The Fluctuating Maturities of Convertible Bonds

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Abstract

The maturities of newly issued convertible bonds vary substantially over time. We find that firm-specific determinants of maturity from the straight debt literature are also relevant for convertible bonds, but that these factors alone do not fully explain the decreasing trend in convertible bond maturities. In the past decade, the growth of the convertible arbitrage industry and in particular the role of hedge funds have changed the importance of firm characteristics in the convertible bond market. Furthermore, recently issued convertible bonds come with particularly short maturities that serve as substitutes for disappearing call provisions, in line with backdoor-equity and sequential-financing rationales for issuing convertible bonds.

Keywords: *convertible bonds, maturity choice, security design, convertible arbitrage*

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1 Introduction

There have been large fluctuations in the stated maturities of convertibles issued over the past 30 years. Convertible bonds with maturities exceeding 20 years were common before the 1990s and in the mid 2000s. However, the general trend has been decreasing and the majority of convertibles issued after 2007 expires within 10 years. We examine the driving factors of convertible bond maturity and its role in the convertible bond design process by studying convertible bonds that were issued in the United States between 1985 and 2016.

Although we are the first to study the maturity of convertible debt, we can build on theories that explain the maturity structure of straight debt since both are equivalent when the equity component of convertible debt is not exercised. The agency cost hypothesis predicts that debt maturity can alleviate agency problems such as underinvestment and risk-shifting. According to the liquidity risk hypothesis, firms manage their debt maturity to reduce the risk of default. The signaling hypothesis states that firms can choose debt maturity to signal their quality to outside investors. Furthermore, macroeconomic factors could have an impact on the maturity of debt as well.

First, we find that large firms and firms with low stock volatility are more likely to issue convertibles with longer maturities, in line with the agency cost hypothesis and liquidity risk hypothesis. Second, convertibles that are issued by profitable firms and highly-rated firms also have longer maturities on average, contradicting the signaling hypothesis and highlighting the importance of borrowing restrictions set by lenders. Third, we find that convertibles issued during the recessions in the early 1990s and after the financial crisis have lower maturities.

However, firm-specific and macroeconomic factors do not explain the downward trend in convertible bond maturities and subperiod regressions show that the importance of firm-specific variables are not time invariant. This could be explained by the increase of hedge fund activity in the convertible bond market. Hedge funds buy convertible bonds

to profit from arbitrage opportunities from underpricing by hedging the position through shorting the underlying stock[1]. Firm quality becomes less important as potential losses are offset by arbitrageurs' short position in the firms' stocks, and high stock volatility actually facilitates the arbitrage strategy (Brown et al., 2012). In fact, we find evidence supporting the findings of Brophy et al. (2009) that hedge funds provide last resort financing to firms without other financing options.

Thus, the evolution in maturity choice could also be driven by changes on the buy-side of the convertible bond market. We hypothesize that firms set shorter maturities because many recently issued convertibles are not embedded with call provisions to satisfy arbitrageurs' preferences (Grundy and Verwijmeren, 2018). We confirm that callable convertible bonds have longer maturities on average and the trend coefficient becomes smaller (but remains significant) after controlling for callability. The substitution effect between maturity and callability is more emphatic in a sample of convertibles placed privately under SEC Rule 144A, which is also the sample where hedge fund activity is expected to be the largest. Furthermore, this substitution is in line with the backdoor-equity rationale of Stein (1992) and sequential-financing rationale of Mayers (1998) for issuing convertible bonds, where call provisions play a crucial role because they give the firm the ability to force conversion. When a convertible bond is not callable, Grundy and Verwijmeren (2018) suggest that a shorter maturity can be used to create a convertible bond that is similar to a callable convertible bond with a longer maturity.

This study contributes to the academic literature in several aspects. First of all, this paper is related to the capital structure literature on the optimal maturity structure of debt. There are studies that explain the maturity of debt, both theoretically (for example Diamond, 1991) and empirically (for example Antoniou et al. (2006), Custódio et al. (2013)). This study attempts to explain an interesting time series pattern in the maturity of newly issued convertible bonds. Furthermore, we are the first to empirically test existing maturity theories in a sample of convertible bonds.

[1]See Mitchell et al. (2007), Choi et al. (2009) and Brown et al. (2012) for more about convertible arbitrage.

Second, this study is related to the literature on security design. We see that firms use various combinations of design mechanisms to obtain convertible bonds with similar characteristics. By studying the maturity choices of convertible bonds over time, we can also learn more about the changing validity of traditional convertible bond issuance rationales. We complement the study of Grundy and Verwijmeren (2018) by showing that the shortening of convertible bond maturity functions as a substitute for call provisions, such that backdoor-equity (Stein, 1992) and sequential-financing (Mayers, 1998) rationales are still valid, even for convertibles that are not callable.

Third, this study deepens our knowledge of the impact that the rise of the convertible arbitrage industry has had on the market of convertible bonds, and in particular the role of the hedge funds. We find evidence that firms issuing convertible bonds to hedge funds are generally lower-quality firms with higher actual default rates, in line with the study of Brophy et al. (2009) that hedge funds are investors of last resort.

The remainder of the paper is organized as follows. In section 2, we build a theoretical foundation for this research by developing hypotheses for convertible bond maturity. Section 3 describes the data selection procedure and the data. The results of our regression analyses are reported and discussed in section 4. Section 5 analyzes the relation between convertible bond maturities and arbitrageurs. Section 6 concludes.

2 Literature and Hypotheses

In this section, we build a theoretical foundation to explain the time to maturity of convertible bonds. There are no specific studies in the literature that explain the maturity choice of convertible bonds. However, predictions can be made based on studies on debt maturity structure and convertible bond issuance and design rationales.

2.1 Firm-specific determinants

We discuss various firm-specific and macroeconomic variables from the straight debt maturity literature that could also affect a firms' convertible bond maturity decision. These debt maturity hypotheses are related to well-established theories in the finance literature. However, we should keep in mind that the setting of our study differs from the straight debt literature in two aspects. First, we study convertible debt instead of straight debt. Second, we do not study the debt maturity structure on the balance sheet of firms, but instead focus on the issuance of new convertible bonds. Nevertheless, we expect that the factors that are relevant to straight debt maturity are also relevant to convertible debt.

Since shorter-term debt needs to be renewed frequently, issuing bonds with short maturities facilitates frequent renegotiation and monitoring activities with lenders. According to the agency costs hypothesis, short-term debt can therefore be used to alleviate risk-shifting (Jensen and Meckling, 1976) and underinvestment problems (Myers, 1977). As small firms and firms with many growth opportunities are particularly sensitive to agency problems, we expect that those firms can benefit the most from issuing short-term. Furthermore, firms match the maturity of their liabilities with their assets to avoid costs from inefficient liquidation of assets (Hart and Moore, 1994; Graham and Harvey, 2001).

Managing the maturity of debt is also an important part of liquidity risk management, as firms want to reduce the risk that they cannot repay their debt and end up in financial distress. Therefore, firms with high leverage choose to issue debt with longer maturities to protect themselves against liquidity risk (Leland and Toft, 1996). For similar reasons, Kane et al. (1985) show that firms with stable firm value use long-term debt to avoid having to rebalance their balance sheet frequently.

On the other hand, we consider the signaling effect of debt maturity (Flannery 1986; Barclay and Smith, 1995). In the presence of information asymmetry, the signaling hypothesis suggests that high quality firms issue short-term debt because they are confident that they can borrow at better terms after the solution of information asymmetry. Hence,

firms with a high degree of asymmetric information are more likely to issue short-term debt. Diamond (1991) shows that there is a trade-off between liquidity risk and signaling. Firms with high credit quality issue short-term because the benefits of issuing short-term offset the increase in liquidity risk. Firms with low credit quality issue long-term to diminish liquidity risk, but also face tight borrowing restrictions from lenders.

By buying bonds with high maturities, lenders make a long-term commitment to the firm and are therefore subject to more risks if the firm's conditions deteriorates in the future, especially in the presence of information asymmetry. Hence, some firms face tight restrictions when they want to borrow long-term. For example, larger firms have better access to long-term borrowing because they have lower information asymmetry, more tangible assets and a better ability to absorb costs of financial distress. According to this hypothesis, firms with low credit ratings, unrated firms, firms with high leverage and high stock volatility could all be excluded from the long-term borrowing market.

We proxy firm size using the natural logarithm of total assets ($SIZE$) and inverse firm growth using the book-to-market ratio (B/M). Asset maturity is inversely measured through the asset depreciation rate, which is defined as depreciation divided by net property, plant and equipment (DR). Leverage is measured by total liabilities divided by total assets (LEV). We measure firm volatility using the historical annualized monthly volatility of the stock price (VOL), estimated over the year before the convertible bond offering. We proxy for firm and credit quality by including the profitability of firms (EBIT scaled by total assets or $PROF$) and credit ratings obtained from Moody's, Standard & Poor's or Fitch. The balance sheet data is collected from the Compustat database, and stock data is collected from the Center for Research in Security Prices (CRSP) database.

Table 1 contains an overview of the variables, the measures that we use and the predicted sign of the relation with debt maturity.

[TABLE 1 ABOUT HERE]

2.2 Macroeconomic determinants

To examine the effect of macroeconomic changes over time on the maturity decisions of convertible bonds, we also include a number of macroeconomic variables in our analysis. Changes in macroeconomic conditions could affect both the demand-side and the supply-side of capital markets.

Mian and Santos (2011) suggest that firms actively manage their debt maturity structure according to the business cycle. Since it is difficult and expensive for firms to find lenders during economic recessions, the forward-looking firms prefer to issue long-term debt when the business cycle peaks so that they are protected against liquidity risk when a crisis happens. We measure the uncertainty of the market using a recession indicator[2] and proxies for credit risk and corporate default risk. Credit risk is proxied by the TED spread, calculated as the difference between the 3-month LIBOR rate, which is the benchmark rate that banks charge each other worldwide, and the "risk-free" 3-month U.S. T-bill rate. We proxy corporate default risk using the difference in credit spreads between Baa-rated corporate bonds and Aaa-rated corporate bonds.

Barclay and Smith (1995) argue that firms time the market and borrow long-term when the term spread is smaller, such that long-term debt is relatively cheap compared to short-term debt. This comparative advantage is measured using the slope of the yield curve, which is approximated by the difference between the 10-year and 3-month constant maturity treasury rate. Data on TED, default and term spreads are available on the website of the Federal Reserve Bank of St. Louis[3].

2.3 Convertible bond design variables

Finally, we propose another explanation for the decrease in convertible bond maturities, based on the role of maturity in the convertible bond design process. Over the past

[2]The recession dates are marked on the website of the National Bureau of Economic Research (NBER): http://www.nber.org/cycles.html

[3]https://fred.stlouisfed.org/

decade, the proportion of convertible bonds that contain a call provision have decreased significantly because of a shift on the buy-side of the convertible bond market. These buyers are arbitrageurs (usually hedge funds) that employ convertible arbitrage strategies, where the long position in the convertible is hedged through shorting the underlying shares. In 2008, more than 80% of the convertible bond proceeds are purchased by hedge funds (Brown et al., 2012). A callable convertible is more risky in arbitrage strategies because a call shifts wealth from convertibleholders to shareholders, so that hedge funds suffer losses on both their long position and their short position. Furthermore, call provisions makes it harder to determine the optimal size of the shorting position, such that arbitrage strategies are riskier.

According to Grundy and Verwijmeren (2018), the decreasing usage of call provisions could have large implications for the backdoor-equity rationale of Stein (1992) and the sequential-financing rationale of Mayers (1998). Stein (1992) develops a signaling model, where firms with high costs of issuing equity choose to issue convertible bonds that are likely to be converted. Mayers (1998) shows that firms with many growth opportunities can benefit from issuing convertible debt[4]. If the investment option turns out to be valuable, a firm can reduce leverage by forcing conversion. If that is not the case, the convertible bond can be called to prevent overinvestment problems. Callability plays a major role in both rationales as it gives issuing firms the ability to force conversion under the right circumstances. The time to first call is set to the moment of resolution of information asymmetry (backdoor-equity) or to exercise potential investment options (sequential-financing). If the convertible bond is non-callable, Grundy and Verwijmeren (2018) suggest that firms can set the maturity to the moment of first call to get a similar design. Hence, we expect that firms issuing non-callable convertibles are more likely to choose for shorter maturities.

Alternatively, various studies have suggested that hedge funds themselves might also prefer short maturities because long-term arbitrage strategies are difficult to implement

[4]see Chang et al. (2004) for more evidence in favor of the sequential-financing rationale.

(for example Ammann et al., 2003). However, Van Marle and Verwijmeren (2017) show that hedge funds usually only hold the convertible for a short period of time (on average 11.6 months) and that the holding period is independent of the maturity. We proxy for hedge fund interest by checking whether a convertible bond is privately placed under SEC Rule 144A (Brown et al., 2012). Securities placed under Rule 144A are exempted from trading restrictions that were common for privately placed securities, and are therefore more liquid and attractive to convertible arbitrageurs. Additionally, private placements allow buyers and sellers to negotiate over the terms of borrowing, such that the hand of the buyer should be more apparent for convertibles placed under Rule 144A.

3 Data Description

This section contains a description of our sample of convertible bonds. First, we describe the sample selection procedure that we followed to filter the raw convertible bond sample from the dataset that we use in this research. Second, we provide summary statistics about convertible bond design and issuers over time.

3.1 Sample selection

The convertible bond data is collected from the Mergent Fixed Income Securities Database (FISD), which is an academic database of U.S. bond offerings. Mergent FISD contains a total of 4,962 convertible bond offerings between January 1985 and December 2016, including information on design features and credit ratings.

First, we remove 1,031 convertible bond offerings that appear twice in the sample. These duplicates are convertibles that are first registered as a private placement under Rule 144A, and at a later date registered again as a public offering. Next, we drop 469 observations that correspond with preferred stocks or perpetual bonds, as they fall outside the scope of the research. Convertibles issued by utility firms and financial institutions are also removed (693 observations). Finally, we drop 4 observations with missing offering

or maturity dates. This results in a sample of 2,765 convertible bonds, which we now refer to as the "Mergent sample".

The Mergent sample allows us to test the relations between convertible bond maturity, macroeconomic conditions, convertible design features and credit ratings. To be able to test the firm-specific hypotheses, we match the convertible bond offerings with data on the issuing firms. We obtain monthly stock prices from the Center for Research in Security Prices (CRSP) database and balance sheet information from the Compustat database. Another 465 observations are lost because of missing identifiers, stock data or balance sheet data. The application of the last filter results in a final "Merged sample" with 2,300 observations.

3.2 Trends in convertible issuers and design

Next, we present some relevant summary statistics. Figure 1a illustrates the yearly average (blue solid line) and median (red dashed line) maturity of all convertible bonds issued between 1985 and 2016. The pattern in the average convertible bond maturities shows large declines during the recession in 1991, a large increase following the burst of the dot-com bubble in 2001 and another decrease before the start of the financial crisis in 2007. The increasing median shows that there were increasing numbers of long-term convertibles issued between the dot-com bubble in the early 2000s and the financial crisis. However, such a trend was not present after the recession in the 1990s and the recession that followed the financial crisis, when lenders and investors remained very conservative with the supply of capital for long-term convertible debt.

[FIGURE 1 ABOUT HERE]

Table 2 contains summary statistics of convertible bond design variables (using the Mergent sample with 2,765 observations) and characteristics of firms issuing convertible bonds (using the Merged sample with 2,300 observations) in subperiods of 5 to 6 years. In terms of the composition of issuing firms in the convertible bond market, we see an increase

in average total asset value of issuers after the year 2000, suggesting that an increasing number of large issuers might be responsible for the increase in long-term convertibles. The average volatility of convertible issuers is also higher after 2000, and in particular between 1996 and 2005, which could be related to the volatility of the entire stock market during the crashes in 2001 and 2008. The average leverage ratio of issuing firms remains fairly stable over time, ranging between 45% to 56%.

Another noteworthy pattern is that firms issuing convertibles at the end of the sample period are recording losses, as the average profitability is negative. Furthermore, the fraction of convertible bond issuers with investment grade credit ratings and below-investment grade credit ratings also decreased in the past decade, suggesting that there might be a deterioration in the quality of convertible issuing firms. This trend is in line with the study of Brophy et al. (2009), who find evidence that hedge funds provide financing for companies with weak fundamentals and high information asymmetries in exchange for substantial discounts and hedge positions in the underlying shares.

[TABLE 2 ABOUT HERE]

Table 2 also exposes a clear decreasing trend in the usage of call provisions, in line with the findings of Grundy and Verwijmeren (2018). Where almost all convertible bonds issued before 2005 were callable, this proportion is almost twice as small after 2005. Furthermore, the number of convertibles placed privately under SEC's Rule 144A has also increased considerable over the years. In fact, more than half of the convertibles offered after 2001 are placed under Rule 144A, supporting the notion that the involvement of hedge funds is most apparent in privately placed convertible bonds.

Finally, we make some simple comparisons between the Mergent sample and the Merged sample. A total number of 465 observations are lost when we merge convertible bond data with CRSP and Compustat data on stocks and balance sheet information. Not surprisingly, a relative large number of observations are lost in the early sample years, and data recorded in recent years is more complete. Figure 1b plots the yearly average

maturity of convertible bonds in the Mergent sample and the Merged sample. The two patterns are almost identical, such that it is unlikely that our data restrictions biases the sample towards convertible bonds with certain maturities.

4 Empirical Results

In this section, we test the relations between convertible bond maturity and various explanatory variables as hypothesized in section 2. First, we test whether these hypotheses can explain cross-sectional variation in convertible bond maturity and whether the validity of hypotheses has changed over time. Second, we examine whether the time series pattern of convertible bond maturities can be attributed to changes in issuing firms and macroeconomic conditions. In section 4.3, we also take factors into account that are related to convertible bond design, convertible arbitrage and the involvement of hedge funds.

4.1 Cross-sectional analysis of firm-specific determinants

First, we analyze the ability of firm characteristics in explaining the cross-sectional variation of convertible bond maturity. We conduct three regressions with year dummies to account for heterogeneity across years. The dependent variable is the log maturity of convertible bond issues. The independent variables are the firm characteristics that are also listed in Table 2. Column (1) contains the results of the baseline regression. Credit ratings are included in the regression of column (2). In column (3), we also control for unobserved heterogeneity across industries by including industry dummies, based on the Fama and French 12 industry classification. The regression results can be found in Table 3.

[TABLE 3 ABOUT HERE]

We see that four firm-specific variables are consistently significant determinants of convertible bond maturity across specifications, and that two determinants are consistently insignificant. As expected, large firms and firms with stable stock prices issue

higher-maturity convertibles than small and volatile firms (significant at the 1% level). This is consistent with the agency costs hypothesis, the liquidity risk hypothesis and the information asymmetry hypothesis. On average, a firm that is approximately twice as large is associated with an increase of maturity of 6.7% to 8.5%, depending on the specification. A 10% increase in annualized volatility is associated with a moderate decrease of approximately 3.5% in convertible bond maturity.

The book-to-market ratio is significantly negative at the 1% significance level. Hence, firms with higher market valuation or growth opportunities issue convertible bonds with higher maturities, which contradicts the prediction of the agency costs hypothesis. A possible interpretation of this finding is that the convertible bonds' equity component of firms with higher growth opportunities is more attractive to both borrowers[5] and investors, and higher maturities increase the likelihood of the convertible eventually being converted.

The profitability coefficient is significantly positive at the 1% level, which contradicts the signaling hypothesis but is in accordance with the notion of Diamond (1991) that low-quality firms could have trouble accessing long-term borrowing markets. Furthermore, rated firms issue higher-maturity convertibles than unrated firms, and firms with investment grade ratings issue higher-maturity convertibles than firms with below-investment grade ratings. Including credit ratings also decreases the magnitude of the size, book-to-market, volatility and profitability coefficients, suggesting that some of the information of these firm characteristics is also captured in the credit ratings.

The leverage ratio is negative but insignificant. The asset depreciation rate is also negative and insignificant. The sign of the coefficient flips when industry dummies are included, suggesting that moderate differences in asset maturity structures are mostly prevalent across industries.

To save space, the regression parameters of the year dummies and industry dummies are not reported in Table 3. The year coefficients are in line with the observed pattern in Figure 1. Compared to the average maturity in 1985, all dummies after 1990 are signifi-

[5]This is also in accordance with the sequential financing rationale of Mayers (1998).

cantly negative at the 1% level. Furthermore, firms in the consumer nondurables industry and telecom industry issue shorter-term convertibles with respect to firms in other industries, and firms in the energy and chemicals industry issue longer-term convertibles (all significant at the 5% level).

We also conduct a number of robustness checks, which can be found in Table 4. In columns (1) to (3), we conduct regressions with the actual (not logged) years to maturity as dependent variable. In columns (4) and (5), we cluster standard errors at the year-level and industry-level, respectively. The results found previously in Table 3 are robust and almost identical when we use the actual years to maturity as dependent variable. Furthermore, clustering on year- and industry-level to account for heteroskedasticity across years or industries also does not affect our main conclusions.

[TABLE 4 ABOUT HERE]

The results are mixed for the hypotheses in the complete sample of 2,300 convertible bonds, which were issued over a time span of 32 years. Because the convertible bond market has changed considerably over the years, mainly driven by the rise of the convertible arbitrage industry, motives for companies to issue convertible bonds and choose certain maturities are likely to have evolved over time as well. Thus, it is well imaginable that the regression parameters have changed over time. We perform a time-varying analysis on the complete sample of convertible bonds. Because the scarcity of data in some years makes it difficult to run separate regressions in each year, we divide the sample period in subperiods of 5 to 6 years, as in Table 2. For every subperiod, we conduct a regression with firm characteristics, year dummies and industry dummies. The results are shown in Table 5.

[TABLE 5 ABOUT HERE]

We examine the results in chronological order, starting with the period before the recession in the early 90s. In line with previous findings, convertibles with longer maturities

were mostly issued by large and profitable firms before 1990. The leverage coefficient is significantly negative at the 5% level, suggesting that highly leveraged firms might have been considered too risky for long-term lending. Surprisingly, convertibles with investment grade ratings had lower maturities on average.

During and after the recession in the early 90s, the average convertible bond maturity decreased from more than 20 years to approximately 10 years (see Table 2). The regression parameters have decreased in terms of magnitude and are generally insignificant, as the size coefficient is the only regression parameter that is significant at the 5% level. A possible explanation for this is that investors and lenders were unwilling to engage in long-term contracts during and after the recession in 1990. Furthermore, the increase in issuing firms with credit ratings and decrease in number of issues suggests that some low-quality firms might have been excluded from the convertible bond market. In that case, the insignificant regression parameters could be driven by the fact that there was less variation in convertible bond maturities and/or issuing firms.

The late 90s and early 2000s were characterized by the rise and the subsequent collapse of the internet bubble, followed by a brief recession in 2001. In the following years, the supply of convertibles with longer maturities increased. Judging by the regression parameters, we can attribute parts of this increase to large, rated firms, as well as firms with high growth opportunities, stable stock prices and high profitability.

The average maturities of convertible bonds started decreasing again after 2005, which was also the period when convertible arbitrage activity had reached its peak (see Brown et al., 2012; Grundy and Verwijmeren, 2018). Interestingly, we find that stock volatility is the only firm characteristics that remains significant throughout the whole period. Furthermore, the profitability variable has decreased in magnitude with respect to the previous period and is only significant at the 10% level, and the investment grade rating dummy has even become negative. As mentioned previously, the increase in arbitrage activity could have an impact on the maturity decisions of firms. Arbitrageurs care less about firm quality because their arbitrage strategy also involves a short position in the

underlying stocks, and they actually prefer high stock volatility because there are more arbitrage opportunities (Brown et al., 2012). Hence, our results could be generated by an increase in firms with high stock volatility who issue short-term convertibles to hedge funds as financing of last resort (Brophy et al., 2009). A more thorough analysis on the composition of firms issuing convertible bonds can be found in section 4.2, and an analysis on the relation between convertible bond maturity and arbitrage strategies follows in section 4.3.

4.2 Explaining the variation over time

To analyze whether changes in the composition of issuing firms in the convertible bond market and macroeconomic conditions can explain the pattern in convertible bond maturities over the years, we conduct a set of pooled linear regressions without year dummies. The results of the pooled regressions can be found in Table 6. Column (1) contains a regression of the logged convertible maturity on a trend. Columns (2), (3) and (4) contains regressions of the logged convertible maturity on a trend and macroeconomic variables, firm-specific variables and industry dummies, respectively. Column (5) pools all explanatory variables from columns (1) to (4). We use the Mergent sample (2,765 observations) in regressions without firm characteristics (columns 1, 2 and 4), and the Merged sample (2,300 observations) in regressions with firm characteristics (columns 3 and 5).

[TABLE 6 ABOUT HERE]

First, we discuss the relation between convertible bond maturity and macroeconomic variables. Credit risk and corporate default risk does not seem to play an important role, as the coefficients of the TED spread are insignificant across specifications. Default spread is even positively associated with maturity, which contradicts the hypothesis that long-term borrowing restrictions are tight in uncertain states of the world. Furthermore, we do not find evidence that firms time the market and borrow long-term when the term structure of interest rates is flat, as the coefficient of the term spread is insignificant in

column (3) and significantly positive in column (5). On the other hand, we find some evidence that firms issue shorter-term convertibles during the recession in the early 1990s, and conclusive evidence that firms issue shorter-term convertibles during the recession that followed the financial crisis of 2008. Overall, we conclude that macroeconomic determinants of convertible bond maturity do not explain the variation over time.

The regression results provide mixed evidence for the firm-specific hypotheses for convertible bond maturity. Throughout the years, short-term convertibles are issued by small firms, firms with high stock volatility, profitable firms and (highly) rated firms. The results are in accordance with predictions of the agency costs hypothesis and the liquidity risk hypothesis. The positive coefficients of profitability and credit ratings suggest that low-quality firms are excluded from long-term borrowing markets. Most interestingly, the trend coefficient remains persistent across specifications and significantly negative at the 1% level. Hence, changes in convertible bond issuers and macroeconomic factors are not sufficient to explain the decreasing pattern in convertible bond maturities.

Bundling the results in Table 5 and 6, we find suggestive evidence that the rise of the convertible arbitrage industry in the past 10 to 15 years could have opened up the convertible bond market to firms that would otherwise not be eligible to obtain financing. As mentioned previously, hedge funds are willing to finance these "bad" and fundamentally weak firms in return for substantial discounts and hedged positions through shorting the underlying stocks. Convertible financing is the last resort for these firms, as they are unlikely to have better alternatives on the capital market. Brophy et al. (2009) show that firms receiving hedge fund financing perform worse than firms receiving financing from other investors, but that these hedge funds themselves perform relatively well. Hence, we expect to find evidence that the quality and performance of convertible bond issuers deteriorate over time. We have already established that firms issuing convertibles in recent years are loss-making and less likely to have obtained an investment grade rating (Table 2).

In Figure 2, we plot the actual default rates of convertible bonds (2a) and the fraction

of convertibles that have an embedded put option (2b), categorized by offering year. Put options could be a proxy for firm quality, as firms issuing putable convertibles generally have positive private information and are therefore confident that the put option will not be exercised. Chemmanur and Simonyan (2010) find that issuers of putable convertibles are large and stable firms with more favorable announcement returns and better operating performance with respect to issuers of non-putable convertibles. Confirming our expectations, we find that the majority of convertibles issued after 2006 are not putable anymore. Furthermore, an increasing number of convertibles that were issued after 2006 have defaulted, especially taken into account that default rates of convertibles issued in recent years are likely to be underestimated because those convertibles have existed for only a few years. Such an increase in default rates does not exist in the (unreported) Mergent FISD sample of straight bond offerings. The 21 convertibles that have defaulted after 2005 have a lower maturity on average (7.3 years against 9.4 years). Furthermore, 20 of the defaulted convertibles were issued by unrated firms, the remaining firm had a below-investment grade rating. The majority of convertibles that had defaulted were issued during or after the recession. All in all, we find strong evidence in favor of the premise that convertible bonds have become a form of last resort financing in recent years.

[FIGURE 2 ABOUT HERE]

4.3 Convertible design and arbitrage

In the previous sections, we have established that the rise of the convertible arbitrage industries is likely to have had a significant impact on the convertible bond market and the determinants of the time to maturity. In section 2.3, we hypothesized that maturities are shorter because most convertibles are not callable due to buyers' preferences. We compare the maturities of callable and non-callable convertibles, and privately placed (starting from 1990) and publicly offered convertibles, over time. Figure 3 plot the average convertible bond maturities per category. We see that the decrease in convertible bond maturity after 2001 is primarily driven by an increasing number of non-callable convertible

bonds. Differences between convertibles with and without call provisions were much smaller before 2000. Furthermore, there are no large dispersions between the maturity of privately placed convertibles and convertibles that are offered publicly.

[FIGURE 3 ABOUT HERE]

We conduct some univariate tests of differences in convertible bond maturity depending on callability and whether it is issued privately or publicly. The results are shown in Table 7. We find that the dispersion between callable and non-callable convertibles is significant at the 1% level after 2001, but insignificant before 2000. Since the convertible arbitrage industry was much smaller in this period, we argue that firms that issued non-callable convertibles were not necessarily issuing short-term convertibles because they did not value their call option. However, this is not the case after 2001, implying that firms issuing non-callable convertibles actually valued the call option, but were not able to include them because of the demands of hedge funds. Instead, these firms choose to issue convertibles with short maturities as a substitute for call provisions, in line with backdoor-equity (Stein, 1992) and sequential-financing (Mayers, 1998) rationales of convertible bond issuance.

Differences between privately and publicly offered convertibles are much smaller and generally insignificant. Since private placement under SEC Rule 144A could be used as a proxy for hedge fund involvement (Grundy and Verwijmeren, 2018), there is no evidence that hedge funds are actually more involved in purchasing shorter-term convertible bonds. This is not surprising, as Van Marle and Verwijmeren (2017) show that hedge funds only hold their positions for less than one year on average and that the holding period is independent of the maturity of the convertible bond.

[TABLE 7 ABOUT HERE]

In Table 8, we examine the relation between callability and convertible bond maturity using regressions. In column (1), we conduct a regression of log convertible bond maturity

on a dummy variable that indicates whether the convertible is callable or not, year dummies and industry dummies. In column (2), we add firm characteristics. In the remaining columns, we regress the log convertible bond maturity on a trend, the callability dummy, firm characteristics and an intercept in the full sample (column 3), a sample of privately placed convertibles (column 4) and a sample of publicly offered convertibles (column 5).

[TABLE 8 ABOUT HERE]

Callability is significantly (at the 1% level) positively related to maturity in all 5 specifications. Hence, the results are robust when controlling for heterogeneity across firms, industries and years. In regressions with year and industry dummies, callable convertibles have maturities that are more than 50% higher, on average. Furthermore, including callability in the regressions increases the R^2 by approximately 10% (absolutely) with respect to the regression in Table 3, column (3). In the pooled regression, callable convertibles also have maturities that are almost 50% higher than non-callable convertibles, and including callability increases the R^2 by approximately 9% (absolutely) with respect to the regression in Table 6, column (3). The trend coefficient dropped from -0.032 to -0.022, indicating that a considerable part of the downward trend in convertible bond maturity can be explained by the substitution between maturity length and the call option. It is not surprising that the trend remains significantly negative however, as the maturities of straight bond offerings also decrease over time[6].

Finally, we compare the results in samples of privately placed convertibles (column 4) and publicly offered convertibles (column 5). Although the trend coefficient is significantly negative in both regressions, the magnitude of the downtrend is almost three times as large in the sample of public convertible bond offerings. On the other hand, the coefficient of the callability dummy is almost twice as large for privately placed convertibles. Therefore, the substitution effect is indeed the largest in the sample where hedge fund activity is the most dominant.

[6]See Custódio et al. (2013) for more about the decreasing trend in debt and bond maturity.

5 Conclusion

This paper examines the historical pattern in the maturities of convertible bonds issued between 1985 and 2016. Prior studies have only briefly mentioned the relevance of convertible bond maturity choice. This paper tests a number of determinants from the straight debt literature, as well as other determinants that are related to the buyers and the design of convertible bonds.

When it comes to firm-specific determinants of convertible bond maturity choice, theories from the traditional debt maturity structure literature also work well in a sample of convertible bonds. As predicted by the agency cost and liquidity risk hypotheses, we find that large firms and firms with stable stock prices issue convertible bonds with longer maturities. Profitable firms and firms with high credit ratings are more likely to issue long-term convertibles because access to long-term borrowing is limited to low-quality firms.

However, time-varying regressions show that the relevance of firm characteristics has changed in recent years. Furthermore, firm characteristics and macroeconomic effects do not explain the decreasing trend in convertible bond maturities. We examine another determinant of convertible bond maturity based on the increasing presence of hedge funds as buyers in the convertible bond market. Because these hedge funds care less about firm characteristics, their presence has allowed low-quality firms that are not eligible to other investors to obtain financing of last resort. Furthermore, we find evidence that firms in recent years issue short-term convertibles as substitutes of call provisions, which have disappeared because of hedge fund preferences. Controlling for callability reduces the magnitude of the negative trend coefficient, in particular in the sample of convertible bonds that are privately placed under SEC Rule 144A. The results of this research highlight the impact of convertible arbitrage hedge funds on the maturity choice and the role of hedge funds as investors of last resort (Brophy et al, 2009), but also the persistence of the traditional convertible bond issuance rationales of Stein (1992) and Mayers (1998).

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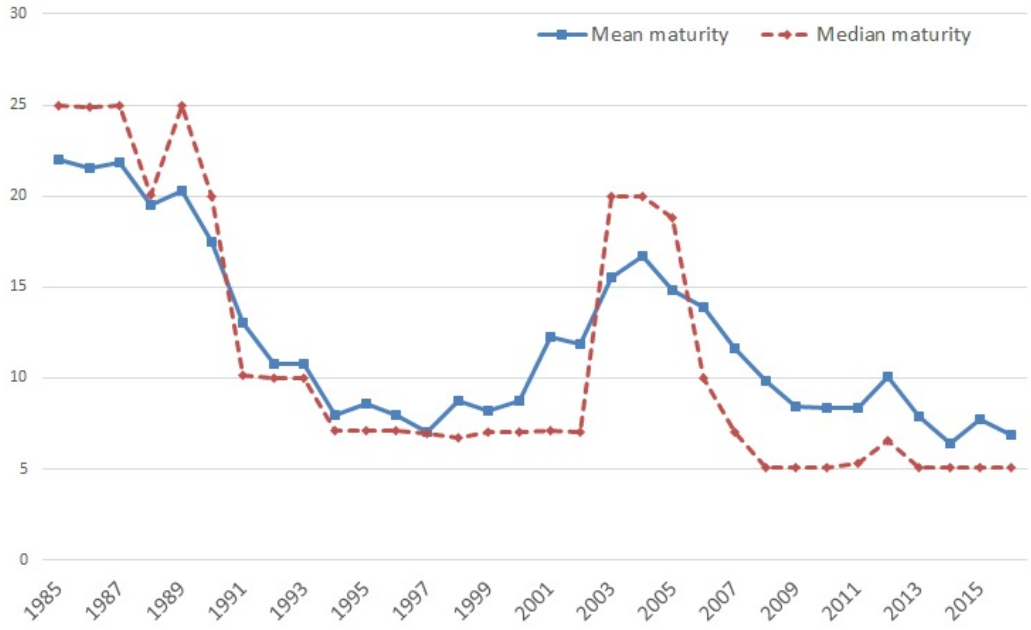
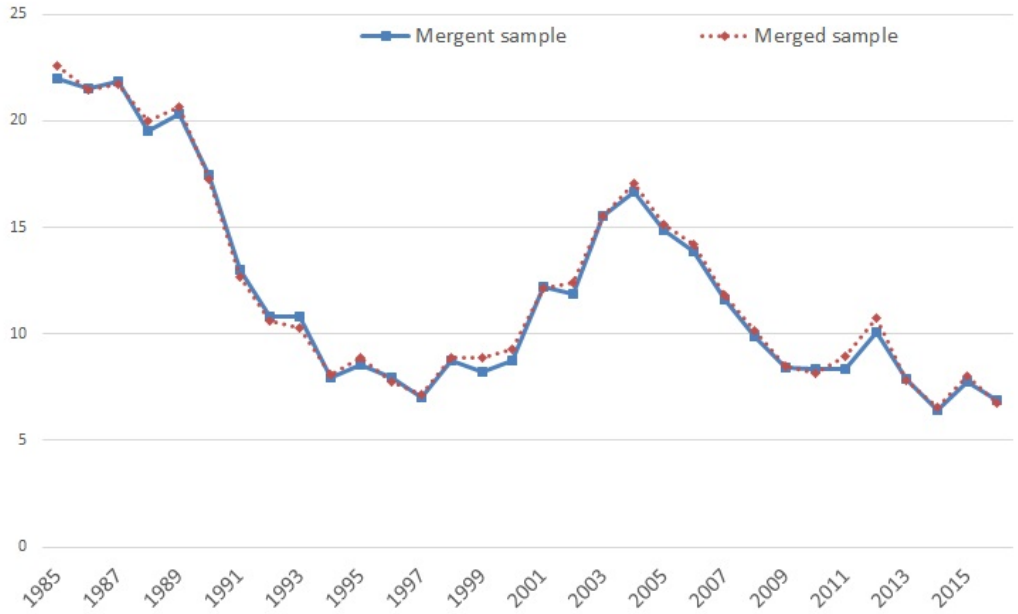
Figures

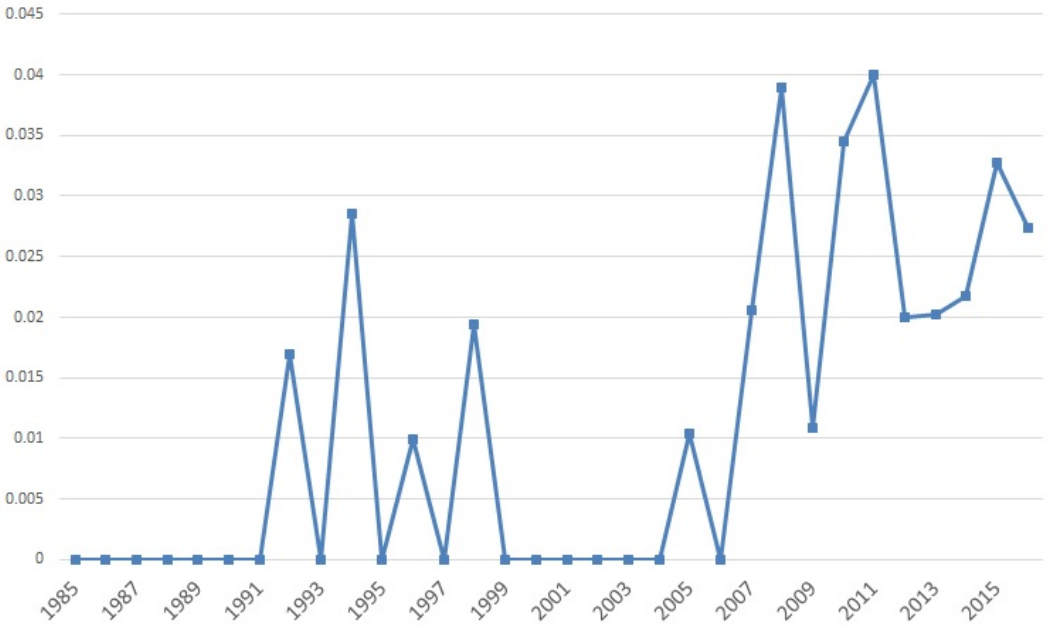


(a) Average and median maturity

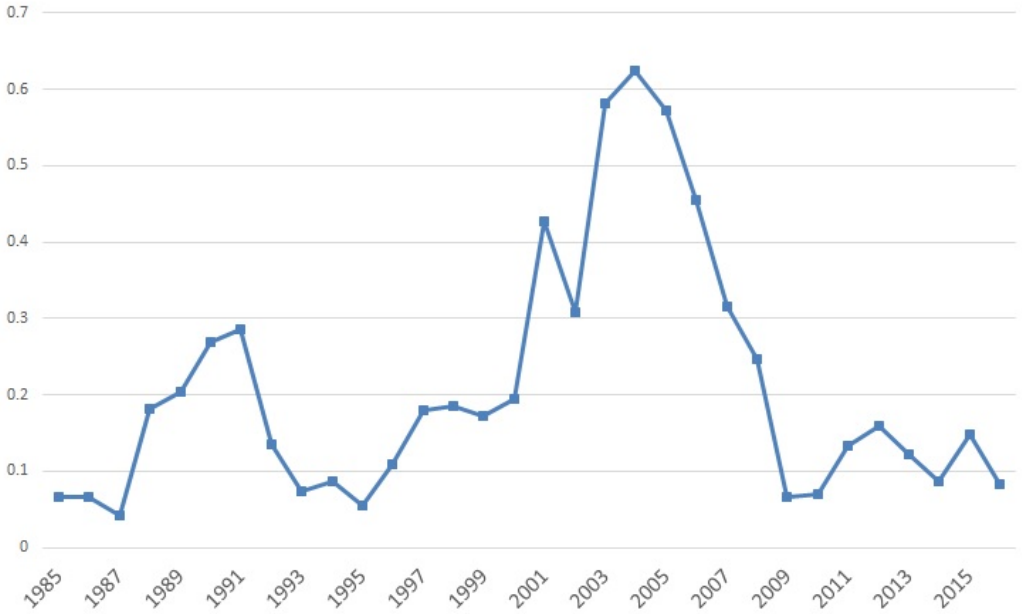


(b) Average maturity of Mergent and Merged sample

Figure 1: **Convertible bond maturity over the years**
This figure plots the average maturity of newly issued convertible bonds of the Mergent sample (2,765 observations, blue solid line) and median maturity (figure 1a, red dotted line) or average maturity of the Merged sample (figure 1b, 2,300 observations, red dotted line) for every year between 1985 and 2016.

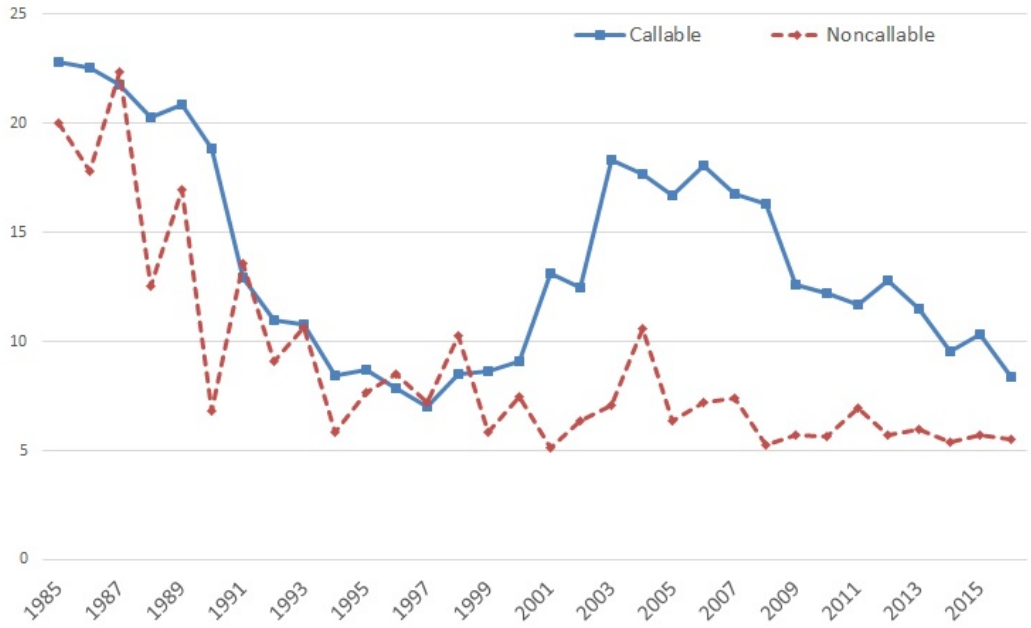


(a) Fraction of convertible bonds that have defaulted

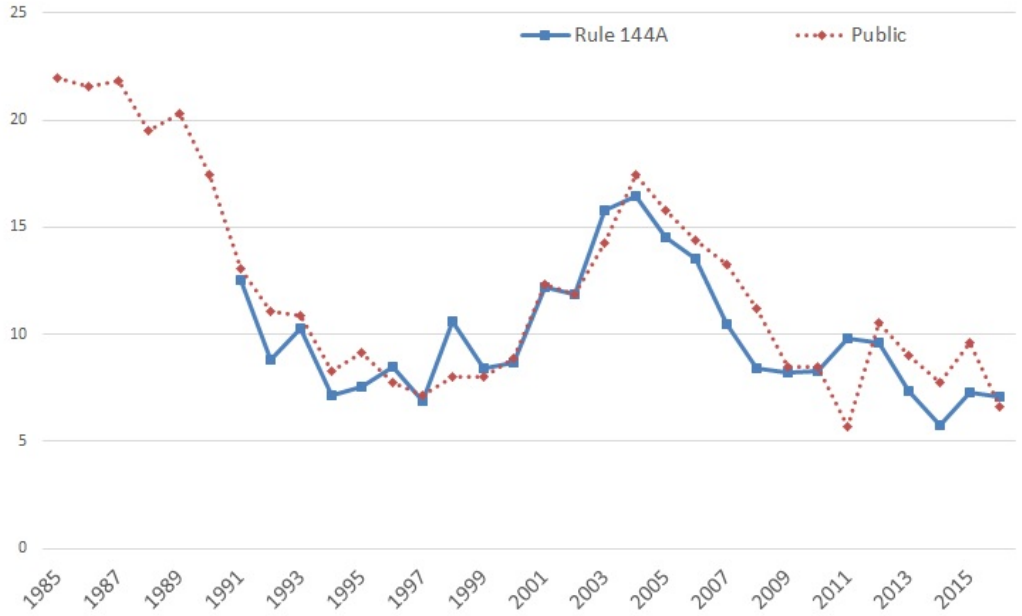


(b) Fraction of convertible bonds that are putable

Figure 2: **Convertible bond default rates and design over the years**
This figure plots the yearly fraction of newly issued convertible bonds that have defaulted (figure 2a), and the fraction of newly issued convertibles that are embedded with a put provision (figure 3b). The convertible bond data is taken from the Mergent sample with 2,765 obsservations.



(a) Average and median maturity



(b) Average maturity of Mergent and Merged sample

Figure 3: **Convertible bond maturity over the years: subsamples**
This figure plots the yearly average maturity of newly issued convertible bonds that are callable (figure 3a, blue solid line) and non-callable (figure 3a, red dotted line), privately placed under SEC Rule 144A (figure 3b, blue solid line) and publicly offered (red dotted line). The convertible bond data is taken from the Mergent sample with 2,765 obsservations.

Tables

Table 1: **Description and predictions of hypotheses**
This table summarizes the predictions of the agency cost hypothesis, liquidity risk hypothesis, signaling hypothesis and other hypotheses, for several firm-specific or macroeconomic variables (first column). The second column describes how the variables are measured. The third column describes the predicted sign of the relation with (convertible) bond maturity.

Variable Name	Measure	Prediction
Firm characteristics		
$SIZE$	log(Total Assets)	+
B/M	Book-to-market ratio	+
LEV	Total Liabilities/Total Assets	+
VOL	Stock Volatility	-
$PROF$	EBIT/Total Assets	+/-
DR	Depreciation/Net PPE	-
Macroeconomic conditions		
$REC1$	NBER: July 1990 - March 1991	-
$REC2$	NBER: March 2001 - November 2001	-
$REC3$	NBER: December 2007 - June 2009	-
TED	3m LIBOR - 3m T-Bill	-
DEF	Baa - Aaa yield	-
$TERM$	10y - 3m yield	-

Table 2: **Descriptive statistics convertible issues and issuers**
This table contains sample means of various characteristics of convertible bond issues and issuers over time. The first panel contains statistics on convertible issues: callability, credit rating and whether the convertible is privately placed under Rule 144A. The second panel contains statistics on the following firm characteristics: size (total assets), leverage (total liabilities/total assets), annualized stock volatility and profitability (EBIT/total assets). The last row shows the percentage of observations that are lost if we require observations to have firm-specific data.

Variable	1985-1990	1991-1995	1996-2000	2001-2005	2006-2010	2011-2016
Maturity	20.98	10.51	8.16	14.60	10.92	7.72
Callable	0.814	0.874	0.854	0.833	0.470	0.382
IG Rating	0.018	0.054	0.084	0.157	0.081	0.020
Junk Rating	0.056	0.222	0.203	0.234	0.176	0.102
144A	0.000	0.188	0.402	0.739	0.540	0.653
N (Mergent)	285	261	513	762	494	450
Total Assets	1,104	1,630	1,344	3,063	4,930	2,962
Leverage	0.536	0.557	0.452	0.529	0.552	0.528
Volatility	0.460	0.471	0.644	0.605	0.536	0.514
Profitability	0.079	0.084	0.013	0.001	0.011	-0.037
N (Merged)	231	202	381	650	447	389
%-Loss of N	18.9%	22.6%	25.7%	14.7%	9.5%	13.6%

Table 3: **Cross-sectional analysis of determinants of convertible bond maturity** This table contains the results of three OLS regressions. The dependent variable is the natural logarithm of convertible bond maturity. The independent variables are listed in the left column. T-statistics with robust standard errors are reported between brackets. *, ** and *** denote statistical significance at the 10%, 5% and 1% level, respectively.

Dependent variable: log maturity			
N=2,300	(1)	(2)	(3)
$SIZE$	0.085***	0.067***	0.071***
	(9.15)	(6.93)	(7.19)
B/M	-0.201***	-0.188***	-0.204***
	(-4.83)	(-4.52)	(-4.85)
LEV	-0.037	-0.057	-0.055
	(-0.75)	(-1.14)	(-1.08)
VOL	-0.352***	-0.329***	-0.329***
	(-7.84)	(-7.30)	(-7.30)
$PROF$	0.361***	0.348***	0.348***
	(5.52)	(5.44)	(5.22)
DR	-0.051	-0.038	0.003
	(-1.04)	(-0.78)	(0.06)
IG Rating		0.206***	0.179***
		(3.94)	(3.41)
Below-IG Rating		0.120***	0.112***
		(3.68)	(3.46)
Year dummies	Yes	Yes	Yes
Industry dummies	No	No	Yes
R^2	0.381	0.388	0.396

Table 4: **Robustness analysis of determinants of convertible bond maturity**
This table contains the results of five OLS regressions. The dependent variable is the convertible bond maturity in columns (1) to (3), and the natural logarithm of convertible bond maturity in columns (4) and (5). The independent variables are listed in the left column. T-statistics with robust standard errors (columns 1 to 3), standard errors clustered by year (column 4) and industry (column 5) are reported between brackets. *, ** and *** denote statistical significance at the 10%, 5% and 1% level, respectively.

Dependent variable: maturity (1-3), log maturity (4 and 5)					
N=2,300	(1)	(2)	(3)	(4)	(5)
$SIZE$	1.061***	0.823***	0.893***	0.071***	0.071***
	(9.42)	(6.94)	(7.37)	(5.43)	(6.01)
B/M	-2.402***	-2.176***	-2.430***	-0.204***	-0.204***
	(-5.17)	(-4.67)	(-5.08)	(-3.22)	(-3.03)
LEV	-0.378	-0.580	-0.584	-0.055	-0.055
	(-0.64)	(-0.99)	(-0.99)	(-0.72)	(-1.06)
VOL	-3.699***	-3.367***	-3.325***	-0.329***	-0.329***
	(-6.88)	(-6.28)	(-6.26)	(-6.86)	(-9.31)
$PROF$	4.380***	4.234***	4.232***	0.348**	0.348***
	(6.07)	(6.04)	(5.80)	(2.51)	(4.82)
DR	-0.723	-0.557	0.026	0.003	0.003
	(-1.24)	(-0.96)	(0.04)	(0.08)	(0.04)
IG Rating		2.938***	2.519***	0.179*	0.179***
		(4.41)	(3.76)	(1.87)	(2.60)
Below-IG Rating		1.355***	1.260***	0.112**	0.112**
		(3.24)	(3.04)	(2.45)	(2.40)
Year dummies	Yes	Yes	Yes	Yes	Yes
Industry dummies	No	No	Yes	Yes	Yes
Standard Errors	Robust	Robust	Robust	Year	Industry
R^2	0.375	0.383	0.394	0.396	0.396

Table 5: **Determinants of convertible bond maturity over time**
This table contains the results of six subperiod OLS regressions. The dependent variable is the natural logarithm of convertible bond maturity. The independent variables are listed in the left column. T-statistics with robust standard errors are reported between brackets. *, ** and *** denote statistical significance at the 10%, 5% and 1% level, respectively.

Dependent variable: log maturity						
	(1)	(2)	(3)	(4)	(5)	(6)
Period	1985-'90	'91-'95	'96-2000	'01-'05	'06-'10	'11-'16
$SIZE$	0.062***	0.043**	0.060***	0.127***	0.050	0.097***
	(2.68)	(2.40)	(3.05)	(5.76)	(1.59)	(3.66)
B/M	-0.138	0.074	-0.074	-0.390***	-0.376***	0.003
	(-1.09)	(0.71)	(-1.07)	(-4.40)	(-3.37)	(0.04)
LEV	-0.306**	-0.112	0.144*	-0.093	-0.188	-0.178*
	(-2.27)	(-0.87)	(1.90)	(-0.94)	(-1.27)	(-1.71)
VOL	-0.136	0.126	-0.087	-0.303***	-0.311***	-0.379***
	(-1.38)	(1.04)	(-0.93)	(-3.58)	(-2.71)	(-3.14)
$PROF$	1.244***	0.175	0.171	0.933***	0.259*	-0.168*
	(4.12)	(0.62)	(1.60)	(6.64)	(1.66)	(-1.66)
DR	0.234*	-0.174	0.026	0.115	-0.074	0.050
	(1.88)	(-1.50)	(0.27)	(1.15)	(-0.56)	(0.56)
IG Rating	-0.337***	-0.050	0.237**	0.266***	-0.242	-0.202**
	(-2.78)	(-0.44)	(2.14)	(3.37)	(-1.60)	(-2.24)
Below-IG Rating	-0.097	0.088*	-0.124**	0.084	0.234**	0.362***
	(-0.98)	(1.76)	(-2.46)	(1.49)	(2.32)	(3.46)
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes
Industry dummies	Yes	Yes	Yes	Yes	Yes	Yes
R^2	0.309	0.326	0.276	0.427	0.191	0.246
N	231	202	381	650	447	389

Table 6: **Pooled analysis of the trend in convertible bond maturity**
This table contains the results of five OLS regressions. The dependent variable is the natural logarithm of convertible bond maturity. The independent variables that are used are listed in the left column. T-statistics with robust standard errors are reported between brackets. *, ** and *** denote statistical significance at the 10%, 5% and 1% level, respectively.

Dependent variable: log maturity					
	(1)	(2)	(3)	(4)	(5)
Intercept	2.781***	2.546***	2.641***	2.792***	2.429***
	(123.68)	(38.38)	(44.38)	(83.05)	(27.27)
Trend	-0.029***	-0.029***	-0.032***	-0.029***	-0.032***
	(-24.00)	(-20.47)	(-20.67)	(-22.26)	(-17.61)
$REC1$		-0.144*			-0.202**
		(-1.66)			(-2.33)
$REC2$		-0.016			-0.016
		(-0.26)			(-0.27)
$REC3$		-0.429***			-0.386***
		(-4.76)			(-4.36)
TED		-0.053			-0.014
		(-1.13)			(-0.29)
DEF		0.271***			0.219***
		(5.81)			(4.53)
$TERM$		0.015			0.027**
		(1.19)			(2.06)
$SIZE$			0.073***		0.079***
			(7.40)		(7.75)
B/M			-0.071*		-0.143
			(-1.77)		(-3.35)
LEV			-0.005		-0.011
			(-0.10)		(-0.20)
VOL			-0.452***		-0.461***
			(-10.75)		(-10.71)
$PROF$			0.229***		0.213***
			(3.43)		(3.04)
DR			0.020		0.027
			(0.39)		(0.49)
IG Rating			0.155***		0.116**
			(2.86)		(2.12)
Below-IG Rating			0.069*		0.079**
			(1.94)		(2.25)
Industry dummies	No	No	No	Yes	Yes
R^2	0.122	0.143	0.237	0.133	0.262
N	2,765	2,765	2,300	2,765	2,300

Table 7: **Univariate analysis of convertible bond maturity and design**
This table contains a univariate comparison of the maturity between callable and non-callable convertibles, and convertibles placed under Rule 144A and offered publicly. The analysis is performed in four subperiods: before 2000, 2001-2005, 2006-2010 and 2011-2016. The values represent the subsample averages of the convertible bond in the left column. *, ** and *** denote that the difference in maturity between the two types of convertibles is statistically significant at the 10%, 5% and 1% level, respectively.

Average maturity	Before 2000	2001-2005	2006-2010	2011-2016
Callable	12.272	16.055	16.013	10.696
Non-callable	11.744	7.326	6.402	5.884
Difference	0.528	8.729***	9.611***	4.812***
Rule 144A	8.574	14.674	10.531	7.570
Public Offering	9.144	14.390	11.369	8.013
Difference	-0.570*	0.284	-0.838	-0.443

Table 8: **Analysis of convertible bond maturity and callability**
This table contains the results of five regressions. The dependent variable is the natural logarithm of convertible bond maturity. The independent variables that are used are listed in the left column. The regressions in columns (1) to (3) are performed in the complete Merged sample with 2,300 observations. The regressions in columns (4) and (5) are performend in subsamples of privately placed (under SEC Rule 144A, 1,139 observations) and publicly offered convertibles (1,161 observations), respectively. T-statistics with robust standard errors are reported between brackets. *, ** and *** denote statistical significance at the 10%, 5% and 1% level, respectively.

Dependent variable: log maturity					
	(1)	(2)	(3)	(4) Rule 144A	(5) Public
Intercept			2.161***	2.014***	2.234***
			(31.93)	(17.29)	(24.45)
Trend			-0.022***	-0.011***	-0.031***
			(-12.54)	(-3.33)	(-13.1)
Callable	0.549***	0.524***	0.474***	0.619***	0.330***
	(18.02)	(18.13)	(17.06)	(17.69)	(7.52)
$SIZE$		0.067***	0.068***	0.049***	0.083***
		(7.49)	(7.38)	(3.37)	(7.05)
B/M		-0.222***	-0.055	-0.027	-0.071
		(-5.64)	(-1.52)	(-0.46)	(-1.38)
LEV		-0.050	0.021	-0.02	0.043
		(-1.04)	(0.42)	(-0.29)	(0.61)
VOL		-0.317***	-0.484***	-0.452***	-0.453***
		(-7.45)	(-11.94)	(-7.80)	(-7.59)
$PROF$		0.286***	0.196***	0.114	0.268***
		(4.59)	(3.04)	(1.35)	(2.83)
DR		0.015	0.043	-0.036	0.106
		(0.33)	(0.91)	(-0.62)	(1.37)
IG Rating		0.197***	0.118**	0.220***	0.051
		(4.26)	(2.50)	(3.50)	(0.72)
Below-IG Rating		0.100***	0.025	0.095**	-0.005
		(3.44)	(0.17)	(2.09)	(-0.10)
Year dummies	Yes	Yes	No	No	No
Industry dummies	Yes	Yes	No	No	No
R^2	0.400	0.492	0.328	0.356	0.339
N	2,300	2,300	2,300	1,139	1,161