated companies.

Ni and Pan (2015) address the capability of the credit and option markets to predict share prices during a short sale ban. The authors choose the 14 days short sale ban implemented by the

Securities and Exchange Commission in September 19th, 2008, as their research time window. During this time, in response to the Lehman Brothers bankruptcy and the bailout of AIG, the SEC decided to implement the ban in order to prevent further damages to other financial institutions and investors. Although investors couldn't directly trade on the shares that were banned, they could still do it indirectly through the use of derivatives, namely through equity options and credit default swaps with the banned shares as underlying assets.

In the equity options market, the authors build put-call ratios based on the investor who bought options on the banned shares, aggregating the shares according to their ratios: the first group had the shares with the 20% highest Put-Call ratio, the third group had the lowest 20% put-call rations, while the second group had the remaining 60%. The first group, which is the one investors are the most negative about, underperformed by 2.13% the second group in the next 3 days returns and by 4.01% in the next 5 days. While the performance of the third group, which is the one investors had a more positive outlook about, wasn't that economically different than the second group. Although the ban was reasonably successful in blocking the negative information into the price of the share, it had no impact on the positive information flow.

For the credit market, the author calculated the daily percentage variation of the credit default swaps spread, using it as CDS signals. For shares where the signal was one standard deviation from another fellow banned share, on average, the first share underperformed 1.29% on the next three days return and 2.6% on the next 5 days.

Even though the options markets appears to be a better predicator of future returns during short ban periods, it has to be noted that the sample was higher for this market, since, out of the 229 banned trades, only 60 were traded under credit default swaps.

For **Elmahdaoui and Dugas (2009)**, the correlation between the CDS spread and the underlying stock is a quantifiable relation addressed by this article. In order to conclude whether the said relation has economic significance they create three strategies:

First, the ascending strategy consists of buying the share if the CDS spread decreases and selling it the next day. Since the CDS market is related to insurance in case of default, if the price of the insurance goes down, according to the authors, one can predict that the price of the share will go up.

The descending strategy is the inverse of the above, and when a CDS spread increases, the authors suggest the investor should buy the shares that same day, sell it the same day and buy back the next day, when the share price is typically lower. The profitability of this strategy rests on the difference between the higher selling price and the lower buying price.

Third, the authors also assume a portfolio of different companies, and though the CDS spread changes daily, the investor can decide which ones to buy and to sell the next day, calling this strategy Portfolio Management.

The authors also note that the profitability of the strategies could originate from the market's situation, as a given economic paradigm or particular factors influence the companies' share prices.

These external variants could negatively or positively impact the interpretation of these strategies. To avoid such situations, the authors create two control metrics: the p-value and the share ratio.

The p-value is the probability of an investor who invests randomly according to random buy/sell signals that have better returns than an investor following the CDS spread signal. While the share ratio expresses the returns as a coefficient of the volatility, meaning the investor will be able to compare companies with different levels of risk, since usually companies with higher risk provide higher returns.

The authors use share prices and CDS spreads from February 5th , 2004, and December 31st , 2008 for all the companies quoted on the New York Stock Exchange.

In order to prove the predictive power that the CDS spread has on the share prices, a series of tests were created.

First, the authors line the companies according to their credit rating, proving that shares with rating from B- to B+ have a lower p-value for the ascending and descending strategy, meaning that, for lower rated companies following random signals, it will provide worse returns than following the CDS signals strategies.

Second, it was also noted that the returns from the descending strategy were higher than the ascending strategy, which could be explained by the U.S. 'Subprime' Crisis during the end part of the sample period.

Third, for the portfolio management strategy, unlike the above two, the p-value doesn't seem to be influenced by the credit rating of the enterprise, but the p-value floats in between the 5% mark for most of the companies.

Through the test applications, investors conclude that the CDS spread has predictive power in the variation of the underlying stock price.

Forte and Pena (2009), aim to discover through which market (i.e., equity, credit, or bonds markets) does the credit risk information flow quicker.

The authors address the bonds spread, CDS spread, and stock implied credit spread, in order to compare credit spreads. The stock implied credit spread is calculated though the derivation of the credit risk model from (Leland & Toft, 1996). The authors defend the use of the stock implied credit spread instead of the share price since the first also absorbs information from other variables, such as the risk-free rate, and considers long term equilibrium between the three markets.

The article considers that if there is efficient pricing in credit risk, at some point in time at least two of the market spreads should be co-integrated. In order to reach their intended goal, the authors start off by using the Johansen co-integration trace test to pinpoint the significance in unit roots, which allows them to divide the sample into three model groups. The Model I is comprised of companies with two co-integration relationships, Model II with only one, and Model III without any co-integration relationships. Out of the 17 companies sampled, Model I was applicable to three, Model II to five, and Model III to seven, while the remaining two companies didn't provide sufficiently clear evidence in order to group them. It is important to note that, across all the companies in Model II, the only co-integrated relationship observed was between the credit and bond markets.

The article goes a step further by seeking to quantify who influences the most. In order to reach their goal the authors use the findings advanced by (Gonzalo & Granger, 1995) and (Hasbrouk, 1995) .

For Model I, it is possible to conclude that the credit risk price discovery is 61% due to the equities market, 31% to the credit market, and 9% to the bonds market, according to the model formulation advanced by Hasbrouck (1995). If the Gonzalo and Granger (1995) model is considered, then the equities market accounts for 70%, the credit market for 39%, and, lastly, the bond market for 9%.

For the Model II set of companies, there is only one relationship between the credit and bonds market, though the application of the Gonzalo and Granger (1995) model suggests that the credit market explains 60% of the price, while bonds only weighs 40%. Similar results were encountered when using Hasbrouck (1995) as the credit market weighs in 56% and the bond markets the remaining 44%.

Lastly, it was also found that the contribution by each market isn't static, as it highly depends on the time period used. This means that during different time windows, the three markets will have distinctive weights in explaining the credit risk component.

Norden and Weber (2009) address the connection between the CDS, bond, and equity markets. In order to reach their goal, the authors focus on the time period between 2000 and 2002. Though a series of co-integration tests, the article divides the sample into three panels, according to the data frequency (daily; weekly; and monthly). The authors are able to reach five different conclusions on the relationship of the three markets. First, the CDS and bond markets have a closer relationship on telecommunications companies than for all other sectors. Second, the connection for share returns and CDS spread variations is higher for financial companies than for non-financial firms. Third, for all the data frequencies, share returns were the least forecastable variable, while bond variations were the most forecastable. Fourth, using monthly frequency data, the CDS markets has an impact on the bond markets over 22 companies, while the opposite only happens over 13 firms out of the 53. While for weekly data, the CDS has an impact over 23 companies and for the daily, the CDS has an impact over 39, out of 58. Lastly, the article also finds that the level of sensitivity the CDS spread has to previous share price variations largely depends on the companies' credit quality and bonds issue.

Summing up, the literature herein reviewed provides qualified evidence that the short term volatility doesn't match with long term investment and will produce unreliable results, while also stating that the equity derivatives market remains the best market segment to forecast changes in the future.

Even though the equity market produces high quality forecasting, and with higher forecastable volatility than the credit derivatives markets, it's still not appropriate for long term investment

Chapter III: Methodology and data

There is a shortage of academic research addressing methods to calculate implied volatility from credit default swaps, but there is in models to determine the theoretical spread of the credit default swaps. The model developed by Risk Metrics in association with JP Morgan, Goldman Sachs and Deutsche Bank, called Credit Graders was mentioned **by Cao et al. (2011) as** the best method to calculate the spread of credit default swaps. Unlike other models, it allows for customization of certain parameters, most noticeably the recovery rate and, it also has a simpler formula that guarantees that multiple individuals with different financial backgrounds can all use this model (Finger , 2002). The model is so frequently used that Byström (2015) considers it the industry's benchmark for credit risk calculation.

Unlike **Yu (2006)** or **Cao (2011),** where the Credit Grader's model was used to calculate the credit default swaps spreads, the **Byström (2015)** approach will be followed to calculate the implied volatility and therefore, the credit market's expectation for the next 10 years.

The model is a development from the credit risk model by Merton (1974), sharing some assumptions with the last. Both assume the company will reach default once its asset value,V, drops below its debt level, D.

Following a standard geometric Brownian motion the *Credit Graders* presents the below mentioned equations: *

$$\boldsymbol{CDS_{Spread} = r(1-R)\frac{1-P(0)+\mathrm{H(t)}}{P(0)-P(t)e^{-rt}-\mathrm{H(t)}}} \quad (1)$$

$$\boldsymbol{H(t) = e^{r\xi}\big(G(t+\xi) - G(\xi)\big)} \quad (2)$$

$$\boldsymbol{A_t^2 = \sigma_E^2 \times t + \lambda^2} \quad (3)$$

$$\boldsymbol{P(t) = N\left(-\frac{A_t}{2} + \frac{ln\,(d)}{A_t}\right) - dN\left(-\frac{A_t}{2} - \frac{ln(d)}{A_t}\right)} \quad (4)$$

$$\boldsymbol{G(t) = d^{z+\frac{1}{2}}N\left(-\frac{ln(d)}{\sigma_E\sqrt{t}} - z\sigma_E\sqrt{t}\right) + d^{-z\frac{1}{2}}N\left(-\frac{ln(d)}{\sigma_E\sqrt{t}} + z\sigma_E\sqrt{t}\right)} \quad (5)$$

$$\boldsymbol{\xi = \frac{\lambda^2}{\sigma_E^2}} \quad (6)$$

$$\boldsymbol{z = \sqrt{\frac{1}{4} + \frac{2r}{\sigma_E^2}}} \quad (7)$$

$$\boldsymbol{d = \frac{V_0}{L \times D} \times e^{\lambda^2}} \quad (8)$$

$$\boldsymbol{V_{t=}E_t + L \times D} \quad (9)$$

* For a full description of the variables, please consult Finger (2002) available in the following link: https://www.msci.com/documents/10199/93396227-d449-4229-9143-24a94dab122f

$$\boldsymbol{\sigma = \frac{\sigma_E \times E_t}{E_t + L \times D}} \quad (10)$$

The variables of the model can be divided into three groups, i) the time series, ii) the constants that the Credit Grader's technical document recommends a value and iii) the constants that are not provided by the technical document.

The first group is composed of the daily CDS spread and , the technical document advises that a 1 000 observations is the optimum for this model. The daily closing price of the shares, E_t, are also included in this category.

The second category is composed of the recommendations of the technical model for certain parameters and, the model suggests that the mean global recovery rate, L, and the specific recovery rate, R, to be 0.5. While the standard deviation, λ, should be 0.3.

Lastly, there are two others parameters that the model demands to be constants throughout time, the risk free interest rate, r, and the debt level, D, wich is calculated according to Equation (11).

$$\frac{\boldsymbol{Short\ and\ Long\ term\ borrows + 0.5(Other\ Short\ and\ Long\ Term\ Liabilities + 0\ x\ Accounts\ Payable)}}{\boldsymbol{Number\ of\ Outsanding\ Shares}} \quad (11)$$

The technical document also provides a grid of content in Table 3.1, where it's possible to extract the volatility for each daily CDS spread, according to the company's debt level.

		Volatility (%)												
		20	25	30	35	40	45	50	55	60	65	70	75	80
	0.5	55	85	125	175	232	297	367	441	520	602	687	774	865
	1.0	8	22	46	82	130	188	253	326	403	486	572	662	755
	1.5	2	8	22	48	85	134	193	260	333	412	495	583	675
	2.0	1	3	12	30	59	101	153	214	283	358	438	523	612
	2.5	0	2	7	20	43	78	124	180	244	315	392	474	561
Share/	3.0	0	1	4	13	32	62	103	154	214	282	355	434	518
Debt	3.5	0	0	3	9	24	50	86	133	190	254	325	401	483
	4.0	0	0	2	7	19	41	73	117	169	230	298	373	452
	4.5	0	0	1	5	15	34	63	103	152	211	276	348	425
	5.0	0	0	1	4	12	28	55	91	138	194	257	326	401
	5.5	0	0	1	3	10	24	48	82	126	179	240	307	381
	6.0	0	0	0	2	8	20	42	74	115	166	224	290	362

Table 3.1: Credit Default Swap Spread according to the volatility and share-per-debt level. Source: **(Finger , 2002)**

In order to use the Grid, the below data had to be collected on the companies composing the Eurostoxx50

1) Daily mid quote senior unsecured CDS spread with 10 year maturities taken from Datastream
2) The short and long term borrowings, provisions, tax and pension liabilities and loans were all taken from each company's 1st quarter reports available and their respective website
3) The number of outstanding shares for each company was taken from Reuters official page.

Besides the data extracted for the *Credit Graders* model, the daily at-the-money European put implied volatility was also taken from DataStream, as it's the market standard equity implied volatility, as it was already proven by Cao, et al. (2011)

The time period for all the data is between 10th November 2009 and 2nd of September of 2019, since the technical document recommended over 1 000 observations sample to be the optimum, the time period was also designed in order to fit the maximum amount of Eurostoxx 50 companies with CDS and equity implied volatility data in Datastream before the beginning of the Sovereign Debt Crisis, since it was essential to capture data before, during, and after the European Sovereign Debt Crisis, which lasted four years, between 2010 and 2014 (Münchau, 2019) (CNN Library, 2019).

With the above time range, only 18 Eurostoxx 50 companies had both daily mid quote senior unsecured CDS spread with 10 year maturities and daily at-the-money European put implied volatility in Datastream.

Chapter IV: The credit and equity implied volatilities for the Eurotoxx50

After estimating the credit implied volatility using the CreditGrader's matrix for all the 18 companies, the results were compared with the equity implied volatility extracted from DataStream on these same companies, in order to expose the difference between the two before, during, and after the crisis.

Air Liquide

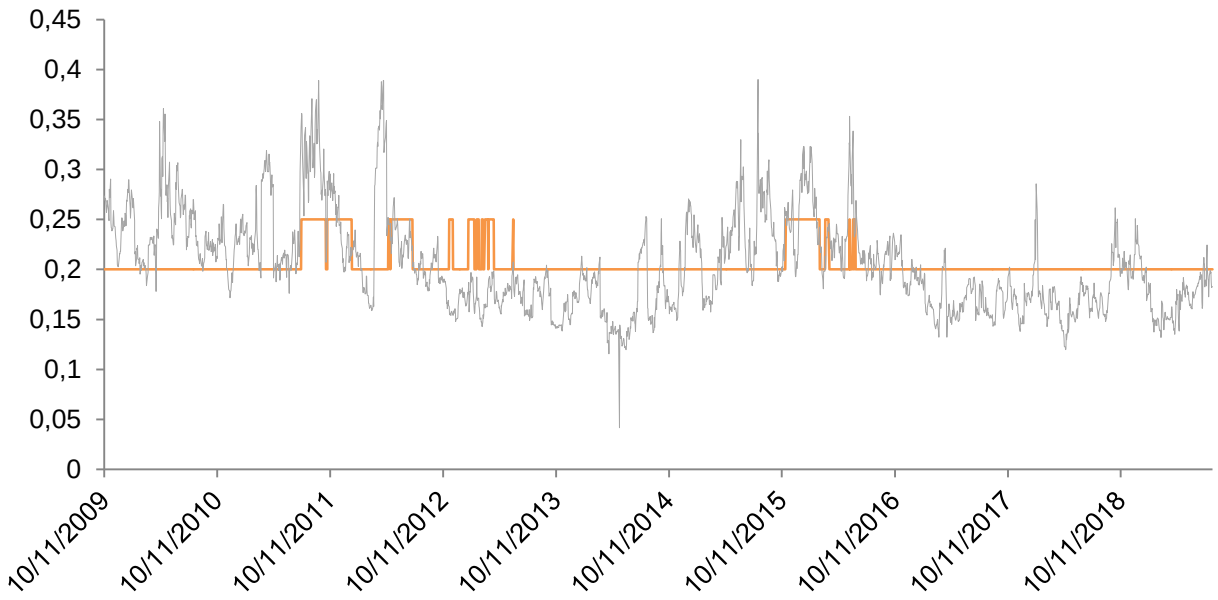

Figure 4. 1: The evolution of Air Liquide's credit implied volatility (orange) and the equity implied volatility (grey) between 10th November 2009 and 2nd September 2019.

Before and during the crisis, the credit market had an optimistic overview of the French company, in comparison with the equity market, highlighted by the significant levels of volatility of the second.

Until 2012, where the markets reversed their forecast, and the credit market had a higher volatility than the equity market. Even though Moody's had a stable outlook for the company after the acquisition of health companies (Moody's Investors Service, 2012a), and the company presented overall positive results at their annual report (Air Liquide, 2013). The concern of the credit market might have been associated to the fact that the gas provider not only didn't grow on their biggest market, Western Europe, but also that 50% of their business was under the crisis affected area (Air Liquide, 2013).

On the other hand, also in 2012 S&P upgraded the long term credit rating from A to A+ (Air Liquide, 2019). The positive signs of the credit rating agencies and the positive results of the company

(Air Liquide, 2015), in contrast with the negative outlook from the worsening of the crisis in the company's biggest market, caused one of the biggest drift between the credit and equity market in 2014, where the equity market was 16% less volatile than the credit market.

After the crisis, the credit market maintained a more pessimistic forecast than the equity market, justified by both S&P and Moody's downgrades on the long term credit rating in 2015. But while the credit market was already expecting this downgrade, having a 5% increase of volatility from 2014 to 2015, the equity market had a much more abrupt response, having an increase of almost 20% from the end of 2014 to the end 2015. As it was already stated by Gürkaynak, Sack, and Swanson (2005), short term variables are much more sensitive to new information, while the markets with long term forecasts also incorporate these changes, but with a lower impact.

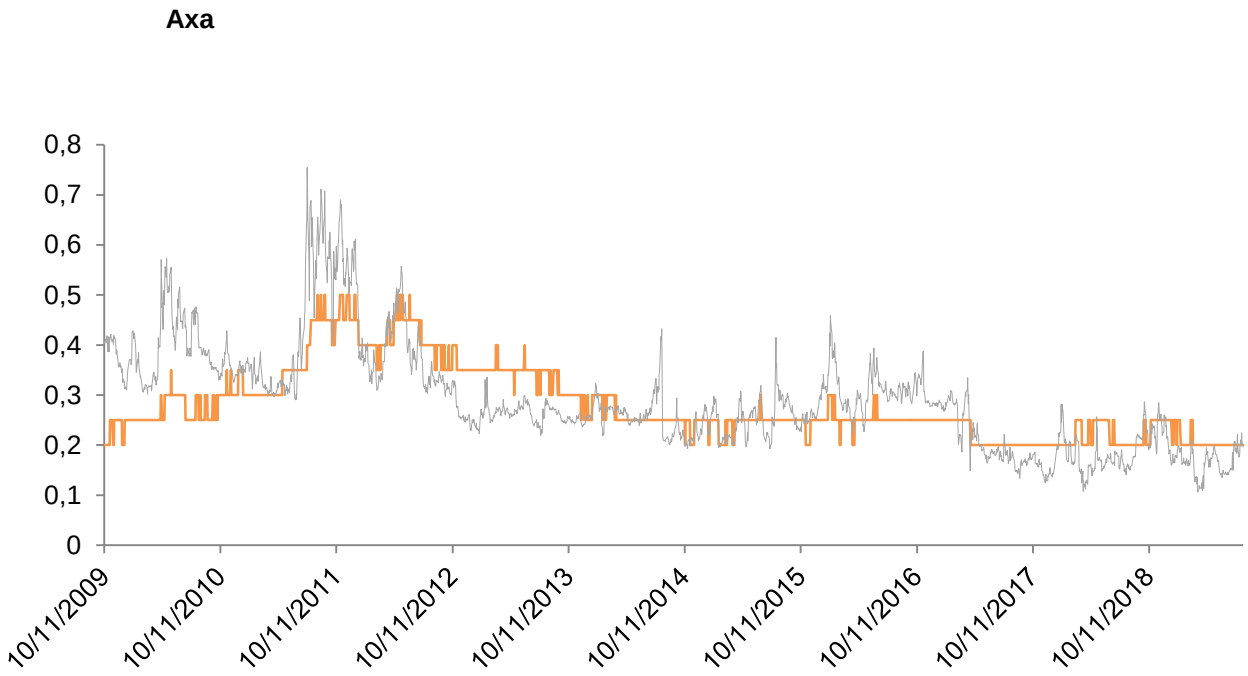

Figure 4. 2 : The evolution of Axa's credit implied volatility (orange) and the equity implied volatility (grey) between 10th November 2009 and 2nd September 2019.

Until 2011, the equity market was much more volatile, while the credit market was slowly becoming more and more pessimist a fact consistent with the disclosure of increasingly lower financial results posted by the company (Axa, 2012).

Between 2011 and 2014, both markets were pessimist with high volatility percentages, but after 2012 the credit market had a relevant negative forecast, much due to the exposure of the group to the Sovereign Debt Crisis.

After 2012, following Moody's Axa downgrade announcement, the conflict and confusion for the future of the company becomes evident. On the one hand, the company wasn't directly exposed to the countries heavily affected by the crisis, since it concentrated 43% of its assets on government bonds (Moody's Investor Service, 2012b). On the other hand, its declining sales, low growth and

increasing costs (Moody's Investor Service, 2012b) raise red flags for the future and, the credit market became fearful that, although the company is being able to stand strong during the European turmoil, their deteriorating profitability and asset quality would, on the medium term, make the company more vulnerable to the ongoing crisis.

From 2014 afterwards, both markets were almost in sync, with lower volatilities caused by the growth of the company and diversification of its assets to Asian countries and the UK (Axa, 2015), enabling the company to escape the crisis. Also the end of the most of the bailout programs, which marked as the end of the crisis, contributed to an unanimous positive outlook for both markets.

Banco Santander

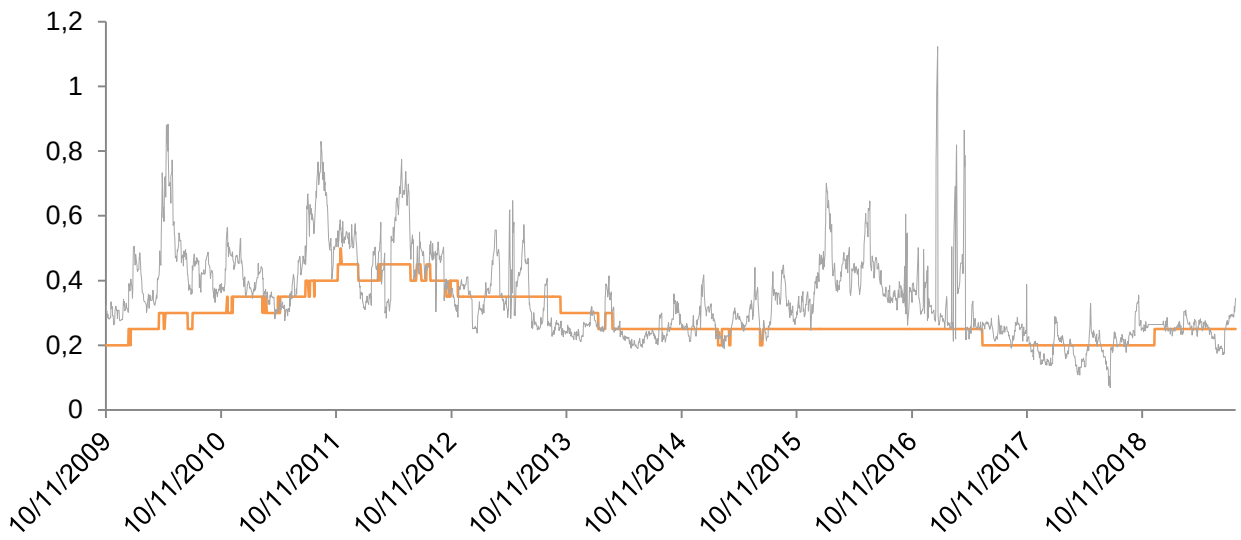

Figure 4. 3 The evolution of Banco Santander's credit implied volatility (orange) and the equity implied volatility (grey) between 10th November 2009 and 2nd September 2019.

For almost all of the time period, the credit market consistently maintained a much positive outlook than the equity market.

Before the crisis, the credit market experienced increasing volatility, forecasting a negative wave, which continued during the crisis, but always lower than the equity market.

Even though Spain was part of the GIIPS, much of the internal crisis was caused by the real estate bubble and not it's banking system (Matthews, 2011). Although the equity market was afraid of a contagious reaction to the banking system based on the austerity measures the government was forced to implement, it's obvious the credit wasn't, since there wasn't much of a change in the bank's CDS spreads. While the Spanish government credit rating was downgraded three time since 2010 (Matthews, 2011), their biggest bank didn't had the same fate, meaning the credit market didn't find a large correlation between the country crisis and its biggest bank.

BNP Paribas

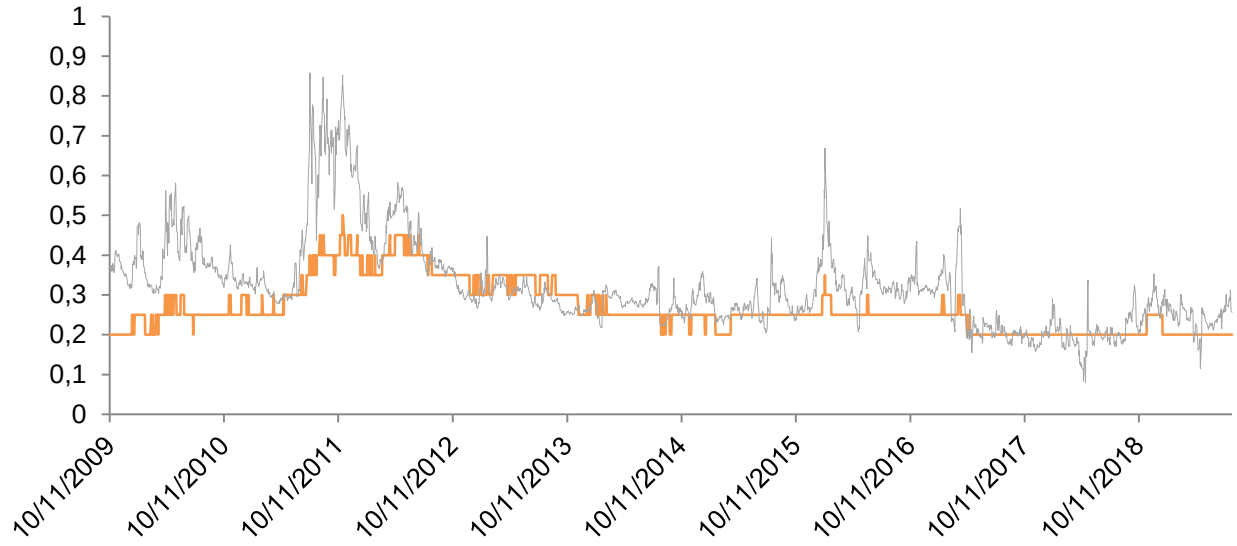

Figure 4. 4: The evolution of BNP Paribas' credit implied volatility (orange) and the equity implied volatility (grey) between 10th November 2009 and 2nd September 2019.

Before 2012, the equity and credit market's volatility was considerably far apart. As already noted in Air Liquide and Axa, dual signal information or mismatch of reviews will cause a drift between the equity and credit market during times of uncertainty. And this is no expectation in the case of BNP Paribas.

Moody's outlook on Belgium, France and Luxembourg banking system is mainly negative because of their exposure to the 2008 Subprime Crisis, as a whole and, the report admits that French banks have been able to shield themselves from the crisis originated from the United States, but there is uncertainty whether the system would be able to hold against the incoming asset deterioration of its European neighbors, diminishing revenue and increase in costs of covering risk (Moody's Investors Service, 2009a). But the report also enhances the structural changes being done in banks in order to prevail during the incoming crisis, and the M&A activity which were letting BNP more and more solid, solvency and profitability wise (Moody's Investor Service, 2009b), creating positive signs throughout the financial markets.

After 2012, both markets were in sync with frequent spikes in volatility, caused by the banks' efforts to recover while it navigates the thickening sovereign debt crisis, the exposure to Greek debt, the economic deceleration of the Eurozone and later, the lower interest rates (Moody's Investor Service, 2016a) and (Daneshkhu, 2010).

Danone

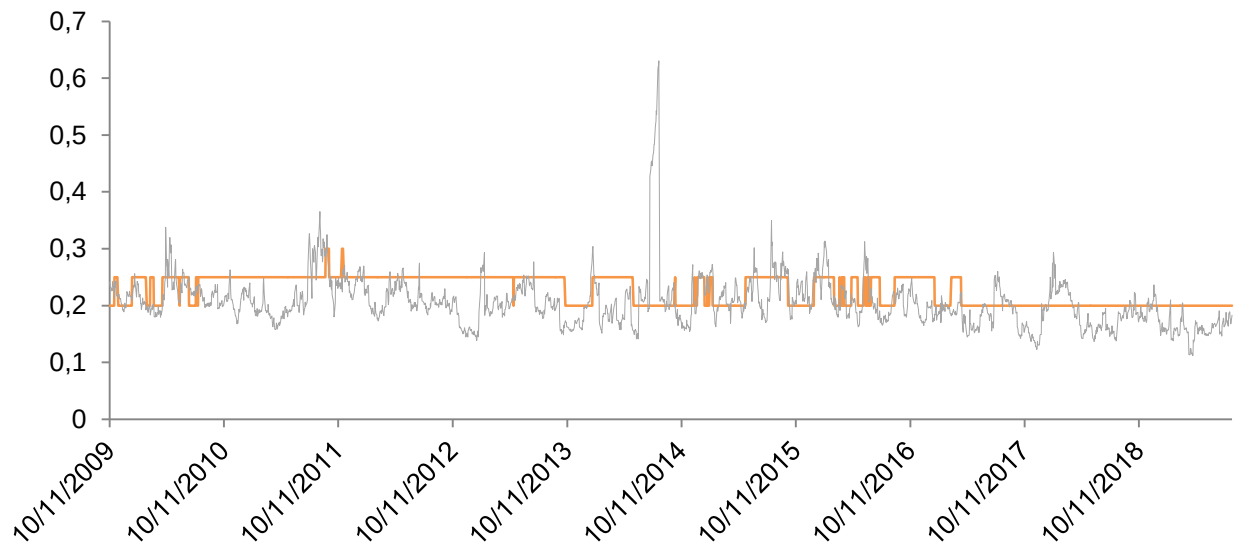

Figure 4. 5: The evolution of Danone's credit implied volatility (orange) and the equity implied volatility (grey) between 10th November 2009 and 2nd September 2019.

Danone has had the same performance throughout the years and, there weren't multiple spikes in volatility during the Sovereign Debt Crisis and both markets have very close volatilities.

Only in the end of 2014 was the companies' credit rating ever downgraded, which simultaneously matched with the biggest gap between the two volatilities. The ambitious 2020 roadmap the company presented that year, caused extreme pressure on their credit and solvency ratios, adding to the fact there no intentions to address their continuing accumulating existing debt (Moody's Investors Service, 2014a). Quite the opposite, these same investments played an immense part in the future development and growth of the company, especially in making it more competitive in the long term (Danone, 2015). While the equity market is concerned with short term, especially on the ability of paying dividends, it has a negative view of the increasing debt. The credit market has an eye for the long term; in this case, 10 years from that date, the perspective that the company is investing and growing in what can arguably be a stable or rapidly rate will only bring a positive outcome for the future.

Enel

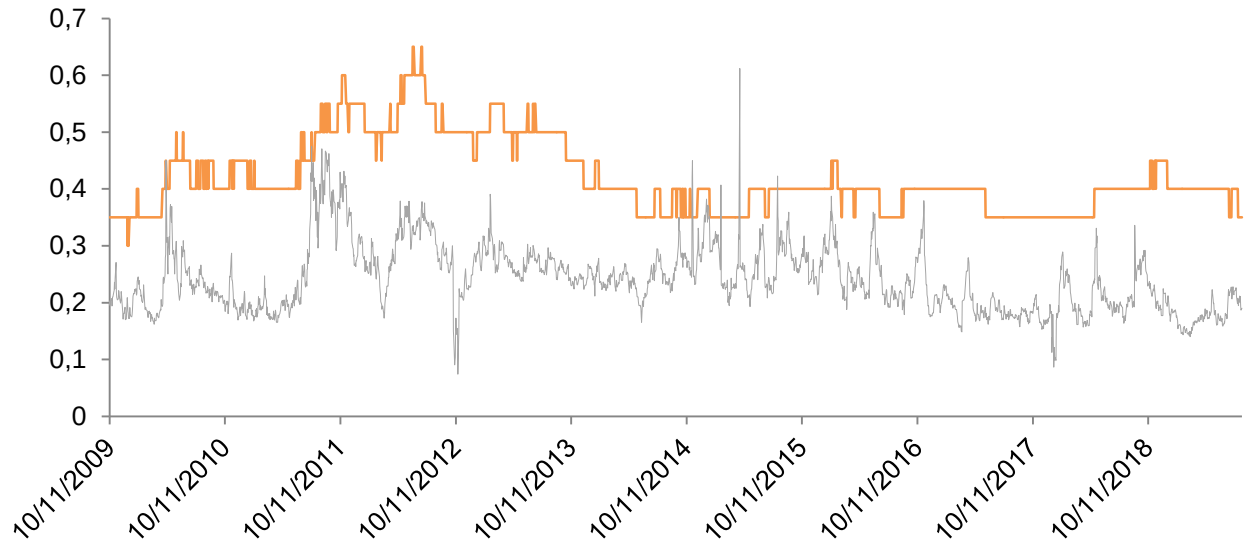

Figure 4. 6: The evolution of Enel's credit implied volatility (orange) and the equity implied volatility (grey) between 10th November 2009 and 2nd September 2019.

The Italian energy company has consistently had high volatility and uncertainty, as it's product/ service depended largely on macroeconomic determinants, the country where the company is inserted didn't bring financial stability during the Sovereign Debt Crisis and is currently ongoing a political impasse. The large volatility still demonstrated in 2019 in the credit market in comparison with the equity can prompt the conclusion that the first is still forecasting a crisis for the near future or/ and isn't convinced the company has recovered into complete financial health.

In 2010, Enel was downgraded for a worrisome increase of debt (Moody's Investors Service, 2010a), especially in a time of crisis and beginning of recession where there will likely be a drop of company revenue, the markets didn't react well to the company's disregards to future financial stability. Later on 2012 they received their second downgrading, mostly done by the negative impact of the austerity measures on their principal markets: Spain and Italy. With declining revenues it's very unlikely the company would accomplish positive solvency rations (Moody's Investors Report, 2012c). The third downgrading came at the end of the same year, due to the aggravation of the crisis, rise in renewable energy competitors, the Spanish government austerity measures and their lack of diversification which let them expose to disturbances in both Italy and Spain (Moody's Investors Report, 2012d).

Considering that one of the inputs of the Credit Grader's model, is the debt level of the company, it comes as no surprise that a company with such debt will have higher than usual credit implied volatility.

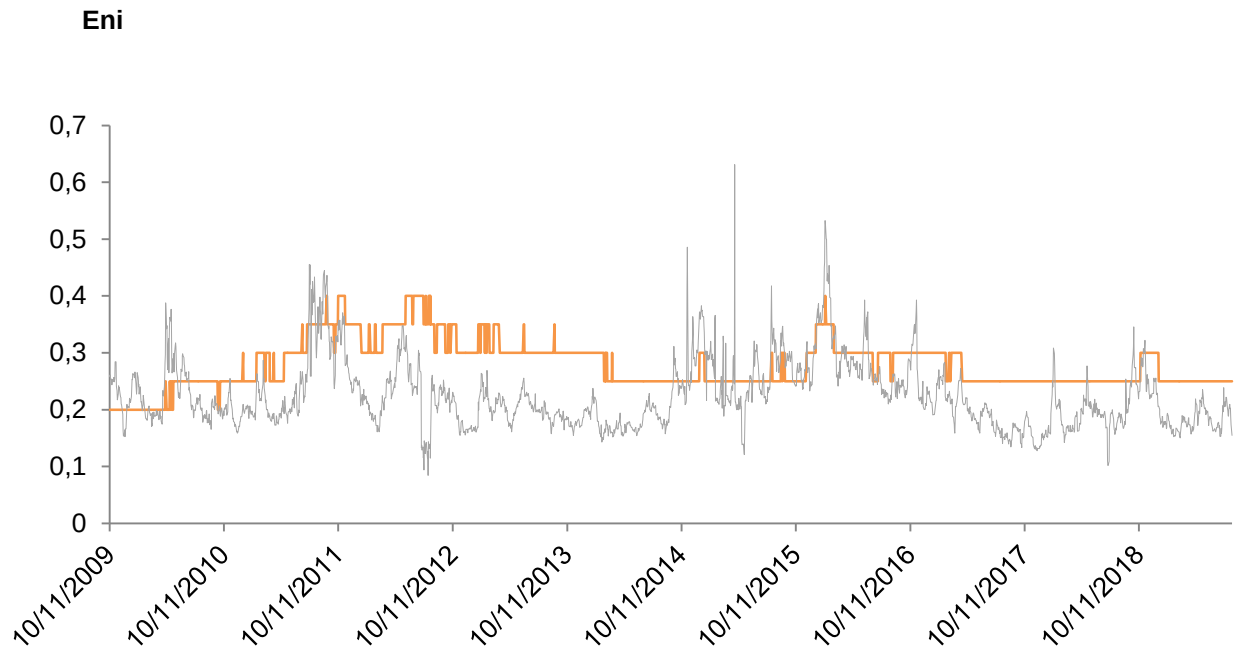

Figure 4. 7: The evolution of Eni's credit implied volatility (orange) and the equity implied volatility (grey) between 10th November 2009 and 2nd September 2019.

The gas and oil company, alike its energy compatriot, Enel, was caught in the middle of a macroeconomic crisis that severely affected its revenues, and accumulating pressure from clean energy competitors and very high debt that amplified the company's problems.

Between 2009 and 2014 both markets showcased high volatility, especially the credit market, caused by the soaring debt levels. During this period, both spikes in the equity volatility happened simultaneously as the company was downgraded by Moody's, doubting that the measures done by management would be enough to deal with the solvency issue (Moody's Investors Service, 2010a). The second downgrade and spike in volatility came in one year later, in response to the inability of the Italian government to deal with the Sovereign Debt Crisis, given that the government owns 30% of Eni and is itself buried under massive debt, was unable to interfere or assist in Eni's debt issues that were continuing to aggravate, even though the company was trying to dispose of some investments, just not fast enough for the market's liking (Moody's Investors Service, 2011a).

There were two major discrepancies between the equity and credit market, one in 2012, where the latter was clearly alarmed with a volatility of 40% while the other market wasn't at all. The equity market calmness was backed up by the reopening of Eni's base in Libya (Moody's Investors Service, 2012d) which didn't have the same effect on the credit market, which didn't consider this move enough to solve the company's issues in the long run. The opposite happened in 2015 where the equity market reached its peak with 60% and the credit maintained its 25% volatility. As already pointed out in previous companies, discrepancies between the two markets happen during times where there are multiple outcomes possible or expected. In 2012, the rise in oil prices gave a new boost not just to Eni but for the entire industry, and the reopening of their complex in Libya also significantly helped the company (Eni, 2013) . With the rise of revenues, the short term market seems

to have taken a more positive approach to the company, while the long term market saw this as a temporary win. In 2015, the exact opposite happened as, oil prices fell causing a decrease of almost 27% of net sales (Eni, 2016). The short term market (unlike the long one) is much more sensitive to changes in oil prices, causing the drift between them again in 2015.

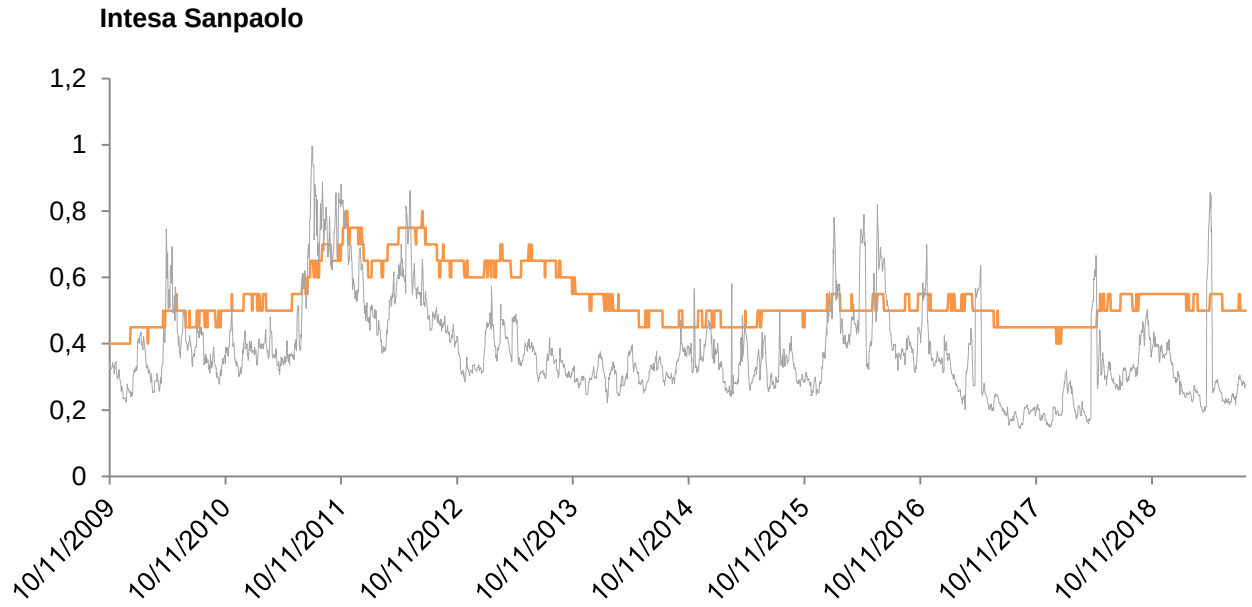

Figure 4. 8: The evolution of Intesa Sanpaolo's credit implied volatility (orange) and the equity implied volatility (grey) between 10th November 2009 and 2nd September 2019.

In line with the other Italian companies, the bank has extremely high credit volatility caused by its large debt.

The evolution of the credit market is almost coincident with the equity market, but the credit market's fears and apprehensions are amplified by the high debt. There have been times where the equity market considerably went above the credit.

The biggest issue for the bank is the lack of reserves and inflexible structure before the crisis as, the institution wasn't ready and didn't take the necessary steps to hedge against the Sovereign Debt Crisis. With a weakening government, forced to take the biggest austerity measures in memory, deceleration of the economy (Moody's Investors Service, 2010b), the bank became very vulnerable to the changes in the political macroeconomic scenario. This scenario wasn't and isn't at all favorable to the bank, as the harsh austerity measures took a toll on the domestic economy and let the country slip into a recession , delaying even more the recovery of the bank (Lane, 2012). The inability of the bank to meet solvency and proficiency ratios and pressure tests sends shock waves to the market as of its riskiness and dependence on the Italian domestic market (Intesa Sanpaolo, 2012). Therefore, until there is a recovery for the Italian economy as a whole, there is no expectation from either one of the markets on the banks recovery, as revealed by the high credit implied volatility still present in 2019.

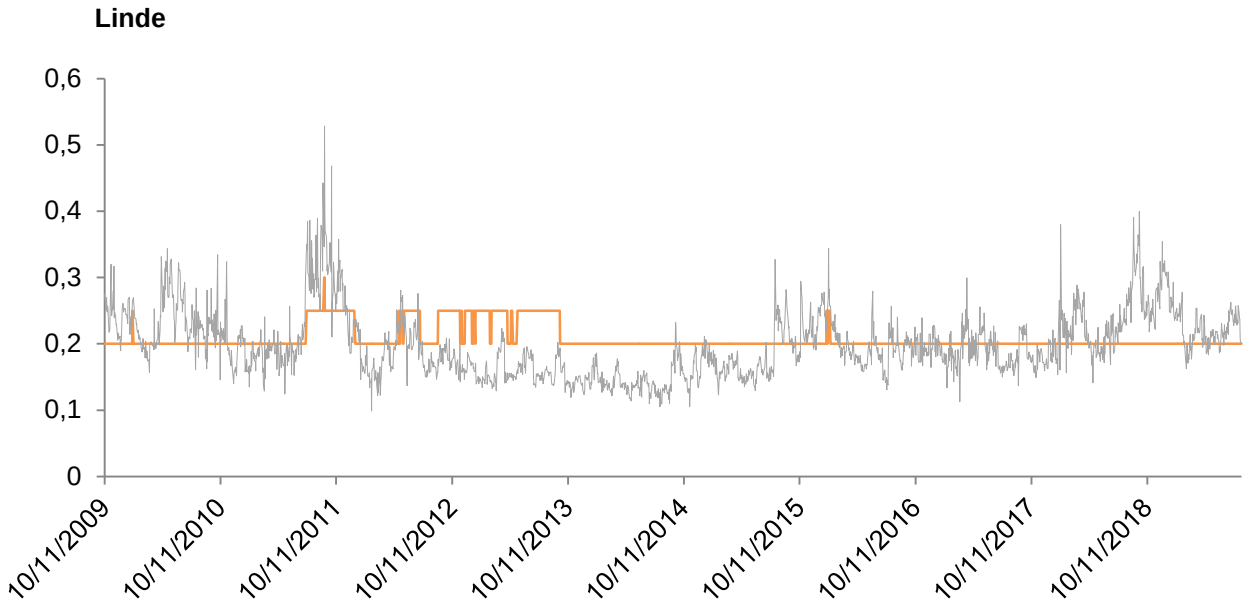

Figure 4. 9: The evolution of Linde's credit implied volatility (orange) and the equity implied volatility (grey) between 10th November 2009 and 2nd September 2019.

Unlike the previous companies, the Irish chemical company has never had a downgrade as, it holds a very strong financial health. The maximum volatility the credit market has presented is approximately 25%.

On the other hand, the equity market,(which is more sensitive) had a spike at the end of 2011, due to the macroeconomic environment on Linde's biggest market, Europe, accompanied by a decrease of 27.8% in Sales revenues. But the company reacted quickly by cutting their cost of sales by 41% allowing to end the year with a growth in profit (Linde AG, 2012). The second biggest spike happened at the end of 2018, when the German Linde AG merged with Irish Praxair plc, creating Linde plc, one of, if not the biggest industrial gas company in the world (Linde plc, 2019)

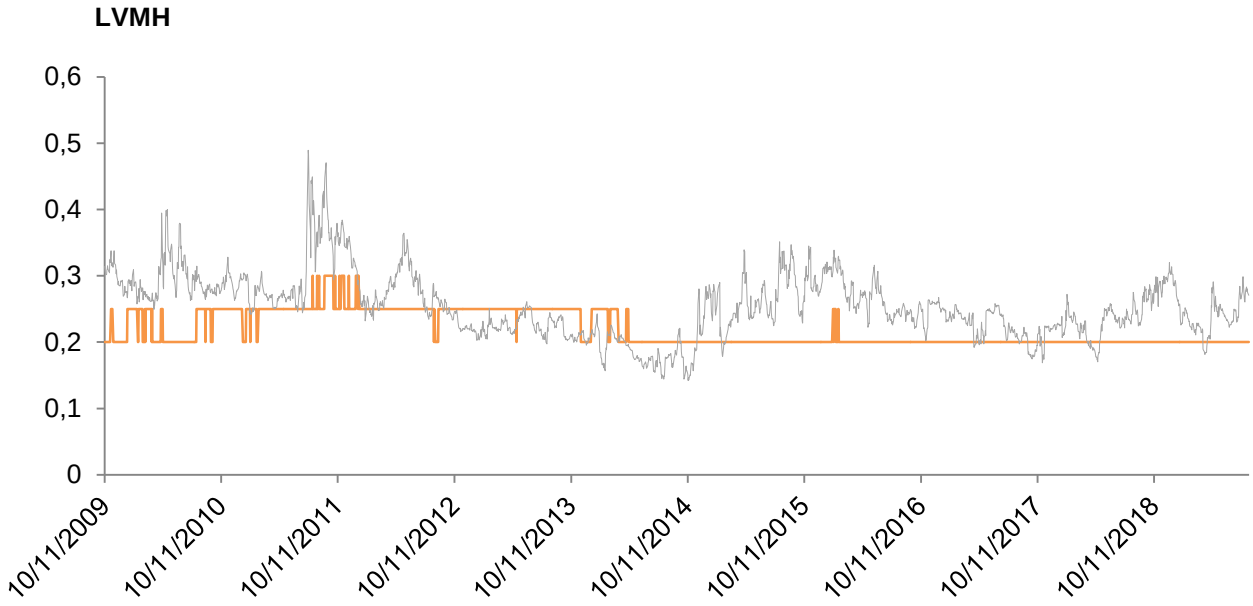

Figure 4. 10: The evolution of LVMH's credit implied volatility (orange) and the equity implied volatility (grey) between 10th November 2009 and 2nd September 2019.

The luxury goods giant came in and out of the European Sovereign Debt Crisis unscathed, much due to its clientele geographic diversity. The company doesn't solely depend on European clients, so when the latter saw their purchasing power diminish, the Asian and US market had more than enough to carry out the company though the recession (LVMH, 2013). Also it is important to note that two of the largest luxury goods European markets (London and Paris) weren't hit as aggressively with the said crisis.

Although all figures seem positive for a company with the most valuables luxury brands, 2011 was tainted by a rise of 43% in net debt, the worsening of the debt-per-equity ratio (LVMH, 2012) and the very public disagreement with the Hermés family , who resisted the acquisition or take over by LVMH (Agnew, 2017).

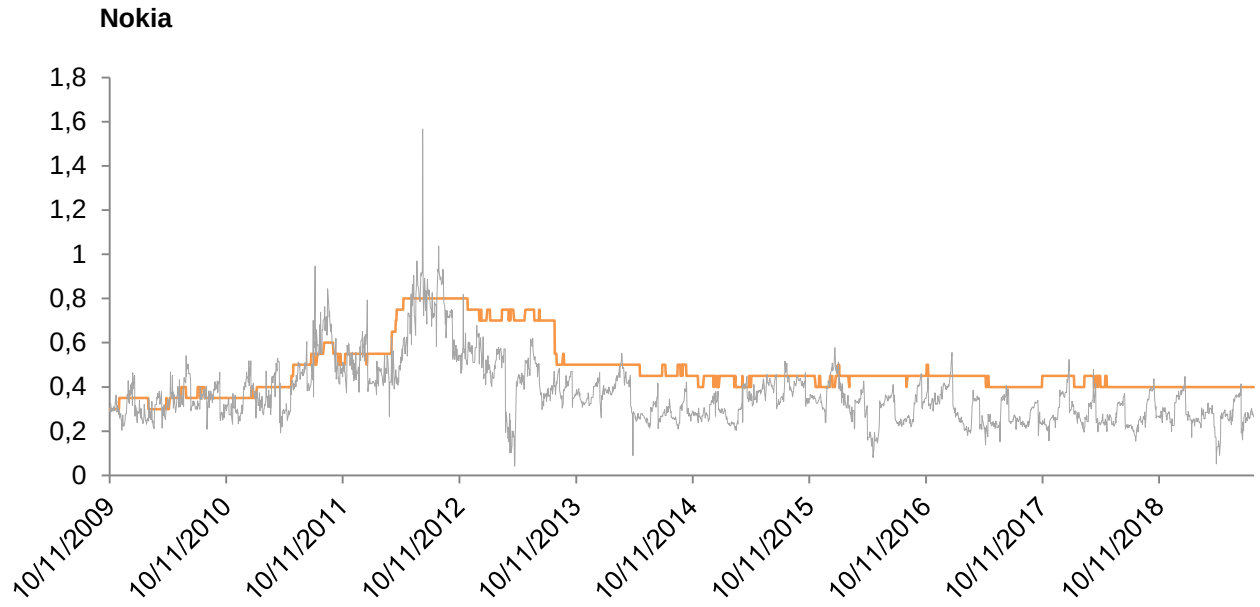

Figure 4. 11: The evolution of Nokia's credit implied volatility (orange) and the equity implied volatility (grey) between 10th November 2009 and 2nd September 2019.

The biggest cellphone company in Europe wasn't able to accompany the new smartphone revolution. In recent years the company reinvented itself and changed into a manufacturer of telecommunications, being the second biggest in the world. The strategy transformation didn't come with higher revenues; the company doesn't present a profit in its financial statements in 4 years (Woo, 2019).

There are no relevant breaks between the equity and the credit market, since there isn't confusion or distinction in the news, forecast or previsions.

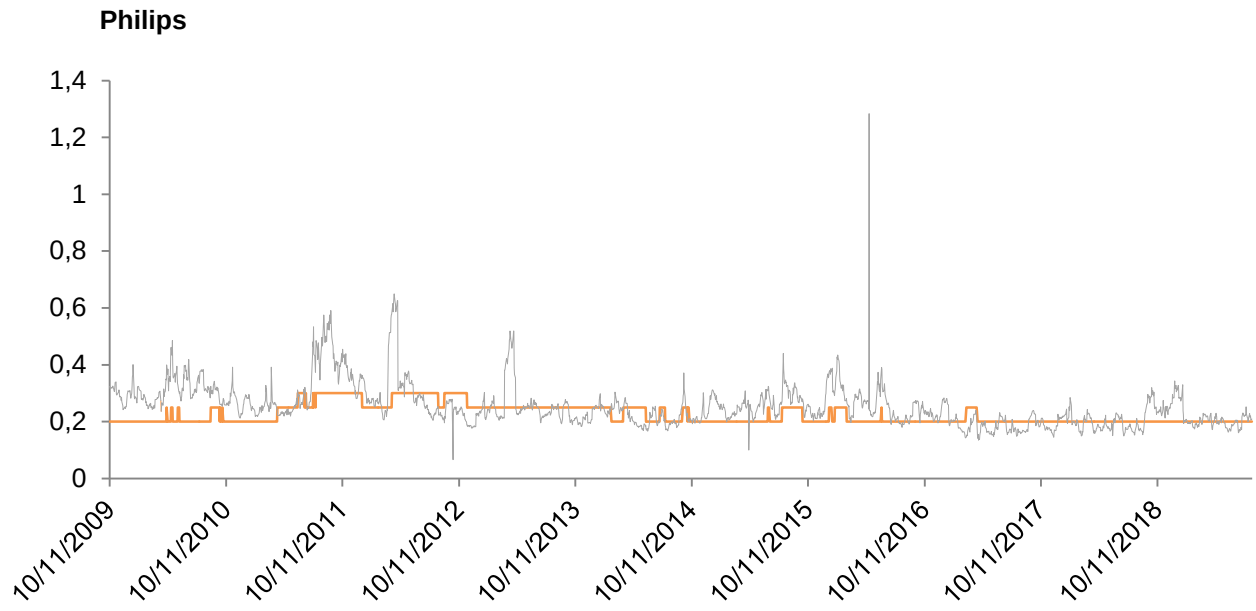

Figure 4. 12: The evolution of Philips's credit implied volatility (orange) and the equity implied volatility (grey) between 10th November 2009 and 2nd September 2019.

The Dutch company doesn't have major breaks between the equity and credit market, except at the end of 2011 and the beginning of 2016.

Between 2011 and 2013, Philips had an issue with maintaining adequate profit margins, much due to the increases in cost, decrease of sales on the consumer electronics segment and a rise in net debt (Philips, 2012), all factors that impact negatively the perspective of the equity market into the company. The same year, it grew its leadership position in the market of most of its product/ services, even though it's margins aren't what might be expected. There is still very high expectation with the continuing investment and development the company is pouring into its business and whether, it will be able to turn around the margin issue in the medium term, causing the credit market to have a lower volatility.

But this discrepancy in viewing the company changed in 2013 when Philips was fined by the European Union for not allowing retailers to fix their own prices on its products as, both markets moved in very similar directions from that date on (Chee, 2018).

Only at the end of 2016 did they diverged again, massively this time, after the separation of the lighting segment into an independent company as, the process of de conglomeration didn't set well with the markets, spiking its volatility to a record high, especially because the process was under extreme scrutiny even being blocked with concerns of disclosing sensitive information to the Chinese (Prodhan & Copley, 2016).

Sanofi

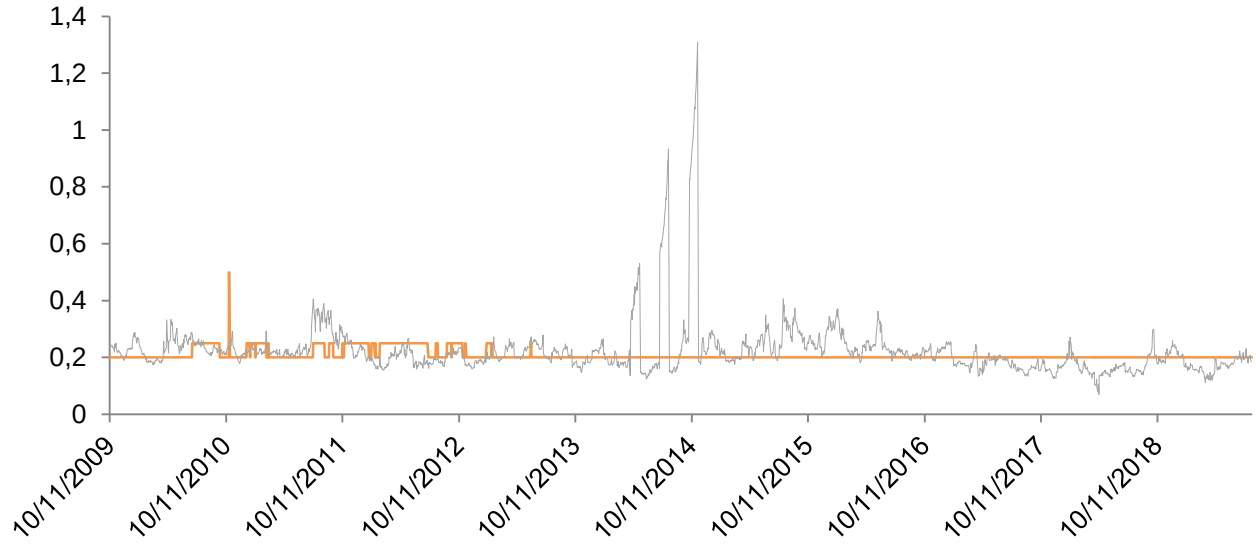

Figure 4. 13: The evolution of Sanofi's credit implied volatility (orange) and the equity implied volatility (grey) between 10th November 2009 and 2nd September 2019.

The discrepancies between the two markets regarding the French pharmaceutical aren't recurrent, at least for the large majority of the period studied, as the CDS and equity market are in sync.

In 2014, the company fired its CEO, who was instrumental in the definition and implementation of a global vision and strategy followed by the company, as the CEO had concrete plans and goals for the company's expansion. The layoff was abrupt and took the market by surprise, especially since the strategy followed by the CEO was having significant returns. Adding to the forecasts that the company might not grow in the next few years due to price wars with their competitors on their most profitable product. Later on, the company guaranteed it would follow the strategy designed by the recently fired CEO, which it did (Jolly & Pollack, 2014).On the long term perspective, this event didn't have any impact and, the company maintained itself faithful to the strategy, but the uncertainty and surprise shook the short term market.

Beforehand, in 2010, under the CEO global expansion strategy, the French pharmaceuticals acquired Genzyme, an American biotech company. The transaction was successful and until this day very profitable for Sanofi (Jolly & Pollack, 2014), but at the time of the offer, the market was skeptical about the financial health of the pharmaceuticals to be able to cope with a billion dollar investment without straining its leverage ratios (Moody's Investors Service, 2010c).

Société Générale

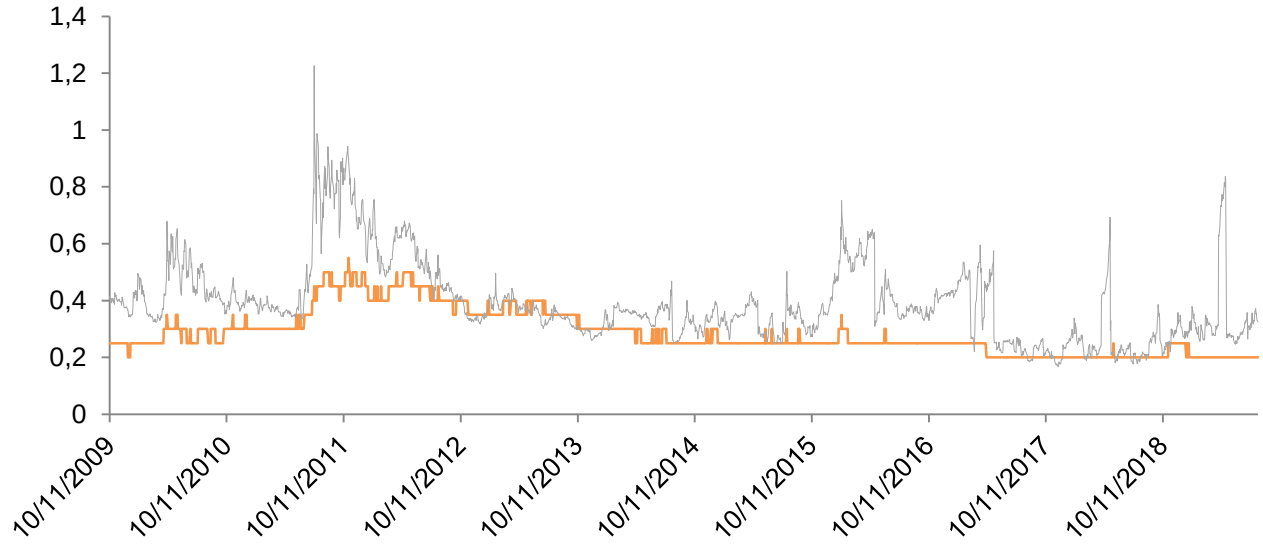

Figure 4. 14: The evolution of Société Générale's credit implied volatility (orange) and the equity implied volatility (grey) between 10th November 2009 and 2nd September 2019.

The pinnacle of volatility came in 2011, following a tough couple of years for the French bank. In the beginning of the year, it dealt with the exposure to the Arab Spring in its investments on Egypt and Libya, the Sovereign Debt Crisis, Greek bond exposure, the recession in Europe and scrutiny over its solvency rations (Laurent & Nair, 2012). Within the year the bank was able to fix most of its problems, selling a large number of assets in order to comply with the BASEL III requirements, including its stake in Egypt, decreased itsexposure on Greek bonds by 75%. But all the measures taken for ensuring its financial health didn't stop the exponential rise in volatility in the equity market, much caused by the fact that the second biggest French bank didn't distribute dividends that year (Societe Generale Group, 2012). Parameters such as dividends affect the short term market with much greater impact than the long term.

The Group didn't start the beginning of 2019 efficiently, with a 1.6% decline in revenue caused by the drench retail banking and the Global Banking and Investment Solutions sectors, paired with a 2.9% rise in operating expenses even though there's a program in place for expenses control.

Telefónica

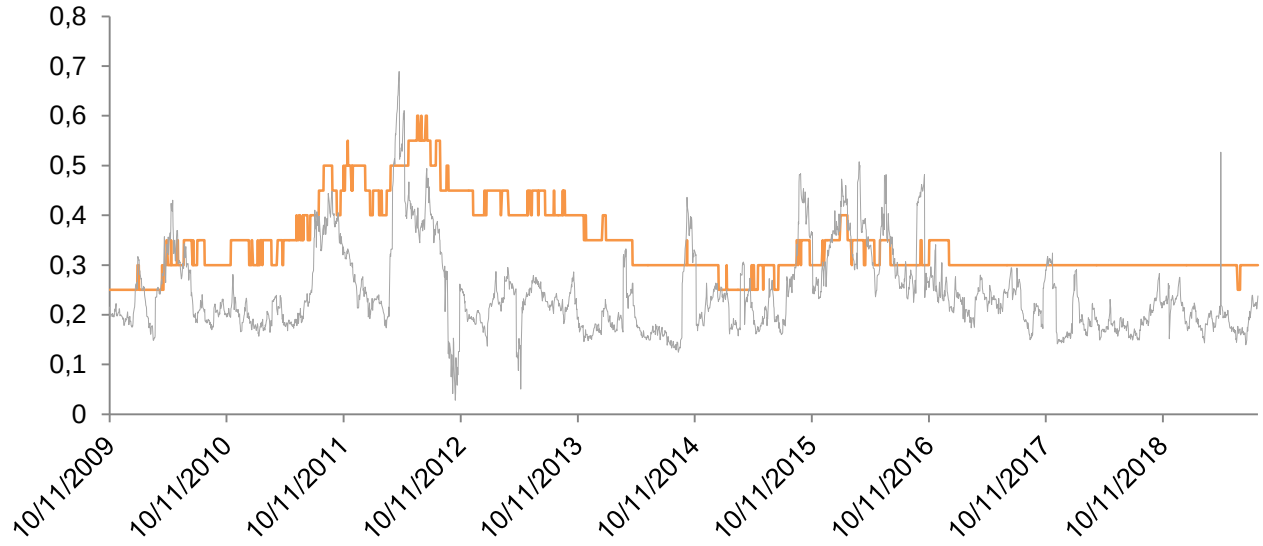

Figure 4. 15: The evolution of Telefónica's credit implied volatility (orange) and the equity implied volatility (grey) between 10th November 2009 and 2nd September 2019.

There aren't many moments where the equity and credit market match their expectations. Much of the concerns of the credit market seem to be related to the sector and not the actual company, since the Spanish telecommunications giant credit implied volatility seems to fluctuate in line with sector changes.

During the years of the Sovereign Debt Crisis, the European telecommunications companies where having a decrease in revenues higher to their significant countries' decrease in GDP, all due to the sensitivity that this market segment has to macroeconomic changes. But this didn't happen with Telecom, since it operates in a highly diversified geographic area, spreading itself though Europe and Latin –America (Moody's Investors Service, 2011b).

The issue with this market resides in the austerity measures, whenever they're implemented, it directly impacts consumers spending. Since telecommunications isn't considered a basic item, consumers can easily diminish the amount spent on this segment, also, the large amount of competitors enables consumers to change to a cheaper service provider once they need to cut down costs. Those factors will always take a big toll on Telefónica's financial stability (Moody´s Investors Service, 2012e). The company is able to maintain it afloat whenever its gains from Latin American profits are enough to sustain the losses of European, especially Spanish, consumers.

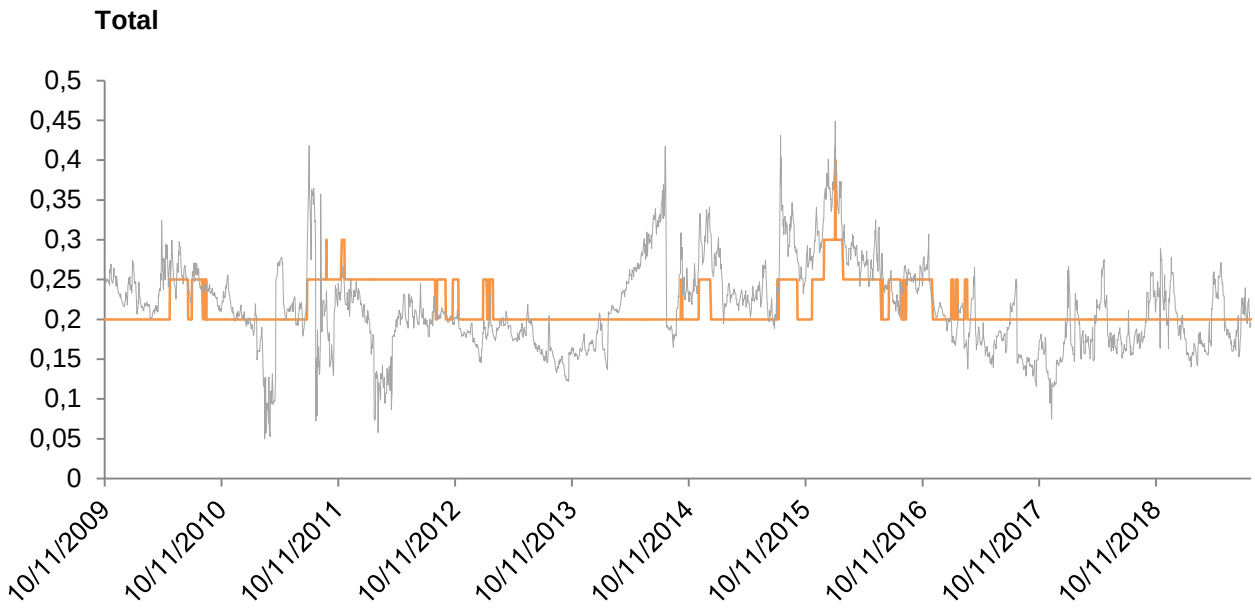

Figure 4. 16: The evolution of Total's credit implied volatility (orange) and the equity implied volatility (grey) between 10th November 2009 and 2nd September 2019.

Total fluctuates according to the oil price and, for that reason is much more volatile in the short term than the long term market. The oil price is then one of the parameters that significantly impacts the short term forecasts.

The oil market itself is extremely volatile, as the equity market is able to go from 5% volatility to 45% in a given year.

2011 and 2012 were characterized by the increase in oil price, enabling an 8% increase in Net income for the company (Total , 2013). The revenues augmentation was caused by the US and European Union embargo on Iran's oil exports, diminishing the supply of in oil and consequently increasing its price (Moody's Investors Service, 2012d).

The stability in the Middle East, especially on areas where the International Oil companies have production caused a decrease in oil price, which has been continuing until this day. At the end of 2014 the volatility significantly rose again, the expenses control and asset sale program didn't offset the losses from the decrease in oil price. The company ended the year with 10% less net income than the previous year (Total, 2015) .

Essentially, oil prices decrease due to an increase in supply and a decrease in oil demand. Due to the residual growth in Europe and the deceleration of the Chinese Economy (the second biggest in the world), there hasn't been a demand for oil as there was before 2014 (Ellwanger, Sawatzky, & Zmitrowicz, 2017). On the other hand, in 2016 Iran saw its sanctions removed (Observador, 2016), and the United States of America started producing more shale oil. These factors should have warned the Organization of the Petroleum Exporting Countries (OPEC) for the excess of oil flooding the market, but the Organization decided that all countries should maintain its production levels, causing a sharp decrease in oil prices (Ellwanger, Sawatzky, & Zmitrowicz, 2017).

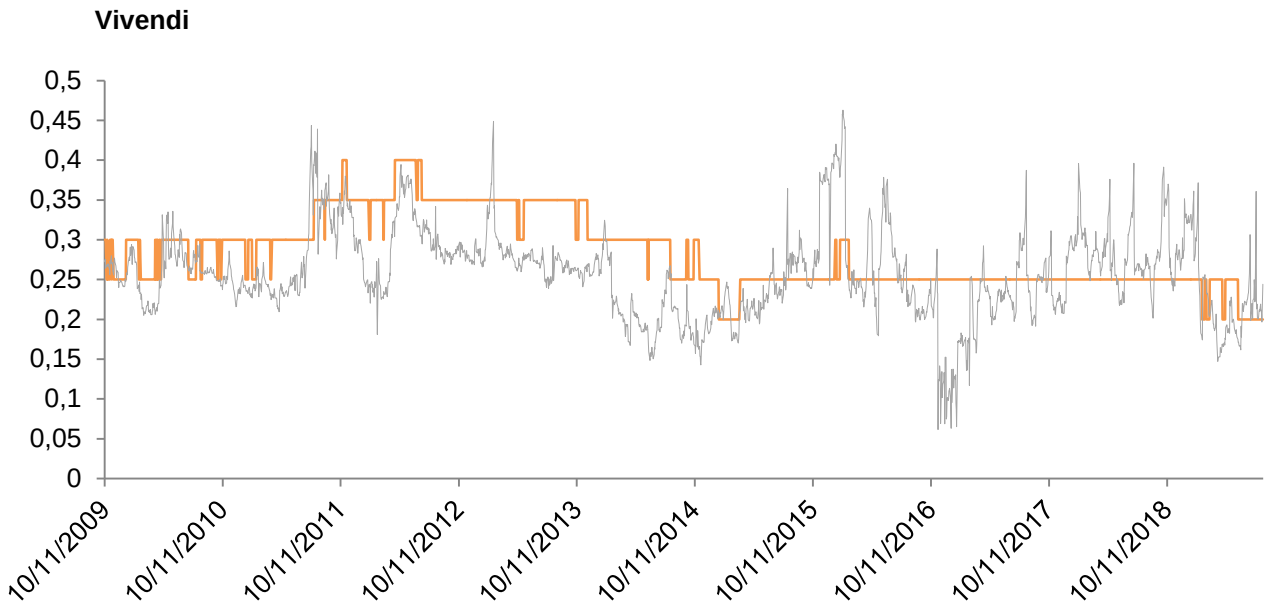

Figure 4. 17: The evolution of Vivendi's credit implied volatility (orange) and the equity implied volatility (grey) between 10th November 2009 and 2nd September 2019.

The French conglomerate has significant volatility variations in both markets as the company strategy changes rapidly.

The wave of de-conglomeration the company has faced, isn't gaining traction with the markets. Especially considering the amount of assets it has been selling, but year after year it still shows a large debt (Stuart, 2013), not appealing to neither the credit nor equity markets, since the company isn't growing or becoming financially sustainable thus, causing this variation in both markets until 2014.

After 2014, the conglomerate announced it wanted to be a media-focused company, justifying all the previously assets sold as companies that didn't fit into the new strategy. The company, with the new strategy at heart then acquired a participation in a French gaming company with hopes of acquiring it in the future, after selling their 5% participation on the third biggest gaming company in the world (Thomson, 2016). The move confused investors for quite some time in both markets. Eventually the management in Vivendi indeed focused on the media market, with a swift range of acquisitions in that area that much benefited the Group and calmed the markets (Reuters, 2015).

Volkswagen

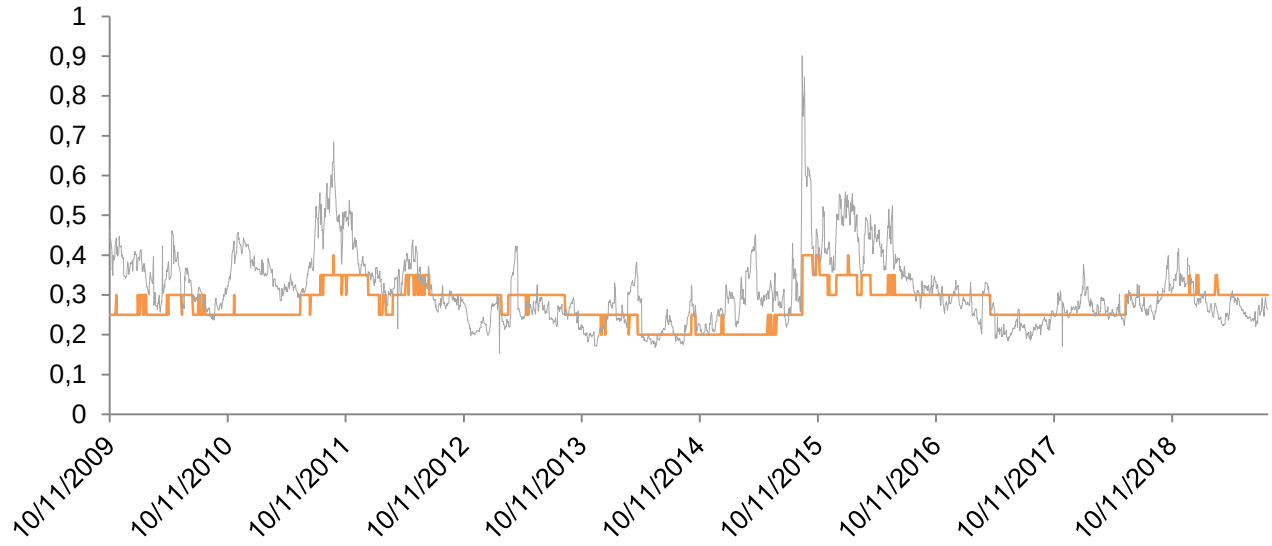

Figure 4. 18: The evolution of Volkswagen's credit implied volatility (orange) and the equity implied volatility (grey) between 10th November 2009 and 2nd September 2019.

The German car manufacturer didn't see much of a discrepancy between 2009 and 2019, and most of it happened until 2011 and a spike in the beginning of 2016.

The news and the acquisition of Porsche unsettled the markets, since it had a worrisome 53 billion euros in debt. Volkswagen, which at that time had a very strong financial health, could see its solvency ratios going considerably down, jeopardizing the rating it enjoyed with the rating agencies (Moody's Investors Service, 2009c)

The large volatility in 2015/2016 was due to the infamous emission crisis, where the company adulterated the results of CO2 emissions in order to sell the car as ecofriendly. The scandal cost the company 30 billion US dollars and a serious dent in its reputation witnessing a decrease in demand for its products (Burger, 2019).

The root causes of the discrepancies between volatilities

In summary, the equity and credit market distance themselves whenever there is a discrepancy in viewing the future of a given company. The equity market is much more sensitive to changes in oil price and dividends, while the long term market is sensitive to changes in the debt level and company strategy. Each market, because of its maturity, prioritizes different components and therefore the information it retains is very different to the other market's information set. One is focused on the short term gain, the commitment that the company is safe and sound until the next dividend distribution; a small variation in sales can take the volatility over the edge. The other focuses on the stability and growth of the company and, the level of indebtedness is essential to know whether the company will be able to pay its creditors, since the market is indirectly one of them.

The short term volatility tends to be more pessimistic for companies with higher debt and optimistic for the ones with lower debt. For that reason, financial firms, for example, have higher discrepancies between equity and credit markets. Their very elevated debt immediately raises the credit implied volatility.

The companies that had the biggest discrepancies between these markets were the ones very exposed to the macroeconomic environment, which releases a multitude of signals to the markets.

It was also proven that the credit market wasn't a very accurate forecaster of the crisis, since prior to the crisis it didn't had high levels of volatility, mostly because of its long term nature and, it's less flexible than the equity market and less sensitive to the news or indicators. Much of the high volatility happened after the crisis began while the equity volatility started increasing the moment the first red flag was shown.

With the exception of the Italian companies, there doesn't seem to be a relation between the country and the discrepancy between the volatilities. This exception is only verified in the case of Italian companies because of their large amounts of debt, and severe exposure to the Sovereign Debt Crisis, which demanded Italy to implement a serious set of austerity measures that constrained consumers demand and shattered firm revenues. Also, even though Italian companies have a global presence, most of their revenues still come from Italy, making them even more vulnerable.

Chapter V: Conclusion

Volatility is one of the most important parameters in the financial world. It's how products are measured, what separates a profitable investment from a loss, it's how investors protect themselves and decide on what, how long, and how to invest.

This parameter is so essential that a large part of economic and financial research is dedicated do it. At the moment there are two types of volatilities mostly used: the historical volatility and the equity implied volatility.

The historical volatility comes from calculating the differences from the share price with the period strictly before and compute a set of volatilities from it. In the Literature Revision, this method is deemed somewhat inaccurate.

The Equity implied volatility is calculated by back tracking the Black-Scholes option premium calculation formula, but with the volatility as the variable. This method is the widely spread standard for calculating volatility, presenting the most reliable results. The issue resides in the fact that the volatility calculated thorough this method only has a short term view, since most equity options are short term. Therefore, it will only reflect the right to buy or sell the underlying asset within a short term span (Bank for International Settlements, 2018).

Using the equity implied volatility to either price or hedge financial products with maturities higher than 5 years will produce uncertain results. The financial products require a volatility that is also long term, in order to match with their timeline and expectations.

This Dissertation is shaped in order to highlight the differences between the short and long term volatilities. For the same company, with the same timeline and same information, the volatilities have different behaviors, depending on whether they're reflecting a short or a long term perspective.

In order to do so, the credit market's standard model for calculating the credit default swaps spread - the Credit Grader's model – was used. Alike the equity implied volatility, the credit implied volatility is calculated by backtracking the Credit Grader's model in order to find the corresponding volatility.

Using daily mid quote senior unsecured CDS Spreads, the debt level of the company and the number of shares outstanding it was possible to find out the volatility through the matrix provided by the model..

The CDS spreads and the equity implied volatility were taken from Datastream, while the debt level came from the company's official first quarter returns from their respective websites and, the number of outstanding shares came from Reuters.

The Dissertation's timeline ranges between the 10th of November 2009 and the 2nd September 2019. The time period was chosen to include the time before, after and during the Sovereign Debt Crisis and also to include the maximum amount of Eurostoxx 50 companies that have data before 2010 in Datastream.

From the 18 companies that were analyzed it was possible to arrive at the four main findings:

Firstly, each market prioritizes different types of information. The equity market is concerned about variables that can alter the ability of the company to pay dividends, with a large focus on revenues and

all factors that could led to the decrease of revenues for the company (even if they are temporary, for example, changes in oil prices). On the other hand, the credit implied volatility isn't sensitive to all types of news and, the biggest reactions from the credit market is associated whether the level of debt of the company has changed or whether the market believes management is not taking actions to decrease high levels of debt, or whether there is a change in the strategy followed the client, M&A activity and, anything that seems to impact their debt within the next 10 years.

The biggest discrepancy between the volatilities always comes during times of opposing news coming out. Since the two markets have different views and priorities when confronted with news, they'll have different reactions as well. When the news flow is ambiguous, for example when a company that didn't distributed dividends that year but incredibly decreased its debt, this would see its equity volatility rise and the credit volatility decrease.

Also, the credit market has a higher volatility, and is therefore more pessimistic on companies with higher debt. Since a credit default swap is a synthetic exposure to a company's or government's debt, it's only natural for the market to pay a special focus to it. This was noticeable in the cases of Italian companies, due to their higher levels of debt and the exposure they had during the Sovereign Debt Crisis, as both volatilities ran incredibly high, but the credit implied was usually a little higher due to the high level of debt, and the same can be said for some European banks.

Lastly, the credit market isn't a better forecaster than the equity market, since the first doesn't have more sensitive information than the second.

This Dissertation has some advantages in relation to the literature of this topic, mainly by focusing on the differences in using a short and long term tem volatility measure, adding to the fact that the position of the Black-Scholes implied volatility as the optimum between all other volatilities is rarely questioned, this was put to question in this Dissertation, and the Credit Grader's model is used in a different way that it's usually used, exposing the versatility of the said model.

A limitation of this Dissertation is associated to the fact that the CDS spread will have to vary 40bps so that the volatility can vary 5%, and it would be much comprehensive if the matrix allowed for more spreads and volatilities.

For future research, it would be useful, instead of using the matrix, to use the Credit Grader's model itself and to recalculate the price of long term investments using the credit implied volatility.

As the financial word revolves around volatility, a minimum change in it could alter a hedge position, an investment analysis, and an intention to buy or sell certain product. It's imperative to use a volatility that reflects long term market's fears and expectations in a long term investment.

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