Motivations for security choice and its developments over time

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Abstract

This study determines firm characteristics and their relevance to the choice of securities issued in a time-varying analysis. By implementing a multinomial logit model I assess the relevance of several firm characteristics to the type of security issued. I find that several firm characteristics are relevant to the choice of securities issued, and evidence supports multiple traditional rationales for issuing convertible bonds, together with indicators of hedge fund involvement. I find supportive evidence for the sequential-financing theory, risk-uncertainty theory and the backdoor-equity theory. Marginal effects for firm level characteristics on the choice of securities issued are large and signifiant. Over time firms issuing convertible bonds have a higher probability of reaching into financial distress. I do not find a clear shift from traditional rationales for issuing convertible bonds to hedge fund involvement, over time.

JEL classification: C12; C51; C61; G14; G24; G30; G32
Keywords: Security issues; Convertible bonds; Backdoor-equity theory; Delta; Hedge funds; Multinomial logit; Time varying

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Contents

1 Introduction

Traditionally, when a firm is in need of funding it can either choose to issue equity, and thereby sell part of the ownership of the firm, or acquire debt, and commit to fixed interest payments to its creditors. As the capital market evolved, traditional debt and equity securities were supplemented by hybrid securities. Securities as such, cannot be classified as being a pure equity nor a pure debt instrument, and therefore have characteristics of both types of securities. One of most widely issued hybrid securities is a convertible bond. This security presents an alternative way of raising capital for firms when regular debt or equity issues do not suffice.

A convertible bond is a debt security which can be converted into common equity at the discretion of the investor. According to Modigliani and Miller (1958), in a perfectly efficient market, whether a firm finances itself through equity or debt should not matter. But why do firms then have a preference for choosing to acquire either debt or equity? And which role do convertible bonds fulfill in this corporate finance debate? One of the most prominent theories as to what motivates firms in choosing the type of security to issue was widely discussed by Stein (1992). In his backdoor-equity theory, Stein (1992) argues that firms avoid issuing equity as this might be perceived by the market as a signal of overvaluation, while issuing straight debt is accompanied by high costs of financial distress. When firms face such a dilemma, convertible bonds present an outcome, as it avoids negative signaling to market and high fixed interest payments. Statistics of the US capital market after the turn of the century indicate that convertible bonds present a desirable outcome for a substantial amount of firms[1].

Figure 1 shows the securities issued by US firms in the years 2000-2017. Although the relative share of funding raised through convertibles seems small, in total, between the years 2000 and 2017, $398 billion was raised through convertible securities. In the same period, $651 billion of funding was raised through seasoned equity offerings and $5610 billion through straight debt offerings. Over the entire sample, the relative size of convertibles in the capital market has decreased, however, it's absolute value in dollar terms remains gigantic[2].

Research reports several findings on how the convertible bond market has developed over time, both on the issuer's side as well as on the investor's side. Historically, convertible bonds were issued through public offerings, whereas recently the vast majority of convertible bond issues are privately placed (Huang and Ramirez, 2010). In addition, previously, convertible bonds were mainly bought by buy-and-hold institutional investors, whereas more recently convertible bond hedge funds are an active participant of this market and buy over 75%

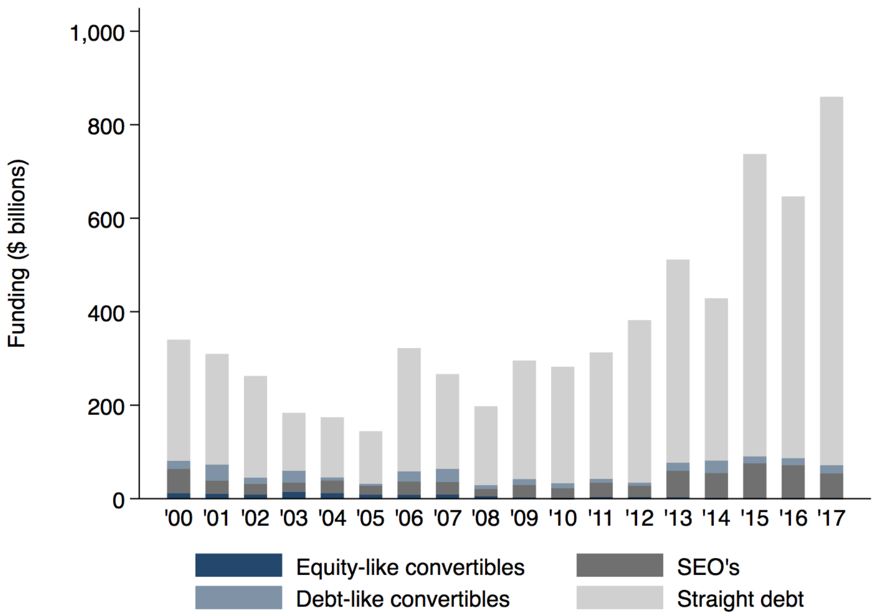
[1] Dutordoir et al. (2014) report that between 2000 and 2011, U.S. corporations raised $510 billion by issuing convertible securities, $1,146 billion in seasoned equity offerings and $6,635 billion in regular bond issues.

[2] Dutordoir et al. (2014) find that convertible bonds comprise 6.15% of the US capital market in their sample period. I find that over 2000-2017 convertibles comprise 5.98% of the sample period. Note, I eliminate financial and utility companies from the sample, whereas Dutordoir et al. (2014) do not report a removal of such firms.

of issues of convertible debt (Choi et al., 2010).

It is questionable, whether, such a shift in suppliers of capital is desirable. Convertible arbitrage hedge funds allow firms to raise capital when issuing equity is very expensive or perhaps even impossible (Brown et al., 2012). However, it could be possible that after hedge funds distribute a firm's equity, regular investors pay the price, as they are generally holding shares which are subject to more risk.

Figure 1: Funding raised per year



In addition, Brophy et al. (2009) report that hedge funds are acting as an investor of last resort, and are therefore keen on investing in firms that suffer from poor fundamentals and severe information asymmetries. As a compensation for this, hedge funds are able to negotiate large discounts and are able to influence the design of securities. These hedge funds then exploit underpricing of the convertible bond by obtaining a long position in the convertible, and a short position in the firm's stock (Loncarski et al., 2009). This strategy is also known as the *convertible arbitrage strategy* and has proven to be very profitable for hedge funds. However, firms acquiring funding from hedge funds show severe underperformance over time (Brophy et al., 2009)[3].

The recent shift in the type of investors, the market for distribution of con-

[3]Statistics on the returns of hedge funds implementing the convertible arbitrage strategy, and returns of firms acquiring funding from convertible arbitrage hedge funds, are provided in section 2.

vertibles and the design of convertible bonds creates a laboratory for academic research on convertible securities (Dutordoir et al., 2014).

Present studies on convertible bonds mainly focus on three topics: (1) Why do firms issue convertible bonds (Dutordoir et al., 2014)? (2) What is the effect of convertible bond issues on shareholder wealth (Rahim et al., 2014)? And (3) the determinants of the design of convertible bonds (Grundy and Verwijmeren, 2018). The literature provides four theoretical motivations as to why firms decide to issue convertible bonds: risk-shifting (Green, 1984), risk-uncertainty (Brennan and Schwartz, 1988), backdoor-equity (Stein, 1992) and sequential-financing (Mayers, 1998). All four theories are extensively discussed in section 2.

However, empirical research in these four theories fails to find evidence which clearly favors one of the four theories. Therefore, given the traditional motivations for convertible bond financing, together with the increasing role of hedge funds in the convertibles market, this paper aims to identify a time varying development in the relevance of firm characteristics to the type of securities issued. The previously mentioned objective is condensed in the following research question:

Do specific firm characteristics influence firms' decision making in issuing equity, straight debt or convertible securities?

In this thesis, I link empirical findings to theories as to what motivates firms to issue a particular type of security. In addition, I assess the impact of hedge funds in the convertibles market by examining what type of both issue and issuer characteristics makes investing for hedge funds attractive. In their paper, Brown et al. (2012) analyze the relevance of firm characteristics to the choice for firms to issue equity through convertible arbitrage hedge funds rather than conventional seasoned equity offerings. I complement the study by Brown et al. (2012) by analyzing whether over time, firm characteristics that indicate hedge fund involvement become more important than traditional rationales for issuing convertible debt.

To the best of my knowledge, this is the first thesis assessing the relevance of firm characteristics to security types issued for the years 2000-2017, and thereby incorporating the role of hedge fund involvement and performing a time varying analysis. I find evidence which favours the risk-shifting theory, risk-uncertainty theory and backdoor-equity theory. Furthermore, I find sufficient evidence which indicates hedge fund involvement, however, clear developments over time on the relevance of firm characteristics to the type of securities issued are not found.

This thesis is structured as follows. Section 2 provides an extensive literature review on traditional corporate finance, convertible bonds, the role of hedge funds as convertible arbitrageurs and formulates the hypotheses. Section 3 provides an overview of the databases consulted and the methodology underlying the construction of the sample analyzed in this thesis. Section 4 covers the independence of irrelevant alternatives test, performed in the pre-estimation analysis, to support the implementation of a multinomial logit model. In addition, section 4 reports an extensive discussion of the methodology implemented to answer the research question. Section 5 presents results for the main analysis, implications and results for time varying developments. Section 6 provides an additional analysis whereby convertible bonds are subdivided according to their Delta and private or public placements. Finally, Section 7 concludes the thesis by discussing the main empirical findings, implications of the findings and recommendations for future research.

2 Literature

This section discusses the literary motivation behind this thesis. Section 2.1 briefly discusses several traditional corporate finance theories. Section 2.2 describes characteristics of a convertible bond, together with theories as to why firms decide to issue such securities. Section 2.3 discusses the role of hedge funds and convertible arbitrage in the convertibles market. Finally, section 2.4 formulates several hypotheses which are tested in the remainder of this thesis.

2.1 Corporate Finance

Modigliani and Miller (1958) argue that in a perfectly efficient financial market, meaning that among other characteristics, there are no taxes, no transaction costs and no bankruptcy costs, a firm's value is independent of its capital structure. Resulting from this, the cost of capital is not influenced by the amount of debt acquired, as the cost of debt will be offset by the additional cost of equity (Modigliani and Miller, 1958). However, as perfectly efficient financial markets do not exist, dropping one or multiple of the assumptions provided by Modigliani and Miller (1958), allows for ample corporate finance research possibilities.

Myers (1984) states that a firm's financing decisions can be motivated according to two theories. These theories being the *static tradeoff theory,* first introduced by Kraus and Litzenberger (1973) and the *pecking order theory* , presented by Myers and Majluf (1984). The first theory assumes that firms have a target debt-to-value ratio to which they gradually move. The second theory argues that firms prefer internal funding over external funding, and subsequently, issuing debt comes highest in the external pecking order, while equity is merely used as a last resort due to information asymmetries (Myers, 1984). When firms choose to be funded by debt this can be acquired in the form of a bank loan or through issuing bonds. The primary choice of debt type depends on the credit quality of the firm, whereby high credit quality firms tend to borrow public debt, whereas firms with lower credit ratings tend to borrow from banks or non-banks private lenders (Bharath et al., 2008).

2.2 Convertible bonds

Typically, corporate finance theories only focus on the trade-off between funding through debt or equity. Convertible bonds are often omitted, however, these instruments play a sincere role in the capital market. A convertible bond is a hybrid investment security which can be converted into regular shares of the firm if the investor wishes to convert the security[4]. Naturally, the investor only chooses to convert the bond if the value of shares for which the bond can be converted exceeds the principal amount of the bond. As a trade-off for the possibility for the investor to benefit from the upside potential of the stock, the convertible bond is subordinated to other types of corporate debt, and furthermore, the security typically pays a lower coupon rate than a straight bond (Brennan and Schwartz, 1980).

From an investor's perspective, the motivation for purchasing a convertible bond is straightforward; the investor can benefit from upside potential and the downside risk is limited. However, amongst academia several theories originated as to why firms decide to issue convertible debt. Particularly, the discussion evolves around what drives firms in their preference to issue convertibles over seasoned equity offerings or straight debt issues.

2.2.1 Agency costs

Green (1984), provides a risk-shifting model as an explanation for firms to issue convertible debt. In his theory, Green (1984), assesses a conflict of interest between bondholders and stockholders. Naturally, bondholders will at most receive the principal amount of their investment, however stockholders have the potential to share in future firm profits. Resulting from this, bondholders will typically try to stimulate a stable scenario for the firm, whereas stockholders might favour risky investments in order to generate excessive profits. If a firm issues convertible bonds, this decreases the stockholders incentives to participate in risky projects. Stockholders will namely have to share benefits from the risky projects with convertible debt holders, making it less attractive for shareholders to stimulate risky projects as such. In this scenario, a convertible bond acts as an instrument to alleviate potential excessive risk taking and overinvestment issues.

In line with the agency costs alleviation argued by Green (1984), another related theory is presented by Mayers (1998). In his paper, Mayers (1998) argues that convertible bonds can be an outcome for potential agency problems between management and shareholders. When a firm faces a sequence of multiple investment opportunities, convertible bonds can prevent overinvestment by management. By issuing convertible bonds, the firm is required to return cash to bondholders if the investment fails, whereas if the project succeeds the convertible bond is transferred into common equity, thereby allowing the new shareholder to benefit from upside potential of firm performance. Management is now incentivized to only invest in investments with high probability of success. Important in this theory is how equity-like a convertible bond is. Convertible bonds with high Deltas behave more like equity than bonds, and are quickly converted into equity. Therefore, the more equity-like convertibles become, the

[4]For simplicity, this study assumes convertible bonds without a call feature

less suitable they are to control the overinvestment problem. If such an over-investment issue arises, issuing convertible debt is cheaper compared to issuing short-term debt and subsequently, rolling it over. Mayers (1998)'s theory is also known as the sequential-financing theory. Further details of Delta are explained in section 6.

2.2.2 Adverse selection

In addition to agency costs, Brennan and Schwartz (1988) and Stein (1992), focus on potential adverse selection problems. Brennan and Schwartz (1988) find convertible bonds to be a suitable outcome when disagreement between managers and stock investors occurs with respect to the risk of the firm. When the firm is risky, bond investors require a higher return on their investment as compensation for this. Managers might not agree with high coupon rates on straight debt, and instead they issue convertible bonds. By issuing convertible bonds, the higher perceived risk increases the value of the conversion option, whereas the credit component of the instrument is undervalued as typically convertibles pay lower coupons. Overvaluation on the conversion option, and undervaluation on the credit component, allows managers and shareholders to come to an agreement on the value of convertible debt more easily than with straight debt.

Stein (1992) focuses on the signaling effect accompanied with an issue of securities. When issuing equity, the market might perceive this as a signal that the firm is overvalued. Managers sell additional stock to exploit overvaluation of the share, thereby enforcing a transfer of wealth from new to old shareholders. Issuing straight debt however is unattractive for firms due to the costs of financial distress. In this case, a convertible bond might provide a useful solution. When firms issue convertible debt, the market cannot interpret this as an attempt to exploit overpricing of equity, whereas firms typically pay a lower compensation for risk to bondholders as they have upside potential in their security. Firms are likely to issue convertible debt only when they expect their share price to rise, and thus accumulate their capital structure with equity. Issuing convertible debt can therefore send a positive signal into the market about expectations of the future performance of the firm.

To support his theory, Stein (1992), introduces a model that builds on an earlier model presented by Myers and Majluf (1984). The model allows for three types of firm quality: "good", "medium" and "bad". Each firm is presented with the same new investment opportunity. The theory predicts that firms of "bad" quality will acquire funding through equity securities whereas "good" firms will issue straight debt. To avoid disadvantages of both forms of traditional funding, a "medium" quality firm will raise funding through a convertible security because: (1) issuing equity is negatively interpreted by the market and (2) due to high costs of financial distress regular debt is unattractive. In Stein (1992)'s model, a call feature is essential, as it allows firms of "medium" quality to force conversion. As a replacement for call features issuers can issue convertibles with high Deltas, instead of forcing conversion, issuers can then easily allow for conversion as a shift in the underlying asset will more easily allow for conversion.

Stein (1992) refers to previous academic work on security issues by Broman (1963) and Essig (1992), who both assess the relationship between firm quality and security choice. Both authors find supporting evidence for Stein (1992)'s prediction that convertible bonds are especially interesting for firms which are subject to high potential costs of financial distress. In addition, Brown et al. (2012) find that firms issuing "equity-like" convertible bonds are subject to higher levels of financial distress, a more volatile stock return pattern, higher levels of institutional ownership and more liquid shares compared to firms acquiring funding through regular seasoned equity offerings. Also, firms issuing straight debt are mainly healthy firms in terms of high levels of tangibility of assets. Furthermore, these firms are more likely to pay dividend, which is a sign of profitability (Brown et al., 2012).

Although previous work on convertibles finds some supportive evidence for Stein (1992)'s theory, conclusive evidence, which excludes other motivations for issuing convertible bonds remains absent.

2.3 Hedge funds and convertible arbitrage

Conventional purchasers of convertible bonds were mainly buy-and-hold institutional investors such as pension funds (Choi et al., 2010). These institutional investors would supplement their portfolio with convertibles in the hope of benefitting from upside potential, and therefore accepting a lower coupon rate.

Recently however, hedge funds have become an important participant in this market and Choi et al. (2010) state that convertible arbitrage hedge funds buy over 75% of issues of convertible debt. In pure rational financial markets that are perfectly efficient, the type of investor, whether it being a traditional pension fund or a convertible arbitrage hedge fund, should be irrelevant (Brophy et al., 2009). The authors question this reasoning, as they find that hedge funds recently have become a last option of funding for firms with inferior financials, and thereby arguing that the type of supplier of capital is not completely irrelevant.

2.3.1 Convertible arbitrage strategy

Since 1995, hedge funds have positioned themselves as an important participant in transactions of so called private investments in public equity (PIPEs), whereby public firms acquire funding through private channels. Traditionally, securities issued in PIPEs are common shares or convertible bonds.

Wu (2004) and Gomes and Phillips (2012) find that firms involved in these private placements are generally poor performing and subject to information asymmetry and imperfect functioning of the market. Particularly, this inefficient functioning by the market provides unique arbitrage opportunities for hedge funds to exploit through convertible bonds. Brophy et al. (2009), find evidence that firms facing a lack of alternative financing options proceed to hedge funds as a source of funding. Through negotiating, hedge funds force companies to sell their equity at large discounts, thereby allowing buyers of the securities to benefit from an underpricing of the convertible bond (Loncarski et al., 2009).

Specifically, Brophy et al. (2009) find that hedge funds are: (1) more likely to invest in PIPEs offering a price-protected structure, compared to other investors, (2) hedge funds force companies to sell their equity at large discounts, meaning companies funded by hedge funds generally face more difficulties in raising capital, (3) short positions in companies that issue their securities to hedge funds increase around the time of issuing (Brophy et al., 2009).

It is important to note that PIPEs are not exactly the same as a private convertible placement under Rule 144A. Generally, PIPE issuers are smaller firms (Brophy et al., 2009). However, as both instruments are fairly similar, I argue that findings by Brophy et al. (2009) on PIPEs, is sufficient reason to assume that these remarkable events to some extent, are also present around private convertible bond placements.

Typically, in a standard arbitrage strategy the arbitrageur obtains of a long position in the convertible bond and a short position in the stock of the firm. If firm performance improves, the convertible bond is converted into equity, and hedge funds are now a partial owner of the firm. If the stock plummets however, due to the short position acquired, the hedge fund still receives a payoff. Because hedge funds purchased the convertible with a discount, they have an opportunity to acquire equity in a firm in a cheap way, with a limited downside risk since they simultaneously acquire a short position in the same firm. The size of the short position is determined by the Delta of the convertible (Choi et al., 2010).

The dominant position of hedge fund involvement in this capital market is proven by Choi et al. (2010), who find that hedge funds' abilities to provide capital is an important determinant in issues of convertible bond securities. Also, during the short-sales bans in 2008, Choi et al. (2010) find a sharp decrease in convertible securities issued. As a short position of the underlying stock is essential in the convertible arbitrage strategy, this finding further supports the importance of hedge funds in the recent convertibles market. Furthermore, Grundy and Verwijmeren (2018) find that changes in the design of convertible bonds are due to the increase of the convertible arbitrage strategy.

In terms of abnormal performance, hedge funds investing in PIPEs have proven to show favourable returns [5] combined with high Sharpe ratios [6], whereas firms selling PIPE's to hedge funds show large negative performance compared to firms selling PIPE's to other investors (Brophy et al., 2009).

Important to mention is the fact that hedge funds are able to exploit arbitrage strategies whereas traditional investors such as pension funds are subject to regulations which prevents them for applying this strategy (Brophy et al., 2009).

[5] Brophy et al. (2009) find that in general, hedge funds investing in PIPE securities show a 2.03% average return in the month of PIPE purchase, hedge funds investing in structured PIPEs show a 1.31% outperformance compared to matching hedge funds.

[6] The Sharpe ratio corrects returns for risk taken, by dividing excess returns on investment over the standard deviation of the returns. The higher the Sharpe ratio the more attractive the investment becomes.

2.3.2 Industry size

The dominant rise of the convertible arbitrage industry, especially after the year 2000 has frequently been demonstrated in the literature and is mostly reported according to three measures. Firstly, Calamos (2003) reports an increase in the size of convertible arbitrage market after 2000. This finding is supported by Choi et al. (2009) who find an increase in reported assets under management by convertible arbitrageurs between 1993 and 2006. Secondly, news stories about convertible arbitrage strategies appear more frequently (Duca et al., 2012). And thirdly, over a sample period of 2000-2008 Brown et al. (2012) find a constant increase in the percentage of privately issued convertible bonds purchased by hedge funds. The recent rise in hedge fund involvement, and their dubious role in the convertibles market, provides ample research opportunities for academia as well as regulators.

2.4 Hypotheses

Since hedge funds are such an important participant in the convertibles market, features of issuing firms that make it interesting for hedge funds to invest, can therefore also be argued as influential factors on the choice of funding by firms (Brown et al., 2012). However, I also still expect to find evidence for traditional rationales for issuing convertible bonds. The aim of this study is to assess whether issuer characteristics drive the choice for a specific type of security issued by firms. By means of identifying firm level characteristics I strive to answer multiple hypotheses related security issuing behavior by firms.

2.4.1 Traditional rationales

Stein (1992), argues firms with "good" quality will issue straight debt, whereas "bad" quality firms are more likely to issue equity. Firms of "medium" quality hope to avoid unfavourable consequence of both securities by issuing convertible debt. Considering previously mentioned theory, I arrive at my first hypothesis:

Hypothesis$_1$*: Information asymmetry is the dominant traditional rationale for issuing convertible bonds over traditional means of funding.*

In addition, the model implemented by Mayers (1998), specifically focusses on the conflict of interest between management and stockholders. By issuing a convertible bond, management hopes to alleviate a potential overinvestment problem. This mechanism only works when the convertible has a low Delta, and therefore the convertibles will not be converted too quickly. Following reasoning by Stein (1992) however, I expect that firms want the convertibles to convert quickly, in order to accumulate their capital structure with equity, meaning convertibles with high Deltas are preferred. Therefore, measuring the amount of equity-like and debt-like convertibles is a good indicator of which of both previously mentioned theories is dominant in issuing motivations, and I arrive at my second hypothesis:

Hypothesis$_2$: The majority of convertible bonds issued are equity-like.

2.4.2 Influence of hedge funds

In their paper, Brophy et al. (2009) prove that hedge funds invest in firms with inferior fundamentals, and acquire the role of lender for firms which lack other funding possibilities. Additionally, Brown et al. (2012) find that firm characteristics are relevant for firms when choosing to issue convertible debt to hedge funds, rather than conventional seasoned equity offerings. Considering previously mentioned findings, I expect to find evidence indicating that hedge funds actively influence the choice of firms to issue convertible debt rather than traditional seasoned equity offerings or straight debt issues. This brings me to the third hypothesis:

Hypothesis$_3$: Convertible bond issues show more characteristics of attractive investment opportunities for hedge funds to implement the convertible arbitrage strategy, compared to seasoned equity offerings or straight debt issues.

Given the findings by Brown et al. (2012), that hedge funds buy the majority of private convertible placements, I expect to find stronger effects for private than public placements. This leads to the fourth hypothesis:

Hypothesis$_4$: Private convertible bond placements show more characteristics of attractive investment opportunities for hedge funds compared to public convertible bond placements.

Given the traditional rationales and the recent involvement of hedge funds I expect to find indicators for both types of rationales. However, interesting is to assess how the relevance of specific characteristics increase or decrease over time, implying a shift from traditional rationales towards more dominant hedge fund involvement. Given this expectation I arrive at my final hypothesis:

Hypothesis$_5$: Over time, characteristics of convertible bond issues are more suited towards hedge fund involvement rather than the traditional rationales for issuing convertible debt.

3 Data

This section discusses the data used in this study together with its sources. Section 3.1 describes from where I extract security issues and firm specific balance sheet data. Section 3.2 describes how I construct subsamples and classify securities. Finally, section 3.3 briefly describes all independent variables included in the model.

3.1 Security issues

From Mergent Fixed Income Securities Database (Mergent FISD) I obtain 3,710 convertible bond issues within the United States of America, over the sample period 2000-2017. For issues to be incorporated in the sample, Standard Industrial Classification (SIC) code, issue date and maturity date should be mentioned by Mergent FISD. This eliminates 200 observations.

As common practice in finance, I eliminate financial firms from the sample. Removing these firms is in line with reasoning by Rajan and Zingales (1995), who argue that financial firms should be eliminated from the sample since these are subject to regulations regarding leverage. Additionally, following Brown et al. (2012) I eliminate utility companies form the sample. Removing financials and utilities drops the sample by another 643 issues. To avoid private issues being registered twice in the database, I eliminate public issues with a similar Mergent IssuerID and maturity date as a previously issued privately placed convertible. This drops the sample size by another 982 observations. As a result, 1,885 convertible bond issues remain.

Firm specific information is obtained from Compustat North America (Compustat). Additionally, I derive stock prices from the Center for Research in Security Prices (CRSP). When merging the convertible bond issues with their respective financials and stock prices I lose an additional 634 observations, resulting in the final sample of 1,251 convertible bond issues over the years 2000-2017.

Similar to convertible bonds, I obtain straight debt issues from Mergent FISD. After eliminating financials, utilities, missing SIC codes, issue dates or maturity dates and merging every company with financial data, a sample of 7,739 straight debt issues remains. Alternatively to debt issues, I extract 9,233 seasoned equity offerings from the SDC ThomsonOne database for the same sample period. After dropping missing SIC codes, merging with matching financials and stock prices, 3,367 seasoned equity offerings remain in the sample.

3.2 Sample construction

Based on the Delta, I divide convertible bonds into equity-like issues and debt-like issues. Lewis et al. (2003) divide convertibles into debt-like and equity-like convertibles based on a Delta threshold of 0.6. Bonds with a Delta smaller than 0.6 form debt-like convertibles and remaining convertibles are classified as equity-like. Brown et al. (2012), however classify a convertible as debt-like if it is in the lowest quartile of Deltas. I follow Lewis et al. (2003) in their threshold of a Delta ratio of 0.6. When applying this my sample has 426 equity-like convertibles and 825 debt-like observations[7]. As a first classification I divide the sample into the following categories:

[7] As the number of equity like convertibles is quite low, I also compute the Delta with a dividend rate of 0, argued by Grundy and Verwijmeren (2018). This results in 483 equity-like convertibles and 768 debt-like convertibles, see figure 4 in appendix B. As the differences between the number of equity-like convertibles is only 57 equity-like convertibles, I choose to compute Delta according to the conventional manner, whereby I include dividends.

Security type	category
Equity-like convertible offering	0
Seasoned equity offering	1
Debt-like convertible offering	2
Straight debt issue	3

Following the first analysis, I also assess the influence of firm characteristics on the choice of private or public convertible bonds. Convertible bond issues placed under Rule 144A are considered private placements. Similar to the the previous analysis, the full sample is divided into four new categories:

Security type	category
Private placed convertible offering	0
Seasoned equity offering	1
Public placed convertible offering	2
Straight debt issue	3

Subsampling the dataset results in the following descriptive statistics:

Table 1: Security issues

Security type	Frequency	Percent	Cumulative
Convertible bond issues	1,251	10.12	10.12
Seasoned equity offerings	3,367	27.25	37.37
Staright debt issues	7,738	62.63	100
Total	12,356	100	
Equity-like convertible bond	426	3.44	3.44
Seasoned equity offering	3,367	27.25	30.69
Debt-like convertible bond	826	6.69	37.37
Straight debt issue	7,738	62.63	100
Total	12,356	100	
Privately placed convertible	847	6.85	6.85
Seasoned equity offering	3,367	27.25	34.10
Public convertible offering	404	3.27	37.37
Straight debt issue	7,738	62.63	100
Total	12,356	100	

The sample period ranges form January 2000 until December 2017, financial companies and utility companies are excluded from the sample group. Issues are considered private when placed under rule 144A. Public convertible bond issues with similar Mergent IssuerID and maturity as a previously issued privately placed convertible bond are removed from the sample. Convertible bonds with a Delta greater than 0.6 are considered equity-like convertible bonds.

Similar to figure 1, statistics in table 1 show that the vast majority of securities issued in the sample are straight debt issues, followed by seasoned equity offerings. Convertible bonds only comprise a tiny part of the securities market. In addition, from the 1,251 convertible bonds issued, only 426 convertibles have a Delta higher than 0.6, making them equity-like convertibles. This implies that most convertibles issued, behave more like bonds than equity. Also, the vast majority of convertibles issued are privately placed. This means that in most cases, if firms decide to issue convertible bonds, they rather issue them to a number of investors rather than making them available to the public. This is not particularly surprising, as hedge funds prefer investing in private placements.

3.3 Independent variables

To measure firm performance and risk I incorporate the *Altman Z-score* which estimates the probability of a firm becoming bankrupt, and is computed as follows:

$$Z - score = 1.2\left(\frac{WC}{TA}\right) + 1.4\left(\frac{RE}{TA}\right) + 3.3\left(\frac{EBIT}{TA}\right) + 0.6\left(\frac{ME}{BL}\right) + \left(\frac{S}{TA}\right)$$

High Z-scores indicate less probability of the firm reaching into financial distress. In addition, I add *Return volatility,* measured as the annualized standard deviation of monthly stock returns up to a maximum of ten years prior to issuing, and *NASDAQ listing,* which is computed as following:

$$NASDAQ\ listing = \begin{cases} 1 & listed\ on\ NASDAQ \\ 0 & else \end{cases}$$

To measure whether a firm is subjective to asymmetric information I include the following variables: *Tangibility,* measured as the ratio of tangible assets over total assets at the fiscal year end prior to issuing, *R&D intensity,* measured as the ratio of reported R&D expenses over total sales in the fiscal year prior to offering and a *R&D Dummy*, which is computed as following:

$$R\&D\ dummy = \begin{cases} 1 & R\&D\ expenditures \\ 0 & else \end{cases}$$

Following Brown et al. (2012) I include *Institutional ownership* as the level of institutional ownership reported in Thomson-Reuters Institutional Holdings database, *Relative size*, measured as issue size over market value of equity at fiscal year end of issuing, and the *Amihud liquidity score*, measured as the monthly average of absolute returns relative to the monthly dollar trading volume in the fiscal year prior to offering. Other continuous independent variables are *Firm size,* incorporated as the natural logarithm of market value of equity and *Dividend-paying,* which is an indicator of firm profitability and is computed as:

$$Dividend\,paying = \begin{cases} 1 & firm\ pays\ dividend \\ 0 & else \end{cases}$$

Brown et al. (2012) take on a value of 1 for the dummy variable *Dividend-paying* if a firm paid dividend in the fiscal year prior to the issue. I however, argue that a dividend payment already is an indicator of prior performance and therefore choose to let the Dividend-paying dummy acquire a value of 1 if the firm pays dividend in the fiscal year of issuance. To control for macroeconomic developments and take economic sentiment into account, I incorporate the following variables: *Equity market return,* measured from daily stock returns of the S&P 500 for a one year period, *Interest rate,* measured as the yield on a ten year US Treasury bond, *Credit spread,* measured as the spread between Moody's Baa corporate bond index and the yield on a ten year US Treasury bond, *Money Supply (M2), Consumer Confidence Index* and the Euro-Dollar *Exchange rate.* The yield on a ten-year US Treasury bond, and Moody's Baa corporate bond index are extracted from the database of the Federal Reserve Bank of St. Louis (FRED). All other macroeconomic variables are extracted from Datastream. Table 2 reports descriptive statistics on all explanatory variables.

Table 2: Descriptive statistics

Continuous variables

Variable	Observations	Mean	Std. Dev.	Min	Max
Financial distress (Z-score)	12,356	4.899	10.123	-94.281	99.504
Return volatility	12,356	0.474	0.246	0.171	1.537
Firm size	12,356	3080	7640	1.068	70900
Tangibility	12,356	0.591	0.517	0	9.273
R&D intensity	12,356	0.280	1.367	0	10.605
Institutional ownership	12,356	0.619	0.042	0.000	0.998
Relative size	12,356	0.167	0.319	0.001	2.752
Amihud liquidity	12,356	0.290	0.717	0.000	2.921
Equity market return	12,356	0.077	0.152	-0.385	0.296
Interest rate	12,356	0.032	0.012	0.018	0.060
Credit spread	12,356	0.027	0.006	0.017	0.040
Money supply (M2)	12,356	9109.348	2760.520	4656.300	13834.100
Consumer confidence index	12,356	88.635	24.107	25.300	144.700
Exchange rate	12,356	0.838	0.124	0.635	1.182

Dummy variables

Variable	Yes	No	Total
NASDAQ listing	3,969	8,387	12,356
R&D expenses	6,358	5,998	12,356
Dividend paying	6,088	6,268	12,356

Firm size is in million $, natural logarithm of firm size is used in the multinomial logit model. Firms acquire a value 1 for the dummy variables when listed on the NASDAQ exchange, reported R&D expenses the year prior to offering or paid dividend in the year of offering.

Z-scores range from -94.281 to 99.504, with a standard deviation of 10.123. This means that there is a wide variation among firms issuing securities with respect to their probability of reaching financial distress. The vast majority of firms are not listed on the NASDAQ exchange, whereas firms conducting

R&D expenditures and paying dividend are roughly equally distributed across the sample. Given that only approximately half of the firms conduct R&D expenditures, note that the average R&D intensity for firms conducting R&D expenditures is thus approximately double than the statistic reported. As table 2 reports statistics for all securities issued combined, a wide distribution of explanatory variables is found and no direct conclusions can be drawn from this table yet.

4 Methodology

This section discusses the empirical setup for this study. Section 4.1 discusses a pre-estimation analysis in order to support the choice of model. Section 4.2 extensively discusses the multinomial logit model used in the analysis. Section 4.3 briefly describes how the model reaches it optimum by using STATA. Finally, section 4.4 discusses how developments over time are measured.

4.1 Pre estimation analysis

The multinomial logit model assumes *independence of irrelevant alternatives (IIA)*, which means that adding or removing outcomes from the model has no influence on the probabilities among the remaining outcomes. This is written as:

$$\frac{Pr(y = m|x)}{Pr(y = n|x)} = e^{(x[\beta_{m|b} - \beta_{n|b}])}$$

Where m and n represent different outcome categories. To test this assumption, I perform the Hausman test of *IIA* (Long et al., 2006). Results are shown in tables 8 and 9 of appendix C. None of the tests rejects the null hypothesis of independence of irrelevant alternatives. In addition, Hausman and McFadden (1984) report that negative chi^2 statistics means that the IIA assumption is not violated. Given these findings, it is appropriate to use a multinomial logit model.

4.2 Multinomial Logit Model

When dealing with a multiple classification problem, without ranking in the dependent variables, a nominal classification problem arises, and a multinomial logit model (MNLM) is implemented (Long et al., 2006)[8]. The econometric setup is similar to a binary classification logit model, however, when the dependent variable consists of multiple classes, multiple binary logit regressions have to be run. For simplicity, I assume there is one continuous variable x affecting the dependent categorical variable which consists of thee categories M, W and

[8] In a nominal classification problem a multinomial probit model would also be possible, however according to Keane (1992) several issues in computation and identification arise when using this model, making it less suitable.

P. To assess the effect of x on the three categories, the binary logit regressions are ran in the following form:

$$ln\left(\frac{Pr(P|x)}{Pr(M|x)}\right) = \beta_{0,P|M} + \beta_{1,P|M}x \quad (1)$$

$$ln\left(\frac{Pr(W|x)}{Pr(M|x)}\right) = \beta_{0,W|M} + \beta_{1,W|M}x \quad (2)$$

$$ln\left(\frac{Pr(P|x)}{Pr(W|x)}\right) = \beta_{0,P|W} + \beta_{1,P|W}x \quad (3)$$

Subscripts of the coefficients indicate which comparison is made. However, as $ln\frac{a}{b} = ln(a) - ln(b)$ holds , it must be that subtracting equation 2 from equation 1 yields equation 3. Therefore, only two binary logits need to be estimated (Long et al., 2006). Specifically, if there are m possible choices, to capture each choice, *m-1* equations are implemented (Brooks, 2014). And logically, the effects of independent variables can differ for each outcome (Long et al., 2006).

A problem that arises when implementing multiple binary logit models is that each comparison is based on a different sample. For instance when comparing Equity-like convertible bonds to Seasoned equity offerings, I exclude 826 and 7,738 observations, as these are the Debt-like convertible bonds and Straight debt issues. If I then run another binary logit model, I eliminate two other outcomes from the sample, which results in a different sample size then previously. Since all subsamples are large in size, I do not expect statistical issues to arise from this.

When comparing coefficients from the binary logit esimates to coefficients estimated in the multinomial logit model for the same comparison of dependent categories, both models do not perfectly estimate the same coefficients (Long et al., 2006). This is due to the fact that a series of binary logit estimates estimates each binary logit equation separately, whereas a multinomial model however, estimated in STATA, arrives at its final logit coefficient by subtracting two previously derived logit equations from one another (Long et al., 2006).

The following multinomial logit analysis is performed, whereby an equity-like convertible (category = 0) forms the reference outcome:

$$F(z_i) = \frac{e^{z_i}}{1+e^{z_i}} = \frac{1}{1+e^{-z_i}} \quad (4)$$

In this setup F is the logistic function of a random variable z. Meaning the logistic model estimate becomes:

$$P_i = \frac{1}{1+e^{-z_i}} \quad (5)$$

Whereby z is a function of all the independent variables in the model. Thus the function of z is:

$$z_i = \alpha + \beta_1 x_{1,i} + ... + \beta_{15,} x_{15,i} \quad (6)$$

Since this is not a linear probability model, parameters need some care before they can be interpreted. In order to assess the effect of a 1-unit increase in one of the independent variables, the function F is differentiated with respect to this variable. For example, the marginal impact of a 1-unit increase in x_1 on the probability of the outcome being one of the categories of the dependent variable is:

$$\Delta P_i = \beta_1(F(x_{1,i})(1 - F(x_{1,i}))) \tag{7}$$

4.3 Estimation

The estimation equation is obtained through a maximum likelihood (ML) function. To obtain the coefficients, the likelihood function computes how likely it is that the observed data would actually be observed if the estimated parameters were the true parameters. To find the parameters, a numerical optimization method is implemented, meaning the model begins with starting values for the parameters, and according to the slope of the likelihood function and the rate of the change in the slope, the model arrives at its next parameters. Each process of estimating new parameters is called an iteration, and the model continues to iterate until the maximum of the likelihood function is found, and therefore the model has reached its so called convergence (Long et al., 2006).

4.4 Developments over time

In order to assess time variation amongst security issues, I divide the sample in three subsamples of six consecutive years: 2000-2005, 2006-2011 and 2012-2017. I divide security issues in three different time periods in order to be able to test a pattern in securities behavior over time, and still retain sufficient observations per subsample in order to perform statistical tests. For each subsample I perform the multinomial logit model as in table 3, to assess developments of firms characteristics and security choices over time.

4.4.1 Analysis of variance (ANOVA)

To test a time varying development in descriptive statistics, I perform an ANOVA test. This tests the null hypothesis that all means of the subsamples are equal:

$$\mu_1 = \mu_2 = \mu_3$$

The numbers in subscript present the subperiod. In order to test this, I compute the mean squared error (MSE), which measures the variance within the subperiods. And the mean squared between (MSB), which measures the variance among the subperiods. The corresponding F statistic is then computed as following:

$$F = \frac{MSB}{MSE}$$

Based on the F-statistic and confidence interval the null hypothesis is then tested (Lane et al., 2017).

5 Results

This section discusses the empirical results computed by the multinomial logit model for the entire sample. In addition, I assess developments over time by implementing the multinomial logit model for each subperiod. Section 5.1 discusses the empirical results, and links the results to traditional rationales for issuing certain securities and hedge fund involvement. Section 5.2 discusses the development over time on relevance of firm characteristics and the securities issued.

In order to interpret the results presented in table 3, one should note that three types of securities were compared: (0) Convertibles, (1) Seasoned equity offerings and (2) Straight debt issue. Coefficients are presented compared to category (0), the convertibles, which forms the base category. This means coefficients should be interpreted as the effect of the independent variable on the categorical dependent variable compared to the base category.

In general, the model shows a high Likelihood Ratio (LR) Chi-Square test score, meaning that at least one of the parameters is not equal to zero, and thus at least one of the independent variables affects the choice of securities issued. Model prediction performance for the full sample and subsamples based on equity-like issues, debt-like issues, private placements and public placements can be found in table 15 of appendix E.

5.1 Securities choice

5.1.1 Traditional motivations

Firms issuing convertible debt have lower Z-scores than firms issuing equity, meaning they are subject to a higher probability of reaching into financial distress. I find negative and significant coefficients for stock price volatility for both outcomes, this is clear evidence that firms issuing convertibles in general have a more volatile stock pattern. Firms with volatile stock patterns issue convertible bonds to avoid security pricing issues by issuing convertibles, and therefore my findings support the risk-uncertainty theory by Brennan and Schwartz (1988). Also, firms conducting R&D expenses are less likely to issue seasoned equity offerings or straight debt. As R&D intensity increases, firms are more likely to issue equity whereas the probability of issuing straight debt decreases. Both findings on the R&D dummy and R&D intensity variable support information asymmetry theory by Stein (1992).

In addition, De Jong et al. (2011) consider low asset tangibility as a proxy for information asymmetry. Results in table 3 show that firms with low asset tangibility, which are subject to more information asymmetry, are more likely to seek funding through convertible debt. Findings that dividend paying firms and firms with high asset tangibility are more likely to issue straight debt, confirms that “good” quality firms are more likely to issue straight debt, and therefore, support the model proposed by Stein (1992). The negative relation between Z-score and a straight debt issues however mitigates the supportive evidence for the theory proposed by Stein (1992).

5.1.2 Hedge fund involvement

As I do not individually identify each investor, evidence on hedge fund involvement is merely suggestive. However, findings in table 3 do suggest that hedge funds significantly participate in the convertible bond market.

According to Brown et al. (2012) firms do not necessarily issue convertibles because of a signaling effect. Instead they argue that firms which face high costs of issuing equity, not necessarily face high costs of issuing convertibles due to the involvement of hedge funds. These convertible arbitrage hedge funds prefer to invest in firms with high stock return volatility as they can buy stocks after a price decline and sell after an increase (Brown et al., 2012). The authors prove this reasoning by finding a positive relation between the percentage of hedge fund purchases of a convertible issue and return volatility of the respective stock. Results presented in table 3 are in line with findings by Brown et al. (2012), as it shows that firms with high volatility are more likely to issue convertible debt, implying hedge funds play a prominent role in these issues.

Brown et al. (2012) show that financial health in terms of Z-scores negatively relates to the percentage of the issue of convertible bonds purchased by hedge funds. Findings in table 3 support this, as I find that if firms have higher Z-scores, they are more likely to issue equity. It is however surprising that if firms improve in terms of Z-scores, they are less likely to issue straight debt. Therefore, table 3 is weak evidence for hedge fund involvement relating to probability of financial distress.

In addition, I find that larger firms are less likely to issue seasoned equity offerings, and more likely to issue straight debt. Brown et al. (2012) find a negative relation between firm size and hedge fund involvement. A significant negative coefficient for seasoned equity offerings compared to convertible debt, therefore is indicative of hedge fund involvement. I find that as the relative size of the security issue increases, the probability of a seasoned equity offering, compared to a convertible offering decreases. Given findings by Brown et al. (2012), this is again indicative of hedge fund involvement, as hedge funds prefer to invest in issues of smaller size as this increases their ability to acquire a short position. Brown et al. (2012) argue that firms with liquid stocks are more attractive for hedge funds, as it is also easier to acquire a short position in stocks as such. The authors however fail to find a significant relation between liquidity and hedge fund involvement in convertible bond issues. I do find that firms with illiquid stocks are more likely to issue seasoned equity offerings and straight debt, however as it is not empirically proven, it remains difficult to state that firms with liquid stocks are more likely to issue convertible bonds because of hedge fund demand in these securities.

Convertible issuers have higher levels of institutional ownership, this is at-

Table 3

Multinomial logit model

Panel A: the choice between convertibles, equity and straight debt

	(1) Seasoned equity offering	(2) Straight debt issue
Constant	-5.611	-8.276*
	(4.438)	(4.287)
Financial distress (Z-score)	0.054***	-0.018***
	(0.005)	(0.006)
Return volatility	-0.947***	-1.665***
	(0.188)	(0.196)
NASDAQ listing	-0.289***	-0.338***
	(0.082)	(0.082)
Tangibility	0.315***	0.572***
	(0.093)	(0.090)
R&D Dummy	-0.853***	-0.485***
	(0.083)	(0.084)
R&D intensity	0.385***	-3.679***
	(0.053)	(0.463)
Relative size	-4.057***	3.338***
	(0.290)	(0.248)
Dividend-paying	0.046	0.987***
	(0.102)	(0.091)
Institutional ownership	-1.518*	-0.664
	(0.891)	(0.851)
Firm size	-0.545***	0.814***
	(0.039)	(0.037)
Amihud liquidity	0.792***	0.876***
	(0.093)	(0.097)
Equity market return	-0.946***	-0.354
	(0.296)	(0.285)
Money supply (M2)	2.070***	-0.608
	(0.437)	(0.424)
Consumer confidence	0.004	-0.006*
	(0.004)	(0.003)
Exchange rate	0.917*	0.485
	(0.509)	(0.492)
Credit spread	5.923	-26.925***
	(10.183)	(9.895)
Interest rate	5.162	-33.455***
	(12.085)	(11.661)
N	12,326	
Pseudo R	0.412	
LR chi	8934.670	

The sample period ranges from January 2000 until December 2017. I winsorize variables return volatility, tangibility and relative size are at the 1% level. Due to a wide distribution of outliers, I winsorize variables R&D intensity and Amihud liquidity at the 5% level. I delete observations when -100 < Z-score or Z-score >100. I report standard errors at firm and year level in parentheses. *, ** and *** indiciate significance levels at 10%, 5% and 1% respectively. See appendix A for a detailed description of varialbes not yet described.

Table 3

Multinomial logit model

Panel B: Marginal effects; convertibles, equity and straight debt

	(0) Convertible issue	(1) Seasoned equity offering	(2) Straight debt issue
Financial distress (Z-score)	-0.001	0.014***	-0.013***
	(0.001)	(0.001)	(0.001)
Return volatility	0.184***	0.074*	-0.258***
	(0.023)	(0.035)	(0.041)
NASDAQ listing	0.044***	-0.006	-0.038*
	(0.010)	(0.014)	(0.016)
Tangibility	-0.063***	-0.028*	0.090***
	(0.011)	(0.012)	(0.014)
R&D Dummy	0.080***	-0.099***	0.019
	(0.010)	(0.016)	(0.016)
R&D intensity	0.293***	0.682***	-0.974***
	(0.042)	(0.086)	(0.124)
Relative size	-0.095**	-1.395***	1.490***
	(0.035)	(0.062)	(0.057)
Dividend-paying	-0.084***	-0.149***	0.232***
	(0.011)	(0.014)	(0.015)
Institutional ownership	0.126	-0.209	0.083
	(0.101)	(0.160)	(0.178)
Firm size	-0.044***	-0.247***	0.291***
	(0.005)	(0.008)	(0.008)
Amihud liquidity	-0.110***	0.023	0.088***
	(0.012)	(0.012)	(0.015)
Equity market return	0.073*	-0.140**	0.067
	(0.035)	(0.049)	(0.055)
Money supply (M2)	-0.044	0.533***	-0.489***
	(0.052)	(0.073)	(0.081)
Consumer confidence	0.000	0.002**	-0.002**
	(0.000)	(0.001)	(0.001)
Exchange rate	-0.083	0.113	-0.030
	(0.059)	(0.084)	(0.095)
Credit spread	1.999	5.639***	-7.638***
	-1.182	-1.706	-1.936
Interest rate	2.584	6.547***	-9.131***
	-1.402	-1.988	-2.246
N	12,326		

The sample period ranges from January 2000 until December 2017. I winsorize variables return volatility, tangibility and relative size are at the 1% level. Due to a wide distribution of outliers, I winsorize variables R&D intensity and Amihud liquidity at the 5% level. I delete observations when -100 $<$ Z-score or Z-score $>$100. I report standard errors at firm and year level in parentheses. *, ** and *** indiciate significance levels at 10%, 5% and 1% respectively. See appendix A for a detailed description of varialbes not yet described.

tractive for hedge funds as it also stimulates their ability to acquire a short position. Brown et al. (2012), however, fail to find a significant relation between institutional ownership of shares and hedge fund involvement. Given findings by Brown et al. (2012) that a NASDAQ listing positively relates to hedge fund involvement, findings in table 3 suggest that firms issuing convertible bonds are more likely to be listed on the NASDAQ exchange and are more likely to be subject to hedge fund involvement.

As hedge funds need to acquire a short position to be able to implement their convertible arbitrage strategy, one would expect that they prefer firms that do not pay dividends. Obtaining a short position means hedge funds actually borrow an amount of shares, and since they borrow these shares they are required to pay the dividends on these shares to the initial owner of the stock. Logically, it is more attractive for hedge funds to exploit a convertible arbitrage strategy on securities from non-dividend paying firms. Brown et al. (2012) try to prove this motivation, however they actually find the opposite effect. In fact, firms paying dividend have a positive relation to hedge fund involvement when issuing convertible bonds. This paper shows a positive relation between dividend payments by firms and the probability of issuing straight debt, meaning if firms do not pay dividends they are more likely to issue convertibles rather than straight debt. This is however too weak to interpret as hedge fund involvement, and is rather supportive evidence of Stein (1992)'s backdoor-equity theory.

I find that as R&D expenditures rise, the probability that a firm decides to issue straight debt decreases. Because Brown et al. (2012) show that R&D expenditures positively relate to hedge fund involvement, I argue that findings in table 3 with respect to R&D expenditures are evidence for hedge fund involvement.

5.1.3 Marginal effects

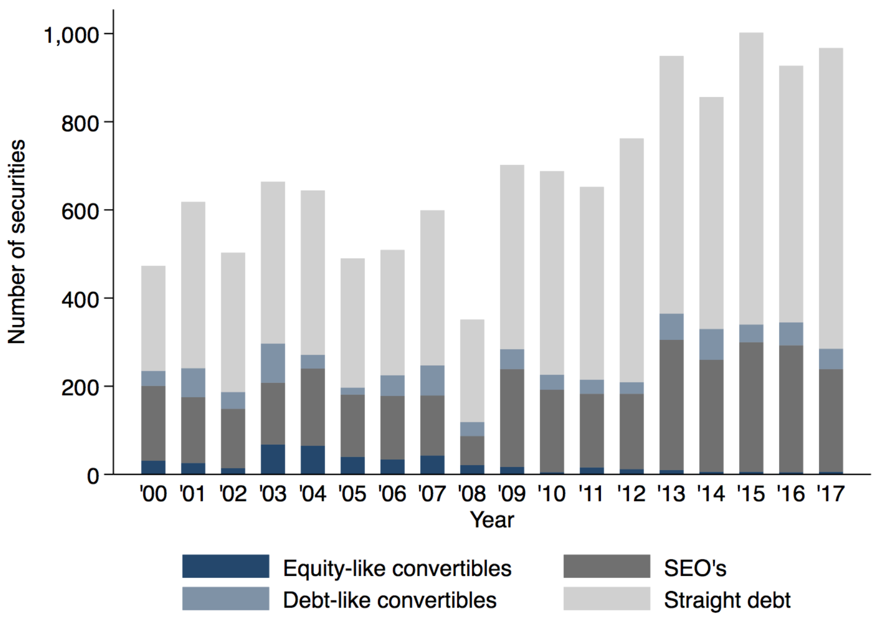
In order to assess the magnitude of changes in probabilities as a result of changes in the independent variables, I compute marginal effects of all independent variables. Note that as predicted probabilities of the model change as the independent variable changes, marginal effects presented panel B of table 3 are average marginal effects.

An increase of volatility by one unit, implies that on average a firm is 18.4% more likely to issue convertible debt. As the magnitude of this coefficient is large, I claim this is strong evidence of the risk-uncertainty theory by Brennan and Schwartz (1988). An increase of tangibility by one unit, means a firm is 6.3% less likely to issue convertible bonds, which is supportive evidence for the asymmetric information motivation by Stein (1992). In addition, significant positive coefficients for R&D Dummy and R&D intensity support the theory proposed by Stein (1992). Clearly, paying dividend has a strong marginal effect on securities issued, a firm which pays dividend is 29.1% more likely to issue straight debt, which is indicative of being a good firm and therefore supports the theory by Stein (1992). Several large and significant coefficients are indicative for hedge fund involvement. Large and significant coefficients for volatility, NASDAQ listing and relative size implies hedge funds play a prominent role in the convertibles market.

5.2 Developments over time

Following the multinomial model for the entire sample, this section assesses the security issues in a time-varying manner. Figure 2 shows the number of security issues since the year 2000. For a time-varying development of the sample in relative terms, see figure 5 in appendix E.

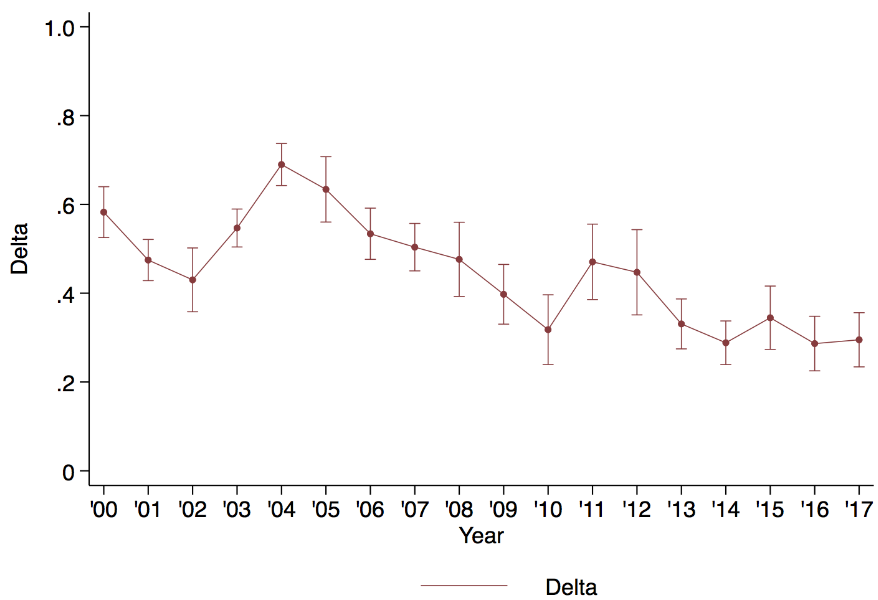
Figure 2: Number of securities issued per year



Over time, the total number of security issues shows an upward trend since 2005. After a sharp decline in 2008, which is not surprising due to the global financial crisis, in the year 2017, US firms together reached a total of 967 security issues. More clearly is the upward trend in funding acquired over the years through securities issued, shown in figure 1. Again, since 2005, total funding raised shows an upward trend, and although 2008 clearly shows less security issuances, this is not clearly reflected in a sharp decline of funding acquired in this year. In total, in 2017 US firms acquired a total of $860 billion through funding of seasoned equity offerings, convertible bond offerings and straight debt issues combined. It is however remarkable, that the rise of total securities issued is not accompanied with a rise in the number of convertible bonds issued. Specifically, convertible bonds with high Deltas, and thus equity-like convertible bonds seem to have become less popular. Related to this, is the the fact that I find no upward trend in amount of funding raised through convertible bonds over time.

Figure 3 shows the distribution of Deltas of convertible securities over time, as expected by the findings in figures 1 and 2, the average Delta of convertibles issued over time shows a downward trend.

Figure 3: Distribution of Delta per year



Robbins and Schatzberg (1986) argue that non-callable debt with short maturities can function as a substitute for callable debt with long maturities if the short-term debt matures after a resolution of information asymmetry. When plotting average maturities for convertibles issued per year, I do indeed find a downward trend over time, whereas straight debt issues do not show a downward trend in maturity. Additionally, I plot average conversion premiums per year, no upward or downward trend is found. Most likely decreasing Deltas are due to a decrease in maturity of convertibles issued. This means more recently more debt-like convertibles with shorter maturities are issued. Plotted maturities and conversion premiums are shown in figures 8 and 9 of appendix E respectively.

5.2.1 Subperiods

Table 4 shows descriptive statistics for each convertible placement per subperiod, together with an F-statistic computed by an ANOVA test. Issue patterns per subperiod are shown in figure 10 of appendix E and table 18 of appendix F.

Table 4
Issue and issuer characteristics over time; convertible bonds

	All issues	Issue period 2000-2005	2006-2011	2012-2017	Diff. of means F-statistic
Continuous variables					
Financial distress (Z-score)	3.532	4.134	3.216	2.979	4.540**
Return volatility	0.607	0.611	0.62	0.586	2.110
Firm size	4,915	4,981	4,835	4,908	0.020
Tangibility	0.458	0.452	0.466	0.467	0.110
R&D intensity	0.225	0.273	0.134	0.253	9.440***
Institutional ownership	0.624	0.626	0.622	0.623	0.890
Relative size	0.193	0.171	0.227	0.186	7.180***
Amihud liquidity	0.167	0.184	0.182	0.124	1.900
Issue characteristics					
Delta	0.468	0.563	0.467	0.323	84.890***
Maturity	10.533	13.375	10.038	6.767	73.390***
Conversion premium	1.353	1.327	1.339	1.413	1.260
Dummy variables					
NASDAQ listing	0.505	0.463	0.472	0.608	9.930***
R&D expenses	0.652	0.641	0.602	0.729	6.800***
Dividend paying	0.189	0.214	0.193	0.147	3.010**
N	1.251	518	394	339	

The sample period is divided into three periods of six year each. Issues belong to the first period if the security was issued in the years 2000 up to and including 2005, the second period if issued in the years 2006 up to and including 2011 etc. See appendix B for a description of Delta, see appendix A for a detailed description of issuer characteristics. Reported difference in means F-statistics do not assume equal variances among the three subperiods. Several firms issue in multiple of the three subperiods, making the subperiods not completely independent, see table 18 in appendix F.

I find significant differences in average Delta per subperiod presented by an F-statistic of 84.89. By considering the average level of Delta per subperiod, I can conclude Deltas of securities issued over time have decreased. In addition to a decreasing Delta, I find that over time convertible issuers are listed on the NASDAQ exchange more frequently, increase their R&D expenses, conduct R&D spendings more frequently, and pay dividend less often. Important are findings in table 4 that suggest Z-scores of firms issuing convertibles have decreased over time, making them more likely to reach financial distress. Brown et al. (2012) find that hedge fund purchases of convertible bonds is positively related to the Altman Z-score, volatility of stock returns and a listing on the NASDAQ exchange. Findings by Brown et al. (2012) together with findings in table 4 suggest hedge funds are becoming more actively engaged in convertible bond purchases, and act as an investor of last resort as argued by Brophy et al. (2009). In the timespan of the last subperiod of table 4, 2012-2017, $111 billion was raised through convertible bonds[9]. Given the development of deteriorating firm quality, increasing hedge fund involvement and the size of the convertible bond market, these findings could be worrying. If hedge fund actively acquire short positions in inferior companies, this means hedge funds later sell stocks to investors, and thus other investors could pay the price for this as they typically are holding stocks from firms with inferior financial health. However, this is not necessarily a bad thing, as owners of risky stocks are generally rewarded by higher returns (Fama and French, 1993). Descriptive statistics for seasoned equity offerings and straight debt issues, per subperiod, can be found in tables 16 and 17 respectively, of appendix F.

Results in table 5 show that, over time, the risk-uncertainty theory by Brennan and Schwartz (1988) remains relevant, volatility negatively relates to the probability of issuing equity or straight debt throughout the entire sample. At the beginning and end of the sample, a NASDAQ listing negatively relates to the probability of issuing equity or straight debt, meaning hedge funds play an active role in the issuance of convertible debt. In the middle of the sample, this effect however, loses its significance. Over time the effect of tangibility remains the same. I find no time varying developments in the choice of securities issued with respect to R&D expenses and the magnitude of R&D expenses. In addition, effects of relative size, dividend, size and liquidity remain similar across the entire timespan of the sample.

From 2000 till 2011 institutional ownership does not have a significant influence on the choice of securities. However, from 2012-2017 institutional ownership negatively relates to the probability of issuing equity. Brown et al. (2012), however, fail to find evidence that institutional ownership relates to hedge fund involvement, meaning this development over time cannot be interpreted as hedge funds becoming more actively involved in the convertibles market over time.

Given that the effect of most independent variables remains similar across all subperiods, I do not find a clear shift from traditional rationales for issuing convertibles towards hedge fund involvement at the end of the sample. This is not surprising, since Grundy and Verwijmeren (2018) argue that traditional rationales for issuing convertible debt are persistent. In their paper, Grundy and Verwijmeren (2018) argue that in the backdoor-equity theory by Stein (1992), a call provision on a convertible bond is essential, as it enables a firm to convert the bond into equity after an increase of the share price. In addition, in the sequential-financing theory proposed by Mayers (1998), convertible bonds need to have a call provision, as this allows firms to convert and thereby reduce leverage if an investment is valuable.

Over time, however, call provisions have decreased in popularity. Based on this reduction of call provisions on convertible debt, one could say traditional rationales for issuing convertible debt have become less important over time. However, Grundy and Verwijmeren (2018) argue that a convertible bond with a short maturity but without a call provision, can function as a replacement

[9]This statistic is based on the sample of this thesis, and thus excludes financials and utility companies

Table 5
Multinomial
logit model

The choice between convertibles, equity and straight debt

	2000-2005		2006-2011		2012-2017	
	(1)	(2)	(1)	(2)	(1)	(2)
Constant	-61.906*	-54.782*	40.237	5.450	5.170	69.943***
	(33.286)	(30.791)	(36.506)	(34.228)	(22.023)	(22.375)
(Z-score)	0.083***	-0.041***	0.053***	-0.043***	0.041***	0.003
	(0.011)	(0.013)	(0.011)	(0.014)	(0.009)	(0.011)
Return volatility	-0.813***	-2.318***	-0.553	-2.766***	-2.410***	-0.763*
	(0.299)	(0.319)	(0.355)	(0.391)	(0.387)	(0.393)
NASDAQ listing	-0.345**	-0.481***	-0.176	-0.236	-0.439***	-0.460***
	(0.141)	(0.142)	(0.149)	(0.149)	(0.149)	(0.150)
Tangibility	0.506***	0.791***	0.704***	0.635***	0.039	0.371***
	(0.170)	(0.160)	(0.183)	(0.179)	(0.145)	(0.143)
R&D Dummy	-0.847***	-0.377***	-0.447***	-0.331**	-1.267***	-0.842***
	(0.134)	(0.137)	(0.154)	(0.153)	(0.163)	(0.168)
R&D intensity	0.318***	-6.130***	0.611***	-2.980***	0.435***	-3.502***
	(0.079)	(1.113)	(0.173)	(0.867)	(0.090)	(0.702)
Relative size	-2.952***	3.597***	-4.320***	2.989***	-5.361***	3.426***
	(0.499)	(0.446)	(0.504)	(0.391)	(0.561)	(0.507)
Dividend-paying	0.003	0.499***	0.253	0.863***	0.045	1.557***
	(0.167)	(0.147)	(0.190)	(0.168)	(0.196)	(0.183)
Inst. ownership	-1.873	-1.745	0.400	0.326	-3.370**	-0.884
	(1.348)	(1.369)	(2.031)	(1.951)	(1.595)	(1.477)
Firm size	-0.602***	0.563***	-0.610***	0.822***	-0.549***	1.024***
	(0.070)	(0.062)	(0.075)	(0.069)	(0.070)	(0.069)
Amihud liquidity	0.367***	0.512***	0.618***	0.675***	1.589***	1.373***
	(0.130)	(0.127)	(0.158)	(0.167)	(0.237)	(0.254)
Equity	-0.821	-0.791	0.537	0.923*	-1.049	0.466
	(0.740)	(0.696)	(0.540)	(0.498)	(0.813)	(0.828)
Money supply (M2)	8.015**	4.904	-2.439	-1.793	1.093	-9.446***
	(3.438)	(3.171)	(3.686)	(3.464)	(2.390)	(2.434)
Cons. confidence	8.015**	4.904	-0.003	-0.011	0.002	0.022*
	(3.438)	(3.171)	(0.009)	(0.008)	(0.012)	(0.013)
Exchange rate	0.024***	0.014**	0.079	0.700	-0.009	2.555
	(0.007)	(0.007)	(2.363)	(2.190)	(2.080)	(2.125)
Credit spread	1.493	0.250	-33.311	-58.278***	51.413	-114.856*
	(1.395)	(1.332)	(22.842)	(21.734)	(59.442)	(60.398)
Interest rate	22.888	0.166	-95.663*	-91.364*	35.215	-134.645**
	(46.092)	(41.810)	(54.192)	(51.236)	(57.597)	(57.521)

(1) = Seasoned Equity Offering, (2) = Straight Debt Issue. The sample period ranges from January 2000 until December 2017. I winsorize variables return volatility, tangibility and relative size are at the 1% level. Due to a wide distribution of outliers, I winsorize variables R&D intensity and Amihud liquidity at the 5% level. I delete observations when -100 < Z-score or Z-score >100. I report standard errors at firm and year level in parentheses. *, ** and *** indiciate significance levels at 10%, 5% and 1% respectively. Marginal effects for each subperiod can be found in tables 12, 13 and 14 of appendix D. See appendix A for a detailed description of varialbes not yet described.

for a convertible bond with a long maturity and a call provision. And thus, Grundy and Verwijmeren (2018) argue that the traditional rationales for issuing convertible bonds have not necessarily decreased in importance.

Findings in figure 8 of appendix E show a decrease in the maturity of convertible bonds, in addition, table 5 shows that the influence of several firm characteristics on the choice of securities issued remains present over time. Therefore, my findings over time, to some extent, support the argumentation provided by Grundy and Verwijmeren (2018).

6 Differences in convertible bond issues

This section discusses the results from an additional analysis, whereby convertible bonds are classified according to their Delta, and according to a private or public placement of the securities. Section 6.1 discusses the computation and intuition of a convertible bond's Delta. Section 6.2 discusses results and implications for both multinomial logit models. I expect to find stronger evidence in favour of the backdoor-equity theory by Stein (1992) for equity-like convertibles, because these securities are more likely to convert quickly. Also, I expect to find stronger indications of hedge fund involvement for private convertible bond placements.

6.1 Delta

Since convertible bonds can be customized in many ways, a wide variation amongst characteristics of convertible bonds is present. A common way of classifying convertible securities is through it's Delta. The Delta of a convertible bond indicates how "equity-like" a convertible security is, and therefore it is a good measure of the probability that the bond will be converted into common equity. Technically, a security's Delta indicates it's dollar sensitivity resulting from changes in the underlying stock (Brown et al., 2012), and it is computed as following:

$$Delta = e^{-\delta T} N \left\{ \frac{\ln\left(\frac{S}{X}\right) + \left(r - \delta + \frac{\sigma^2}{2}\right) T}{\sigma\sqrt{T}} \right\} \tag{8}$$

Brown et al. (2012) compute the Delta by obtaining the stock price five days prior to issuance and divide this by the conversion price. I however choose to divide one over one plus the issue premium. Intuitively, convertibles with low conversion premiums, low volatility and short maturities typically have lower Deltas and therefore behave more like bonds. Variables implemented in the computation of the Delta are described in appendix A.

6.2 Rule 144A

In the year 1990, the so called Rule 144A was introduced by the Securities and Exchange Commission (SEC). Under this rule, firms are allowed to sell their securities to institutional investors without the issue being registered with the SEC. Subsequently, the securities issued under Rule 144A can only be traded between institutional investors. The motivation to introduce Rule 144A was based on the belief that institutional investors are more sophisticated investors and therefore they do not need the SEC to inspect each offering extensively before purchase. Public issues are however required to be registered with the SEC. This is because these securities are typically also sold to individual investors, which are generally believed to be less skilled and might therefore benefit from SEC inspections into securities (Livingston and Zhou, 2002). For this thesis I consider convertible bonds issued under Rule 144A, as a private convertible bond placement.

6.3 Classification of convertibles

As shown in table 1, I find that only 34% of the convertibles issued in the sample are equity-like convertibles. This implies that most convertibles which have recently been issued have low Deltas, and therefore they can be considered to function more like a straight debt security rather than a common share. In such a form, the security acts as an instrument to reduce overinvestment by firms, and therefore, these findings support the sequential-financing theory by Mayers (1998). Logically, my findings of few equity-like convertibles is evidence against the backdoor-equity theory by Stein (1992).

Results in table 6 show that firms with high volatility are more likely to issue convertible bonds with high Deltas. This implies that firms with volatile stock price patterns prefer to issue convertibles which will convert into equity quickly. Considering the motivation proposed by Stein (1992), results in table 6 seem supportive for this backdoor-equity theory.

Finally, a firm which pays dividends is more likely to issue a debt-like convertible bond than an equity-like convertible bond. Financially healthy firms are more likely to pay dividends, and if they choose to issue convertibles they issue the security in such a way that it is debt-like. Therefore to some extend, findings in table 6 support Stein (1992)'s backdoor-equity theory. However, because I find positive and significant coefficients for all outcomes related to dividends, this evidence cannot be considered to be strong evidence in favour of Stein (1992)'s theory. Surprisingly, Brown et al. (2012), find that dividend payments positively relate to hedge fund involvement. And thus, findings in table 6 suggest that hedge funds prefer investing in debt-like convertible bonds.

Given the findings by Brown et al. (2012), that a NASDAQ listing positively relates to hedge fund involvement and firm size negatively corresponds to hedge fund involvement, findings in table 7 suggest that public convertible bond issuers are subject to less hedge fund involvement than privately placed convertible securities.

Table 6

Multinomial logit model

Panel A: the choice between debt, equity, debt-like convertibles and equity-like convertibles

	(1) Seasoned equity offering	(2) Debt-like convertible offering	(3) Straight debt issue
Constant	-52.381***	-65.887***	-56.015***
	(7.026)	(7.754)	(7.027)
Financial distress (Z-score)	0.061***	0.010	-0.012
	(0.008)	(0.010)	(0.009)
Return volatility	-2.700***	-2.868***	-3.436***
	(0.263)	(0.303)	(0.271)
NASDAQ listing	-0.254**	0.078	-0.302**
	(0.125)	(0.137)	(0.126)
Tangibility	0.488***	0.275	0.745***
	(0.159)	(0.176)	(0.158)
R&D Dummy	-1.008***	-0.219	-0.638***
	(0.136)	(0.149)	(0.137)
R&D intensity	0.430***	0.066	-3.685***
	(0.083)	(0.099)	(0.471)
Relative size	-4.294***	-0.412	3.088***
	(0.393)	(0.404)	(0.358)
Dividend-paying	0.679***	0.757***	1.617***
	(0.211)	(0.222)	(0.206)
Institutional ownership	-0.174	1.842	0.707
	(1.346)	(1.426)	(1.340)
Firm size	-0.636***	-0.153**	0.720***
	(0.064)	(0.068)	(0.062)
Amihud liquidity	1.051***	0.371*	1.138***
	(0.172)	(0.191)	(0.173)
Equity market return	-0.583	0.469	0.019
	(0.455)	(0.502)	(0.453)
Money supply (M2)	6.994***	6.929***	4.418***
	(0.699)	(0.769)	(0.698)
Consumer confidence	-0.005	-0.017***	-0.015***
	(0.006)	(0.006)	(0.006)
Exchange rate	5.286***	6.119***	4.933***
	(0.819)	(0.893)	(0.819)
Credit spread	21.876	21.825	-10.389
	(15.895)	(17.381)	(15.903)
Interest rate	80.235***	112.614***	43.780**
	(18.727)	(20.732)	(18.715)
N	12,326	LR chi^2	9293.46
Pseudo R^2	0.399		

The sample period ranges from January 2000 until December 2017. I winsorize variables return volatility, tangibility and relative size are at the 1% level. Due to a wide distribution of outliers, I winsorize variables R&D intensity and Amihud liquidity at the 5% level. I delete observations when -100 < Z-score or Z-score >100. I report standard errors at firm and year level in parentheses. *, ** and *** indiciate significance levels at 10%, 5% and 1% respectively. See appendix A for a detailed description of varialbes not yet described.

Table 7

Multinomial logit model

Panel A: the choice between debt, equity, privately placed convertibles and publicly placed convertibles

	(1) Seasoned equity offering	(2) Public convertible offering	(3) Straight debt issue
Constant	-19.956***	-45.844***	-23.120***
	(5.049)	(7.771)	(4.969)
Financial distress (Z-score)	0.058***	0.011	-0.015**
	(0.006)	(0.009)	(0.007)
Return volatility	-0.788***	0.471	-1.501***
	(0.214)	(0.296)	(0.225)
NASDAQ listing	-0.395***	-0.318**	-0.448***
	(0.094)	(0.136)	(0.094)
Tangibility	0.558***	0.582***	0.816***
	(0.117)	(0.155)	(0.115)
R&D Dummy	-0.978***	-0.357**	-0.613***
	(0.097)	(0.140)	(0.098)
R&D intensity	0.374***	-0.086	-3.690***
	(0.058)	(0.119)	(0.465)
Relative size	-3.770***	0.761**	3.636***
	(0.333)	(0.386)	(0.302)
Dividend-paying	0.060	0.066	1.002***
	(0.119)	(0.172)	(0.111)
Institutional ownership	-1.340	0.460	-0.498
	(0.987)	(1.404)	(0.960)
Firm size	-0.472***	0.195***	0.888***
	(0.045)	(0.062)	(0.044)
Amihud liquidity	1.061***	0.631***	1.150***
	(0.131)	(0.167)	(0.134)
Equity market return	-1.003***	-0.305	-0.422
	(0.359)	(0.472)	(0.353)
Money supply (M2)	3.313***	3.907***	0.684
	(0.496)	(0.767)	(0.489)
Consumer confidence	0.007*	0.007	-0.002
	(0.004)	(0.006)	(0.004)
Exchange rate	0.050	-1.716**	-0.406
	(0.602)	(0.841)	(0.593)
Credit spread	43.681***	91.304***	11.890
	(12.654)	(16.375)	(12.508)
Interest rate	38.426***	98.701***	1.000
	(13.944)	(20.857)	(13.702)
N	12,326	LR chi^2	9081.440
Pseudo R^2	0.391		

The sample period ranges from January 2000 until December 2017. I winsorize variables return volatility, tangibility and relative size are at the 1% level. Due to a wide distribution of outliers, I winsorize variables R&D intensity and Amihud liquidity at the 5% level. I delete observations when -100 < Z-score or Z-score >100. I report standard errors at firm and year level in parentheses. *, ** and *** indiciate significance levels at 10%, 5% and 1% respectively. See appendix A for a detailed description of varialbes not yet described.

This is not particularly surprising as Grundy and Verwijmeren (2018) report that the average percentage of privately placed convertibles purchased by hedge funds increases from 60% in 2000 to 85% in 2008. Significant and positive coefficients for all three outcomes with respect to the Amihud liquidity score, implies firms with liquid stocks are more likely to issue convertible debt privately, which are attractive investment opportunities for hedge funds.

Marginal effects of the independent variables implemented in the multinomial models in tables 6 and 7 can be found in tables 10 and 11 of appendix D. For a graphical representation of the development of equity-like issues, debt-like issues, private placements and public placements, over time, see figures 6 and 7 in appendix E.

7 Conclusion and limitations

My findings show that firms issuing convertible bonds are subject to multiple of the traditional rationales for issuing convertible bonds. Findings that most convertibles issued are debt-like, supports Mayers (1998)'s sequential-financing theory. Moreover, as Stein (1992) expects firms to issue convertibles when information asymmetry is present, it is expected that convertibles are issued with high Deltas. However, results show that the majority of convertible bonds issued have low Deltas.

I find that firms issuing convertible bonds are subject to the risk-uncertainty theory proposed by Brennan and Schwartz (1988). Firms with more volatile stock price patterns are more likely to issue equity-like convertibles, moreover, significant issuer characteristic differences between privately placed convertibles and publicly placed convertibles are present. Private convertible placements show more characteristics of attractiveness for hedge funds to invest.

Although I find some evidence indicating that hedge funds play an active role in the recent convertible bond market, to explicitly assess the role of hedge funds, each buyer of a convertible bond should be identified, and thus for each issue the hedge fund activity should be documented. Only when this is done, significant conclusions can be drawn. Markets change quickly and the convertibles market is smaller both in terms of securities issued and funding raised, than previous decade. Simply taking findings by previous literature as indicators of hedge fund involvement is no longer robust, and although the findings in this paper are indicative of hedge fund involvement, I argue the setup of this paper is only able to provide an indication of hedge fund involvement, rather than hard evidence.

Over time the Delta of convertibles has decreased. I argue this is mainly caused by decreasing maturities of convertibles issued. I find that over time firms issuing convertible bonds are more likely to reach into financial distress. Furthermore, evidence shows that over time firms issuing convertibles are more frequently listed on the NASDAQ exchange and conduct R&D expenses more often. These findings are consistent with convertible bonds being a suitable investment security when firms are more risky, as suggested by Brennan and

Schwartz (1988). Also, a higher propensity to be listed on the NASDAQ by convertible issuers is weak evidence supporting active hedge fund involvement in the convertibles market. Over time no shift from traditional rationales for issuing convertibles to hedge fund involvement is found.

Future research could identify each buyer of convertible bonds both in private and public placements, as performed in the analysis by Brown et al. (2012). Only when this data finds hedge funds still play an active role in the convertibles market, together with my time varying findings, strong conclusions can be drawn. In addition to academia, regulators should come up with regulation on how to prevent exploitation of the convertibles market. This is however beyond the scope of this paper.

Additionally, future research can incorporate behavioral factors such as an anchoring effect and CEO overconfidence. Baker et al. (2012) document that a recent peak in stock prices influence a bidder's offer price and the probability of success of deal, based on a sample of M&A transactions. Relevant is to document whether convertible bond issues and security design are influenced by current stock price with respect to the previous 52-week high of the respective firm's stock. In addition, Malmendier and Tate (2005) find that investments made by overconfident CEO's are more sensitive to cash flows. As overconfident CEO's overestimate future performance of firms, interesting is to assess whether overconfident CEO's are more likely to issue convertible bonds.

Appendix

Appendix A: Issuer variable descriptions

Altman Z-score, an estimate of the firm's probability of bankruptcy, computed as:

$$Z - score = 1.2\left(\frac{WC}{TA}\right) + 1.4\left(\frac{RE}{TA}\right) + 3.3\left(\frac{EBIT}{TA}\right) + 0.6\left(\frac{ME}{BL}\right) + \left(\frac{S}{TA}\right)$$

WC = Working Capital, TA = Total Assets, RE = Retained Earnings, ME = Market value of Equity, BL = Book Value of Liabilities and S = Sales.

Amihud liquidity, computed as the monthly average of absolute returns relative to monthly dollar trading volume in the year prior to the offering.

Credit spread, spread between Moody's Baa corporate bond yield and yield on ten-year Treasury bond

Consumer confidence, Consumer Confidence Index in the year of offering, obtained from Datastream.

Dividend-paying, if Compustat DVC > 0 at the end of year before issue

Equity market return, one year stock return on S&P 500

Exchange rate, €/$ exchange rate at the beginning of the month of offering

Firm size, the market value of equity, measured as price multiplied by shares outstanding at the fiscal year of offering. In the multinomial logit model, natural logarithm of size is implemented.

Institutional ownership, level of institutional ownership from Thomson-Reuters divided by total shares outstanding

Interest rate, yield on ten-year US Treasury bond

Money supply (M2), money supply measured as M2 in the year of offering, obtained from Datastream

NASDAQ listing, if a firm is listed on the NASDAQ exchange

R&D Dummy, if a firm conducts R&D expenditures

R&D intensity, magnitude of R&D expenses

Relative size, ratio of issue size to market value of equity

Return volatility, annualized standard deviation of monthly stock returns, with a maximum of ten years prior to offering.

Tangibility, ratio of tangible assets over total assets at the end of the year before the issue date

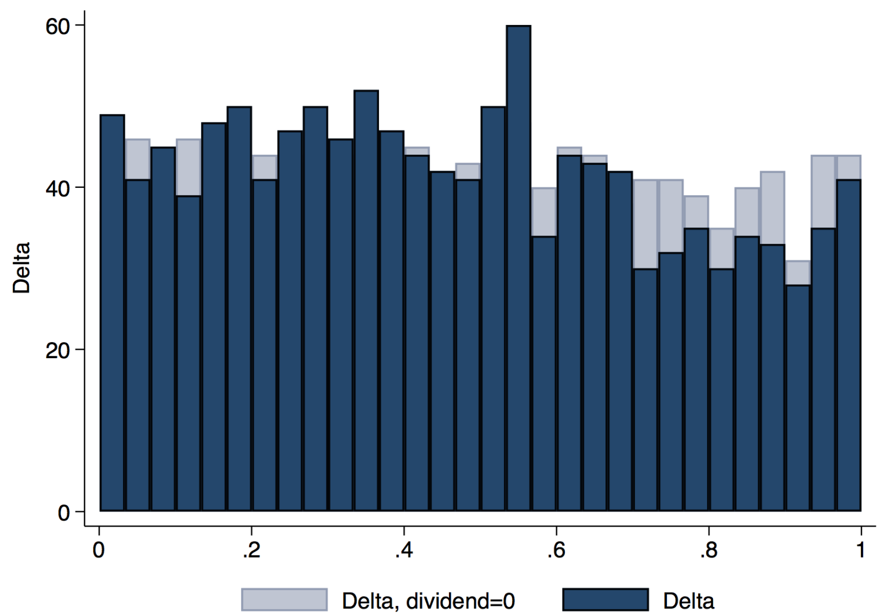
Appendix B : Determinants of Delta

To classify the convertible bonds in the sample I divide the securities in subsamples according to the Delta, computed as follows:

$$Delta = e^{-\delta T} N \left\{ \frac{\ln\left(\frac{S}{X}\right) + \left(r - \delta + \frac{\sigma^2}{2}\right) T}{\sigma\sqrt{T}} \right\}$$

In the formula above, N is the cumulative probability given a standard normal distribution, I compute $ln\left(\frac{S}{X}\right)$ as the natural logarithm of 1 divided by 1 plus the conversion premium. r is the risk free rate, in this means the yield on a ten-year U.S. Treasury bond, δ is the continuously compounded dividend yield, σ is the annualized stock return volatility estimated from ten years of monthly stock data, T is the maturity of the convertible at its issue date.

Figure 4: Alternative Delta



Appendix C: Pre estimation analysis

Table 8

Hausman tests of Independence of irrelevant alternatives

Security type issued	chi^2	df	$P > chi^2$
Equity-like convertible	-2.436	18	-
Seasoned equity offering	3.558	24	1.000
Debt-like convertible	20.107	17	0.269
Straight debt issue	-5940.378	18	-

H0: Odds(Outcome-J vs Outcome-K) are independent of other alternatives

Table 9

Hausman tests of Independence of irrelevant alternatives

Security type issued	chi^2	df	$P > chi^2$
Private convertible	-2.436	19	-
Seasoned equity offering	3.558	24	0.797
Public convertible	20.107	16	0.787
Straight debt issue	-5940.378	17	-

H0: Odds(Outcome-J vs Outcome-K) are independent of other alternatives

Appendix D: Marginal effects

Table 10

Multinomial logit model

Marginal effects; between debt, equity, debt-like convertibles, and equity-like convertibles

	Equity-like convertible	Seasoned equity offering	Debt-like convertible	Straight debt
Financial distress (Z-score)	-0.000	0.015***	-0.000	-0.014***
	(0.000)	(0.001)	(0.001)	(0.001)
Return volatility	0.059***	0.114**	0.026	-0.199***
	(0.009)	(0.036)	(0.024)	(0.042)
NASDAQ listing	0.005	-0.007	0.041***	-0.038*
	(0.002)	(0.014)	(0.010)	(0.016)
Tangibility	-0.011***	-0.032**	-0.040***	0.083***
	(0.003)	(0.012)	(0.011)	(0.014)
R&D Dummy	0.013***	-0.098***	0.058***	0.027
	(0.003)	(0.016)	(0.009)	(0.016)
R&D intensity	0.036***	0.708***	0.244***	-0.988***
	(0.007)	(0.089)	(0.036)	(0.126)
Relative size	-0.007	-1.413***	-0.094**	1.514***
	(0.007)	(0.063)	(0.033)	(0.059)
Dividend-paying	-0.023***	-0.153***	-0.053***	0.230***
	(0.004)	(0.014)	(0.010)	(0.015)
Institutional ownership	-0.011	-0.226	0.159	0.078
	(0.024)	(0.163)	(0.095)	(0.179)
Firm size	-0.004**	-0.250***	-0.042***	0.296***
	(0.001)	(0.008)	(0.004)	(0.008)
Amihud liquidity	-0.019***	0.017	-0.078***	0.079***
	(0.003)	(0.012)	(0.011)	(0.015)
Equity market return	0.002	-0.144**	0.072*	0.070
	(0.008)	(0.050)	(0.034)	(0.055)
Money supply (M2)	-0.104***	0.476***	0.187***	-0.559***
	(0.017)	(0.074)	(0.051)	(0.082)
Consumer confidence	0.000*	0.002***	-0.001	-0.002*
	(0.000)	(0.001)	(0.000)	(0.001)
Exchange rate	-0.098***	0.059	0.128*	-0.089
	(0.018)	(0.085)	(0.057)	(0.095)
Credit spread	-0.070	5.552**	2.263*	-7.746***
	(0.287)	-1.742	-1.132	-1.947
Interest rate	-1.202**	5.367**	6.228***	-10.393***
	(0.377)	-2.032	-1.400	-2.267
N	12,326			

Table 11

Multinomial logit model

Marginal effects; between debt, equity privately placed convertibles and publicly placed convertibles

	Private convertible	Seasoned Equity offering	Public convertible	Straight debt
Financial distress (Z-score)	-0.001	0.014***	0.000	-0.014***
	(0.001)	(0.001)	(0.000)	(0.001)
Return volatility	0.088***	0.075*	0.092***	-0.256***
	(0.016)	(0.036)	(0.015)	(0.041)
NASDAQ listing	0.035***	-0.004	0.004	-0.035*
	(0.008)	(0.014)	(0.007)	(0.016)
Tangibility	-0.056***	-0.029*	-0.004	0.089***
	(0.009)	(0.012)	(0.007)	(0.014)
R&D Dummy	0.056***	-0.097***	0.018**	0.023
	(0.008)	(0.016)	(0.007)	(0.016)
R&D intensity	0.165***	0.694***	0.113***	-0.971***
	(0.025)	(0.088)	(0.019)	(0.125)
Relative size	-0.078***	-1.412***	-0.010	1.500***
	(0.024)	(0.063)	(0.020)	(0.058)
Dividend-paying	-0.048***	-0.152***	-0.031***	0.231***
	(0.008)	(0.014)	(0.008)	(0.015)
Institutional ownership	0.055	-0.208	0.068	0.084
	(0.069)	(0.161)	(0.071)	(0.178)
Firm size	-0.031***	-0.251***	-0.010***	0.292***
	(0.003)	(0.009)	(0.003)	(0.008)
Amihud liquidity	-0.085***	0.020	-0.022***	0.086***
	(0.010)	(0.012)	(0.006)	(0.015)
Equity market return	0.047	-0.135**	0.015	0.073
	(0.026)	(0.049)	(0.021)	(0.055)
Money supply (M2)	-0.138***	0.511***	0.140***	-0.514***
	(0.038)	(0.074)	(0.039)	(0.082)
Consumer confidence	-0.000	0.002**	0.000	-0.002**
	(0.000)	(0.001)	(0.000)	(0.001)
Exchange rate	0.027	0.110	-0.086*	-0.051
	(0.043)	(0.085)	(0.040)	(0.095)
Credit spread	-2.156*	5.534**	4.032***	-7.411***
	(0.941)	-1.725	(0.765)	-1.942
Interest rate	-1.546	6.104**	4.921***	-9.478***
	-1.017	-2.010	-1.050	-2.256
N	12,326			

Table 12

2000-2005, marginal effects

	(0) Convertible offering	(1) Seasoned equity offering	(2) Straight debt issue
Financial distress (Z-score)	-0.004	0.025***	-0.021***
	(0.002)	(0.002)	(0.003)
Return volatility	0.296***	0.138*	-0.434***
	(0.051)	(0.064)	(0.069)
NASDAQ listing	0.081**	-0.015	-0.066*
	(0.025)	(0.027)	(0.027)
Tangibility	-0.122***	0.006	0.116***
	(0.028)	(0.029)	(0.027)
R&D Dummy	0.114***	-0.142***	0.028
	(0.022)	(0.028)	(0.026)
R&D intensity	0.559***	0.937***	-1.496***
	(0.084)	(0.126)	(0.199)
Relative size	-0.076	-1.192***	1.267***
	(0.090)	(0.090)	(0.104)
Dividend-paying	-0.048	-0.070*	0.118***
	(0.026)	(0.028)	(0.026)
Institutional ownership	0.338	-0.189	-0.149
	(0.222)	(0.270)	(0.277)
Firm size	0.001	-0.219***	0.218***
	(0.014)	(0.013)	(0.014)
Amihud liquidity	-0.083***	0.013	0.070***
	(0.022)	(0.021)	(0.020)
Equity market return	0.151	-0.079	-0.072
	(0.120)	(0.138)	(0.132)
Money supply (M2)	-1.201*	1.169	0.032
	(0.558)	(0.650)	(0.608)
Consumer confidence	-0.004**	0.004*	0.000
	(0.001)	(0.001)	(0.001)
Exchange rate	-0.160	0.311	-0.151
	(0.231)	(0.251)	(0.244)
Credit spread	-2.103	5.287	-3.184
	-7.338	-8.630	-8.014
Interest rate	-8.975	11.498	-2.523
	-8.810	-9.953	-9.472
N	3,393		

Table 13

2006-2011, marginal effects

	(0) Convertible offering	(1) Seasoned equity offering	(2) Straight debt issue
Financial distress (Z-score)	0.002	0.016***	-0.018***
	(0.002)	(0.002)	(0.003)
Return volatility	0.280***	0.300***	-0.580***
	(0.047)	(0.061)	(0.080)
NASDAQ listing	0.029	0.002	-0.031
	(0.018)	(0.024)	(0.030)
Tangibility	-0.086***	0.036	0.050
	(0.023)	(0.025)	(0.030)
R&D Dummy	0.047**	-0.033	-0.014
	(0.017)	(0.025)	(0.030)
R&D intensity	0.257**	0.542***	-0.799***
	(0.091)	(0.151)	(0.234)
Relative size	-0.121*	-1.217***	1.338***
	(0.053)	(0.109)	(0.102)
Dividend-paying	-0.090***	-0.078**	0.167***
	(0.021)	(0.025)	(0.029)
Institutional ownership	-0.045	0.026	0.020
	(0.233)	(0.316)	(0.388)
Firm size	-0.055***	-0.230***	0.284***
	(0.008)	(0.017)	(0.018)
Amihud liquidity	-0.086***	0.015	0.072*
	(0.020)	(0.021)	(0.028)
Equity market return	-0.107	-0.036	0.143
	(0.061)	(0.082)	(0.098)
Money supply (M2)	0.258	-0.183	-0.075
	(0.424)	(0.540)	(0.657)
Consumer confidence	0.001	0.001	-0.002
	(0.001)	(0.001)	(0.002)
Exchange rate	-0.069	-0.087	0.156
	(0.268)	(0.345)	(0.416)
Credit spread	6.704*	2.382	-9.086*
	-2.684	-3.335	-4.110
Interest rate	12.114	-4.152	-7.961
	-6.368	-7.959	-9.727
N	3,499		

Table 14
2012-2017, marginal effects

	(0) Convertible offering	(1) Seasoned equity offering	(2) Straight debt issue
Financial distress (Z-score)	-0.001	0.008***	-0.007***
	(0.001)	(0.002)	(0.002)
Return volatility	0.108**	-0.375***	0.267***
	(0.034)	(0.080)	(0.079)
NASDAQ listing	0.039**	-0.009	-0.030
	(0.013)	(0.024)	(0.026)
Tangibility	-0.021	-0.061***	0.082***
	(0.011)	(0.018)	(0.020)
R&D Dummy	0.078***	-0.115***	0.036
	(0.015)	(0.031)	(0.028)
R&D intensity	0.175***	0.748***	-0.923***
	(0.046)	(0.167)	(0.207)
Relative size	-0.033	-1.793***	1.826***
	(0.049)	(0.150)	(0.133)
Dividend-paying	-0.082***	-0.273***	0.355***
	(0.015)	(0.024)	(0.024)
Institutional ownership	0.141	-0.559*	0.418
	(0.116)	(0.275)	(0.285)
Firm size	-0.039***	-0.310***	0.349***
	(0.006)	(0.021)	(0.020)
Amihud liquidity	-0.118***	0.085**	0.033
	(0.022)	(0.030)	(0.032)
Equity market return	0.004	-0.313*	0.308*
	(0.063)	(0.132)	(0.145)
Money supply (M2)	0.474*	2.001***	-2.476***
	(0.187)	(0.381)	(0.423)
Consumer confidence	-0.001	-0.004	0.005*
	(0.001)	(0.002)	(0.002)
Exchange rate	-0.136	-0.480	0.616
	(0.160)	(0.325)	(0.361)
Credit spread	4.700	32.531***	-37.231***
	-4.561	-9.398	-10.361
Interest rate	6.211	32.749***	-38.960***
	-4.388	-8.856	-9.694
N	5,464		

Appendix E: Predicted probabilities and developments over time

Table 15: Model prediction performance

Security type	Percent	Cumulative	Predicted probabilities
Convertible bond issues	10.12	10.12	10.15
Seasoned equity offerings	27.25	37.37	27.17
Straight debt issues	62.63	100	62.67
Total	100		
Equity-like convertible bond	3.44	3.44	3.45
Seasoned equity offering	27.25	30.69	27.16
Debt-like convertible bond	6.69	37.37	6.70
Straight debt issue	62.63	100	62.69
Total	100		
Privately placed convertible	6.85	6.85	6.86
Seasoned equity offering	27.25	34.10	27.17
Public convertible offering	3.27	37.37	3.27
Straight debt issue	62.63	100	62.70
Total	100		

The sample period ranges form January 2000 until December 2017, financial companies and utility companies are excluded from the sample group. Issues are considered private when placed under rule 144A. Public convertible bond issues with similar Mergent IssuerID and maturity as a previously issued privately placed convertible bond are removed from the sample. Convertible bonds with a Delta greater than 0.6 are considered equity-like convertible bonds.

Figure 5: Sample construction over time

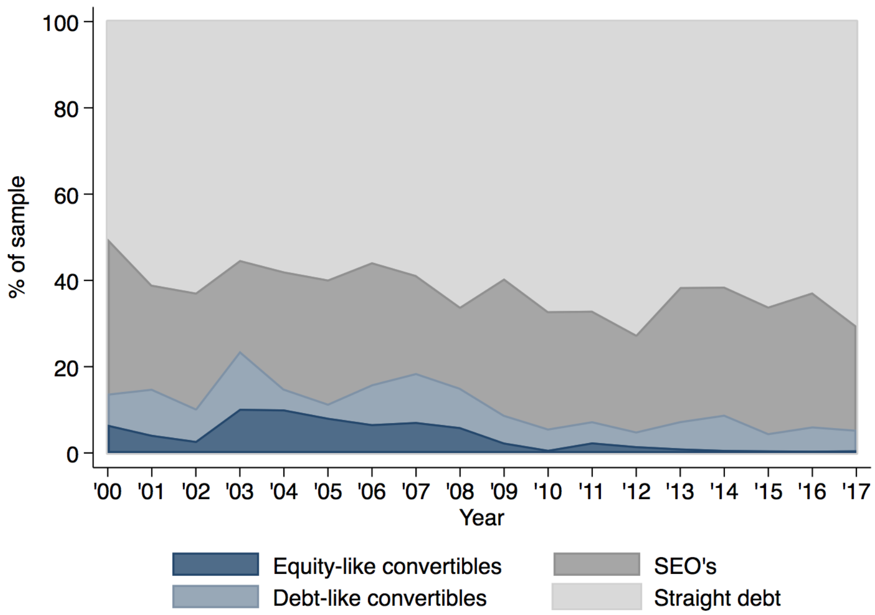


Figure 6: Equity-like convertibles vs Debt-like convertibles

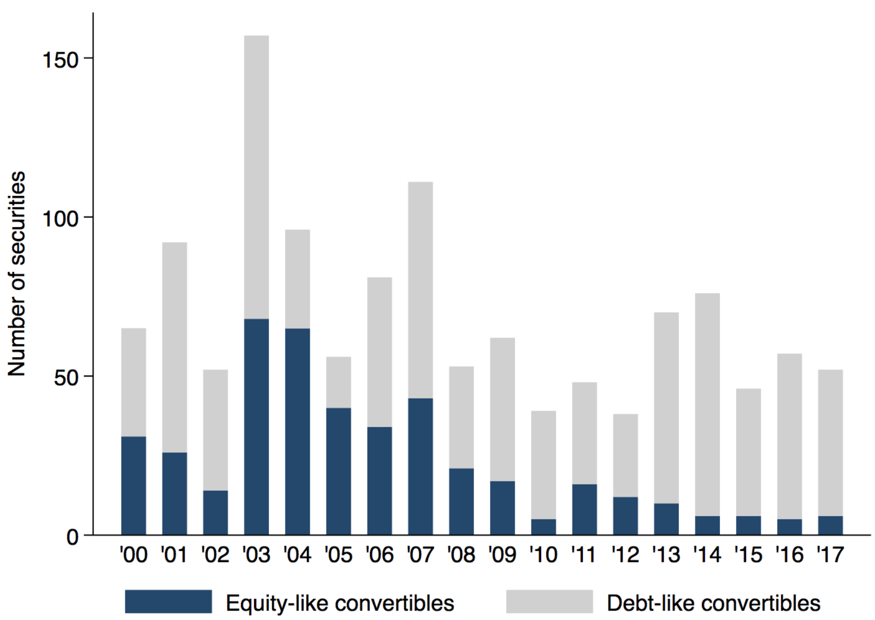


Figure 7: Private convertibles vs Public convertibles

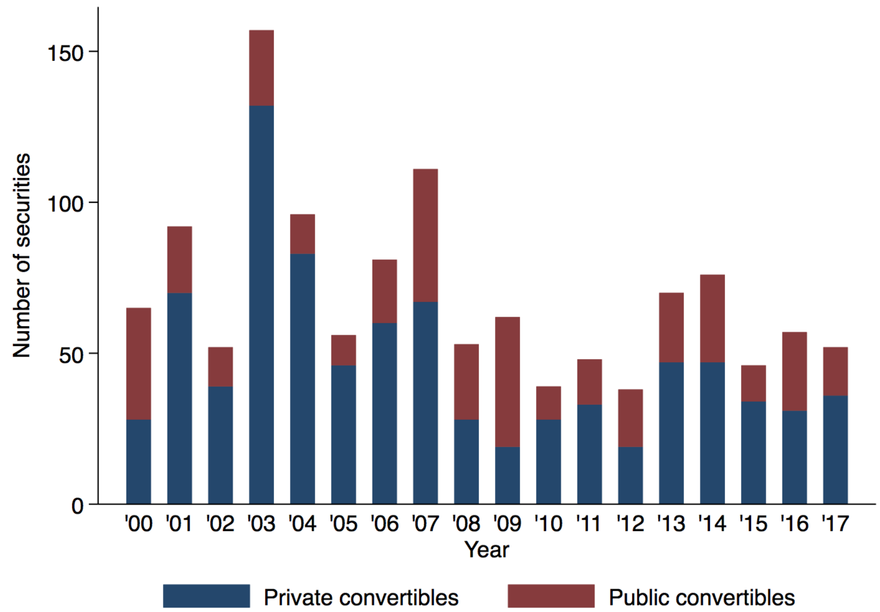


Figure 8: Average maturities per year

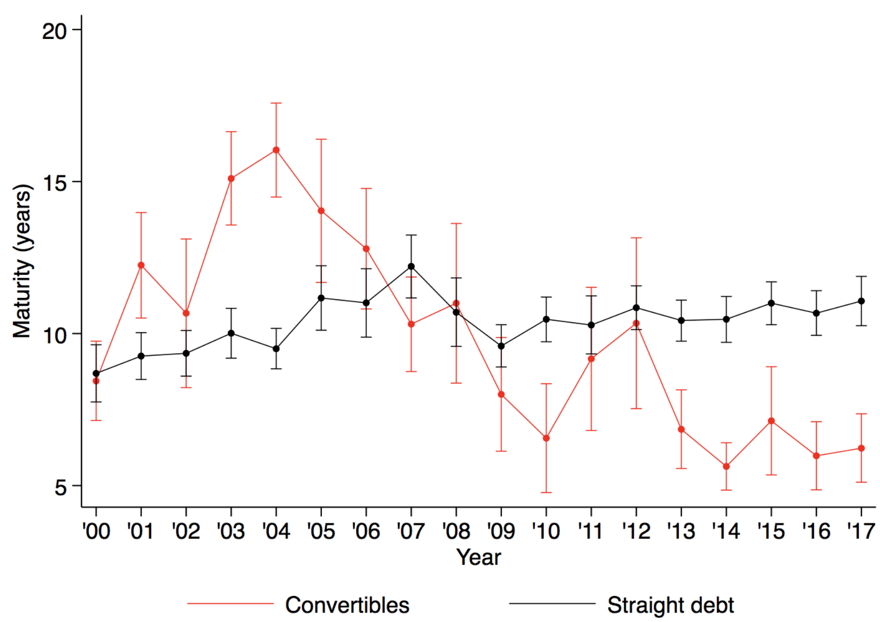


Figure 9: Average conversion premiums per year

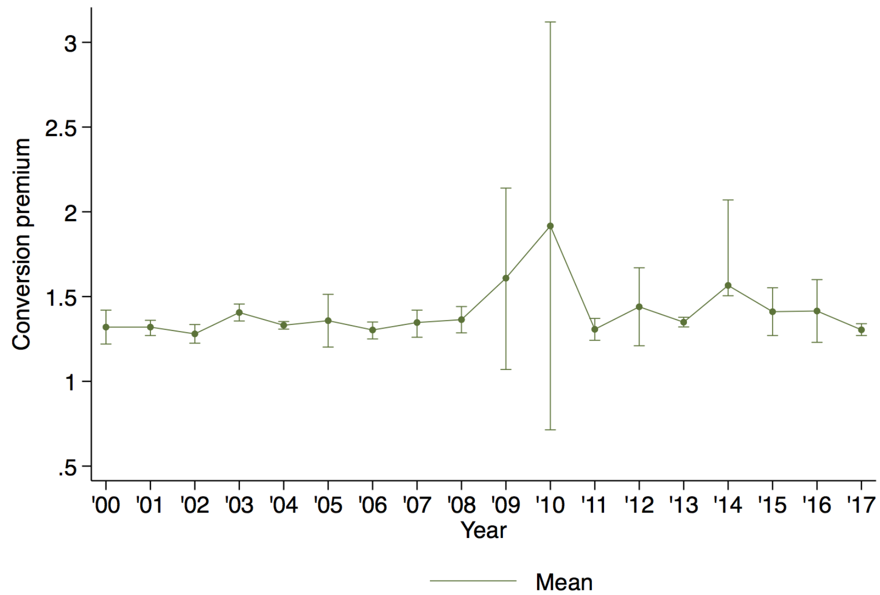
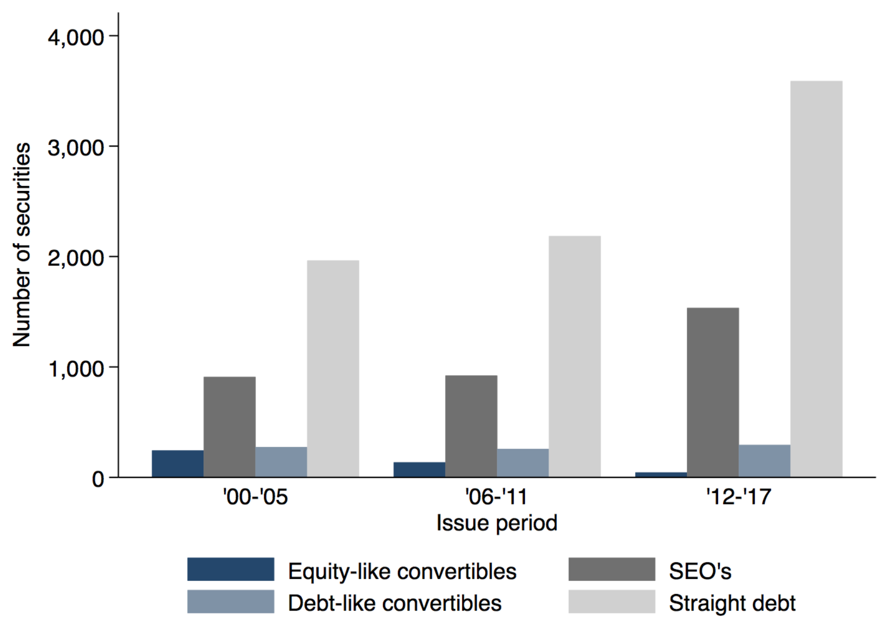


Figure 10: Securities issued per subperiod



Appendix F: Issuer characteristics and overlap in subperiods

Table 16

Issue and issuer characteristics over time; seasoned equity issuers

		Issue period			
	All issues	2000-2005	2006-2011	2012-2017	Diff. of means t-statistic
Continuous variables					
Financial distress (Z-score)	7.342	10.642	7.824	5.095	28.730***
Return volatility	0.633	0.609	0.681	0.617	20.860***
Firm size	2580	2870	1820	2870	8.390***
Tangibility	0.524	0.537	0.553	0.498	3.650**
R&D intensity	0.880	0.553	0.794	1.126	15.890***
Institutional ownership	0.617	0.621	0.617	0.615	4.500**
Relative size	0.171	0.174	0.175	0.165	1.080
Amihud liquidity	0.655	0.452	0.726	0.733	26.010***
Dummy variables					
NASDAQ listing	0.512	0.446	0.512	0.550	12.530***
R&D expenses	0.524	0.453	0.541	0.556	12.990***
Dividend paying	0.155	0.196	0.145	0.138	8.030***
N	3,367	910	922	1,535	

The sample period is divided into three periods of six year each. Issues belong to the first period if the security was issued in the years 2000 up to and including 2005, the second period if issued in the years 2006 up to and including 2011 etc. See appendix C for a description of Delta, see appendix B for a detailed description of issuer characteristics. Reported difference in means F-statistics do not assume equal variances among the three subperiods. Several firms issue in multiple of the three subperiods, making the subperiods not completely independent, see table 13 in appendix G.

Table 17

Issue and issuer characteristics over time; straight debt

		Issue period			
	All issues	2000-2005	2006-2011	2012-2017	Diff. of means t-statistic
Continuous variables					
Financial distress (Z-score)	4.057	3.641	4.025	4.305	16.420***
Return volatility	0.383	0.431	0.387	0.355	113.710***
Firm size	47,300	15,700	29,800	75,200	345.970***
Tangibility	0.641	0.700	0.636	0.613	17.890***
R&D intensity	0.028	0.016	0.027	0.035	71.670***
Institutional ownership	0.619	0.619	0.622	0.618	5.530***
Relative size	0.162	0.236	0.171	0.116	25.080***
Amihud liquidity	0.153	0.310	0.149	0.070	140.340***
Issue characteristics					
Maturity	10.455	9.681	10.644	10.765	10.410***
Dummy variables					
NASDAQ listing	0.209	0.144	0.201	0.247	39.730***
R&D expenses	0.488	0.390	0.495	0.539	57.940***
Dividend paying	0.689	0.570	0.677	0.762	115.700***
N	7,738	1,967	2,182	3,589	

The sample period is divided into three periods of six year each. Issues belong to the first period if the security was issued in the years 2000 up to and including 2005, the second period if issued in the years 2006 up to and including 2011 etc. See appendix C for a description of Delta, see appendix B for a detailed description of issuer characteristics. Reported difference in means F-statistics do not assume equal variances among the three subperiods. Several firms issue in multiple of the three subperiods, making the subperiods not completely independent, see table 13 in appendix G.

Table 18: Number of issues

Securities issued per subperiod

	Frequency of issues											
	1	2	3	4	5	6	7	8	9	10	11	12
Unique firms	767	268	108	54	26	15	5	2	2	2	1	1

	Issue period		
	2000-2005	2006-2011	2012-2017
Unique firms			
392	X		
290		X	
261			X
104	X	X	
34		X	X
38	X		X
26	X	X	X

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