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Western European choices in the convertible debt market: A study on the likelihood and structure of issuing convertible debt

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Abstract
The implications of contracting costs arising from moral hazard, adverse selection and financial distress can be mitigated by the issuance of convertibles. This has shown to influence both security choice and security design decisions. Using binary logistic-based regression models, this thesis investigates the decisions to issue convertible debt and its associated design. It is shown that as adverse selection and financial distress costs rise, firms issue more convertibles over straight debt. These convertibles however are only structured to be more debt-like as adverse selection costs have the only real significant impact on the design. The factors influencing these decisions are firm-specific where firm size, leverage and stock volatility are the main deciding factors. It too has been demonstrated that the little to non-existent influence of macroeconomic variables over this time frame may be attributable to the unique economic environment over the past decade, characterized by low to negative interest rates and steady economic growth.

Table of Content

List of Tables

List of Figures and Tables in Appendix

1. Introduction

With increasing complexity and innovation in financial instruments over the past decades, security choices for firms is of crucial importance to compete in competitive environments. Graham and Harvey (2001) find in their survey that the decisions regarding capital structure are most influenced through financial flexibility. One security which offers a high degree of financial flexibility is a convertible bond (or convertible debt). A convertible is a hybrid security which initially is regarded to have the same characteristics as standard or straight debt, such as regular coupon payments and fixed maturity, but has an additional option or call component embedded in which the bond can be converted into a predetermined number of equity shares or common stock. The conversion feature is typically specified by the issuer and may have multiple conversion dates depending on specifications in the prospectus. The conversion usually takes place when the value of the convertible is equal to the value of stocks received. Therefore, the convertible possesses both equity- and debt-like features.

Literature has shown that convertible debt is issued for two main reasons. Firstly, convertibles offer a lower coupon due to the option component and therefore is a cheaper source of funding when debt is needed to be raised. Secondly, issuing equity can become costly due to dilution of stock prices and can therefore be delayed through convertible debt. The conversion feature therefore offers a firm to indirectly raise equity. This study however goes deeper and considers the contracting costs of issuing straight debt or equity that arise through moral hazard, adverse selection and financial distress problems. The argument is that convertibles can mitigate these costs. Specifically, the costs that are mitigated in relation with the decision of firms to issue convertible debt over straight debt and the decision to design the convertible (more equity- or debt-like structure) accordingly.

This thesis aims at analyzing the convertible bond market in Western Europe in the time frame 2009-18 while considering both firm-specific and macroeconomic factors to capture the contracting costs that arise in moral hazard, adverse selection and financial distress. Dutordoir and Van de Gucht (2004) among others find that the European convertible market is rather different to its United Sates (US) counterpart. The convertibles offered in the US tend to be characterized as more equity-like (or have higher probabilities of conversion) whereas in Europe it tends to be more debt-like. Furthermore, firm-specific characteristics differ where European firms are larger and more mature than US firms which tend to be described as high growth and high risk (Lewis et al., 1999). The macroeconomic factors that define the economic environment further shed light as they allow for time-series variation in the contracting costs

according to Choe et al. (1993). Through the use of binary or logistic based regressions that make use of the two-dimensional aspect of choosing between convertible and straight debt as well as the design (equity- or debt-like), the results demonstrate evidence for the mitigation of adverse selection and financial distress costs through the issuance of convertible debt over straight. These firms facing these costs can be characterized as having low growth opportunities, relatively more volatile, are smaller and have a lower leverage ratio. Furthermore, the economic environment for firms tends to include high interest rates and, but less significantly, economic growth times. Consistent with the previous literature on the European convertible bond market, the convertibles in this sample are more debt-like (median probability of conversion of just over 20%). The contracting costs in determining the design is solely influenced by firm-specific factors in adverse selection where again small and low leveraged firms are typical however with the difference of being of low risk. Of interest in this analysis is the lack of support for macroeconomic factors. The economic environment over the past decade in Europe has been competitive for firms, characterized by low interest rates and steady economic growth. It has become apparent through this analysis that the convertible debt market was not solely utilized for its purpose of mitigating contracting costs over this time frame and there may be other unknown rationales.

The structure of this thesis is as follows: in Section 0 the literature regarding convertible debt issuance and its design as well as the theoretical framework for this study is outlined; Section 0 provides a detailed description of the variables used as well the data for both convertible and straight debt sample; the underlying methodology and results are presented in Sections 0 and 5 respectively; Section 0 discusses the limitations of this analysis while also commenting on future avenues of further research and Section 0 concludes.

2. Literature review and theoretical framework

This section provides two different strands of literature that have characterized a part of the convertible debt research. The first strand presents the earliest studies on convertible debt like offerings as well as the most formal theoretical consensus on rationales for issuing convertible debt. The underlying theoretical framework for this study is then intentionally described where the contracting costs in moral hazard, adverse selection and financial distress are discussed. This provides a clearer and more fundamental understanding of the more recent research. Therefore, the other strand of literature relates to the topics regarding the decision to issue and how to design convertible debt and the specific role of the contracting costs.

2.1. Earliest literature and "Big Four" models

Prior literature and academic research have provided evidence on two main reasons for the issuance of convertible debt. In line with the equity- and debt-like features of this instrument, the "Sweetened Debt" and "Backdoor Equity" viewpoints have yielded the most influential rationales. These viewpoints imply either a motivation in line with cheap debt due to lower coupons for issuance or an alternative to equity issuance without the direct problems of diluting the prices of stocks.

The earliest research on convertible debt prior to any theoretic models based its findings on surveys of managers in firms. Brigham (1966), Hoffmeister (1977) and Pilcher (1955) find that, based on their qualitative analysis, the rationale for issuing convertibles in the US lies on the hope that it will be converted into equity over the lifetime of the bond or also known as "Backdoor Equity". The surveys asked the managers specifically why they would choose to issue convertible debt with majority of the managers agreeing on raising new equity.

Following the developments of this earlier research, the models commonly known as the "Big Four" were established and were used for testing to determine motives for convertible debt issuance. These models provide the most solid rationales for the "Sweetened Debt" and "Backdoor Equity" viewpoints for issuing convertible debt. Three of the models provide rationales for the "Sweetened Debt" viewpoint whereas the fourth model provides a rationale for the "Backdoor Equity" viewpoint:

Risk-shifting theory of Green (1984): This model argues that the conflict between bondholders and shareholders can be solved by the issuance of convertible debt. The bondholders are in favor of low-risk projects whereas the shareholders seek high-risk projects with high returns. Substituting convertibles for straight debt allows the bondholders to have the option to convert and become a shareholder. Firms will issue convertible debt when there are high-risk shifting costs and/or high-risk uncertainty.

Risk uncertainty theory of Brennan and Kraus (1987) and Brennan and Schwartz (1988): This theory considers the scenario in which there is a disagreement on the firms' level of risk between management and investors. In order to compensate the high levels of risk in standard debt, the issuer must pay higher interest, for example higher coupon rate. To overcome this problem, the management can issue convertible debt as the option component increases in value when risk levels are high which in turn increases the overall value of the convertibles. The basis is the positive correlation between volatility and option values. Therefore, issuing

convertibles compensates the investors for the higher level of risk due to the option to convert to equity.

Sequential financing theory of Mayers (1998): Mayers suggests that the use of convertible debt in financing a sequence of investment opportunities (overinvestment) is more beneficial to reduce the agency problems between management and shareholders than the use of short- or long-term bonds when assuming the possibility to force conversion of the convertible at the discretion of the issuer. He considers two scenarios where projects are either beneficial or worthless. When projects have a positive NPV, the convertibles initially benefit from lower issuance costs (lower coupon rate) and are then converted, keeping funds within the firm while also lowering the leverage ratio. When the projects have a negative NPV, the bonds can be redeemed where the proceeds are returned to the bondholders alleviating the problem of overinvestment.

Backdoor Equity of Stein (1992): Contrarily to the previous models, the model of Stein considers the issuance of convertible debt to be a more optimal source of funding than issuing new equity. As the issuer knows its stock is overvalued, it is unwilling to issue equity as the adverse selection costs in price drops are too high. Issuing therefore delayed or "Backdoor Equity" through convertibles alleviates this problem as the equity component is much smaller than in equity offerings signaling less of an overvaluation and therefore mitigating these adverse selection costs while still allowing for equity issuance. Stein however goes further and considers the trade-off the firm has between the costs of financial distress and adverse selection. The costs of financial distress arise when firms that are already levered will have to carry the burden of the possibility of taking on more debt should the convertibles not be converted. Therefore, firms will issue convertible debt when they feel optimistic about future stock prices, to avoid further financial distress, but currently cannot issue equity due to announcement effects arising from adverse selection costs on their stock price.

2.2. Theoretical framework – Contracting costs hypotheses

Following the earliest research and the developments of the "Big Four" models, the research regarding convertible debt has more or less been closely linked to these "Big Four" models. Dutordoir et al. (2014) review the most up to date literature regarding issuance motives, shareholder wealth effects and design of convertible debt while linking each study to the theoretical "Big Four" models. The analysis of this research considers the role convertible debt has in mitigating contracting costs in moral hazard, adverse selection and financial distress. The underlying hypotheses therefore center around the role of each contracting cost

in the likelihood of convertible debt issuance over straight debt and in the design or structure of the convertible debt.

Prior to discussing the contracting costs, it is important to note that only convertible and straight debt will be analyzed, purposely excluding equity offerings from the analysis. The rationale behind this exclusion is three-fold. Firstly, the study by Schneider et al. (1999) provided empirical evidence in the U.S. market that market participants do not significantly distinguish between convertible and straight debt in the years following issuance. This showed that differences in convertible and straight debt are at the early stages after issuance are small and negligible. Secondly, in comparison to the largest convertible debt market in the US, the European market has proven to have some major differences in the structure of convertible debt. Dutordoir and Van de Gucht (2004) empirically find the European convertible market to be more debt-like (the convertible has a larger debt component) than its US counterpart where these differences are attributable to both issuer-related and institutional differences. Finally, the convertible debt models (Green ,1984; Brennan and Kraus, 1987; Brennan and Schwartz, 1988) present the scenarios where convertibles, in comparison with straight debt, are the optimal security choice for firms where equity offerings are primarily ignored. The models therefore show initially the decision to either issue convertible or straight debt.

2.2.1. Moral hazard

The first rationale for issuing convertible bonds is to mitigate the costs arising due to moral hazard problems or agency issues. Previous literature has suggested the manifestation of these costs that arise through the risk-shifting problem by Jensen and Meckling (1976) and the underinvestment problem by Myers (1977).

The risk-shifting problem, as discussed by Jensen and Meckling (1976), suggests that the shareholders of firms whose performance has been poor will have the incentive to invest increasingly heavier in projects which have a negative net present value. Through this, they can benefit from the unlimited upside potential but are simultaneously secured in their bounded downside potential, through their limited liability. Therefore, as bondholders bear these costs, they demand higher yields for the extra risk, resulting in a shift of the risk onto the shareholders. The risk-shifting model of Green (1984) exactly shows how this issue is solved by the issuance of convertible bonds. The bondholders can too engage in the upside potential in which they take advantage of the equity-like nature of the convertible bond, alleviating the issues of moral hazard costs.

The second problem of underinvestment suggested by Myers (1977), contrarily to the risk-shifting problem, considers the scenario where the shareholders are unwilling to invest in projects that do have positive net present value. However, it is uncertain if the payout is sufficient to cover both bondholders and shareholders, as bondholders hold precedence over shareholders and the share of the fixed liability claim (the coupon payments) is relatively large. As this motive of the shareholders is rational and can be foreseen by the bondholders, the projects are not undertaken resulting in a lack of investment and consequently, these costs are carried by the shareholders. Mayers and Smith (1987) argue in their framework that due to the smaller fixed liability claim in convertibles (the early conversion feature and lower coupon), increasing the value of the option component, and again taking advantage of equity-like nature of the convertible debt, will reduce the fixed component, thereby alleviating the contracting cost in moral hazard.

The issuance of convertible debt mitigates the contracting costs of moral hazard as theoretically proven through both problems. Therefore, firms with higher moral hazard costs should be more likely to issue convertible debt over straight debt and the convertible debt will be structured to have a higher probability of conversion, i.e. be more equity-like.

2.2.2. Adverse selection

The second class of theories relating convertible debt as a tool to reduce contracting costs, now from adverse selection, focuses on the costs arising from asymmetric information. Two models have been developed that focus on the asymmetric information about the firm value and about the firm risk between firm management and outside investors.

The basis for the assumption regarding asymmetric information about firm value stems from the framework developed by Myers and Majluf (1984). They argue that when the management has more information regarding the firm's value than outside investors and the firm must raise capital to fund investments, the firm may forego an equity offering. This can send negative signals to the market as rational investors believe the firm is overvalued, lowering the stock price. Therefore, the firm prefers to issue straight debt as it is less information sensitive and hence, in theory, subject to lower adverse selection costs. Including convertible debt in this framework results in convertible debt, having a smaller equity component than a standard equity offering, having lower adverse selection costs, however, still less preferred than straight debt. Therefore, with higher levels of information asymmetry, the convertible issued will be more debt-like in their nature. The model developed by Stein (1992) goes further and presents a trade-off between adverse selection costs and financial distress

costs. Here, he finds that convertible debt is optimal if the firm faces adverse selection costs, resulting in issuing straight debt over equity, as well as financial distress costs, where issuing more straight debt will create an even greater debt burden on the firm should it be already heavy levered and unable in the future to force conversion. Issuing convertible debt lowers the fixed component thanks to the option automatically embedded. He further shows that the likelihood of issuing convertible debt increases with asymmetric information should the firm be in financial distress and the structure of the convertible debt is to be of a more debt-like nature to mitigate the adverse selection costs.

The arguments put forward by Brennan and Kraus (1987) and Brennan and Schwartz (1988) deal with the assumption about asymmetric information about the firm risk. In periods of high levels of information asymmetry, the risk uncertainty theory as mentioned before allows convertible debt to be issued to mitigate the contracting costs emerging from adverse selection. When the levels of asymmetric information for a firm are high, the adverse selection problems in straight debt and equity are also high, resulting in firms being more likely to issue convertible debt during these times.

2.2.3. Financial distress

The final rationale for issuing convertible debt relates to the costs incurred through financial distress. Literature has provided empirical and theoretical evidence which support the model of Stein (1992), as mentioned in the previous section, which developed a framework to highlight the function of convertible debt for financially distressed firms.

In the study by Opler and Titman (1994), they find there is a positive relationship between financial condition and firm performance in industry downturns. They highlight that those firms who have high leverage ratios fare worse off in terms of market share and levels of operating profits than their competitors. Furthermore, in Castanias' (1983) study to determine the optimal capital structure while considering default risk, he shows that the leverage policy of firms with high ex ante default costs is considerably affected, forcing lower leverage ratios or, in relation to this study, hold less debt in their capital structure.

With this evidence, the model of Stein (1992) argues that when firms face financial distress, equity is a more viable option for them as straight debt can increase the debt burden onto the firm. However, as the model creates an equilibrium between adverse selection costs and financial distress costs, the firm cannot easily issue equity if information asymmetry is causing high adverse selection costs. Therefore, the model argues that in order to mitigate the high financial distress costs, convertible debt is the more likely optimal security choice for

these firms where they are structured to have higher probability of conversions, i.e. to be more equity-like.

2.3. Recent literature on the likelihood of issue and structure of convertible debt

The recent research on the likelihood of issuing convertible debt over straight debt/equity can be summarized in either being quantitative and qualitative in nature. Dong et al. (2019) argue that the results from quantitative analysis may be too ambiguous in the sense that the proxies used for measuring contracting costs can be too vague in defining and proving convertible debt theories. They too, however, mention that qualitative analysis in the form of surveys can be too simplistic in confirming a theory. Furthermore, the qualitative surveys do not provide as much detailed analysis or explanation of firm-specific characteristics as the sample sizes are rather small. The following section therefore provides a concise overview of both quantitative and qualitative research on the likelihood of issuing and the design of convertible debt.

The quantitative study by Lewis et al. (1999) find evidence of a sample of US firms that have issued convertible debt to have high moral hazard and adverse selection costs when compared to firms who issued straight debt. They find convertible debt issuers, whose structure is more debt-like, are to have an even higher potential of shifting risk through issuance of convertible debt over straight debt. This firms are characterized with larger debt capacities, valuable investment opportunities and high firm risk. Furthermore, they also show that convertible debt firms have higher adverse selection costs, through higher levels of information asymmetry and financial distress, in comparison to issuers of common equity. The structure is more equity-like to mitigate these contracting costs. Dutordoir and Van de Gucht (2009) use a similar approach as Lewis et al. (1999) to determine if convertible debt issuance in Western Europe have the same issuance driven decisions as in the US. They find the European market to be of a more debt-like nature with lower probability of conversions where convertibles are used to only alleviate debt-like financing costs. A limitation to this study is that they test the joint validity of the sweetened debt models (Green, 1984; Brennan and Kraus, 1987; Brennan and Schwartz, 1988; Mayers, 1998) and therefore cannot infer which theoretical model has the largest impact on the decision to issue to convertible debt. Nonetheless, they find that these firms have higher stock return volatility, are larger and more mature companies. They find no evidence for the delayed equity model as presented by Stein (1992) in which firms issue equity-like convertibles to mitigate high adverse selection costs. However, they explain that this is due to the larger debt capacities of European firms in comparison to those in the US as well as

different perceptions of convertibles where US firms prefer to consider convertibles automatically to be more equity-like. The study by Krishnaswami and Yaman (2008) investigates the role of convertible debt in mitigating the contracting costs of moral hazard, adverse selection and financial distress on a sample of US firms. They find all contracting costs are a factor in the likelihood of issuing convertible debt over straight debt, consistent with the theories of Green (1984), Brennan and Kraus (1987), Brennan and Schwartz (1988) and Stein (1992). The firms issuing convertibles tend to be high growth and smaller firms that issue during high interest rates and economic downturns. Furthermore, they find that financial distress is the cost with the most influence on the design of the convertible bonds issued, making them more equity-like, consistent with Stein (1992), where these firms are smaller and issue during high interest rates. The other contracting costs, adverse selection and moral hazard only have a weak impact on the design of the convertible debt. Overall, all contracting costs influence the decision to issue convertible bonds however financial distress determines the structure.

In the survey by Graham and Harvey (2001), they ask CFOs in a US sample about their corporate finance policies. They consider those CFOs who ever seriously considered issuing convertible debt and look at the determinants that drive their decision. They find the answers support strongly the theoretical model of Stein (1992) where financial distress costs play a role, only moderate evidence supporting the risk-uncertainty theory and sequential finance theory arguments as put forward by Brennan and Kraus (1987) and Brennan and Schwartz (1988) and Mayers (1998) respectively. They find only little and perhaps not significant evidence supporting the risk-shifting theory provided by Green (1984) for a reason to issue convertible debt. Following this study, Bancel and Mittoo (2004) survey firms in Europe who have issued convertible debt. They extend previous survey analysis to include not only direct implications of convertible debt issuance but also indirect implication regarding the influence of market conditions and the call policy of the issuing firm. They generally find mixed evidence for the theoretical convertible debt issuance models, however, the majority of issuers state issuing convertible debt as a response to overvalued stock price and to avoid equity dilution, consistent with the idea to mitigate adverse selection costs with the presence of information asymmetry, linking to the theoretical model of Stein (1992). Also, they observe firms that issue do so for the reason of extra financial flexibility in designing the convertible to be more equity- or debt-like as well as when market conditions allow for "windows of opportunities" due to low interest rates to capitalize on lower coupons. The survey is with its limitations where the sample size is relatively small and has missing representation in sectors and small cap firms. Dong et al.

(2019) take a different qualitative approach in which they conduct in-depth interviews with corporate managers of firms issuing convertible debt from Australia, Canada and the United Kingdom. The advantage of interviews over questionnaire surveys, as used by Graham and Harvey (2001) and Bancel and Mittoo (2004), is that it may provide a more accurate understanding, through direct interaction, of the motives of firms issuing convertible debt than what can be achieved through simply agreeing to or ranking a theory. They find most managers agree with the risk uncertainty theory of Brennan and Kraus (1987) and Brennan and Schwartz (1988) where the levels of information asymmetry are high about the riskiness of the firm. Interestingly, they find that many managers find more common ground when general capital structure theories were suggested for the motivation to issue convertible debt that were not related to any of the four theories. Both the pecking order theory (always prefer to straight debt to equity when debt capacities are available but prefer convertible debt over straight debt when financing costs are high) and market timing (where the value of the firm's stock and "windows of opportunity" determined by market conditions) determined the decision to issue convertible debt.

3. Variable definition and data sample

3.1. Variable definitions for proxies of contracting costs

The following section assigns the variables which are used to demonstrate the existence of the contracting cost. Both firm-specific and macroeconomic variables are included to analyze at firm- and country-level. It has been argued and shown by Choe et al. (1993) and Krishnaswami and Yaman (2008) that time-series variation in the contracting costs is caused through incorporating macroeconomic variables. The table in Appendix C gives a compact summary of the relationships between the variables proxying contracting cost and the likelihood of issuing convertible debt over straight debt and the design of the convertible debt (if it is more equity- or debt-like).

3.1.1. Moral hazard

Following Barclay and Smith (1995) and Eisdorfer (2008), contracting costs that arise due to the underinvestment problem and risk-shifting problem are found to be higher and more present in those firms who demonstrate to have high growth options resulting in moral hazard problems being higher in high growth firms. They show that the conflict between shareholders and bondholders is greater in these firms. Barclay and Smith (1995) find that the underinvestment problem where positive net present value projects are not undertaken is higher

for high growth firms as the fixed claim is higher resulting in the bondholders benefiting more. Eisdorfer (2008) similarly finds that the risk-shifting problem where shareholders move risk onto the bondholders is higher in growth firms as these firms are more likely and more easily able to choose a risky project over a safe project. Therefore, to proxy growth firms, I choose the ratio of the stock price to the book value per share for each firm one year prior to issue of as the measure.

3.1.2. Adverse Selection

In the study by Wang (1993), a relation between information asymmetry and stock price volatility is found to exist when different levels of information exist among the investors. The author shows that when information asymmetry is high, the investors with less superior information require premia resulting in higher stock volatility. This can lead to making equity issuance less attractive and costly for firms. On this basis, I include the 90-day stock volatility measured one month prior to issue to measure the level of information asymmetry relating to high adverse selection costs.

Stulz (1990) and Lewis et al. (1999) argue that information asymmetry is to be higher for smaller firms, measured by their total assets, and therefore can serve as a proxy for adverse selection costs. Large firms tend to have much higher and in more depth analyst coverage, are much older and may be part of some major indices. Fosu et al. (2016) further show this relationship highlighting that it is stronger in post-crisis times fitting well with the time frame chosen for this analysis following the 2007/08 financial crisis. Therefore, I include a measure of firm size defined as the total of all short and long-term assets as reported on the balance sheet one year prior to issue.

In a recent study by Gao and Zhu (2015), the relationship between market leverage, defined as total debt divided by market value of firm, and four unique information asymmetry proxies in developed and emerging markets is analyzed. They show that higher leverage ratios appear in markets with higher information asymmetries as the possibility of the firms to issue equity is too costly. In developed markets, the information environment is less transparent which results in more agency problems between firm insiders and outside shareholders. On this basis, I use a leverage measure defined as the total debt to total assets one year prior to issue.

The macroeconomic variables, economic growth and equity performance, are used to proxy the market conditions in Western Europe. Following Choe et al. (1993), they provide consistent evidence of the phenomenon in which adverse selection costs are lower when market conditions are favorable. They find a counter-cyclical relationship where firms choose not to

issue straight debt during these times, allowing for convertible debt issuance to be a good substitute. To measure economic growth, I use the logarithmic quarter-on-quarter Gross National Income growth rate for the EU-28 countries. This growth rate is deflated by the change in the Consumer Producer Index with a base quarter set to Q1:2008. It is measured in the quarter prior to the quarter in which the straight or convertible debt was issued. In order to provide a measure for the performance of the firms, a representative selected index was chosen. The MSCI Europe Price Index was chosen to proxy an all-rounded equity performance measure of the firms in Western Europe. The index is representative of the countries, covering all where the countries with most index constituents corresponding to the most issuers in the sample. Furthermore, the distribution across sectors is similar as in the sample in this analysis where the distribution across sectors is rather spread out in the index (see Section 3.3.1 for sample descriptions) (MSCI, 2019). The equity performance measure is given by its daily natural logarithmic growth rates and are measured one month prior to issue.

3.1.3. Financial distress

The firm-specific variables total assets and leverage, while measuring adverse selection costs, also capture financial distress costs. Brennan and Schwartz (1988) argue that smaller firms face higher probabilities of being in financial distress. These firms are not as well diversified as larger firms as they may be younger and are simply more prone to facing financial difficulties. As before, firm size is measured by the total of all short and long-term assets as reported on the balance sheet one year prior to issue.

In the study by Ofek (1993), the argument is brought forward that highly levered firms are more capable of surviving during times of financial distress than their more conservative less levered counterparts. Highly levered firms can respond faster as a decline in leverage has less of an impact on firm value than a less levered firms. They are then able to take financial actions to ensure the financial health of the firm. Therefore, contrary to the leverage ratio when considering adverse selection costs, I use the same definition of leverage, defined as total debt to total assets one year prior to issue, to determine the financial distress cost of firms where a low leverage indicates poor financial health.

Graham and Harvey (2001) and Bancel and Mittoo (2004) find firms in their survey that believe the aspects of market timing and seeking a “window of opportunity” when considering issuing debt of great important. They find interest rates to be one of the main determinants of this decision where ideally low interest rates would result in convertible debt issuance to capitalize on the low coupon to be paid. However, should interest rates be high, those firms in

distress will struggle to issue straight debt, they are unable to meet the payments, and therefore turn to convertible debt, where they need the financing to service the outstanding debt. Therefore, I take the yield of the 10-year German government bond one month prior to issue date as a proxy for the interest rate.

Furthermore, economic growth and equity performance can further be used to capture financial distress costs. Following Choe et al. (1993) and Krishnaswami and Yaman (2008), during macroeconomic and industry downturns, the overall financial situation makes it more difficult to execute and finance new and successful investment opportunities. This results in more firms facing higher potential financial distress costs when economic growth and industry performance worsen. I use the same measures for economic growth and equity performance as described in the previous section for adverse selection costs.

3.2. Probability of conversion measure

A key variable in the analysis following is the measure which determines the nature or design of the convertible debt. In order to determine if the bond security takes a more equity- or debt-like structure, a probability measure, as used by Lewis et al. (1999) and Krishnaswami and Yaman (2008), estimated by using the assumptions of the standard Black-Scholes model and taking the risk-neutralized probability that the bond will be converted into equity is used. This probability is analogous to a call option being exercised. A high (low) probability of conversion translates to the convertible issued to be more equity-like (debt-like). The pricing equation as presented by Merton (1973) is used where $N(d_2)$ shows the probability of conversion on the date the convertible debt is issued in a risk-neutral world where $N(.)$ is the cumulative probability under the standard normal distribution. Here, d_2 is determined by:

$$d_2 = \frac{ln(S/X) + \left(r - \left(\sigma^2/2\right)\right)T}{\sigma\sqrt{T}} \tag{1}$$

In Equation (1), S equals the stock price on the day the bond was issued, X is the conversion price on the day the bond was issued, r is the risk-free rate proxied by the 10-year German government treasury on the day the bond was issued, σ is the 90-day stock volatility on the day the bond was issued and T is the maturity in years of the bond.

The original d_2 equation takes the dividend yield into consideration where it is subtracted from the risk-free rate in the numerator. Due to data limitations, the dividend yield was only available for roughly a third of the convertible debt in the sample. Therefore, the dividend is initially taken to be 0% for all firms. In Section 5.5, the sample of convertibles which have a

dividend yield is modelled for robustness according to the methodology as discussed further on in this study.

3.3. Data collection and sample

3.3.1. Convertible debt and straight debt sample

The data gathered consists of non-financial Western European firms over the time frame of 2009-2018 and was collected from Bloomberg. The list of convertible debt stem from firms included in all sectors excluding financials, utilities and governments. Excluding these sectors is for one common in corporate finance research and two, those companies may have different motivations for issuing convertible debt such as for regulatory reasons (Dutordoir et al., 2014). Furthermore, to maintain a data sample with qualitatively similar bonds, bond characteristics such as perpetuals and exchangeable were excluded. Those bonds with missing fundamental information such as coupon, maturity and amount issued were also excluded. This generated a sample of 432 convertible bond issuances over the sample period.[1]

Next, firm-specific data on all issuers of those convertibles was downloaded from Bloomberg. This however resulted in some bonds being excluded from the sample as some issuers did not have data for multiple variables. In order to maintain a consistent data sample, I refrained from directly obtaining the missing values from the issuer's balance sheets or financial statements as the method Bloomberg uses to construct the values was not clear enough to do it on an issuer by issuer basis.[2] Thus, after generating all data for each issuer, a total of 335 convertibles from 14 countries were obtained.

Similarly, to obtain a sample of straight debt, the same restrictions regarding the convertible debt were used with the difference of the bonds required to be bullet bonds. Bullet bonds were used as they are the most generic and standard form of debt available on the market. Also, a required criterion for the search is that the straight debt sample always includes an equity ticker. The reason for this is to ensure that the issuer has the means to issue equity, essentially making the sample more comparable with the convertible debt sample. This generated a data sample of 5,099 bonds. This sample was again treated to the same conditions as the convertible debt sample. Any missing values resulted in the bond being excluded from the data sample. Finally, a sample of 1,197 straight debt issuances was generated.

[1] For a comprehensive overview of the selection criteria generated in Bloomberg, see Appendix D.
2 Furthermore, as many issuers are from countries where the reporting language is not English, this was another difficulty in obtaining the missing values and a reason from refraining to do so.

Next to bond- and issuer-specific variables, the general macroeconomic variables in time-series form, were retrieved from other sources than Bloomberg. The interest rate, equity performance and economic growth were retrieved from the Datastream database. The measure for inflation, the consumer price index or CPI, to quantify the economic growth in real terms was sourced from the FRED website (Federal Reserve Bank of St. Louis). The European Central Bank (ECB) rate for main refinancing operations, which will be used in later analysis, was downloaded from the ECB's Statistical Data Warehouse.[3]

In Table 1, the number of firms and bonds issued in the convertible and straight debt samples distributed over country, year and sector are shown. In Panel A, for the convertible debt sample, France has the highest number of firms as well as the greatest number of bonds issued, around 20% for both respectively, followed by Germany and the Netherlands. Austria, Finland and Ireland have the least number of firms as well as the lowest number bonds issued, accounting together for only around 6% of the sample in both cases. In the straight debt sample, France is by far the largest issuer of straight debt, accounting for over a quarter of debt, while also having the highest number of firms in the sample. Switzerland and the United Kingdom have the second and third most firms whereas the Netherlands and the United Kingdom follow France for most bonds issued. Finland, Norway and Sweden are all the least represented in terms of firms and bonds issued of the sample, accounting for less than 3% in terms of firms and less than 1% in terms of bonds. Furthermore, the number of unique firms in both samples relative to the number bonds issued is significantly different for both samples. The ratio of unique firm to bonds issued in the convertible bond sample lies around 1:1.5 (335 bonds divided by 231 unique firms) whereas for the straight debt sample, this ratio is much higher at around 1:3.7 (1,197 bonds divided by 328 unique firms). Thus, as expected, the convertible debt market is much smaller and is used much rarely relative to the straight debt market.

In Panel B, the years 2009 and 2014 have the highest count of convertible bond issuances and firms participating in this market. In contrast, 2011 and 2018 have the least convertible bond issuances as well as the lowest number of firms. In comparison, in the straight debt sample the years 2012 and 2013 dominate in terms of number of firms and bond issuances whereas the years 2016 and 2018 are the least representative. In the graph in Appendix A, a trend can be seen in both samples that represent a business cycle. The first year starts with a peak in issuances, followed by a low phase over two years, then another peak around 2013/2014 which again is followed by a low phase coming towards 2018.

[3] For a more compact overview of all variable definitions and sources, see Appendix E.

Table 1: Frequency distribution of convertible and straight debt samples

This table shows the distribution of bonds over countries, years and sectors. The columns show number of firms issuing bonds and the total number of bonds issued in each panel specification. The percentage of each to the total is also shown in terms of firms and bonds.

Panel A: Country distribution of convertible bonds and straight debt issuances

	Convertible debt				Straight debt			
Country of issue	No. of firms	% to total	No. of bonds	% to total	No. of firms	% to total	No. of bonds	% to total
Austria	4	1.73%	9	2.69%	9	2.74%	15	1.25%
Belgium	7	3.03%	10	2.99%	22	6.71%	41	3.43%
Finland	6	2.60%	6	1.79%	1	0.30%	1	0.08%
France	45	19.48%	72	21.49%	78	23.78%	309	25.81%
Germany	37	16.02%	55	16.42%	22	6.71%	37	3.09%
Ireland	4	1.73%	5	1.49%	9	2.74%	20	1.67%
Italy	15	6.49%	20	5.97%	21	6.40%	72	6.02%
Luxembourg	13	5.63%	18	5.37%	19	5.79%	85	7.10%
Netherlands	34	14.72%	52	15.52%	29	8.84%	203	16.96%
Norway	9	3.90%	14	4.18%	4	1.22%	8	0.67%
Spain	15	6.49%	24	7.16%	17	5.18%	75	6.27%
Sweden	9	3.90%	10	2.99%	3	0.91%	4	0.33%
Switzerland	14	6.06%	18	5.37%	50	15.24%	140	11.70%
United Kingdom	19	8.23%	22	6.57%	44	13.41%	187	15.62%
Total	231		335		328		1,197	

Panel B: Year distribution of convertible bonds and straight debt issuances

	Convertible debt				Straight debt			
Year of issue	No. of firms	% to total	No. of bonds	% to total	No. of firms	% to total	No. of bonds	% to total
2009	48	15.38%	51	15.22%	88	12.54%	151	12.61%
2010	28	8.97%	32	9.55%	72	10.26%	116	9.69%
2011	21	6.73%	22	6.57%	69	9.83%	121	10.11%
2012	25	8.01%	27	8.06%	106	15.10%	185	15.46%
2013	34	10.90%	35	10.45%	95	13.53%	151	12.61%
2014	41	13.14%	44	13.13%	82	11.68%	135	11.28%
2015	30	9.62%	33	9.85%	53	7.55%	86	7.18%
2016	29	9.29%	32	9.55%	42	5.98%	78	6.52%
2017	34	10.90%	37	11.04%	48	6.84%	94	7.85%
2018	22	7.05%	22	6.57%	47	6.70%	80	6.68%
Total	312		335		702		1,197	

Panel C: Distribution according to industry group of convertible bonds and straight debt issuances

	Convertible debt				Straight debt			
Sector of issue	No. of firms	% to total	No. of bonds	% to total	No. of firms	% to total	No. of bonds	% to total
Automobiles & Components	5	2.16%	10	2.99%	11	3.35%	140	11.70%
Capital Goods	30	12.99%	39	11.64%	52	15.85%	145	12.11%
Commercial & Prof. Services	1	0.43%	2	0.60%	5	1.52%	11	0.92%
Consumer Durables & Apparel	2	0.87%	3	0.90%	7	2.13%	30	2.51%
Consumer Services	13	5.63%	23	6.87%	23	7.01%	46	3.84%
Energy	29	12.55%	45	13.43%	26	7.93%	175	14.62%
Food & Staples Retailing	3	1.30%	4	1.19%	10	3.05%	30	2.51%
Food, Beverage, Tobacco, Household & Personal Prod.	10	4.33%	16	4.78%	31	9.45%	111	9.27%
Health Care Equipment & Svc.	10	4.33%	15	4.48%	13	3.96%	27	2.26%
Materials	32	13.85%	43	12.84%	53	16.16%	173	14.45%
Media & Entertainment	10	4.33%	12	3.58%	18	5.49%	27	2.26%
Pharma., Biotech. & Life Sc.	20	8.66%	23	6.87%	10	3.05%	23	1.92%
Retailing	9	3.90%	15	4.48%	15	4.57%	58	4.85%
Information Technology	36	15.58%	52	15.52%	20	6.10%	32	2.67%
Telecommunication Services	12	5.19%	16	4.78%	15	4.57%	118	9.86%
Transportation	9	3.90%	17	5.07%	19	5.79%	51	4.26%
Total	231		335		328		1,197	

Finally in Panel C, the sectors, as classified by the Generalized Industrial Classification Standard (GICS), are presented to display the variety in which the issuers and debt stems from.[4] The largest sector in terms of number of firms and bonds issued is Information Technology, accounting for over 15% of firms and bonds, followed by Materials with nearly 14% of firms and nearly 13% of bonds. The smallest sectors are Commercial & Professional Services and Consumer Durables & Apparel with less than 1% of bonds and firms. In the straight debt sample, Materials and Capital Goods have by some margin the greatest number of firms (around 16% each). In terms of bonds, Materials and Energy provide the highest number, over 14% in both cases. The least number of firms are found in the Commercial & Professional Services and Consumer Durables & Apparel with five and seven firms respectively. Commercial & Professional Services however has by far the least number of bonds issued with less than 1%, in comparison to the sector with the second least, Pharmaceuticals, Biotechnology & Life Sciences, with double that amount. In comparison with the samples, Materials presents itself as the most dominant sector across convertible and straight debt markets whereas Commercial & Professional Services is the sector with the least activity.

3.3.2. Descriptive statistics

In Table 2, the descriptive statistics for the convertible debt and straight debt samples are shown in Panels A and B. In Panel C, the descriptive statistics for the macroeconomic factors are displayed. In comparing the convertible and straight debt samples on a firm level, the average straight debt firm is by a great margin much larger in terms of total assets where the mean firm has around €75 billion in total assets, over €60 billion more than the average firm issuing convertible debt. This is further magnified when the largest firm is analyzed. There, the largest firm issuing straight debt is over six times larger. This finding is not surprising as the consensus of convertible issuers are smaller and younger firms. In terms of leverage, the median for straight debt firms is around 4% higher than the convertible debt firm which has a median leverage of over 26%. Considering the growth opportunities of the firms, proxied by price-to-book ratio, the convertible debt firms are on average and at the median larger than the straight debt firms. The firm with the highest ratio in the convertible debt sample with 86.75 is also much larger than that in the straight debt sample with 18.95, highlighting the potential in growth opportunities in convertible debt issuers. Next, the stock volatility is evidently higher

[4] Please note, the Information Technology sector is a product of a merger between the sectors Software Services, Technology Hardware & Equipment and Semiconductors & Semiconductor Equipment. As the straight debt sample had no firms in the Semiconductors & Semiconductor Equipment industry group, the groups were merged together in order to have representation in all sectors for both samples.

Table 2: Descriptive statistics

This table presents the descriptive statistics for the convertible debt sample and the straight debt sample. These include bond-specific variables and firm-specific variables. The macroeconomic factors are also presented in the final panel.

Panel A: Convertible debt descriptives

	Convertible debt							
Variable	Obs.	Mean	Median	Std. dev.	Min.	Max.	Skewness	Kurtosis
Total Assets (€ million)	335	13,789.37	1,849.10	38,744.55	1.02	309,518.00	4.64	27.58
Leverage (%)	335	29.02	26.64	19.49	0.00	117.57	1.25	5.85
Price-to-book ratio	312	2.59	1.36	5.89	0.07	86.75	10.40	138.80
Stock vola. (%)	335	54.76	40.82	67.62	13.20	942.11	9.33	110.95
Total amount issued (€ million)	335	302.57	150.00	517.50	1.09	4,000.00	4.44	28.28
Total amount issued/total assets (%)	335	20.58	7.46	81.71	0.18	1,408.92	14.97	251.07
Maturity (years)	335	5.31	5.00	2.26	1.50	29.99	5.19	51.63
Coupon (%)	335	4.21	4.00	2.65	0.05	15.00	0.45	2.99
Conversion price (€)	335	30.16	9.44	59.31	0.00	730.46	6.24	63.20
Probability of conversion (%)	335	0.23	0.21	0.17	0.00	1.00	2.28	10.43

Panel B: Straight debt descriptives

	Straight debt							
Variable	Obs.	Mean	Median	Std. dev.	Min.	Max.	Skewness	Kurtosis
Total Assets (€ million)	1197	75,379.93	29,120.00	119,000.00	17.81	1,906,625.00	6.37	86.04
Leverage (%)	1197	30.88	30.48	13.87	0.00	93.72	0.45	3.43
Price-to-book ratio	1197	1.98	1.28	2.13	0.07	18.95	3.41	18.18
Stock vola. (%)	1197	30.79	27.19	16.39	8.70	191.55	3.40	24.33
Total amount issued (€ million)	1197	395.58	282.76	376.30	0.40	2,500.00	1.15	4.47
Total amount issued/total assets (%)	1197	3.60	1.19	6.20	0.00	60.78	3.73	23.40
Maturity (years)	1197	6.70	6.00	3.93	0.07	30.00	1.79	9.96
Coupon (%)	1197	3.36	3.25	2.07	0.01	11.50	0.57	3.24

Panel C: Macroeconomic factor descriptives

	Macroeconomic factors							
Variable	Obs.	Mean	Median	Std. dev.	Min.	Max.	Skewness	Kurtosis
Interest rate (%)	2608	1.46	1.38	1.10	-0.18	3.70	0.43	1.85
ECB rate (%)	2608	0.52	0.25	0.54	0.00	2.50	0.72	2.83
Equity performance index	2608	1,503.74	1,504.86	203.33	794.23	1,915.23	-0.55	3.13
Ln equity performance growth rate (%)	2,608	0.01	0.02	1.28	-9.18	8.31	-0.21	7.20
Economic growth (€ million)	40	3,150,000.00	3,122,962.00	149,000.00	2,920,000.00	3,480,000.00	0.40	2.13
Ln real economic QoQ growth rate (%)	39	0.43	0.98	2.73	-5.55	4.18	-0.73	2.42

and more dispersed for the convertible debt sample where the mean and standard deviation lies at around 54% and 68% in comparison to 31% and 16% of the straight debt sample. When looking at distribution of the data of the firm-specific variables, all but leverage possess very non-normal distributions. High values of skewness and kurtosis are present resulting a positively skewed leptokurtic distribution in these variables, indicating the disparity within the samples.

When comparing the bond-level characteristics in Panel A and B, the amount issued is much greater for the straight debt sample, nearly €400 million at the mean and €280 million at the median, than the convertible debt sample, around €300 million at the mean and €150 million at the median. The relation of total amount issued to total assets shows that the firms in the

convertible debt sample issue relatively large amounts where the mean is above 20% and the median just below 7.5% in comparison to the firms in the straight debt sample where the mean is below 4% and the median below 1.2%. This difference is made more clear when considering the skewness value where the value for the convertible debt is nearly 15 and for the straight debt is at a moderate 3.7, highlighting the growth potential firms have when issuing convertible debt.[5] The bonds of the straight debt sample are on average over a year longer than the convertible debt sample, where the mean is 6.7 years and 5.31 years for the straight debt and convertible debt sample respectively. In contrast to the general understanding of convertible debt having a lower coupon than straight debt to accommodate for cheaper financing, the sample here presents the opposite case. Here, the coupon for the convertible debt on average is 4.21%, 85 basis points higher than the average of the straight debt sample (the difference however is smaller at the median 75 basis points). This observation primarily contradicts the theory of the "Sweetened Debt" idea as mentioned by Green (1984), Brennan & Kraus (1987), Brennan & Schwartz (1988) and Mayers (1998). The final two convertible-debt specific variables in Panel A, show that the mean conversion price is €30.16 and mean probability of conversion is 23%. Further, the level kurtosis for the probability of conversion shows that the levels for the convertible bonds are more centered around the mean, suggesting the lower probability rates that the convertible debt will be converted and hence, being initially more debt-like in their nature. Overall, the firms which issue convertible debt are in comparison to straight debt firms smaller (adverse selection and financial distress claim), have a lower leverage ratio (financial distress claim), have higher potential growth opportunities (moral hazard claim) and are more volatile (adverse selection claim). In terms of the bonds that they issue, they are smaller in size, have a shorter lifetime and have a higher coupon rate.

In the final Panel, the macroeconomic variables over the time sample are presented. The first four variables are daily and are, according to their skewness and kurtosis values, close to being distributed normally except for the measure for equity performance growth rate having a rather high level of kurtosis. Interestingly, the interest rate having negative values, taking a minimum value -0.18%, shows the unique nature of this timeframe as this event is rather rare in the past. The negative skewness for the equity performance index indicates that there may have been some drops in the index, further exemplified by the minimum value of 794.23 being much further away from the mean than the maximum value of 1915.23. The high kurtosis value

[5] The largest value for the ratio of total amount issued to total assets of 1,408.92% relates to an outlier (Net Gaming Europe AB) whose total assets increased massively in the year following issue.

in the equity performance growth rate indicates little daily change, however, the minimum and maximum values show it is possible that large growth increases and decreases are possible. Finally, the measure for economic growth is on a quarterly basis. The negative skewness indicates the growth rates are more concentrated under the mean indicating more frequent moderate to even negative growth rates over the sample.

4. Methodology

In this section, the methodology employed to determine the statistical relationship between the decision to issue convertible debt over straight debt and the structure of the convertible debt against firm-specific and macroeconomic variables is presented. In the first part, the relationship of the decision to issue either convertible and straight debt is investigated where first, the macroeconomic variables on a country level are considered and second, both the firm-specific and macroeconomic variables on a firm-level are analyzed. In the second part, the relationship of the structure, if the convertible is structured to be more equity- or debt-like, is investigated analogous to the first part.

4.1. Logistic Regression and Fractional Logistic Regression

For the analysis, the statistical framework employed will make use of non-linear logistic models, or Logit models, in panel data samples. The main benefit of this class of model is the ability to use a logistic function to represent the dependent variable as a binary outcome (win or lose, pass or fail) where the constraints of upper and lower bounds (0 and 1) limit the values it can take. Following Brooks (2014), in linear probability models, problems occur when the dependent variable is qualitative or binary as the predictions result in values outside the range of the allowed probabilities between 0 and 1. Therefore, by making use of a cumulative distribution function of a logistic distribution, the regression is transformed to accommodate for values within the boundaries. The logistic function for any random variable y_i is given by:

$$F(y_i) = \frac{1}{1+e^{-(y_{i,t})}} \tag{2}$$

Therefore, $F(y_i)$ must lie in the boundary between 0 and 1 as when extremes are inserted, the model tends to these boundaries. The model, that is then estimated using a maximum likelihood estimator instead of OLS as in linear models due to the non-linear nature is:

$$P_i = p(y_{i,t} = 1) = \frac{1}{1+e^{-(\alpha+\beta_1 x_{1,i,t}+\cdots+\beta_k x_{k,i,t}+u_{i,t})}} \tag{3}$$

$$\text{where } y_{i,t} = \alpha + \beta_1 x_{1,i,t} + \cdots + \beta_k x_{k,i,t} + u_{i,t}$$

Here, P_i is understood as the probability that y_i equals 1, α is the constant, β_k is a vector of the coefficients of the independent variables, $x_{k,i}$ is a vector of the model explanatory variables

and u_i is the error term. With this model, the changes from the variable in state 0 to state 1 can be analyzed through the significance of the coefficients from the explanatory variables.

The next model to be used in this analysis is called a fractional logistic regression which is an extension of the logistic framework mentioned previously. For this class of model, the dependent variable is given as a fraction, where the values are limited between 0 and 1 and are especially useful to capture non-linear relationships. Examples of dependent variables suitable for this model includes probabilities, proportions or rates. Papke and Wooldridge (1996) argue that the drawbacks of binary dependent variables in linear models are analogous to those when using fractional data as the predicted values are not for certain going to lie within the boundaries. The model is described analogous to that mentioned before and resulting in Equations (2) and (3) where y_i represents a fraction instead of a binary number.

A main benefit of using logistic regression models over other classes of binary regression models, such as Probit models (which is very similar to the logistic regressions used here), is that the coefficients can be made much more interpretable due to its logistic nature. Probit models use a cumulative distribution function of the standard normal distribution instead of a logistic distribution.

Following the methods presented by Long and Freese (2006), the coefficients in the output are difficult to interpret. The raw coefficients are interpreted as a unit increase in x results in a logit changing by the coefficient β holding all other variables constant. To explain the meaning by what is meant by logit, Equation (3) can be rewritten by taking the inverse of the logistic function to show that:

$$\ln(P_i) = \ln\left[\frac{p(y_{i,t}=1)}{1-p(y_{i,t}=1)}\right] = \text{logit}\, p(y_{i,t}=1) = \alpha + \beta_1 x_{1,i,t} + \cdots + \beta_k x_{k,i,t} + u_{i,t} \quad (4)$$

The regression now can be understood as being linear when transformed into the logit. For the coefficients to have a simpler meaning, the logit model can take the exponent of the coefficients resulting in a term known as the odds ratio. Therefore, a unit change in x results in the odds changing by the factor of the exponent of β when holding all other variables constant. An odds ratio of more than 1 is interpreted as an increase whereas under 1 is a decrease. Further, the relation of the odds ratio above and below 1 is not symmetrical. An odds ratio of 0.5, i.e. the odds of something decreasing by a factor of 0.5 when some variable increases, is not the reverse of an odds ratio 1.5 but rather an odds ratio of 2. The odds ratio must be interpreted as a fraction or ratio, where the odds ratio of 0.5 corresponds to 1/2 or 1:2 and 2 corresponds to 2/1 or 2:1.

It is important to note the assumption or prerequisites needed to use logistic regression models. As the model is non-linear, many of the assumptions common to linear regression models do not need to be considered such as linearity in the independent and dependent variables, normal distribution of residuals or homoscedasticity. A main assumption however regarding multicollinearity is needed for this analysis. Methods such as the Variance Inflation Factor cannot be used to measure the multicollinearity of the variables in the models as these rely on linear relationships to the dependent variable. However, the relationship between the independent variables can be linear and therefore multicollinearity can be checked with a pairwise correlation analysis. Too high correlations result in the variables being weak estimators and lead to poor model results.

4.2. Likelihood of issuing convertible debt

In this section, two models of regressions are used to determine which contracting costs determine the likelihood of issuing convertible over straight debt. The first part considers the macroeconomic factors alone whereas the second part takes both macroeconomic and firm-specific factors into account.

The first regression considers the relationship of the likelihood of issuing convertible debt over straight with macroeconomic factors. As the macroeconomic variables are country-specific, the dependent variable is therefore also on a county level. The dependent variable therewith is the share of all convertible debt issued to all debt issued (convertible and straight debt) for each quarter and each country over the whole sample. This provides the dependent variable, $y_{i,t}$, to be a fraction, ranging from 1 (only convertible debt was issued for a country in a quarter) to 0 (which either signifies that either there was only straight debt issued or no debt at all was issued) and thus the fractional logistic regression is employed for this case. The independent variables are interest rate, equity performance and economic growth and are measured, as previously defined, with their respective lags. Furthermore, country and year fixed effects are included to control for heterogeneity across countries and time. The regression equation is therefore:

$$y_{i,t} = \alpha + \beta_1 \times Interest\ rate_{i,t-n} + \beta_2 \times Eq.performance_{i,t-n,} + \beta_3 \times Economic\ growth_{i,t-n} + Fixed\ effects + u_{i,t} \quad (5)$$

In extending the regression in Equation (5) to include firm-specific factors to determine the likelihood of issuing convertible over straight debt, the regression is now at firm-level. The dependent variable here takes a value of 1 if the issued debt is convertible and 0 if the issued debt is straight. The logistic regression is used in this case. The independent variables and

coefficients are as in Equation (5) with the inclusion of the firm-specific variables: price-to-book ratio (denoted as growth opportunities), stock volatility, the natural logarithm of total assets (denoted as firm size) and leverage ratio where the lags are as mentioned earlier. Fixed effects in years, countries and sectors (according to GICS classification) are included to again control for heterogeneity across time, countries and industries. The logistic regression is:

$$\begin{aligned} y_{i,t} = \alpha &+ \beta_1 \times Interest\ rate_{i,t-n} + \beta_2 \times Eq.performance_{i,t-n,} \\ &+ \beta_3 \times Economic\ growth_{i,t-n} + \beta_4 \times Growth\ opp_{i,t-n} \\ &+ \beta_5 \times Stock\ volatility_{i,t-n} + \beta_6 \times Firm\ size_{i,t-n} \\ &+ \beta_7 \times Leverage_{i,t-n} + Fixed\ effects + u_{i,t} \end{aligned} \quad (6)$$

4.3. Structure of convertible debt

In a similar structure to the previous section, this section considers the contracting costs which result in differences in the design of the convertible debt. First, the macroeconomic factors are considered. In the second regression, both macroeconomic and firm-specific factors are included.

To analyze the impact of macroeconomic variables on the design of the convertible debt, the dependent variable must again be transformed to be at country-level. As the probability of conversion in Equation (1) determines the equity- or debt-like nature of the convertible, these probabilities are grouped into country and quarter for the whole sample. When more than one convertible was issued in a country in a quarter, the average of the probabilities is used. Initially, this may result in losing some of the variance in the probability of conversion measure however most countries issue at most two convertibles in a quarter, therefore retaining a significant degree of the variation. On this basis, the fractional logistic regression is used. The independent variables and coefficients are the same as in Equation (5). Year and country fixed effects are again included. The regression therefore takes the form:

$$\begin{aligned} y_{i,t} = \alpha &+ \beta_1 \times Interest\ rate_{i,t-n} + \beta_2 \times Eq.performance_{i,t-n,} \\ &+ \beta_3 \times Economic\ growth_{i,t-n} + Fixed\ effects + u_{i,t} \end{aligned} \quad (7)$$

Finally, the last regression includes both macroeconomic and firm-specific factors as contracting costs in determining the structure of the convertible debt. The dependent variable is simply the probability of conversion for each issue. A fractional logistic regression is again used in this case. The independent variables and coefficients are as stated for the model in Equation (6). Fixed effects in years, countries and sectors (according to GICS classification) are included as before. The regression takes the form:

$$y_{i,t} = \alpha + \beta_1 \times Interest\ rate_{i,t-n} + \beta_2 \times Eq.performance_{i,t-n,} + \beta_3 \times Economic\ growth_{i,t-n} + \beta_4 \times Growth\ opp_{i,t-n} + \beta_5 \times Stock\ volatility_{i,t-n} + \beta_6 \times Firm\ size_{i,t-n} + \beta_7 \times Leverage_{i,t-n} + Fixed\ effects + u_{i,t} \quad (8)$$

5. Results

5.1. Multicollinearity check

In Appendix F, the correlation matrix of the variables is presented. The values overall show little sign of any correlation that may cause any concern for the quality of the variables. The highest correlation value is 0.1518 between the interest rate and stock volatility and the lowest being -0.2880 between stock volatility and firm size. The majority have values in the range of -0.1 and 0.1 signaling no correlation. On this basis, there is no concern of multicollinearity and the variables in this study seem to be adequate for the use in the models.

5.2. Likelihood results

The results from the fractional logistic regression on the relationship between issuing convertible debt or straight debt when considering the macroeconomic variables as contracting costs is shown in Table 3. The regression includes four specifications where each variable's statistical impact is analyzed alone and a final specification with all variables. Interestingly, the nature of all the odds ratios contradict the claims of the contracting costs. The financial distress cost claims the interest rate should positively influence the decision to issue relatively more convertible debt over all debt, however, the odds ratio is under 1 and not significant. The reverse holds true for equity performance and economic growth, where both contradict the adverse selection cost and financial distress cost claim. However, it is important to note that only the odds ratio for economic growth in specifications (3) and (4) are significant, indicating that in the presence of adverse selection and financial distress costs, countries issue more convertible debt relative to all debt, by a factor of around 1.09 when economic growth increases by 1 percent. Further, this contradicts the models of Brennan and Kraus (1987), Brennan and Schwartz (1988) and Stein (1992). The macroeconomic effect on the likelihood of a country issuing convertible debt over straight is therefore, at most, weakly described to have the opposite effect in the presence of adverse selection and financial distress costs.

In Table 4 the results of the logistic regression where firm-specific and macroeconomic variables are analyzed at firm-level. The odds ratio for growth opportunities is significant at the five percent level with a value of 0.95 with sector and year fixed effects included. Primarily,

Table 3: Fractional logistic regression – likelihood of convertible debt issue with macroeconomic factors

The table presents the results of a fractional regression with a logistic specification for the relationship between the choice of convertible and straight debt to macroeconomic factors. The odds ratio with its significant values are shown with the standard errors below each time in italics. The dependent variable is the share of convertible debt to all debt issued aggregated by each country in each quarter. The specification of the independent variables is as follows: interest rate is measured as the three-month median interest rate in the prior quarter, equity performance is measured as the three-month median index in the prior quarter, and gross national income growth is the previous quarter's growth rate.

Fractional regression with logistic specification (odds ratio)				
Dependent variable:	Regressions			
Share of convertible debt to all debt	(1)	(2)	(3)	(4)
Interest rate	0.5892			0.8563
	0.2611			*0.4440*
Equity perforamnce		1.5698		1.585
		1.1033		*1.0978*
Economic growth			1.0921**	1.0868*
			0.0435	*0.0498*
Constant	5.1489	0.834	0.7988	1.3229
	8.5115	*0.4908*	*0.4871*	*2.5296*
N	374	374	374	374
Year fixed effects	Yes	Yes	Yes	Yes
Country fixed effects	Yes	Yes	Yes	Yes

Note. Standard errors are in italics; for year fixed effects, the first year is chosen as the base year; * p < 0.1, ** p < 0.05, *** p < 0.01

this provides evidence against the moral hazard claim as suggested by Barclay and Smith (1995) and Eisdorfer (2008) and that firms with growth potential do not issue convertible debt over straight debt when the agency problems in risk-shifting and underinvestment are high. The variable stock volatility has, in both specifications, highly significant values where the odds ratio is just over 1. Firm size also has a highly significant and very low odd ratios of 0.597 and 0.6649. This can be interpreted as the odds of issuing convertible over straight decrease by a factor of 0.597/0.6649 when the variable firm size increase by one unit holding all other variables constant. Both the findings of stock volatility and firm size, so risky and small firms choose to issue convertible debt over straight debt, provides strong evidence for the adverse selection cost claim where firm size is the most dominant and strongest of the firm-specific variables, consistent with Brennan and Kraus (1987), Brennan and Schwartz (1988) and Stein (1992). Leverage on the one hand provides contradictory evidence for the adverse selection cost claim where its odds ratio is less than 1 and highly significant at 0.9817. This does on the other hand provide evidence of the financial distress cost claim, as lower leverage ratios can indicate financial unhealthiness. As the variable firm size is used for both adverse selection

Table 4: Logistic regression – likelihood of convertible debt issue with firm-specific and macroeconomic factors

The table presents the results of a logistic regression for the relationship between the choice of convertible and straight debt to firm-specific and macroeconomic factors. The odds ratio with its significant values are shown with the standard errors below each time in italics. The dependent variable is equal to 1 if the bond issued is convertible and 0 if the bond issued is straight debt. The specification of the macroeconomic independent variables is as follows: interest rate is measured as the three-month median interest rate in the prior quarter, equity performance is measured as the three-month median index in the prior quarter, and gross national income growth is the previous quarter's growth rate. For the firm-specific variables: price-to-book ratio is measured one year prior to issue, stock volatility is computed one month prior to issue, total assets and leverage are both measured one year prior to issue.

Logistic regression (odds ratio)		
Dependent variable:	Regressions	
Is convertible (1 = yes, 0 = no)	(1)	(2)
Interest rate	2.1624**	2.4805***
	0.7148	*0.7555*
Equity perforamnce	1.9277	2.0505
	1.2044	*1.2036*
Economic growth	1.047	1.041
	0.0319	*0.0307*
Growth opportunities	0.9719	0.9566**
	0.0212	*0.0189*
Stock volatility	1.0276***	1.0347***
	0.0058	*0.0054*
Firm size	0.5970***	0.6649***
	0.0725	*0.0275*
Leverage	0.9817***	0.9923
	0.0068	*0.0055*
Constant	1.524	0.0727**
	2.2230	*0.0953*
N	1509	1509
Year fixed effects	Yes	Yes
Country fixed effects	Yes	No
Sector fixed effects	No	Yes

Note. Standard errors are in italics; for year/country/sector fixed effects, the first year/country/sector is chosen as the base year; * p < 0.1, ** p < 0.05, *** p < 0.01

costs and financial distress costs claim, the financial distress cost claim is further supported. However, the variable interest rate, contrary to the results in the previous table, is highly significant and significantly above one, taking odds ratios of over 2 with country and year fixed effects and even nearly 2.5 with sector and year fixed effects. Therefore, higher interest rates can be associated with a higher likelihood of a firm issuing convertible debt. This is strong evidence that financial distress, in form of periods of high interest rates, results in firms issuing convertible debt over straight debt, consistent with the claims of Stein (1992), Graham and Harvey (2001) and Bancel and Mittoo (2004). However, the macroeconomic variables equity

performance and economic growth, proxying adverse selection and financial distress, provide no significant evidence for any contracting cost claim, similar to the results in the previous table.

Overall, the contracting costs which result in convertible debt being issued over straight debt are semi-strongly supported by the adverse selection and financial distress costs claim, partly similar to the findings on adverse selection costs of Lewis et al. (1999). However, the financial distress cost claim seems to be more dominant, especially in terms of the impact of the odds ratios of firm size and interest rate. Moral hazard seems to be weakly and insignificantly contradicted in this analysis displaying no relation between issuing convertible debt and the level of growth opportunities of firms. Krishnaswami and Yaman (2008) find similar results in the US market. They however in contrast to these results, find stronger evidence for all three contracting costs driving the choice of security whereas I find evidence of only two.

5.3. Structure results

Following the results of the decision to issue convertible debt over straight debt, this section provides the regression results of the decision of how the convertible is designed to mitigate the contracting costs of moral hazard, adverse selection and financial distress.

In Table 5 the results of the fractional logistic regressions are presented where only macroeconomic variables are considered. For the interest rate, equity performance and economic growth, no significant odds ratio indicate that on a country-level, the adverse selection costs and financial distress costs proxied by these variables have any influence on the design of convertibles in any country. Nonetheless, the odds ratio, although not significant, indicate that the convertibles are designed to mitigate the contracting costs in adverse selection and financial distress. Equity performance and economic growth show an odds ratio of less than 1, except for economic growth having realistically no influence in specification (4) with 1.0003, and for the interest there is an odds ratio of over 1. It must be said that the macroeconomic variables, so the economic climate and environment, have no statistical influence on the design of this security. Thus, the theory that convertible design on a country level mitigates the contracting costs of adverse selection as mentioned by Brennan and Kraus (1987), Brennan and Schwartz (1988) and Stein (1992) and financial distress as mentioned by Stein (1992) is not supported.

The final logistic fractional regression in Table 6 shows the relationship of the probability of conversion or design of the convertible and the firm-specific and macroeconomic factors.

Table 5: Fractional logistic regression – structure of convertible debt issue with macroeconomic factors

The table presents the results of the fractional regression with a logistic specification for the relationship between the structure of convertible debt and macroeconomic factors. The odds ratio with its significant values are shown with the standard errors below each time in italics. The dependent variable is defined as the mean probability of conversion of each country in each quarter. The specification of the independent variables is as follows: interest rate is measured as the three-month median interest rate in the prior quarter, equity performance is measured as the three-month median index in the prior quarter, and gross national income growth is the previous quarter's growth rate.

Fractional regression with logistic specification (odds ratio)				
Dependent variable:	Regressions			
Mean probability of conversion	(1)	(2)	(3)	(4)
Interest rate	1.0696			1.0843
	0.2834			*0.3059*
Equity perforamnce		0.9043		0.8854
		0.4124		*0.4145*
Economic growth			0.9976	1.0003
			0.0238	*0.0251*
Constant	0.2047*	0.2566***	0.2559***	0.1972*
	0.1867	*0.0728*	*0.0721*	*0.1936*
N	205	205	205	205
Year fixed effects	Yes	Yes	Yes	Yes
Country fixed effects	Yes	Yes	Yes	Yes

Note. Standard errors are in italics; for year/country fixed effects, the first year/country is chosen as the base year; * p < 0.1, ** p < 0.05, *** p < 0.01

There is no evidence for the moral hazard claim, as measured by growth opportunities, influencing convertibles to be issued more equity-like as the odds ratio is in both specifications insignificant. Of interest however is the variables that proxy the claim of adverse selection costs that the convertibles are issued to be more debt-like in design. The variables stock volatility, firm size and leverage are all at least significant at the 5% significance level whereas firm size is even highly significant at the 1% level in both specifications. The odds ratios are at the same level when considering country and sector fixed effects however firm size has the largest impact on the design of convertible debt. The odds of the convertible debt becoming more equity-like decreases by a factor of around 0.94 when firm size increase by 1 unit holding all other variables constant. The odds ratio for stock volatility and leverage however are much more moderate, the odds for increasing the equity-like nature decreases by a factor of only 0.99 when stock volatility or leverage increase by 1 unit holding all other variables constant. As firm size and leverage have odds ratio of under 1 and therefore imply the design to be therefore more debt-like when they increase, the financial distress cost claim is not supported. The odds ratio for the interest rate is above 1 but not significant further providing no evidence for the

Table 6: Fractional logistic regression – structure of convertible debt issue with firm-specific and macroeconomic factors

The table presents the results of the fractional regression with a logistic specification for the relationship between the structure of convertible debt and firm-specific and macroeconomic factors. The odds ratio with its significant values are shown with the standard errors below each time in italics. The dependent variable is equal to the convertible bond's probability of conversion measure. The specification of the macroeconomic independent variables is as follows: interest rate is measured as the three-month median interest rate in the prior quarter, equity performance is measured as the three-month median index in the prior quarter, and gross national income growth is the previous quarter's growth rate. For the firm-specific variables: price-to-book ratio is measured one year prior to issue, stock volatility is computed one month prior to issue, total assets and leverage are both measured one year prior to issue.

Fractional regression with logistic specification (odds ratio)		
Dependent variable:	Regressions	
Probability of conversion	(1)	(2)
Interest rate	1.2321	1.2117
	0.2427	*0.2545*
Equity perforamnce	0.8685	0.893
	0.3514	*0.3651*
Economic growth	0.9821	0.976
	0.0171	*0.0192*
Growth opportunities	0.9889	0.9913
	0.0072	*0.0073*
Stock volatility	0.9943**	0.9942**
	0.0025	*0.0027*
Firm size	0.9338***	0.9400**
	0.0233	*0.0228*
Leverage	0.9943**	0.9920**
	0.0024	*0.0033*
Constant	0.4444	0.5542
	0.3601	*0.4641*
N	312	312
Year fixed effects	Yes	Yes
Country fixed effects	Yes	No
Sector fixed effects	No	Yes

Note. Standard errors are in italics; for year/country/sector fixed effects, the first year/country/sector is chosen as the base year; * p < 0.1, ** p < 0.05, *** p < 0.01

financial distress cost claim. The final two variables, equity performance and economic growth in both specifications are found to have no significant odds ratio. However, their values are under 1 indicating, although not significant, that the structure is to be more debt-like when they increase and thus some evidence is provided for the adverse selection cost claim and contrary evidence for the financial distress cost claim.

On this basis, the findings are rather clear. The contracting costs arising through adverse selection costs measured by high levels of information asymmetry are mitigated through the issuance of convertible debt with a design that tends to be more debt-like. The firms can be

characterized as smaller, low levered and have lower stock volatility. This is contrary to the findings of Krishnaswami and Yaman (2008) who, in their study of the US market, find adverse selection costs to only weakly affect the design whereas financial distress costs are the main drivers. The evidence that moral hazard has no effect is however consistent with their results, they proxy growth opportunities using a market-to-book ratio, similar to the price-to-book ratio in this study. The evidence provided in the study by Dutordoir and Van de Gucht (2009) similarly shows the debt-like nature of the European convertible debt market where the issuance is related to mitigate debt-like financing costs.

5.4. Frequency results

The final analysis digs deeper into the macroeconomic factors which affect the likelihood of issuance and the structure of the convertible debt and tries to further examine the impact of macroeconomic factors. Table 7 follows the analysis of Krishnaswami and Yaman (2008) in which the high and low periods of the macroeconomic factors are considered. Here, the frequency of equity- and debt-like issuances are counted according to high or low phases of the macroeconomic factors to try and explain a relationship attributable to either the adverse selection cost and/or financial distress cost claims. Furthermore, the frequency distributions of the convertible debt are split into three sub-periods, 2009-2011, 2012-2014 and 2015-2018, to identify any economic or policy-induced influence. Therefore, the ECB's main refinancing operations rate is also included to capture the economic climate from a monetary policy perspective. To provide an even better understanding of these time-series factors, Appendix B shows the variables over time with the subperiods marked by different shaded areas.

The only real evidence of the financial distress claim can be found in Panel B in sub-period II where in periods of high interest rates, firms issued more equity-like convertible debt in comparison to debt-like convertibles (16 equity-like issuances against 10 debt-like). The issuances in the two other subperiods provide no real consistency in providing any evidence. When looking at the graph in Appendix B.1 in the first sub-period, the relative high levels in interest rates may have influenced the firms to issue more equity-like convertibles in the year or months after to mitigate the financial distress costs. The low rates in subperiod II and III indicate that financial distress may have not been an issue. Similarly, the new variable, the ECB rate, is consistent with the claim that financial distress may not be present. Even though the relatively high rates in subperiod I resulted in twice the number of debt-like issuances, as can be seen in Panel A, the issuances in subperiod II and III are largely identical in terms of structure. This may be a reason for the weak or non-significant macroeconomic factors in this

Table 7: Distribution of convertible debt issuances classified as either equity- and debt-like during macroeconomic high and low periods

Distribution of both equity-like and debt-like convertible debt issuances in periods of high and low macroeconomic factors. Separation point between equity- and debt-like at the median value of probability of conversion (20.64%). Distribution split into three subperiods to observe macroeconomic changes in Western Europe. High (low) rates defined as the top (bottom) quartile of the 3-month moving averages for interest rate, ECB rate and equity performance within the subperiod time frame. Similarly, for economic growth, high (low) periods defined as top (bottom) quartile over the subperiods. #Equity-like (#Debt-like) is the number of equity-like (debt-like) convertible bond offerings in the high (low) period. Further columns provide ratios of amount of equity-like (debt-like) convertible debt offered in high (low) period in relation to all convertible debt issued in the subperiod and to all convertible debt (equity-like and debt-like) issued in the subperiod in the high (low) times.

Panel A: Subperiod I - 2009 - 2011

Variable	#Equity-like	#Equity-like / All convertible debt in subperiod	#Equity-like / All convertible bonds in each high or low group	#Debt-like	#Debt-like / All convertible debt in subperiod	#Debt-like / All convertible bonds in each high or low group
Interest rate						
High	14	13.33%	43.75%	18	17.14%	56.25%
Low	13	12.38%	56.52%	10	9.52%	43.48%
ECB rate						
High	7	6.67%	33.33%	14	13.33%	66.67%
Low	0	0.00%	0.00%	0	0.00%	0.00%
Equity performance						
High	16	15.24%	42.11%	22	20.95%	57.89%
Low	7	6.67%	63.64%	4	3.81%	36.36%
Economic growth						
High	16	15.24%	42.11%	22	20.95%	57.89%
Low	10	9.52%	58.82%	7	6.67%	41.18%

Panel B: Subperiod II - 2012 - 2014

Variable	#Equity-like	#Equity-like / All convertible debt in subperiod	#Equity-like / All convertible bonds in each high or low group	#Debt-like	#Debt-like / All convertible debt in subperiod	#Debt-like / All convertible bonds in each high or low group
Interest rate						
High	16	15.09%	61.54%	10	9.43%	38.46%
Low	12	11.32%	50.00%	12	11.32%	50.00%
ECB rate						
High	9	8.49%	52.94%	8	7.55%	47.06%
Low	5	4.72%	38.46%	8	7.55%	61.54%
Equity performance						
High	20	18.87%	64.52%	11	10.38%	35.48%
Low	10	9.43%	35.71%	18	16.98%	64.29%
Economic growth						
High	14	13.21%	46.67%	16	15.09%	53.33%
Low	11	10.38%	40.74%	16	15.09%	59.26%

Panel C: Subperiod III - 2015 - 2018

Variable	#Equity-like	#Equity-like / All convertible debt in subperiod	#Equity-like / All convertible bonds in each high or low group	#Debt-like	#Debt-like / All convertible debt in subperiod	#Debt-like / All convertible bonds in each high or low group
Interest rate						
High	16	12.90%	47.06%	18	14.52%	52.94%
Low	18	14.52%	50.00%	18	14.52%	50.00%
ECB rate						
High (0.05	24	19.35%	51.06%	23	18.55%	48.94%
Low (0%)	38	30.65%	49.35%	39	31.45%	50.65%
Equity performance						
High	20	16.13%	58.82%	14	11.29%	41.18%
Low	14	11.29%	51.85%	13	10.48%	48.15%
Economic growth						
High	17	13.71%	56.67%	13	10.48%	43.33%
Low	14	11.29%	46.67%	16	12.90%	53.33%

analysis. The monetary policy decisions of the ECB have been characterized as very accommodative, lowering rates to the zero-lower bound in subperiod III to induce economic

activity and cheaper sources of financing in European institutions.

The equity performance measure in Table 7 provides an interesting finding. In Panel A and B there are more convertible issuances in high phases than in down phases. This is inconsistent with the rationale of adverse selection and financial distress that market conditions negatively correlate with convertible debt issuances to mitigate costs. The only exception is in Panel B where the number of debt-like issuances is for one higher than equity-like issuances in low times and is more than the debt-like issuances in high times. This does provide evidence for the adverse selection cost claim that information asymmetry induces firms to issue more debt-like securities, consistent with the findings in the previous section. It is however contrary to the findings of Krishnaswami and Yaman (2008) who find that when information asymmetry is high, firms issue more equity-like convertible debt. When looking at Appendix B.2, the expectations of continuous growth following the crisis in 2007/08 may have been dampened which is noticeable in the drop at the end of subperiod I. However, the trend of this measure is upward indicating market conditions over the medium to long run have improved further highlighting that perhaps the contracting costs may have been low altogether when considering macroeconomic factors.

Finally, economic growth tends to have more convertible debt issuances when growth rates are in the higher percentiles as can be seen in all three Panels. Only in Panel C, where 16 debt-like convertibles are issued in low times in comparison to "only" 13 in high times. This is consistent with the counter cyclical nature as proposed by Choe et al. (1993). Also, the number debt-like issuances are marginally higher than that of the equity-issuances (16 debt-like in comparison to 14 equity-like) providing modest evidence of the adverse selection cost claim. In Appendix B.3, the subperiods I and II propose no indication of any downturns in Gross National Income, only seasonal fluctuations. At the end of subperiod II and throughout subperiod III, there is substantial growth to be seen which again indicates potentially healthy and growing European markets.

Overall, the evidence from analyzing the distributions of equity- and debt-like convertible debt issuances in subperiods has shed more light on the reasons for its weak or non-existent influence in the previous analysis. The market conditions are seemingly improving with cheaper funding possibilities and better market conditions characterized by low interest rates and upward-trending equity performance and economic growth.

5.5. Robustness checks

As mentioned in the Section 3.2, a major limitation of the sample of convertible debt is the incomplete sample of dividend yields as the data source did not provide a complete list. In order to test the results while simultaneously considering dividend yields in the probability of conversion measure, the models used in analyzing the structure of the issued convertibles and the impact of macroeconomic and firm-specific variables is run on a sample including only those issuances which have a dividend yield. These two models incorporate the measure whereas the previous models consider the decision to issue convertible debt over straight debt. Therefore, a sample of 111 convertibles (in comparison to the initial 312 convertibles) is left over. The setup of the models is analogous to before, with the difference of using the probability of conversion measure with the dividend yield. In Appendix G and Appendix ***H***, the results of the fractional logistic regressions, where again the odds ratio are provided, are shown. When analyzing on a country-level, the macroeconomic variables in Appendix G are not significant with the exception of equity performance. It takes a very high odds ratio of 3.1 in the final specification however only significant at the 10% level. This suggests the convertible structure is designed to become more equity-like by a factor of 3.1 when economic growth increase by one unit keeping all other variables constant. Although this in line with the financial distress claim, the findings in Appendix H contradict this. The odds ratio for equity performance is nearly the reverse, taking the asymmetrical nature of the odds ratio into consideration, when including country and year fixed effects taking a value of 0.35 and is significant at the 5% level. These suggest the adverse selection costs claim are driving the security design. Furthermore, the only other significant variable is stock volatility which is slightly less in terms of odds ratio than in the earlier analysis however the implications are the same. All other variables are insignificant. This may well be due to the small sample size in this analysis, reducing the explanatory power, and therefore not too much can be taken away from this.

To further show the significance of the firm-specific variables in both determining the likelihood of convertible debt issuance and the structure of the debt, the models including firm-specific and macroeconomic factors are run again. However, the firm-specific variables are regressed with each macroeconomic factor individually. Therefore, there are six specifications, half include country and year fixed effects and the other half includes sector and year fixed effects. The results are presented in Appendix I and Appendix ***J***. The odds ratio of both tables

are near identical to the results in Table 4 and Table 6, where the only real difference lying in either a marginally higher or lower odds ratio.

6. Limitations and further research

As is with several previous studies such as Lewis et al. (1999), Krishnaswami and Yaman (2008) and Dutordoir and Van de Gucht (2009), the reliance on proxies to determine motivations and decisions to issue convertible debt over straight or the structure of the debt is limited. The variables, as in this study, are subject to more than one interpretation regarding if and what contracting cost it represents. They therefore may not provide the most reliant of indicators. Nonetheless, a quantitative study in this style is difficult without making assumptions. Other alternatives, as discussed, may provide more insight through surveys and interviews, such as that of Graham and Harvey (2001), however, these usually have found to represent smaller samples, not near the sizes of quantitative analysis. They do however allow for more concise questioning, in the form of directly asking if the moral hazard, adverse selection and financial distress contracting cost claim influences their decision. Hence, this provides a more representative and reliant rationale for issuing convertible debt. A perhaps extensive yet insightful study may be to combine a qualitative and quantitative analysis on, if possible, the same set of firms to determine for one, how well do proxies for contracting costs really do work, and two, discover more about the previous research as to if the theoretical models on convertibles really do explain the motives.

A further limitation of this analysis is that the sample excludes the financial sector which accounts for a large scale of the convertible debt issues in Western Europe. Although their motivations for issuing may be of different concern than mitigating contracting costs, one cannot be certain that this is the case. A framework therefore which incorporates an institutions financial health in terms of meeting the regulatory requirements, such as capital ratios, and including this in a model as presented in this study may provide further insight into why and how convertibles are issued.

Lastly, the issuance of convertible debt across firms in this study can be interpreted as a rather rare event. Most firms in this sample issue between one and two bonds on average. In order to determine if the convertibles can be used to mitigate the contracting costs in moral hazard, adverse selection or financial distress, a study can be extended to analyze the firm-specific variables across multiple years. This would entail starting from a year prior to issue until the first or second call date, usually a couple years after the issue date. It is quite common for convertible debt to have multiple call dates listed in the prospectus. As this study considers

probability of conversion on an ex ante basis where the probability of conversion is estimated by using the Black-Scholes model, including actual call dates and measuring the firm-specific variables over time may provide more accurate insights to whether or not convertible debt is used to mitigate contracting costs.

7. Conclusion

The overriding message of this study has presented two new findings contributing to the convertible debt research in Western Europe. Firstly, the theories of convertibles in mitigating contracting costs in moral hazard, adverse selection and financial distress is limited and even perhaps weakly present in the time frame analyzed. The claim for moral hazard (Green, 1984; Mayers and Smith, 1987) has shown to have contrary to no significant statistical impact on first, the likelihood of convertible debt issuance over a more straight-forward debt security, and second, the structure or design of the convertibles that have been issued. Adverse selection costs (Stein, 1992; Brennan and Kraus, 1987; Brennan and Schwartz, 1988) and financial distress costs (Stein, 1992) have stronger implications for the likelihood of issuing convertible debt. However, here financial distress costs seem to be even stronger than adverse selection costs, indicating the firms feel the need to mitigate the financial distress costs while taking on more adverse selection costs. However, in terms of the security design and structure, the only significant impact comes from adverse selection costs and only in the form of firm-specific variables. Firms can be characterized as having low growth, more volatile, small size and low leverage ratios which choose to issue convertibles over straight debt in times of high interest rates and even at times during economic growth. With regard to the structure of the convertible, the sample of firms choose to issue more debt-like convertibles, especially smaller, low risk and low levered firms. Although macroeconomic factors have been previously demonstrated to induce time-variation in these contracting costs, I find overall only little to weak evidence, limited to the likelihood of issuing convertible debt. Therefore, the Western European convertible debt market can be summarized as, from an issuer perspective, to be driven by firm-specific factors over the past decade.

Of further interest is the economic environment in Europe since the financial crisis in 2007/08. Increasingly lower interest rates and an accommodative monetary policy climate have allowed the financing conditions for institutions to perhaps rely on the more classical or standard securities. One of the main motivations for the use of convertibles in the literature is that debt can be cheaply issued without forcing negative expectations on the health of the institution. The sample has shown to have on average and at the median a higher coupon than

straight debt, initially signaling the motivation to follow the second main motivation for convertible issuance, namely the "Backdoor Equity" approach. Should this be the case for these firms, the importance of mitigating adverse selection costs and therefore designing the bonds to have lower probabilities of conversion as made evident through the analysis, is making this idea more puzzling. New chapters on discovering motivations for issuing convertible debt outside the theoretical models has emerged and it seems that, in a European context at least, understanding these new rationales may uncover why convertible debt is still an attractive security to issue.

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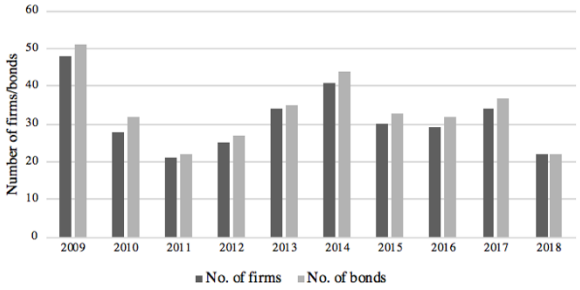
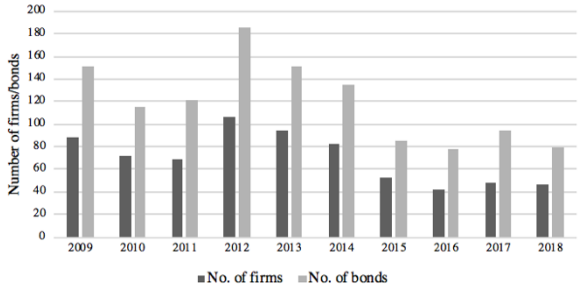
9. Appendix

Appendix A: Frequency distributions of convertible and straight debt samples over years

Appendix A.1: Convertible debt sample



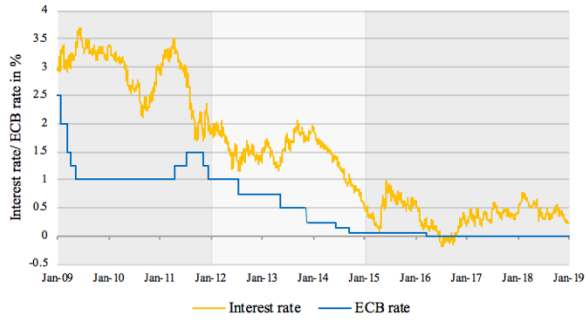
Appendix A.2: Straight debt sample



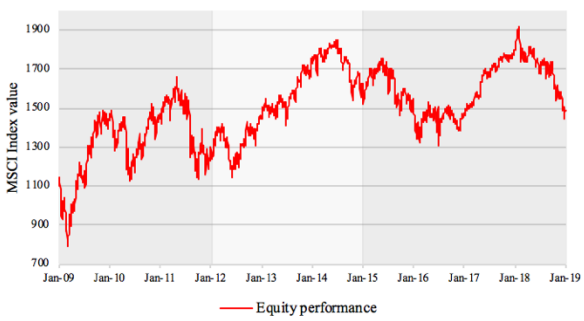
Note. This figure graphically presents the distributions of the number of unique firms issuing debt and the number of debt issuances per year for both the convertible debt sample (Appendix A.1) and the straight debt sample (Appendix A.2). The darker bar represents the number of unique firms per year and the lighter bar represents the number of debt issuances.

Appendix B: Time-series of macroeconomic factors with shaded subperiods

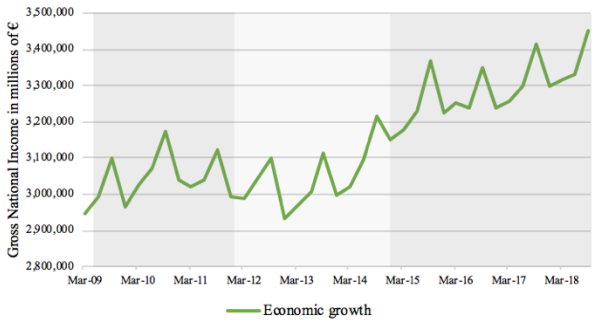
Appendix B.1: Interest rate and ECB rate



Appendix B.2: Equity performance



Appendix B.3: *Economic growth*



Note. This figure graphically presents the time-series of the macroeconomic variables split over the sample period where the subperiods are made more clearer through the shading in the background of each graph. Appendix B.1 shows the interest rates and ECB rate, B.2 shows the equity performance index and B.3 shows the economic growth.

Appendix C: Contracting costs summary

This table gives a summary of the expected relationship between nature of the contracting costs in moral hazard, adverse selection and financial distress with (i) the likelihood of issuing convertible debt over straight debt and (ii) the design of the convertible debt (if it is more equity- or debt-like).

Contracting cost claims			
		Likelihood	Structure
Contracting cost	Variable	Increase in likelihood of issuing convertible debt when:	Design of convertible debt to be more:
Moral hazard	Growth opportunities	High	Equity-like
Adverse selection	Stock volatility	High	Debt-like
	Firm size	Low	Debt-like
	Leverage	High	Debt-like
	Economic growth	Low	Debt-like
	Equity performance	Low	Debt-like
Financial distress	Firm size	Low	Equity-like
	Leverage	Low	Equity-like
	Interest rate	High	Equity-like
	Economic growth	Low	Equity-like
	Equity performance	Low	Equity-like

Appendix D: Selection criteria in Bloomberg for convertible and straight debt samples

This table provides the selection criteria for both samples of debt in the terminal of Bloomberg.

Panel A: Bloomberg search criteria for convertible debt sample

Search Results

Number of securities: 432
Currency: EUR

Created by BLOOM010 BLOOM010 (ERASMUS UNIVERSITY) on 07/14/2019 14:57:03 GMT+0100 (BST)

SRCH Criteria
Asset Classes: Corporates
Sources: All Securities
Security:

AND	Security Status	Include	Bonds : All
AND	BICS Classification	Exclude [Match Any]	Banks or Commercial Finance or Consumer Finance or Diversified Banks or Financial Services or Funds & Trusts or Life Insurance or Property & Casualty Insurance or Real Estate or Power Generation or Utilities or Sovereigns or Government Agencies or Government Regional or Supranationals or Government Development Banks or Winding Up Agencies or Central Bank or Government Local
AND	Country of Incorporation	Include [Match Any]	Austria or Belgium or Denmark or Finland or France or Germany or Iceland or Ireland or Italy or Liechtenstein or Luxembourg or Netherlands or Norway or Portugal or Spain or Sweden or Switzerland or United Kingdom
AND	Issue Date	In the range	01/01/2009 to 12/31/2018
AND	Is Convertible	--	True
AND	Maturity Type	Exclude [Match Any]	Perpetual or Exchangeable
AND	Coupon	Has Data	
AND	Announce Date	Has Data	
AND	Maturity	Has Data	
AND	Amount Issued	Has Data	
AND	Issuer Parent Equity Ticker	Has Data	
AND	Ticker	Has Data	
AND	Isin	Has Data	

Panel B: Bloomberg search criteria for straight debt sample

Search Results

Number of securities: 5,099
Currency: EUR

Created by BLOOM010 BLOOM010 (ERASMUS UNIVERSITY) on 07/14/2019 15:09:00 GMT+0100 (BST)

SRCH Criteria
Asset Classes: Corporates
Sources: All Securities
Security:

AND	Security Status	Include	Bonds : All
AND	BICS Classification	Exclude [Match Any]	Banks or Commercial Finance or Consumer Finance or Diversified Banks or Financial Services or Funds & Trusts or Life Insurance or Property & Casualty Insurance or Real Estate or Power Generation or Utilities or Sovereigns or Government Agencies or Government Regional or Supranationals or Government Development Banks or Winding Up Agencies or Central Bank or Government Local
AND	Country of Incorporation	Include [Match Any]	Austria or Belgium or Denmark or Finland or France or Germany or Iceland or Ireland or Italy or Liechtenstein or Luxembourg or Netherlands or Norway or Portugal or Spain or Sweden or Switzerland or United Kingdom
AND	Issue Date	In the range	01/01/2009 to 12/31/2018
AND	Maturity Type	Include [Match All]	Include [Bullet] and Exclude [Callable and Make Whole Call and Putable and Convertible and Reverse Convertible and Reverse Convertible with Barriers and Synthetic Convertible and Sinkable and Extendable and Pass Thru and Perpetual and Refundable and Exchangeable and Death Put]
AND	Coupon	Greater than	0%
AND	Announce Date	Has Data	
AND	Maturity	Has Data	
AND	Amount Issued	Has Data	
AND	Issuer Parent Equity Ticker	Has Data	
AND	Ticker	Has Data	
AND	Isin	Has Data	

Appendix E: Variable functions, definitions and sources

This table provides an overview of the variables included in the analysis, both firm-/debt-specific and macroeconomic variables. The function indicates which use the variable has in this study. Frequency highlights, for Panel B, in what frequency the variables were retrieved. Definition denotes the formal definition as stated if possible, in the data source as well as in which time lag the data is used. Source represents from which database the variables were retrieved.

Panel A: Firm- and debt-specific variables

Variable	Function	Frequency	Defintion	Source
Maturity	Input for probability of conversion	-	Time between the bond was issued and until its final payment, measured in years.	Bloomberg
Coupon	General information	-	Coupon percentage of bond per annum in percentage.	Bloomberg
Amount issued	General information	-	Nominal amount issued of bond in € millions.	Bloomberg
Conversion price	Input for probability of conversion	-	Dollar value at which convertible bond can be converted into common stock. The conversion price is established at the time the of issue of the convertible bond.	Bloomberg
Firm size	Contracting cost	-	Total assets as reported in balance sheet one year prior to issue in € millions.	Bloomberg
Leverage	Contracting cost	-	Total debt to total assets as reported on balance sheet one year prior to issue in %.	Bloomberg
Stock price	Input for probability of conversion	-	Stock price on day of issue in €.	Bloomberg
Growth opportunities	Contracting cost	-	Ratio of the stock price to the book value per share one year prior to issue.	Bloomberg
Stock volatility	Input for probability of conversion	-	Measure of the risk of price moves for a security calculated from the standard deviation of day to day logarithmic historical price changes. The 90-day price volatility equals the annualized standard deviation of the relative price change for the 90 most recent trading days closing price.	Bloomberg
Risk-free rate	Input for probability of conversion	-	10-year German goverment bond yield in %, measured on day of issue.	Datastream

Panel B: Macroeconomic variables

Variable	Function	Frequency	Defintion	Source
Interest rate	Contracting cost	Daily	10-year German goverment bond yield in %, measured on month prior to issue.	Datastream
ECB rate	Contracting cost	Daily	ECB Main refinancing operations rate measured one month prior to issue.	ECB SDW
MSCI Index	Contracting cost	Daily	MSCI Europe Price Index represents large- and mid-cap equities across Western Europe, measured one month prior to issue.	Datastream
Gross National Income	Contracting cost	Quart.	EU-28, Non-Financial transactions (ESA2010), Gross National Income at market prices: Total economy: paid, current prices, in millions €, measured one quarter prior to issue.	Datastream

Note. SDW stands for the Statistical Data Warehouse of the European Central Bank.

Appendix F: Multicollinearity check

In this table, the pairwise correlation matrix of the firm-specific and macroeconomic variables for the whole sample, including convertible and straight debt, is shown.

Pairwise Correlation Matrix

	Interest rate	Equity perforamnce	Economic growth	Growth opportunities	Stock volatility	Firm size	Leverage
Interest rate	1.0000						
Equity perforamnce	0.1316	1.0000					
Economic growth	-0.1126	0.1291	1.0000				
Growth opportunities	-0.1072	0.0067	-0.0292	1.0000			
Stock volatility	0.1518	-0.0084	-0.0714	0.0544	1.0000		
Firm size	0.0506	-0.0841	-0.0765	-0.2251	-0.2880	1.0000	
Leverage	-0.0742	0.0403	-0.0065	0.0326	-0.0752	0.0476	1.0000

Appendix G: Fractional logistic regression – structure of convertible debt issue with macroeconomic factors for the convertible sample with dividend yield

This table presents the results of the fractional regression with a logistic specification for the relationship between the structure of convertible debt and macroeconomic factors. Here, the sample is limited to those observations which include a dividend yield. The odds ratio with its significant values are shown with the standard errors below each time in italics. The dependent variable is defined as the mean probability of conversion of each country in each quarter. The specification of the independent variables is as follows: interest rate is measured as the three-month median interest rate in the prior quarter, equity performance is measured as the three-month median index in the prior quarter, and gross national income growth is the previous quarter's growth rate.

Fractional regression with logistic specification (odds ratio)

Dependent variable:	Regressions			
Mean probability of conversion with dividend yield	(1)	(2)	(3)	(4)
Interest rate	0.8442			0.8069
	0.4042			*0.3690*
Equity perforamnce		2.9113*		3.1175*
		1.8014		*2.0992*
Economic growth			1.0084	1.0092
			0.0347	*0.0334*
Constant	0.2455	0.1242***	0.1409***	0.2396
	0.3612	*0.0505*	*0.0598*	*0.3350*
N	95	95	95	95
Year fixed effects	Yes	Yes	Yes	Yes
Country fixed effects	Yes	Yes	Yes	Yes

Note. Standard errors are in italics; for year/country fixed effects, the first year/country is chosen as the base year; * p < 0.1, ** p < 0.05, *** p < 0.01

Appendix H: Fractional logistic regression – structure of convertible debt issue with firm-specific and macroeconomic factors for the convertible sample with dividend yield

This table presents the results of the fractional regression with a logistic specification for the relationship between the structure of convertible debt and firm-specific and macroeconomic factors. Here, the sample is limited to those observations which include a dividend yield. The odds ratio with its significant values are shown with the standard errors below each time in italics. The dependent variable is equal to the convertible bond's probability of conversion measure. The specification of the macroeconomic independent variables is as follows: interest rate is measured as the three-month median interest rate in the prior quarter, equity performance is measured as the three-month median index in the prior quarter, and gross national income growth is the previous quarter's growth rate. For the firm-specific variables: price-to-book ratio is measured one year prior to issue, stock volatility is computed one month prior to issue, total assets and leverage are both measured one year prior to issue.

Fractional regression with logistic specification (odds ratio)		
Dependent variable:	Regressions	
Probability of conversion with dividend yield	(1)	(2)
Interest rate	1.3969	1.0832
	0.3551	*0.2834*
Equity perforamnce	0.3466**	0.4069**
	0.1630	*0.1686*
Economic growth	0.9976	0.9819
	0.0263	*0.0247*
Growth opportunities	0.9798	0.979
	0.0221	*0.0304*
Stock volatility	0.9925**	0.9901***
	0.0032	*0.0031*
Firm size	0.9697	0.9858
	0.0302	*0.0359*
Leverage	0.9969	0.9956
	0.0029	*0.0035*
Constant	0.1522*	0.2953
	0.1600	*0.3372*
N	111	111
Year fixed effects	Yes	Yes
Country fixed effects	Yes	No
Sector fixed effects	No	Yes

Note. Standard errors are in italics; for year/country/sector fixed effects, the first year/country/sector is chosen as the base year; * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Appendix I: Fractional logistic regression – likelihood of convertible debt issue with firm-specific and each macroeconomic factor individually

The table presents the results of a logistic regression for the relationship between the choice of convertible and straight debt to firm-specific factors and one macroeconomic factor at a time. The odds ratio with its significant values are shown with the standard errors below each time in italics. The dependent variable is equal to 1 if the bond issued is convertible and 0 if the bond issued is straight debt. The specification of the macroeconomic independent variables is as follows: interest rate is measured as the three-month median interest rate in the prior quarter, equity performance is measured as the three-month median index in the prior quarter, and gross national income growth is the previous quarter's growth rate. For the firm-specific variables: price-to-book ratio is measured one year prior to issue, stock volatility is computed one month prior to issue, total assets and leverage are both measured one year prior to issue.

Logistic regression with odds ratio presented

Dependent variable:	Regressions					
Is convertible (1 = yes, 0 = no)	(1)	(2)	(3)	(4)	(5)	(6)
Interest rate	2.0292**			2.3033***		
	0.6911			*0.6761*		
Equity perforamnce		3.015			2.6631*	
		2.5153			*1.5008*	
Economic growth			1.037			1.0251
			0.0370			*0.0278*
Growth opportunities	0.9689	0.9653	0.9653	0.9558**	0.9559**	0.9566**
	0.0231	*0.0296*	*0.0299*	*0.0189*	*0.0190*	*0.0190*
Stock volatility	1.0266***	1.0290***	1.0287***	1.0328***	1.0329***	1.0326***
	0.0062	*0.0106*	*0.0105*	*0.0053*	*0.0053*	*0.0053*
Firm size	0.5660***	0.5280**	0.5266**	0.6557***	0.6585***	0.6563***
	0.0812	*0.1681*	*0.1714*	*0.0270*	*0.0271*	*0.0271*
Leverage	0.9808***	0.9782*	0.9784*	0.9927	0.9921	0.9926
	0.0074	*0.0122*	*0.0122*	*0.0055*	*0.0054*	*0.0054*
Constant	3.6026	50.6745	63.6691	0.1366	1.7789	2.2123
	5.6127	*122.4259*	*162.7218*	*0.1716*	*1.3834*	*1.6902*
N	1509	1509	1509	1509	1509	1509
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Country fixed effects	Yes	Yes	Yes	No	No	No
Sector fixed effects	No	No	No	Yes	Yes	Yes

Note. Standard errors are in italics; for year/country/sector fixed effects, the first year/country/sector is chosen as the base year; * p < 0.1, ** p < 0.05, *** p < 0.01

Appendix J: Fractional logistic regression – structure of convertible debt issue with firm-specific and each macroeconomic factor individually

The table presents the results of the fractional regression with a logistic specification for the relationship between the structure of convertible debt and firm-specific and one macroeconomic factor at a time. The odds ratio with its significant values are shown with the standard errors below each time in italics. The dependent variable is equal to the convertible bond's probability of conversion measure. The specification of the macroeconomic independent variables is as follows: interest rate is measured as the three-month median interest rate in the prior quarter, equity performance is measured as the three-month median index in the prior quarter, and gross national income growth is the previous quarter's growth rate. For the firm-specific variables: price-to-book ratio is measured one year prior to issue, stock volatility is computed one month prior to issue, total assets and leverage are both measured one year prior to issue.

Fractional regression with logistic specification (odds ratio)

Dependent variable:	Regressions					
Probability of conversion	(1)	(2)	(3)	(4)	(5)	(6)
Interest rate	1.2942			1.3016		
	0.2641			*0.2743*		
Equity perforamnce		0.8472			0.8601	
		0.3378			*0.3473*	
Economic growth			0.9759			0.9703
			0.0177			*0.0192*
Growth opportunities	0.9892	0.9897	0.9891	0.9914	0.9917	0.9915
	0.0071	*0.0072*	*0.0072*	*0.0072*	*0.0073*	*0.0073*
Stock volatility	0.9944**	0.9940**	0.9941**	0.9943**	0.9939**	0.9940**
	0.0024	*0.0024*	*0.0024*	*0.0026*	*0.0026*	*0.0026*
Firm size	0.9344***	0.9345***	0.9330***	0.9392***	0.9381***	0.9396***
	0.0237	*0.0237*	*0.0232*	*0.0226*	*0.0223*	*0.0227*
Leverage	0.9944**	0.9946**	0.9945**	0.9919**	0.9922**	0.9922**
	0.0024	*0.0024*	*0.0024*	*0.0034*	*0.0034*	*0.0033*
Constant	0.3511	0.9008	0.8923	0.3956	1.0009	1.0199
	0.2950	*0.3868*	*0.3714*	*0.3334*	*0.4025*	*0.3858*
N	312	312	312	312	312	312
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Country fixed effects	Yes	Yes	Yes	No	No	No
Sector fixed effects	No	No	No	Yes	Yes	Yes

Note. Standard errors are in italics; for year/country/sector fixed effects, the first year/country/sector is chosen as the base year; * p < 0.1, ** p < 0.05, *** p < 0.01