MASTER THESIS

Study of the impact of industry volatility on convertible bond issuance

Simrat Ahluwalia

Student ID: 484126

Supervisor: Rex Wang Renjie

Erasmus School of Economics

Preface

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Abstract

This thesis examines the potential impact of volatility in an industry on the issuance of convertible bonds. It introduces a volatility metric which has been created for the various Fama French 12 industries by taking into account the stock returns of the firms within the industry. The impact of this volatility metric is examined on both the number of issuances in the period 2000-2014 and the proceeds from issuance. It is found that volatility has a positive and significant impact on both the issuances and the proceeds from issuance. This impact is true to a certain point after which an increase in volatility shows a diminishing effect. The study is limited to US firms only.

1. Introduction

Convertibles are a form of financing that are embedded with features of both debt and equity. They are made to mimic the format of bonds which carry a coupon, but also have the benefit of being converted into equity at the choice of the issuer or the holder. They have been found to be quite an attractive form of capital especially for small high growth firms but big names like Ford Motor and Arcelor Mittal have also participated in the market. The security offers an attractive coupon to the issuer and at the same time helps it give an indication to the market that it can take on more debt while issuing a security which can be converted to equity. The 'signal' that a convertible provides the market can be of great benefit to the issuer and at the same time the flexibility of conversion makes it attractive to the holder. But the security is complicated in terms of its structure and so there have been many studies to understand how to value and price it. There have also been many studies to explain what factors and intentions are that make an issuer choose a convertible over a seasoned equity offering or debt. The most pronounced reasons that most studies have found is the problem of asymmetric information and the volatility of stock. The more fraught a firm is which the problem of asymmetric information, the more attractive it becomes to issue this complex security for raising capital. On the other hand, the more volatile the stock market is, the more unattractive it is to raise equity due to misvaluation which is why issuers resort to this form of security.

There are many articles focusing on the timing of issuance of convertible bonds. These studies try to establish the possibility of a 'window of opportunity' to issue a convertible security which offers the issuer to exploit favorable terms of this security type (Bayless and Chaplinsky, 1996). There is some research done on convertible arbitrageurs and hedge funds being involved in the market to buy convertible issues and make a profit on the trade. It has been established that an individual firm's stock volatility acts as a catalyst in its decision to issue a convertible bond. But, there has been no study to my knowledge on the impact of an industry's volatility on the issuance of this security by the firms in the industry. This is why I explore whether the issuance of this capital form is driven by the volatility in the industry.

The thesis is structured in the following manner: Section 2 provides the theoretical background of convertible bonds and discusses related literature extensively. Section 3 explains the data sample and the methodology. The construction of the industry volatility measure is explained in detail in this section. Section 4 and 5, discuss the results, limitations and additional areas of research. Finally, section 6 concludes this analysis.

2. Background and related literature

There is been considerable literature covering the characteristics of a convertible offering and why they are an attractive form of financing. There are some theories that back the motives of the issuers for issuing such a security. Most important and popular theories that suggest the reasons for convertibles being an attractive source of financing are the back door financing hypothesis and the risk shifting hypothesis.

Theoretical backing for issuance

a) Back door financing

The hybrid form of security is preferable to firms especially because it gives a positive signal to the market about the health of the company and so it is also considered to be a type of 'back-door' financing. The backdoor equity hypothesis states that the firms which face high levels of information asymmetries and financial distress cost, issue convertible debt over common equity. This theory basically states that capital raising problems can be alleviated by using convertible debt which is considered as an indirect form of financing and especially works for those firms that are debt-constrained with significant asymmetric information problems. These firms face incremental costs of financial distress which makes straight debt unattractive. Equity issue would lead to lower leverage but the asymmetric information problems lead to equity being too costly. The investors in the market understand that the motivation behind equity issuance is mispricing and so react negatively to the offers. So, convertibles is the best way to solve such a problem.

b) Risk shifting hypothesis

Some of the earliest researches on convertibles revolve around clearing the myth that the hybrid security provides a 'free lunch' to the issuing firm. Brennan and Schwartz (1988) in their paper establish as to why some firms issue convertibles and what could be the characteristic feature of a firm that resorts to this as a choice of financing. The main argument is that the firms which possess high risk about their future plans and performance will find it more expensive to raise capital through common equity or straight debt. This is primarily because if the management issues straight debt, the riskiness of the firm would lead to a demand of a high coupon rate in order to compensate for the additional risk. So when they issue a convertible instead, because of having an option to claim the equity, the purchasers would be less affected by the increase in future risk of the firm as that would in fact be beneficial to them. The firms whose riskiness is hard to assess, and investment policy is hard to predict are the firms which are most likely to issue convertibles. The paper develops models in an environment where investors have difficulty in assessing the risk faced by the firm's assets in place. The uncertainty about this risk is resolved by issuing convertibles.

Another study which highlights the risk shifting hypothesis is that by Green (1984) which develops a model in an agency framework wherein there is a conflict in interests among the shareholders and the bondholders. By nature, shareholders prefer high risk projects as they gain in times of high investment returns and high limited liability when the returns are low. The managers who work as agents of shareholders have incentives to invest in projects which pose high risk and this is in conflict with bondholders who prefer low risk projects. In such a case, convertibles provide bondholders with an option of conversion which results in reduction of their concern about risk shifting.

c) **Cheaper source of financing**

There have been a fair number of studies on why companies choose convertibles as a form of capital over equity or debt. A key finding emerging out of many studies is that convertibles are preferred because they are perceived to be a less expensive form of financing in comparison to straight bonds and equity. Dong et al. (2016) in their paper stated that through their interview approach they found that most firms have a strong perception about their equity being undervalued in the market at the time they want to issue. This is one of the major reasons, convertibles are seen with a strong perception that the market undervalues their equity at the time of issuance. But they also find that even after being driven by the cost differential aspect of convertibles, firms are also aware of the fact that they could be left worse off ex post compared to the standard type of financing.

In their study, Billingsley and Smith (1996) survey managers and find that reasons why convertibles are considered attractive as they are a ‘debt sweetener’ or a form of ‘delayed equity’. They find that straight debt and not common equity is considered as the next best option after convertibles by most managers. This differs from what Graham and Harvey (2001) found in their study which follows a similar format to examine the motivation of mangers on capital structure policy. They found that 58% of them (managers interviewed) consider it to be delayed equity while 42% of them state that they find it less expensive that debt. The possible explanation for this difference could be that Billingsley and Smith (1996) request a response from firms that have actually issued convertibles whereas Graham and Harvey (2001) condition on whether the firm has considered issuing convertibles seriously.

Convertibles and issuer characteristics

The use of hybrid securities such as convertible debt rather than the choice of straight debt or common equity has also been investigated from the perspective of the issue and issuer characteristics.

a) Volatility

Lewis et al. (1999), in their paper test security choice models with the inclusion of convertible debt. They find robust indicators of security choice by managers when they choose a hybrid instrument. One of the important features investigated as an issuer characteristic in this and other researches is the stock volatility of firms. Stock return volatility of firms, measured over a period of 200 days, 240 days prior to issue announcement, shows significant results. The issue of a debt-like convertible is higher than that of an equity-like convertible if the firm shows high levels of stock return volatility (Lewis et al, 1999).

Brown et al. find the opposite results when they test the equity or debt likeness of a convertible issue in response to the issuer characteristics. They first establish the relation between an issuer’s characteristics and convertibles placed with hedge funds. The paper establishes that 73.4% of the financing of the newly issued convertibles is provided by hedge funds and finds a robust relation between issuer stock return volatility and purchase of issue by hedge funds. In addition, the seasoned equity offerings to firms are also compared to the issue of convertibles to hedge funds, and a statistically significant result that higher stock return volatility increases the probability of issuing convertibles to hedge funds than issuing seasoned equity is found. Building on their model of issuer characteristics and probability of issuing convertibles, they also distinguish between equity-like and debt-like convertible issues. In this case the relation between stock return volatility and convertibles is favorable towards equity-like convertibles being issued by firms which show higher levels of stock return volatility.

b) Other characteristics

Size of a firm has been found to be a characteristic that affects the choice of convertibles as a form of capital. Lewis et al. (1999), Essig (1991) and Fridson (1994), found that in the US market, smaller companies tend to be the ones to issue convertibles. In general, smaller companies tend to be riskier and thus theoretically it makes sense that they issue convertibles in order to take advantage of the equity upside.

Another factor is the possibility of growth, companies with future possibilities of high growth resort to convertibles as for them debt would be quite expensive. Studies by Brennan and Krauss (1987), Essig (1991), and Lewis et al. (1991) have used market-to-book ratio as a proxy for the future growth opportunities and found that the convertible issuers have higher market to book ratios than straight debt issuers.

As mentioned above the theoretical foundation of convertible issuance is that it is a suitable choice of capital in case asymmetric information persists. When adverse costs make it expensive for firms to issue equity, the issuance of convertibles is the next best alternative. In this case the issuer characteristic that drives the issuance is its tangibility which basically is the amount of tangible assets it is endowed with (De Jong et al 2011)). Another factor which can also contribute to the asymmetries is the amount of research and development expenses the firm has. The more the investment in research and development, the more detail is hidden from the open market and thus there is more asymmetry. (Brown et al, 2012)

Contribution to the literature

All studies that I have come across, have examined the impact of stock volatility and convertible issuance from a firm perspective. The accepted conclusive reason is that a firm's stock volatility is one of the reasons that pushes the firm to issue a convertible. In Jong et. al (2010) the firm's volatility is one of the reasons that positively affects the issuance of convertibles (primarily bought by hedge funds) and simultaneous repurchase of stock.

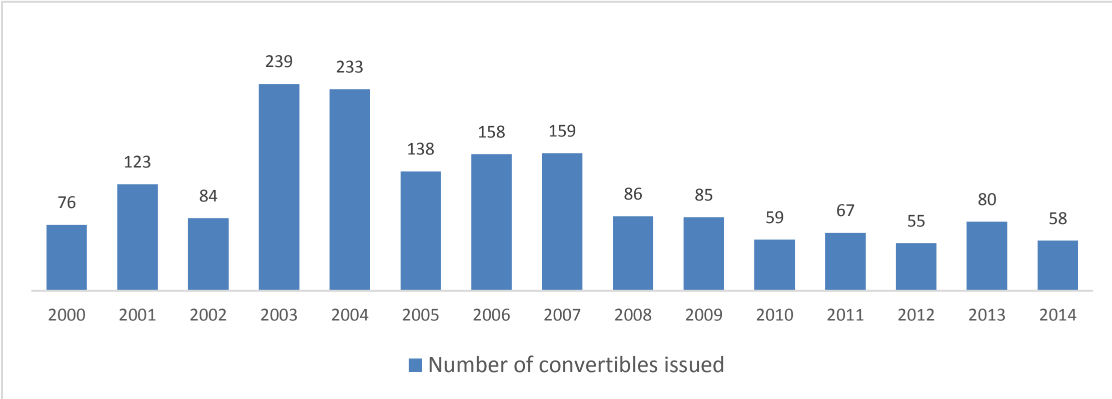
This study will contribute to the literature by studying the effect of stock volatility on the issuance of convertibles but at an industry level. The aggregation of firms forms an industry and as the individual stock volatility has been convincingly found to affect the issuance of convertibles, the expectation is that it would hold true for an industry as well. But as there is no obvious available measure of industry volatility, this study will also contribute by construction of a volatility measure by using stock returns of individual companies in the industry.

3. Data and Methodology

Firm Data

The data for this thesis has been extracted from SDC, CRSP and Datastream. The issuance data is from SDC and CRSP has been used for financial data which form the explanatory variables. The main explanatory variable is the stock volatility which has been calculated by taking daily stock prices from Datastream. The time period in consideration is 2000-2014. The focus is on US firms that have the same currency and same tax governing atmosphere which would not be the case for say European or Asian firms. There is a total of 529 companies that have issued one or more convertible bond in the market during the time period in consideration. There is a total of 1700 issuances in the period from 2000-2014. The breakdown of the issuances per year can be seen in the graphical representation on page 11.

Graph 1: Total issuances in the sample period of 2000-2014



The biggest issuance in the data set is by Ford Motor Company with an issuance of $4.5 billion in the year 2006. The smallest issuance is by Banks.com Inc in 2012 with an issuance amount of $0.125 million. In the dataset, Micron Technology Inc. turns out to be the most active issuer with 11 issuances in the sample period. In total it issued an amount of $4.9 billion in convertible bonds from 2003-2013. It was most active during the period of 2011-2013 when it issued 8 out of its 11 convertible bonds. As it can be seen above the highest number of convertible bonds issuances were in the year 2003. In 2003, I find that the maximum issuances are done by companies which fall in the technology sector followed by the healthcare sector. On inspection of the issuances in the overall time period as well, the highest issuers are companies in the technology and healthcare sector.

Industry level data

After the preliminary analysis of the issuances, I segregate the data into industries by using Fama and French 12 (FF12) classification. In order to divide the companies into the classification, the industry code or SIC code is used. Each industry code is attached to a certain industry type. The classification can be found on the website of Fama and French and is updated regularly. As per previous studies, Utilities and Banking are two industries which are not considered, and I remove them from my sample (Brown et al, 2012). Thus, out of 12 industries, 2 are removed leaving me with a total of 10 industries over a period of 15 years. In terms of nomenclature, industry code 8 represents Utilities and industry code 11 represents money and finance (Banking). Over the years in consideration, these two industries contribute to the issuance market by a very small number. They together issue 26 convertibles in the period 15-year period thus removing them does not limit my sample. In terms of proceeds from the issuance, the 2 industries do not represent a very high percentage. They together contribute to 1% of the total issuance as described by the data sample across the 15 years.

Dependent variable(s)

For the dependent variable, the number of convertibles issues for each half yearly period is defined. This is done for the purpose of ease in the running the regression model which is applied in this thesis. Thirty time periods and ten industries give a total of 300 observations across the board and thus make the analysis easier to carry out. The maximum number of convertible issues in a defined in half a year is 58 and the minimum is 0.

Table 2: Number of convertibles issued by the industries
Summary statistics of number of convertibles issued by industry from 2000-2014. The Fama French 12 classification has been used to divide the data into industries. As it can be seen below industries 8- utility and 11-Banking are not included in the analysis. The minimum number of issuance is none during the year and the maximum is 58 issuances.

Industry	min	mean	p50	Sd	max
1 Consumer Non-Durables	2.00	14.17	11.50	8.86	37.00
2 Consumer Durables	0.00	1.20	1.00	1.67	8.00
3 Manufacturing	0.00	4.97	4.00	4.06	16.00
4 Energy	0.00	2.90	2.00	2.52	9.00
5 Chemicals and Allied Products	0.00	0.73	0.50	0.87	3.00
6 Business Equipment	3.00	17.90	13.50	10.95	47.00
7 Telephone and Television Transmission	0.00	2.03	2.00	1.85	6.00
9 Shops Wholesale, Retail, and Some Services	0.00	4.43	3.50	4.10	18.00
10 Healthcare, Medical Equipment, and Drugs	7.00	25.73	20.00	14.89	58.00
12 Other	0.00	7.47	6.50	5.89	25.00

Additionally, for robustness of the relationship that is being tested, I include another dependent variable which is the value of proceeds from the issuance of convertibles. It has been covered in detail in section 4 under "Additional dependent variable". The proceeds of the convertible issuances of all the firms is taken and then summed up. The log of the proceeds is then taken in order to form the variable for each industry. Choi et al. (2010) in their study use log of proceeds from a convertible issuance to test a relationship between the demand and supply of capital in the market. The model I use takes the proceeds for all the 10 industries across 30 half year periods (15 years) from 2000-2014. In cases where the issuance in the industry is zero, the value of proceeds has been kept zero.

Table 3: Log of proceeds from issuance of convertibles
Summary statistics of log of proceeds from issuance of convertibles issued by industry from 2000-2014. The Fama French 12 classification has been used to divide the data into industries. As it can be seen below industries 8-utilities and 11- Banking are not included in the analysis.

Industry	min	mean	p50	sd	max
1 Consumer Non-Durables	7.49	8.48	8.44	0.60	9.37
2 Consumer Durables	0.00	4.02	5.25	3.18	8.41
3 Manufacturing	4.61	7.34	7.27	0.99	8.39
4 Energy	5.77	6.91	7.05	0.77	8.04
5 Chemicals and Allied Products	0.00	3.44	4.17	2.34	6.32
6 Business Equipment	7.97	8.90	8.89	0.61	9.74
7 Telephone and Television Transmission	0.00	6.21	6.81	2.31	8.12
9 Shops Wholesale, Retail, and Some Services	4.61	6.72	6.56	1.22	8.46
10 Healthcare, Medical Equipment, and Drugs	6.96	8.34	8.43	0.69	9.34
12 Other	6.20	7.56	7.53	0.71	8.92

Construction of the main independent variable

In order to define the main independent variable i.e., volatility at an industry level, a volatility parameter has been constructed. The volatility measure has been constructed by taking the following steps:

I compile the list of all companies in the US from Compustat and the daily stock prices from Datastream. The stock return for each company is calculated by taking the log returns of the daily stock prices. Example: $\text{Log}(X_2)/\text{Log}(X_1)$ will be the stock return for the day X_2.
This process gives the daily returns for each company. Taking the standard deviation of the daily returns for each company is the daily volatility which is then annualized to give each specific year's volatility for each of the firms.
After getting a dataset of firm annual volatilities, the universe of all companies is divided in the Fama French 12 industries by SIC code classification. These firms are of different sizes and so to account for that market capitalization of the firms in the sample, data for the same is taken from Compustat. The volatilities (standard deviations) are weighed by the market capitalization to

arrive at a single volatility number for each industry per year. The yearly volatility is divided by 2 to estimate the half-yearly volatility.

The hypothesis that is tested in this thesis is that industry volatility has a positive impact on the issuance of convertibles. So higher the volatility variable, higher would be the number of issuances.

The data of the main independent variable (industry volatility) can be summarized as below:

Table 4: Industry volatility
Summary statistics of industry volatility from 2000-2014. The Fama French 12 classification has been used to divide the data into industries. As it can be seen below industries 8- utility and 11- Banking are not included in the analysis. The least volatility during the period is 8% and the maximum yearly industry volatility is around 45%.

Industry	min	mean	p50	Sd	Max
1 Consumer Non-Durables	0.09	0.12	0.10	0.04	0.21
2 Consumer Durables	0.10	0.14	0.13	0.04	0.26
3 Manufacturing	0.10	0.15	0.13	0.05	0.28
4 Energy	0.09	0.13	0.12	0.05	0.28
5 Chemicals and Allied Products	0.08	0.12	0.11	0.04	0.21
6 Business Equipment	0.11	0.18	0.14	0.08	0.34
7 Telephone and Television Transmission	0.09	0.14	0.12	0.06	0.25
9 Shops Wholesale, Retail, and Some Services	0.09	0.14	0.12	0.05	0.24
10 Healthcare, Medical Equipment, and Drugs	0.10	0.19	0.17	0.09	0.45
12 Other	0.10	0.16	0.14	0.06	0.29
Total	**0.08**	**0.15**	**0.13**	**0.06**	**0.45**

Control variables

Brown et al. (2012) find that on an average, more than half the buyers of an individual convertible issue are hedge funds and they buy a much higher percentage of a particular offering than other buyers do. As mentioned before, convertibles are issued because of the advantage they offer in terms of cheaper funding. But, Brown et al. (2012) find that on an average, more than half the buyers of an individual convertible issue are hedge funds. These hedge funds involve in convertible arbitrage and the firm eventually repurchases its stock. These agreements between hedge funds and convertibles issuers (which are for over 50% of the issues) are investigated to be due to the cost of seasoned equity offering being high. So, the reason an issuer agrees to issue a convertible with the intent of repurchase of stock also holds true as a reason to why the issuer issues convertible bonds. The authors find probability of distress which is proxied by Altman Z-score. The higher the probability of distress the higher there is a probability of an issuer issuing a convertible bond. A high Altman z-score implies there is a lower risk of bankruptcy which means the probability of distress is lower. So high Altman Z-score would imply lower chance of issuance of convertibles. As the regression analysis in this thesis is at an industry level, the variables must also be aggregated at an industry level. For this reason, I take an average Altman Z-score of every industry under the analysis.

The size of a firm is used as another variable which has mixed evidence about its effect on source of raising capital. Some studies have found that the cost of issuance of equity is lower for larger firms so in that respect the expectation would be for them to not resort to issuance of convertibles. The natural logarithm of market value of equity of the firms in the dataset has been used and averaged as the size variable of an industry.

Constantinides and Grundy (1989) and Stein (1992) find that adverse selection could make convertible bond issues more attractive. So, information asymmetries could be the reason for higher convertible issuance. Like Brown et al (2012), I use two variables to proxy for information asymmetry: Firm tangibility and R&D intensity. The fewer the tangible assets in a firm, the higher there is a potential for an information asymmetry (see, e.g., De Jong, Dutordoir, and Verwijmeren 2011). Tangibility is measured for each firm by taking the ratio of tangible assets over total assets. R&D intensity is measured as R&D expenses over total sales. Average of tangibility and R&D measures for each industry are the variables used as controls.

Choi et al (2010) explore the convertibles market by establishing the relationship between demand and supply of funds concerning the issuance of convertibles. They use the financial and institutional constraints that affect the demand of proceeds of convertible issuance. Two variables they use are leverage and cash holdings. Leverage is measure by the lagged debt to total capital. A lagged measure is used so that the impact of the current issuance is excluded. The rationale is that financial constraints affect how much capital can be demanded. The existing leverage makes the issuance of new debt riskier and creates incentive problems and thus issuing convertibles is a solution to the problem by providing the ability to shift risk. At an industry level, I construct this variable by taking the lagged debt to capital for every firm and them taking an average value for the respective industry. The study also considers Cash Holdings, defined as cash and short-term investments divided by end-of-quarter capital. They theorize that when the internal cash in the economy is high then there is low dependence on external financing. This would mean that issuance of convertibles would attract lower proceeds. I constructed the variable for the industry by taking the average of cash holdings of each industry by taking the short term investments and cash and dividing it by the end of quarter capital.

Methodology

On establishing and creating the main independent and dependent variables, I run a basic OLS regression. The results are significant but the R-squared is almost negligible. It can be understood that the basic OLS regression model is not appropriate to test the relationship between the variables at hand. The data is a panel with multiple number of years and industries and a simple OLS isn't the appropriate model to test the relation between the variables.

As part of understanding the data better, I use a graphical method to plot the industry volatilities against the number of convertible issuances. As a result, I found that the relationship between the two variables is not linear. The resultant graphs are parabolas as can be seen in images on page 16. This finding is essential in this study because as the relationship between the issuances and volatility is non-linear, an additional variable which is the square of industry volatility should be included in the regression to ascertain the relationship between number of issuances and volatility. This relationship between volatility and issuance should be looked at by introducing a quadratic form to the equation.

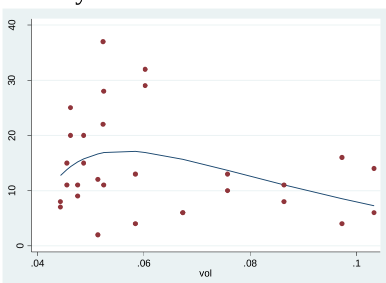
To cater for the shape and the behavior of volatility in this equation, I introduce a new variable which is vol2 in my regression. Vol2 is the square of volatility which will help to capture the effect of volatility on issuance of convertibles and explain thee parabola like shape of the lines in the graphs.

Additional observations from the graphical relationships captured in the graphs on page 16: Just by looking at the graphs it can been seen that most industries show a positive relation between issuance of convertibles and industry volatility. Industries 4- energy, 5- chemicals and 10-healthcare show parabolas which are initially downward sloping but after a certain point, slope upwards. These are the only industries in which I expect the issuance of convertibles to increase after a certain point of volatility is reached. In all other industries the issuance increases till a certain point of volatility and then it goes down. Industry 2 – consumer durables has a flat but downward sloping graph so it would be expected to follow the overall trend as well.

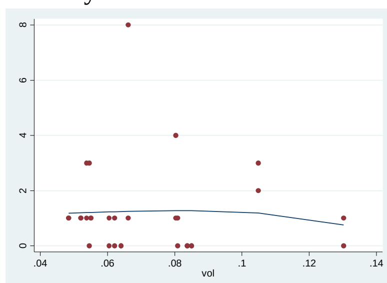
Graph: Convertibles and industry volatility per industry.

These graphs plot the number of convertibles (on the Y-axis) issued against the industry volatility (X-axis). Each industry's convertible issuance and volatility can be seen in the scatter plot and fitted line graphs. There are no graphs for the industries 8- Utilities and 11- Banking. The dots of the scatter plot represent the convertible issuance and the line is the fitted predicted convertibles.

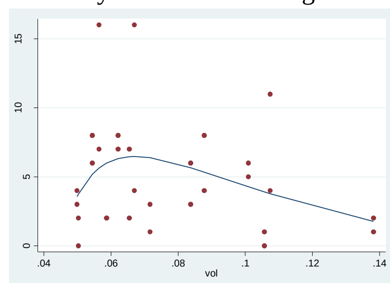
Industry 1- Consumer Non-Durables



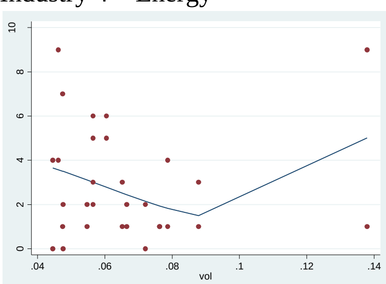
Industry 2- Consumer Durables



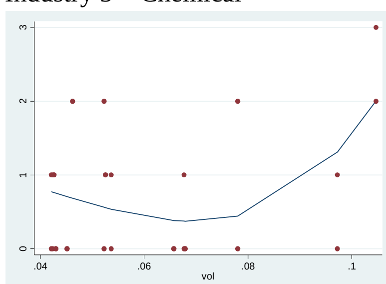
Industry 3 – Manufacturing



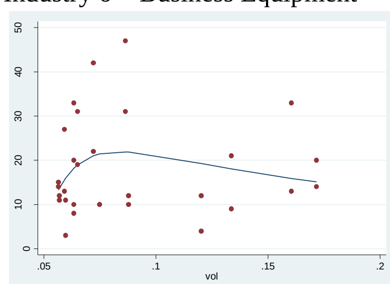
Industry 4 – Energy



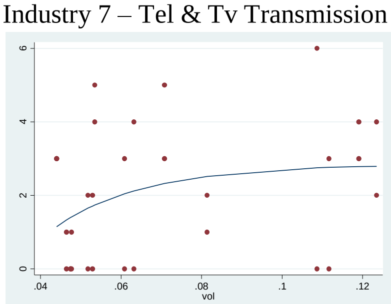
Industry 5 – Chemical



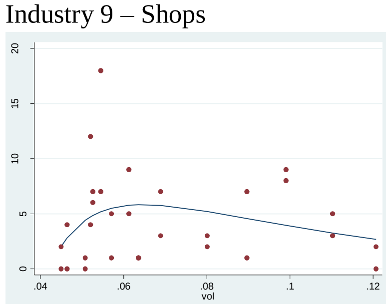
Industry 6 – Business Equipment



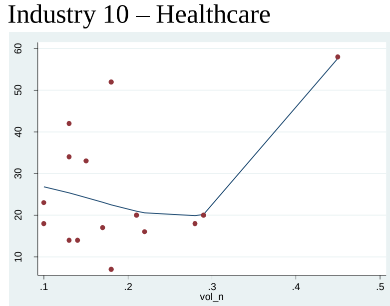
Industry 7 – Tel & Tv Transmission



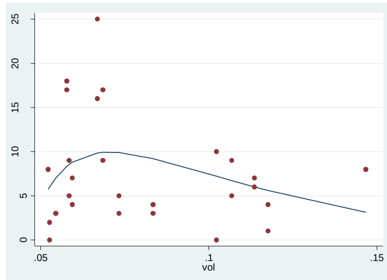
Industry 9 – Shops



Industry 10 – Healthcare



Industry 12- Other



After encountering weak results in the basic OLS regression, I add time dummies to find out if time contaminates the estimation. Also I do not consider the parabola shape of the curves and so do not include the variable vol2. The results are not significant which is probably because of incomplete information in the model. So, I run the same regression model but with the additional variable of vol2 to cater for the shape of the curves.

Table 5: Pooled OLS regression

This table shows the regression results of pooled OLS regression of the main independent variable volatility which is represented by vol and the square of volatility represented by vol2 on number of convertibles issued. Model 1 and 2 are run without industry dummies but time dummies are added. There are no controls in this regression analysis. T-statistics are in parentheses, significance is judges at 10% (*), 5% (**) and 1% (***) levels.

No of convertibles issued	(1)	(2)
Constant	-10.65783	-29.482
	(-3.26)	(-4.93)
Vol	144.306***	169.602***
	(6.82)	(5.23)
vol2		-1335.12***
		(-3.73)
Industry dummies	No	No
Time dummies	Yes	Yes
Adjusted R2	0.2682	0.3017
N	300	300

Here, it can be seen that by adding the various time dummies, the volatility variables (vol and vol2) are significant at 1%. The coefficient of vol is positive which implies that when the volatility increases, the issuance of convertibles will also show an increase. The coefficient of vol2 on the other hand is negative. This implies that after a turning point is reached, industry volatility has a negative effect on the issuance of convertibles.

The various time dummies were also found to be significant at 1%, 5% and 10% levels. Periods 7-16, 28 are significant at 1%, periods 27, 29, 30 are significant at 5% and 22, 25 and 26 are significant at 10%. The coefficients of all the significant time dummies are also positive. The estimate of the coefficient for being in a certain year is positive and significant. But the adjusted R2 is not too high even in model 2. In order for the model to have explanatory power, I extend the same analysis by adding industry dummies and the enhanced adjusted R2 gives a much stronger picture of the statistical relationships been discussed.

As the main approaches to analyze panel data are pooled regression and fixed effects regression models (Greene, 2011) and pooled regression is the most restrictive one, it is not deemed appropriate for such datasets. In this thesis, I will use a fixed effects model with industry and time effects. The poor explanatory power as seen in table 5 is a good indication of the pooled OLS being an unattractive methodology. There are multiple observations for each observation and there is between subject variation and within subject variation over time. The fixed effects method is better equipped to explain this and also control for omitted variable bias. (Hsiao, 2003)

4. Final model and results

The final model I adopt is a panel regression with fixed effects. A panel data regression for the 10 industries for 15 years (30 half year periods) is run with the dependent variables as volatility (vol) and the volatility squared (vol2) with time and industry fixed effects. The following equation is used in this analysis

$$Y_{it} = \beta_0 + \beta_1 X_{1,it} + \ldots + \beta_k X_{k,it} + \gamma_2 E_2 + \ldots + \gamma_n E_n + \delta_2 T_2 + \ldots + \delta_t T_t + u_{it}$$

Y_{it} is the dependent variable – number of convertibles, where i = industry and t = time. $X_{k,it}$ represents independent variables- volatility, square of volatility, average Altman Z-score, average size, average R&D intensity and average tangibility. E_n is the industry n. Since they are dummies, they are n-1. This represents the industry fixed effects and T_t is time as binary variable which represent the time fixed effects. u_{it} is the error term.

In the results that follow, the interesting thing to note is that the coefficient of vol2 is negative while the coefficient of vol is positive and both the variables are significant at 1%. This corroborates the results that I had found while running the simple OLS regressions. The opposite signs confirm that industry volatility as a whole has a positive effect on the issuance of convertibles until a certain turning point is reached, post which the effect is negative and the issuances start to fall. In tandem with the lines in the graph we see that the relationship between convertible issuances first increases with the increase in volatility and then starts falling. This is true on an overall level for most industries. The results of the fixed effects regression run with only the main independent variables vol and vol2. can be seen in table 6. In the extension of the models, I add the control variables as well.

Table 6

This table shows the regression results of regression of the main independent variable volatility which is represented by vol and the square of volatility represented by vol2 on number of convertibles issued. Model 1 and 2 are run without time fixed effects and models 3 and 4 are run with both industry and time fixed effects. There are no controls in this regression analysis. T-statistics are in parentheses, significance is judges at 10% (*), 5% (**) and 1% (***) levels.

No of convertibles issued	(1)	(2)	(3)	(4)
Constant	6.56***	11.634***	-1.918	-19.248***
	(6.96)	(5.79)	(-0.84)	(-3.75)
Vol	4.00	-115.063***	68.143***	345.80***
	(0.34)	(-2.61)	(4.25)	(4.57)
vol2		589.588***		-1048.567***
		(2.80)		(-3.75)
Industry FE	Yes	Yes	Yes	Yes
Time FE	No	No	Yes	Yes
Adjusted R2	0.4897	0.5015	0.7145	0.7281
N	300	300	300	300

In model 1 & 2 with only industry fixed effects, it is seen that with the addition of the squared term, volatility becomes significant. But when I add time-fixed effects, the effect emerges even in the model without the squared term. Even though the results in model 2 are significant, the specification of the model without time fixed effects would mean that we assume that all the years are the same as the base year. Interestingly, when I control only for industry heterogeneity, volatility has a negative sign and volatility squared has a positive sign but on controlling for time, the signs are reversed. But as mentioned that controlling for the differences in the different years is essential for a sensible model, model 4 is ideal for drawing conclusions. Time contaminates the effect on the main dependent variable and this is separated and the true effect is seen in model 4 results. The time dummies show significant coefficients for more time periods than were seen in the pooled OLS before. Periods 7-16 and 25-30 are significant at 1%, 23 is significant at 5% and 3 and 4 are significant at 10% confidence intervals. Coefficients of time periods 6, 17 and 18 are negative and insignificant, all others remain positive as seen before. This corroborates the positive relationship that I am testing between issuance of convertibles and industry volatility. The time dummies being significant implies that all else remaining constant, there is a higher issuance of convertibles in comparison to the base period. So the significant time periods show higher issuances and when I correct for this impact I can see that the impact of volatility emerges very significantly as affecting the issuance positively. The adjusted R2 of approximately 72% is strong and means that the model has sound explanatory power.

The turning point can be calculated by taking the first differential of the regression equation. The following expression will give the required value:

$$x = \frac{\text{Coefficient of the linear variable}}{\text{2 x Coefficient of the squared variable}}$$

By using the constant and the coefficients of volatility and square of volatility we can form a regression equation. And the differentiation of the dependent variable by the independent variable gives the above equation to find the turning point. Using the values from table 6, [345.8 / (2*1048.567)] = 0.1649. This implies that on an average, after volatility reaches a level of ~16.5%, its impact on issuances of convertibles becomes negative. This means that beyond this, increase in industry volatility does not lead to an increase in convertible issuances but in fact leads to reduction in the issuances.

On running individual regressions on each industry, it is found that the industries
1- Consumer Non-Durables - Food, Tobacco, Textiles, Apparel, Leather, Toys
3- Manufacturing - Machinery, Trucks, Planes, Office Furniture, Paper, Com Printing
4 - Energy - Oil, Gas, and Coal Extraction and Products
5 - Chemicals and Allied Products
6 - Business Equipment - Computers, Software, and Electronic Equipment and
12 - Other - Mines, Constr, BldMt, Trans, Hotels, Bus Serv, Entertainment show a significant

relationship between issuance of convertibles and volatility in the industry. Industries 4 and 5 as seen in graph 1 as well, show a relationship opposite to that of the other industries. For both these industries, the volatility variable (vol) has a negative coefficient but the square of volatility (vol2) has a positive coefficient. This implies that industry volatility has a negative impact on the issuance of convertibles in these industries and post a certain turning point, the effect is opposite, i.e. issuance starts to increase with increase in volatility.

Table 7: Panel regression with controls (1)

This table shows the regression results of regression of the main independent variable volatility which is represented by vol and the square of volatility represented by vol2 and controls on number of convertibles issued. Model 1 is run without any industry and time fixed effects, model 2 is run with only industry fixed effects and models 3-7 are run with both industry and time fixed effects. The models 4-7 are run with the added control variables. The prefix 'Av' represents average of the financial variable across the industry. T-statistics are in parentheses, significance is judges at 10% (*), 5% (**) and 1% (***) levels.

No. of convertibles issued	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Constant	9.7321***	11.634***	-19.248***	-5.676	-17.177	-17.658	-16.568
	(3.54)	(-2.61)	(-3.75)	(-0.58)	(-1.45)	(-1.49)	(-1.38)
Vol	-99.132*	-115.063**	345.80***	340.25***	314.071***	316.537***	310.96***
	(2.43)	(2.80)	(4.57)	(4.48)	(4.07)	(4.09)	(4.00)
vol2	700.00**	589.588***	-1048.56***	-1024.23***	-950.93***	-955.23***	-935.83***
	(-1.65)	(5.71)	(-3.75)	(-3.65)	(-3.36)	(-3.37)	(-3.28)
Av Size				-1.9624	-2.082*	-2.1053*	-2.258*
				(-1.65)	(-1.75)	(-1.77)	(-1.87)
Av Tangibility					17.664*	18.361*	18.99*
					(1.69)	(1.75)	(1.80)
Av Altman						-0.035	-0.0361
						(-0.70)	(-0.72)
Av R&D							-0.06720
							(-0.74)
Industry FE	No	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	No	No	Yes	Yes	Yes	Yes	Yes
Adjusted R2	0.0371	0.5015	0.7281	0.7291	0.7311	0.7305	0.7300
N	300	300	300	300	300	300	300

As it was established that the final model is the one with both industry and time fixed effects, I complete my analysis by running the model with the control variables into account as well. From the table above, we can see that volatility and the square of volatility are significant at 1% in all the models where both time and industry fixed effects are employed and as established before they have a strong effect on the issuance of convertibles bond issues. The sign of the coefficient of the square of volatility (vol2) is negative and that of volatility is positive. So, the hypothesis that industry volatility has a positive effect on issuance of convertibles is confirmed. But as noted before it is established that after reaching a tipping point, industry volatility has a negative effect on the issuances.

The control variable of size has a negative coefficient which would mean that smaller firms issue more convertibles. This is significant at 10% level which is in line with research that smaller firms are more likely to resort to choosing convertibles as a means of raising capital. Though in Brown et al., 2012 there is a mention that the effect of firm size of issuances is not conclusive but the accepted result is that smaller firms tend to resort to convertible issuances as the cost of equity turns out to be to expensive. The paper also finds that there is a negative relation between this variable and convertible issuance and the result found is consistent with the research.

The variables Altman Z-score and R&D have negative coefficients but as they are insignificant one cannot derive any conclusions about its effect on issuance of convertible bonds.

Average tangibility has a positive and significant coefficient (at 10%). This means that higher the tangibility higher is the issuance of convertibles. But theoretically, higher the tangibility, higher the tangible assets, lower is the expected information asymmetry. As studies have shown that higher information asymmetry is one of the reasons that push firms to issue more convertible bonds, we should see a negative relation between the two. As, the coefficient shows a positive sign, this would result to the conclusion that the lower the information asymmetry higher would the issuance of convertibles. This result is not in line with existing research and the reason it could be is because of the construction of the variable. All the previous research is at firm level, but I look at the aggregation of firms at an industry level and take an average of the measure. It is possible that due to the aggregation effect the effect of tangibility on issuance of convertibles is not seen. In this test as well, the time dummies that are significant have positive coefficients. The significance of these time dummies implies that all else remaining constant, there is a higher issuance of convertibles in comparison to the base period. So the significant time periods show higher issuances and when I correct for this impact I can see that the impact of volatility emerges very significantly as affecting the issuance positively. The adjusted R2 of 73% is strong and means that the model has sound explanatory power.

Alternative dependent variable

Description

In order to corroborate the relationship found in the thesis up till now, I use an alternative dependent variable which is the proceeds from issuance of a convertible. In their article, Choi et al (2010) test the relationship between convertible bond issuance and capital supply. They study the impact of capital supply from convertible bond arbitrageurs on observable convertible bond issuance. In this research the main variable for regression is the log of proceeds from issuance. This is affected by various demand and supply factors in the market like financial constraints and market conditions. Keeping in line with this research, I use it as another variable to test the relationship between the stock volatility and convertible issuance.

The proceeds from issuance is normalized by taking the natural logarithm. To get an industry level variable, the proceeds of the issuances from all the firms are taken together and then the logarithm of the amount is taken as the issuance amount for that industry. Intuitively, this variable is another way of looking at the number of convertible issuances.

In their research, they find that the various supply and demand factors that affect the issuance proceeds. In terms of supply market factors such as volatility, costs of hedging and flow into convertible hedge arbitrage are considered important factors. On the demand side, financial and institutional factors are taken into account. These include cash flow, cash holdings, leverage etc. I incorporate some of the demand side factors into my analysis and from the supply, volatility is used by taking into account the volatility measure that I constructed in this thesis. As the size of issuance could be correlated with the size of the firms in the industry, this is taken into account in the analysis. On running the test of correlation of the log of proceeds and the industry's average size, we see that they are not highly correlated and so running the regression would not hamper the results. This variable has not been explored by very few researchers as per my knowledge and so this is an added contribution to look at the market issuance.

To take into account the control variables, I incorporate some of the demand factors explored in Choi et al (2010) which are understood to affect the demand of the proceeds from convertible issuance. They are mainly financial constraints which a firm faces due to its current capital structure and performance. I use two of the proxies they use, leverage and cash holdings. Leverage is to cater for the debt capacities of the firms and cash holdings explains the financial constraint that firms face in raising funds. Debt becomes more risky when firms are highly levered and financial distress cost is higher. So to cater to this aspect, I also use the variable of Altman Z-score in my analysis. An interesting variable that the research used is ‘Other Proceeds’ which is the (log) sum of straight debt and equity issued by the issuers listed on NYSE and NASDAQ. The finding is that even the firm’s contemporaneous demand has a positive effect on the proceeds of convertible issuance. Due to lack of data resources, I do not include this variable in my study.

The study expects that financial constraints are more binding when the funds generated internally are scarce. The poor performance of the firm makes straight bond financing more expensive and can also cause the value of equity to decline. Due to these reasons the undervaluing of equity would make firms turn to convertibles as backdoor equity and so the proceeds would be negatively related to cash holdings and positively related to leverage.

Methodology

First, I run the basic regression of proceeds on volatility. As seen before, volatility shows a non-linear relation with issuance proceeds as well and so, I introduce a squared volatility variable in the equation. Following a similar approach as before, I initially run simple pooled OLS regressions with just the independent variables and then add in the industry and time dummies. The regression results of simple pooled OLS without the dummies are extremely insignificant and adjusted R2 estimates are poor. On adding the dummies, the effects are seen and as the data set is in the form of a panel of 15 years (30 half year periods) and 10 industries it makes more sense to use panel data techniques. I run Huasman test to find the appropriateness of fixed or random effects. I find that fixed effects are appropriate for this analysis and go ahead with it.

I run panel regressions and the model looks as follows:

$$Y_{it} = \beta_0 + \beta_1 X_{1,it} + \ldots + \beta_k X_{k,it} + \gamma_2 E_2 + \ldots + \gamma_n E_n + \delta_2 T_2 + \ldots + \delta_t T_t + u_{it}$$

Y_{it} is the dependent variable – log of proceeds where i = industry and t = time. $X\text{k}_{,it}$ represents independent variables- volatility, square of volatility, average Altman Z-score, average leverage and average cash holdings. E_n is the industry n. Since they are dummies, they are n-1. This represents the industry fixed effects and T_t is time as binary variable which represent the time fixed effects. u_{it} is the error term

In model 1, I run simple regressions without catering for industry or time heterogeneity. In model 2 I cater for the industry heterogeneity. In the models after that both time and industry fixed effects are applied. Variations of the same model are run from regressions 3 to 7. Starting from model 4, the additional controls are also added.

It is seen that in all the tests without time fixed effects none of the variables are found to have significant values and through this test one cannot really deduce concrete results about the relationship between industry volatility and issuance proceeds. In the enhanced models, I add time fixed effects to eliminate omitted variables bias arising both from unobserved variables that are constant over time and from variables that are constant across industries. In this improved model, the volatility of the industry has a significant effect on issuance proceeds and this is seen all through.

Table 8: Panel regression with controls (2)

This table shows the regression results of regression of the main independent variable volatility which is represented by vol and the square of volatility represented by vol2 and controls on log of proceeds from convertibles issued. Model 1 is run without any industry and time fixed effects, model 2 is run with only industry fixed effects and models 3-7 are run with both industry and time fixed effects. The models 4-7 are run with the added control variables. The prefix 'Av' represents average of the financial variable across the industry. T-statistics are in parentheses, significance is judges at 10% (*), 5% (**) and 1% (***) levels.

Proceeds	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Constant	2.917***	3.360***	-0.0824	-1.409	-1.599	-1.800	-1.906
	(7.34)	(11.93)	(-0.09)	(-0.89)	(-1.00)	(-1.11)	(-1.16)
vol	5.749	-0.495	49.127***	46.500***	47.275***	48.189***	49.012***
	(0.66)	(-0.88)	(3.66)	(3.38)	(3.43)	(3.48)	(3.52)
vol2	7.712	11.126	-163.059***	-155.90***	-157.314***	-160.503***	-163.2***
	(0.19)	(0.38)	(-3.29)	(-3.09)	(-3.12)	(-3.17)	(-3.21)
Av Size				1.897	2.105	2.236	2.286
				(1.02)	(1.13)	(1.19)	(1.21)
Av Altman					-.0106	-0.01	-0.011
					(-1.19)	(-1.17)	(-1.16)
Av Leverage						1.792	3.548
						(0.68)	(0.89)
Av Cash							-3.247
							(-0.67)
Industry FE	No	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	No	No	Yes	Yes	Yes	Yes	Yes
Adjusted R2	0.0048	0.5402	0.5876	0.5868	0.5875	0.566	0.5855
N	300	300	300	300	300	300	300

In table 8, it can be seen that both volatility (vol) and square of volatility (vol2) are significant at 1% levels. Volatility has positive coefficient, which means that when industry volatility rises, the proceeds from convertible issuances also rise in an industry in a year. As seen in the case of number of convertibles, the coefficient of volatility squared also has a negative sign. This means that initially volatility has a positive effect on issuance proceeds but after a tipping point is reached, the issuance proceeds are affected negatively. This means, after a certain level of industry volatility has been reached, the incentive to raise a high amount of capital from convertible issuance is not that attractive for issuers. In model 3 the periods 7-9, 12-16 and 29-30 are significant at 1%, 10-11, 26-27 are significant at 5% and 21 and 22 are significant at 10% confidence intervals. In terms of years, 2004-2008, 2013, 2014 and 2015 are significant. Coefficients of time periods 2, 17 and 18 are negative and insignificant, all others remain positive. The time dummies in the models are significant which implies that all else remaining constant, the proceeds from the issuance is significantly more in these periods in comparison to the base year. The time dummies are significant for 6 years in the sample. The significant time periods show impact that is present across industries and emerge in certain years. When I correct for this impact I can see that the impact of volatility emerges very significantly as affecting the issuance proceeds positively. The adjusted R2 of the models are also high and thus have strong explanatory power.

After running the basic regression with the main independent variable, I add the control variables as well (models 4-7). The controls are basically the proxies for asymmetric information, adverse selection and financial constraints that affect the issuance proceeds. The fixed effects regression is run with industry and time fixed effects and the control variables. As can be seen in table 8, volatility and volatility squared continue to be significant at 1% levels. The adjusted R2 remains high in all the models proving that the model high explanatory power. Interestingly none of the control variables are found to be significant in any of the models. Leverage which according to Choi et al (2010) had a positive and significant impact on the issuance proceeds also shows a positive coefficient in the models run. But as the coefficient is highly insignificant, I cannot truly deduce its impact. The coefficient of average cash holdings is also in line with the research. Choi et al. (2010) expected that the cash holdings of a firm have a negative impact on the issuance of proceeds, which is also found to have a negative coefficient in my model. But, in their research as well, the variable ended up having an insignificant coefficient which is also seen in table 8 above. Finally, Altman Z-score, the rationale is that a lower Altman Z-score leads to higher risk of financial distress which would in turn lead to higher dependence on convertibles. As per the rationale, the coefficient should have a negative sign which is in line with the logic and previous research and can be seen in table 8, but as this is also highly insignificant, nothing can be explained about its impact. The adjusted R2 of all the models are strong and are quite in line which makes them all viable for this research.

5. Limitations and additional areas of research

This research has contributed to the existing literature by looking at the capital choices of firms from a different angle. All existing studies are at firm level and most of the research around the convertibles issuance are event studies. This research breaks the trend and analyses the issuance at an industry level. Whilst being an interesting perspective to look at issuance, it makes the study and analysis difficult and limits its scope. The fact that everything has to be seen at an industry level and not a firm level, the variables from exiting research have to be used carefully for the results to make sense. Aggregating variables can lead to difficulty in comprehending results. More studies at an industry level could bolster this analysis and lead to more robust selection of variables which affect the convertible issuance.

Another limitation which could be a valuable addition would be another definition of volatility in the industry. While the current definition is sound but looking at the market through implied volatility could be a welcomed inclusion. Using the VIX index as an alternative to establish a relationship between issuance and volatility could strengthen the analysis. The VIX index is for only S&P500 companies and to my knowledge segregation of the same into industries is not possible which is why by the design limitation of this thesis, I could not include it in my analysis. Finally, I look at only stock market volatility but interest rate volatility can be seen through the bond market as well. Including both the markets to contribute to the volatility index of an industry could be another avenue of research and would make the picture even more complete.

6. Conclusion

This thesis examined the relationship between industry volatility and convertible bond issuance by considering both the number of issues in the US market and the proceeds from the issuance between the time periods 2000-2014. The volatility measure used has been self-constructed by taking the deviations of stock prices returns of firms and aggregating them into various industry types as per the Fama French 12 classification. The relationship between volatility and issuance was found to be nonlinear but positive. It has been established that during this time period, the impact of stock volatility of an industry has a positive and significant impact on both the number of convertibles issued and the proceeds that one generates from it. Specifically, it is found that the industries 1, 3, 4, 5, 6 and 12 show a significant relationship between issuance of convertibles and volatility in the industry. Interestingly 2 out of these 6 industries show a relationship opposite to that of the other industries i.e. instead of having an effect wherein volatility leads to fall of issuance after a certain point has reached, they have increased issuances after the tipping point has reached. Also to be noted is that size and tangibility hsve been found to have a significant impact on the issuance of convertibles. The result of - smaller the size the higher will be the issuances is in line with research, the effect that tangibility has is opposite to what has been found in most existing research and so may be interpreted with caution.

Additionally, the proceeds from issuance has also been found to be affected positively by the volatility in the industry. In line with the first model volatility has a dampening effect on the issuance proceeds after a certain tipping point is reached but overall the relationship is positive and significant. Also, in line with previous research the financial constraint of cash holdings does not affect the issuance proceeds but leverage which is believed to have a significant impact on the proceeds is found to not be of importance in this research. This could be considered as a limitation of the research but it must also be understood that as all variables available are at firm level, the transformation to industry level indicators may be the reason the results differ from what we see in existing research.

Overall, the impact of volatility has been found to be have a positive influence on convertible issuance in most industries which confirms the intuitive reasoning this thesis has sought out to establish.

7. Appendix

A: Tests for multicollinearity

I used the Variance Inflation factor (VIF) to test for multi-collinearity in my models. Table A.1 shows results of the VIF test for the first model with number of convertibles as the dependent variable. Table A.2 shows the results for the models with log of proceeds as the dependent variable. In both the cases, the VIF levels re not worrisome, and so the model results should not have inflated standard errors. The tables exclude vol2 in the test.

Table A.1

Variable	VIF
Volatility	1.12
Av size	1.09
Av Altmanzscore	4.09
Av Tangibility	3.95
Av R&D intensity	1.11
Mean VIF	2.27

Table A.2

Variable	VIF
Volatility	1.02
Av Leverage	1.93
Av Size	1.07
Av Altmanzscore	1.07
Av Cash Holdings	1.90
Mean VIF	1.40

B: Table detailing the description of variables used in the thesis

Volatility (vol)	A measure constructed by taking the log returns of the daily stock prices of the firms. Taking the standard deviation of the returns and annualizing them gives the yearly volatility. The firm level volatilities are weighed by the respective market capitalizations to arrive at an industry level volatility for each industry per year.
Volatility squared	It is the square of the volatility measure constructed. (Volatility x Volatility).
Proceeds	The value of issuance proceeds from each convertible issuance. The natural logarithm of all the issuances in the industry is taken.
Average Size	Firm size is the market value of the equity. The natural logarithm is taken to measure the size. The size of all firms in an industry is taken and divided by the number of industries to come to an industry level variable.
Average R&D	The R&D expenses divided by total sales of the firm. The measure is equal to 0 if the firm does not report the expenses.
Average Altman Z-score	As per the accepted definition of Altman Z-score: Z-score is a simple weighted average of 5 accounting ratios that measure the operating efficiency, total asset turnover, leverage ratio, asset liquidity, and earning power, as follows: Z-Score = A x 3.3 + B x 0.99 + C x 0.6 + D x 1.2 + E x 1.4, Where, A=EBIT/Total Assets, B=Net Sales /Total Assets, C=Market Value of Equity / Total Liabilities, D=Working Capital/Total Assets, E=Retained Earnings /Total Assets. Source (https://wrds-www.wharton.upenn.edu/pages/support/applications/risk-and-valuation-measures/tobins-q-altman-z-score-and-companys-age/)
Average Tangibility	The ratio of tangible assets over total assets, averaged for all the firms in the industry.
Average Leverage	The debt to total capital ratio but lagged to cater for the current period issue. Averaged for all firms that form the industry.
Average Cash Holdings	Cash and short-term investments divided by the quarter end capital. Averaged for all firms in the industry.

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