Where are they now? An analysis of the life cycle of convertible bonds

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ABSTRACT

We study the determinants of life span of convertible bonds issued between 1980 and 1998. About 60% of the bonds survive either to a call or to their maturity. The issuers of the remaining bonds are delisted during the life of their bonds. Calls and delistings shorten the average life span of convertibles from the original 17 years to an effective life span of only 7 years. Issuer's post-issuance performance and investment behavior affect the effective life of convertibles. Our results support the sequential financing hypothesis, as bonds issued by firms with speedier investment schedules have shorter life spans.

KEYWORDS: convertible bonds, callability

JEL Classification G13, G30, G32

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1. Introduction

Two points in the life cycle of convertible bonds have received lively research interest, namely their birth in issuance, and their "death" through a call. However, besides recent studies by King and Mauer (2012), and Grundy and Verwijmeren (2012), few papers consider the entire life cycle of convertible bonds and the joint determinants of their tenure. We aim to fill that gap with this study. We track the life of a convertible bond sample that was initially issued between 1981 and 1998, and study determinants of the effective life of those bonds.

Our study has two main goals. First, we seek to provide information concerning factors that affect the end of life for these bonds. How common is it for them to be called vs. how many of them mature as bonds? How many of them cease to exist for other reasons, such as mergers and firm failures? Secondly, we observe certain design features in convertible bonds, and relate those design features to existing literature that motivates their usage. Features such as conversion premium, coupon rate, maturity, callability and call protection all come with potential costs and benefits. We seek to evaluate how the use of these design features is related to the subsequent behavior of the issuing firms. The existing studies on call policy of convertible bonds focus on factors such as yield differential and conversion premium as determinants of call policy. Our focus is different, as we measure the calendar time that the bonds remain active beyond their call protection period. Our results should be of interest to convertible bond investors such as commercial banks, whose ability to remain invested in the issue is limited after a forced conversion to equity, and to hedge funds holding a convertible bond as one leg in a convertible arbitrage portfolio. For both groups, an unexpected shortening of the life of a convertible bond would present unexpected transaction costs.

Our results indicate that many convertible bond issuers are delisted during the life of the convertible. Out of our 955 sample bonds, only 60% remain active to either a call announcement or to original maturity. Over 65% of the delistings, counting for about 26% of the original sample, occur due to mergers, while about 12% of the original sample is either liquidated or dropped by the stock exchange. Both calls and delistings have the effect of significantly shortening the effective life span of convertible bonds. For the overall sample, the effective life span falls from an original time to maturity of about 17 years to a realized life span of about 7 years. In observing the connection between the design of convertible bonds and their eventual life cycle, we exclude bonds whose issuers are delisted, as we assume that mergers and bankruptcies are not foreseen at the time of the issuance.

We find that features in the original bond design have a limited effect on the length of the bond's life. Bonds with longer original maturities survive longer as bonds, and bonds with higher (original) yield advantage tend to be called sooner. Call protection type and conversion premium fail to affect the bonds' life cycle in a consistent manner. Issuer's performance after issuance, however, has a significant effect on the life span of the convertible. Higher post issuance stock returns shorten the life of convertibles, and improvements in an issuer's credit rating have a similar effect.

Most interestingly, firms with high capital expenditures subsequent to issuance call their bonds sooner. That finding is consistent with the sequential financing hypothesis, forwarded by Mayers (1998). Using three different measures suggested by Korkeamaki and Moore (2004) to gauge convertible issuers' post-issuance investment activity, we find that firms with speedier investment schedules tend to call their bonds more quickly. The connection between the bond's tenure and its issuer's subsequent capital investments is robust to controlling for several issue, issuer and market characteristics, including the variables noted above, and factors such as issuers' Tobin's Q at issuance and issuers' stock return volatility after issuance.

Our regressions with sub-samples that are specific to certain security design features show that the connection between the length of convertible bond life cycle and issuer's capital expenditure growth is present in samples with different call protection types and in different time sub-samples. When we study sub-samples that are based on whether the issue is an equity-like or a debt-like convertible, as defined in Lewis, Rogalski, and Seward (2003), we find that the connection between life span beyond call protection and investment growth is present only in the debt-like convertible bond sample. This suggests that with equity-like convertibles, issuance motives other than sequential financing play an important role.[1]

2. Determinants of issuance and calling of convertible bonds

2.1 Issuance motives

The literature provides several different motivations for issuance of convertible bonds. The proposed motives are not mutually exclusive, and empirical studies have failed to provide conclusive evidence for one being more important than the others in motivating convertible bond usage. Green (1984) and Mikkelson (1980) highlight the value of convertibles in incentive alignment among security holders. At issuance, the conversion feature reduces the risk inherent in bonds, and thus can entice investors to invest (Brennan and Schwartz, 1988). Lewis, Rogalski, and Seward (2003) find that convertible bond issuers have better investment

[1] Brown, Grundy, Lewis, and Verwijmeren (2012) report that convertibles that are privately issued to hedge funds tend to be very equity-like. It is safe to assume that for such bonds, the connection to issuer's capital expenditure growth would be weaker.

opportunities but lower investment growth, which leads them to suggest that convertible debt alleviates overinvestment problems.

Stein (1992) suggests the use of convertibles as backdoor equity. Firms that ultimately want to issue equity resort to convertibles because equity is prohibitively expensive for them to issue. Convertibles can also satisfy an investor's appetite for equity. Papers by Brown, Grundy, Lewis, and Verwijmeren (2012) and de Jong, Dutordoir, and Verwijmeren (2011) focus on the recent expansion of private (144A) issues in the convertible market. They suggest that firms issue convertibles privately to hedge funds engaging in convertible arbitrage. The firms save on issuance costs, compared to a public seasoned equity offering, while enabling hedge funds to form arbitrage portfolios consisting of convertible bonds and short positions in the underlying stock.[2] Lewis and Verwijmeren (2011) note the speed of financial engineering, continuously creating new issue features in hybrid securities such as convertible bonds. For example, towards the latter part of their sample that runs from 2000 to 2007, more than half of the convertible bonds are cash-settled – a feature that was non-existent during our sample years.

Convertibles have also been suggested as vehicles to finance sequential financing needs (Mayers, 1998; Wang, 2009). The sequential financing motivation of convertible issuance suggests that due to agency costs between management and investors, financing is obtained gradually. The firm issues a convertible bond to finance the first sequence, and then, at the time the firm is ready for the following sequence, it forces conversion of the convertible, reducing debt on the balance sheet, which allows financing of the next sequence.

2.2 Call determinants

[2] Evidence of such convertible arbitrage is reported already much earlier by Brent, Morse, and Stice (1990), who report higher levels of short interest in the stock of firms with convertible bonds outstanding.

Under perfect market assumptions, the firm should call its convertible bond as soon as the conversion value of the bond reaches the stated call price (Ingersoll, 1977; Brennan and Schwartz, 1977). When the value of the bond exceeds the conversion value, a potential for wealth transfer from bond holders to stock holders exists, which increases management's incentive to place a call (Byrd, Mann, Moore, and Ramanlal, 1998). However, the notice period between the call announcement and the time of eventual conversion/redemption limits management's ability to transfer wealth. As opposed to conversion to equity, redemption by convertible holders requires cash, and couldeven jeopardize the financial health of the firm (Jaffee and Shleifer, 1990). Paired with the higher transaction costs of redemption, firms predominantly call their convertibles only when a sufficient safety premium exists. Asquith and Mullins (1991) cite a conversion premium of 20 to 25 percent as the premium "most often mentioned by investment banks". Call protection terms and safety cushion account for a large portion of the observed premium (Asquith, 1995).

The difference between the coupon interest of the bond and the dividend yield of the stock should be a significant factor in the firm's incentives to call the bond. When a dividend yield advantage exists, the firm may let the bond remain uncalled. In such case, savvy investors will voluntarily convert to equity, which saves the firm transaction costs, while "sleeping" investors will fail to notice the yield differential (Constantinides and Grundy, 1987). Recent findings by Grundy and Verwijmeren (2012) support the importance of yield advantage in explaining earlier reported delays to call convertible bonds. They find that dividend protection, which has become a common feature in more recent convertible bond issues, and abolishes the effects that dividends would have on investors' conversion decision, has reduced call delays significantly.

2.3 The life cycle of convertible bonds

Few studies consider the life cycle of convertible bonds in its entirety. Asquith (1995) studies convertible bonds issued between 1980 and 1982 to determine whether the call policies used by the issuing firms are optimal. More recently, King and Mauer (2012) and Grundy and Verwijmeren (2012) use a similar strategy. These works focus on the determinants of the call policy, with less emphasis on the security design. Bhabra and Patel (1996) compare convertible bonds that ultimately bring equity to the firm's capital structure against those that fail to do so. They find that the two groups come with similar contract terms, but that firms whose bonds remain bonds tend to be riskier, smaller, less profitable, and have lower market-to-book ratios. These findings lead Bhabra and Patel (1996) to label the latter group 'mimickers'.

In the current study, we observe both the initial security design features and the subsequent call behavior. We seek to explore the determinants of the length of the life cycle of convertible bonds, and both security design and call behavior should have an effect on it. While most of the literature on calls of convertible bonds observes the relation between the firm's stock price and the conversion price of its convertible bond, our main variable of interest is the time that the convertible bond remains as a bond. Since call protection disallows the issuer to call the issue while the protection is in effect, we are interested in the time period after the call protection has expired.

Sequential financing is forwarded by Mayers (1998) as an issuance motive for convertible bonds. In sequential financing, the firm initially issues a convertible bond with an idea that once the next investment stage arrives, the firm can force conversion on its convertible, thereby cleaning up its balance sheet, which further allows a new issue to finance the following investment sequence. Call provisions and call protection play crucial roles in security design for firms that use convertibles for sequential financing. Korkeamaki and Moore (2004) provide evidence of a connection between the call protection period in convertible bonds, and their issuers' investment behavior subsequent to the issue. They report that firms whose subsequent capital expenditures grow faster tend to provide weaker call protection terms for their convertible bonds. Besides the implied connection between call protection terms and expected timing of financing needs, the sequential financing hypothesis implies also that firms adjust their call behavior depending on their investment growth so that issuers with fast investment growth call their convertibles sooner.[3] Building on the assumption that convertibles are used for sequential financing, we expect that firms with faster investment growth subsequent to the issue would call their bonds sooner, after controlling for call protection and factors that have been found to affect call delays in prior literature.

3. Data

Most of the issue-specific data used in this study come from Securities Data Corporation's (SDC) New Issues database. Altogether, SDC reports 4,262 convertible bond issues between 1980 and 1998. Tofocus on a relatively homogenous group of convertible bonds, we exclude all issues with the following characteristics from the sample: (1) original maturity of two years or less, (2) variable coupon rate (including reset issues), (3) issues exchangeable or convertible to a security other than the issuing company's common stock, (4) issues that were combined with

[3] This latter point is challenged by Alderson, Betker, and Stock (2006), who report that investment behavior of convertible issuers who force conversion on their convertibles is not different from those convertible issuers who call their convertibles out of the money. However, a recent study by Chen, Mao, and Wang (2010) provides a rationale for a connection between investment patterns and call behavior even in the absence of a conversion option, suggesting that calls of out-of-the-money convertibles could also be motivated by increasing investments by the firm.

other types of securities. Also, issues for which neither SDC, issuance announcements on Lexis-Nexis Academic Universe, SEC's Edgar database nor Moody's Industrial Manuals provide call protection terms were rejected. For the remaining sample, primary SIC codes were obtained from Standard & Poor's COMPUSTAT database. After elimination of issuers with primary SIC codes between 6000 and 7000 (financial institutions), the final sample consists of 955 convertible bond issues.

As of 2007, nine years have passed since the last bond in this sample was issued. This allows us to observe a significant portion of their realized tenure. We gather information on which of our sample bonds have been called, and track issuers for potential delistings. We have identified call events from call announcements using the Lexis-Nexis Academic Universe and Bloomberg. The delistings are captured from the CRSP database, so that the issuer is classified as delisted if a delisting code appears for it in the CRSP database before either a call event or the maturity date of the convertible bond. If no call announcement for the bond can be found in either Lexis-Nexis or Bloomberg, and the issuer's stock remains active according to CRSP, we classify the bond either as matured or as still running, depending on its original maturity. At the end of 2007, 43 out of the original 955 bonds are still determined to be active. Their continued existence is confirmed using Bloomberg.

Convertible bondscould retire prior to their maturity in ways other than through a call by the issuer. Besides termination of issuer's stock through either a merger or a bankruptcy, Grundy and Verwijmeren (2012) note exchange offers by issuers, full exercises of put features and full voluntary conversions by investors as possible ways the life of a convertible bond may end. In this study, we have concentrated on calls and maturing bonds, while also capturing delistings due to various reasons. The above-mentioned alternative causes of convertible bond retirement are relatively infrequent[4], and besides exchange offers, they are outside the control of the bond issuer.

Table 1 provides information about our sample. In Panel A, we segregate the delisted issues further, based on the delisting codes from CRSP. The most common reason for delistings is mergers. About 66% of the delisted issuers disappear from the CRSP database for that reason. Numerous issuers also confront business difficulties, as 111 out of the total 379 delisted issuers are either liquidated or dropped by the stock exchange.

Insert Table 1

In Panel B of Table 1, we report the bond outcomes by their call protection types. Soft call protection is contingent on the issuer's stock price. For example, a convertible bond with a 140 percent soft call protection is callable during the call protection period if the stock price is at least 40% above a predetermined price level for a set number of days. Hard call protection dictates that the bond is not callable during the protection period.[5] We classify bonds as having an absolute call protection if they have hard call protection for their entire life.[6] Between the two most common call protection types, namely soft and hard call protection, calls are almost equally common, as 41% of bonds with soft call protection and 43% of bonds with hard call protection

[4] In the Grundy and Verwijmeren (2012) sample (bonds issued between 2000 and 2006), 93% of the sample retires either through a call, a delisting, or is still running at the time of the observation.

[5] Convertible bond issuance is a field where active financial engineering activity produces new contract innovations (see Lewis and Verwijmeren, 2011). Our sample precedes most recent innovations, such as cash settled issues and joint issues of convertibles and stock for convertible arbitrage demand by hedge funds (de Jong, Dutordoir, and Verwijmeren, 2011). A significant change in contract design that occurs during our sample years is the emergence of call protection and shifting between soft and hard call protection terms (Korkeamäki and Moore, 2004). We consider different call protection terms separately, and also include issue year dummies in our regression analysis to control for potential unobserved time-dependent heteroskedasticity in security design features.

[6] Since bonds with absolute call protection allow neither security design nor firm behavior to play a role in the bonds' life span, we exclude the nine bonds with absolute call protection that are not delisted from our regression analysis in Section 4.

are called. Issuers who offered soft call protection on their bonds have been delisted somewhat more commonly, whereas running to maturity is more common among hard call protection, and even more so among bonds with absolute call protection.

In Panel C of Table 1, we report the original maturity and the realized effective life span of our sample bonds, by call protection type, and by whether the bonds end up being called or not. The effective life span of the bonds is severely shorter than the original tie to maturity. It appears that both calls and delistings have a similar effect on shortening of the bonds' life span. The average effective life span for called bonds falls from the original 17.16 years to the realized 7.09 years. For the non-called bonds the corresponding figures are 16.59 years, and 7.38 years. The latter group includes bonds that are delisted. Consistent with our evidence, Brown, Grundy, Lewis, and Verwijmeren (2012) report that 13.38% of their sample of convertibles issued between 2000 and 2008 are outstanding after 5 years.

Finally, in Panel D of Table 1, we compare the length of the call protection period and the eventual life span past the protection period between bonds with soft and hard call protection. Panel D only includes bonds that either matured (or continue to be active at the end of 2007) or were called. No marked differences exist between the two call protection types, with the exception that among those bonds that are called, bonds with hard call protection are called somewhat sooner after the protection period expires. The difference is slightly more substantial than it appears, as some of the bonds with soft protection are actually called during their protection period, as King and Mauer (2012) report.

4. Determinants of convertible bond life span

In this section, we turn to regression analysis to study determinants of the tenure of convertible bonds.

4.1 Variables used in the regression analysis

As Asquith (1995) and numerous subsequent authors point out the importance of call protection in lengthening the life of convertible callable bonds, our main interest is in the bonds' tenure past their call protection period. Therefore, in our regression specifications, the dependent variable is set to capture the length of the time period after the bond's call protection expires. We do not rely on the first call information in the SDC database because for bonds with soft call protection, first call is typically defined to equal the issue date. We specify our dependent variable PASTPROT as follows:

$$\text{PASTPROT} = \log[1 + t_{end} - t_{prot}], \qquad (1)$$

where t_{end} represents the time from issuance to either the bond's call date or maturity, whichever is sooner, and t_{prot} is the time from issuance to the end of the bond's call protection period. For bonds that remain active at the end of 2007, we assume that they continue to run through their maturity. Our aim is to observe the effects that both the initial design, and the call policy determinants have on the tenure of convertible bonds. Therefore, our regression analysis excludes bonds that are eventually delisted, under the assumption that their delistings were not foreseen and predicted at the time of the issuance[7].

[7] As mentioned above, mergers are the most common reason for delistings. The treatment of convertible bonds in mergers varies. Some are retired and some are assumed by the acquiring firm.With some of the issues that are

Most of the independent variables in our regressions are motivated by prior studies on call policy of convertible callable bonds. Conversion premium is the key variable in most prior studies, and we expect bonds with higher original conversion premium (CONVPREM) to live longer. A yield advantage of the bond over the underlying stock could cause the firm to rush calling its convertible. Accordingly, a high yield advantage (YIELDA) should shorten a bond's life.[8] Firms with greater stock returns after the issuance will have the conversion options in their convertible bonds in-the-money sooner. As issuers are thus able to force conversion sooner, this could shorten the time to call. We measure post-issuance returns with variable RET, which captures the issuers' cumulative stock returns during the 500 trading days (2 years) following the issuance.[9] Stock volatility could induce firms to allow an additional safety premium to accumulate before mounting a call on their convertible bond. We control for that effect with the variable POSTVOL, which represents the standard deviation of the issuer's stock returns, measured during the 250 trading days after the issuance.

High coupon (COUPON) bonds are less likely to offer a yield advantage, but they are also more likely to be called for refinancing, which should further shorten the life of those bonds. Decreases in corporate bond yields will also induce some issuers to call their bonds for refinancing. We control for that effect with the variable RATECHG, which measures the change in Moody's AAA corporate bond yield index from issuance to three years after it.[10] At the firm

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acquired prior to a call or maturity, we are able to determine that the bond continues its life after the deal. However, it is difficult to track all of the bonds in a consistent manner through a merger. We have therefore decided to discard those bonds from our regression samples.

[8] While most of our issue-specific data come from the SDC, we have used Compustat as a secondary data source in cases where SDC reports missing data points. Yield advantage is missing for a large number of our sample bonds in the SDC database, which is why we have used SDC's original yield minus Compustat's dividend yield at issuance as our proxy of yield advantage.

[9] We also use the five-year post-issuance return as an alternative measure.

[10] Data come from The Federal Reserve Bank of St. Louis. We use annual averages of the index. The three-year time window is motivated by the normal call protection period being around three years. However, using 5-year changes instead of 3-year changes yields identical inferences.

level, improvements in the issuer's credit rating could allow refinancing at a lower rate, and thus provide a motive for an earlier call of the convertible. We obtain issuers' Moody's credit ratings three years after the issuance from Thomson One, and compare them to the same ratings at issuance, as reported by the SDC New Issues database. The credit rating improves for 43 bonds in our sample, and deteriorates for 16 of them. We use an indicator variable for positive rating changes (RATING+) to control for any effect that they would have on the firms' call behavior. Some of the calls may be motivated by a large amount of voluntary conversion, in which case the company would institute a so-called "clean up" call. By controlling for the amount of the issue outstanding at the time of the call (OUTSTANDING = amount outstanding at call/original proceeds), we control for that effect.

Given that we measure the time between the end of the call protection period and either call or maturity with our dependent variable, it is obvious that the bond's original maturity affects that measure. We include the variable LOGMAT (defined as log(1 + time between call protection end and maturity)) to capture the effect of original time to maturity on the realized maturity.

Korkeamaki and Moore (2004) provide evidence of sequential financing by showinga connection between convertible bonds' call protection and issuers' subsequent investment behavior. While we control for call protection type with the variable PROTTYPE (takes on values of zero for no protection, one for soft protection, two for hard protection, and three for absolute protection), we also include measures of the issuer's investment behavior after the issuance. Following Korkeamaki and Moore (2004), our variable CAPRATE is defined as follows.

$$CAPRATE = (C_1/A_1) + (C_2/A_2)/2 + ... + (C_5/A_5)/5, \quad (2)$$

where C_i = capital expenditures in each year i following the issuance, and A_i = total assets at the end of each year i, i = 1, ..., 5. Firms with high investments occurring soon after the issuance exhibit high CAPRATE values, and are more likely to call sooner, which, according to the sequential financing hypothesis makes them ready to finance their next investment sequence. Therefore, a high CAPRATE value should shorten the bond's life. Lewis, Rogalski, and Seward (2003) motivate measurement of convertible bond issuers' behavior relative to their industry. Thus, we also define a version of the CAPRATE measure where each year's industry median (C_t/A_t) is subtracted from the firm-level observation as our main measure of a firms' post-issuance investment behavior.[11] We denote the industry-adjusted measure as CAPRATEIND. Some of the firms in our regression sample (53 out of 447 firms), discontinue reporting capital expenditures in Compustat at some point after the issuance. While our main sample consists of only firms with available capital expenditures throughout the CAPRATE measurement period, we consider among our robustness tests a possibility that capital expenditures are not reported because they do not exist.

As an alternative proxy for post-issuance investment growth, we use TIMING, which is also defined and used by Korkeamaki and Moore (2004). For TIMING, we calculate the issuer's cumulative capital expenditures for the five years following the issuance, and then track when those expenditures surpass the proceeds of the issue. TIMING is the number of years when the cumulative capital expenditures exceed the proceeds from the convertible. Thus, TIMING varies from 1 to 5.

[11] Korkeamaki and Moore (2004) consider this industry-adjusted CAPRATE measure in one of their robustness tests.

Finally, we include a size proxy (log(total assets)), measures of relative proceeds (proceeds/total assets), and leverage (total debt/total assets), and a growth option proxy (log(Tobin's Q)) as control variables. They are all commonly used proxies in studies of convertible bond calls. Time variation affects several variables in our models through business cycles. Also, convertible bond issuance activity (see our Table 1), usage of call protection (see Korkeamaki and Moore, 2004), and other innovations in convertible bond design (see Lewis and Verwijmeren, 2011) introduce time variation into our sample. To ensure that such variation does not cause our models to be biased, we use issue-year dummies in all of our regression specifications. In the interest of space, we do not report the coefficient values for the issue-year dummies in our tables.[12]

4.2 Regression results

We begin the regression analysis of our data in Table 2. In column (1), we show our base model, where all the aforementioned control variables are included. We are measuring the post-issuance investment growth with the variant of the CAPRATE variable that excludes firms that fail to report a value for capital expenditures in any of the five years subsequent to the issue. Not surprisingly, the bond's original time to maturity past call protection is positively related to its eventual life span. The coefficient for protection type is negative albeit statistically insignificant. Although Korkeamaki and Moore (2004) show that protection type is related to a firms' subsequent investment growth so that firms with faster investment growth provide weaker call protection, our results indicate that bonds' tenure past their call protection period is somewhat

[12] Additional variables that we have considered in unreported regressions include change in assets in the year of the issuance (motivated by Lewis, Rogalski, and Seward, 2003), market-to-book in years after the issuance (motivated by King and Mauer, 2012 as a control for agency issues related to the call decision), and an indicator for private issues (motivated by different motives for issues directed to institutional investors, e.g., in de Jong, Dutordoir, and Verwijmeren, 2011). Inclusion of these additional variables leaves our reported findings intact.

shorter for bonds with stronger call protection. As expected, yield advantage is inversely related to the bond's life span beyond its call protection, indicating that bonds that offer higher yields than their underlying stocks tend to be called sooner. The indicator for positive credit rating changes enters with a strong negative coefficient, supporting the notion that firms that experience improvements in their credit terms call their outstanding convertible bonds sooner. Our test variable CAPRATE enters with a negative and significant coefficient, indicating that firms that invest sooner appear to be calling their bonds sooner. In summary, besides the original maturity, other security design features seem to play a very minor role in determining the life span of convertible bonds beyond their call protection period. Meanwhile, the firm's post-issuance success, measured by stock returns, credit rating changes, and investment growth seem to be important determinants of the bond's life cycle.

In column (2), we re-estimate CAPRATE, assuming that a missing observation for capital expenditures in a year indicates that the firm had no capital expenditures that year. The sample grows by 53 observations, which indicates the number of firms with a missing value for capital expenditures in any of the five years subsequent to issuance. The connection between capital expenditure growth and the life span of the convertible is robust to this alternative definition. Among control variables, the original coupon rate and the post-issuance interest rate change enter now with a statistically significant positive sign and findings regarding yield advantage strengthen somewhat. Otherwise, the results are very similar between the first two columns of Table 2.

Insert Table 2

In column (3) of Table 2, we use TIMING as our measure of firms' post-issuance investment behavior. The expectation for TIMING is the opposite to that of CAPRATE, as a larger value for TIMING indicates a slower accumulation of capital expenditure investments. The coefficient for TIMING is positive albeit not statistically significant. CAPRATE takes into account the investment growth relative to the whole firm, whereas TIMING relates capital expenditures to the size of the issue. This part of the effectcould be captured by the control variable for relative proceeds. The coefficient of TIMING strengthens when we leave PROCEEDS out of the regression, but it remains still slightly below the conventional levels of statistical significance (results not reported in detail). We will focus on the CAPRATE measure in our subsequent tests.

In column (4) of Table 2, we employ the industry-adjusted CAPRATE measure (referred to as CAPRATEIND), still assuming that non-reported capital expenditures mean no capital expenditures. Compared to results in column (2), the inverse relation between capital expenditure growth and life span beyond call protection period gains additional statistical strength. In column (5) of Table 2, we rerun the column (1) specification while using five-year cumulative returns in place of the two-year returns considered earlier. Our results regarding CAPRATE become even stronger in this specification.

In column (6) of Table 2 we use an alternative, simpler dependent variable. END is defined as the natural logarithm of (1 + time to end of life), where time to end-of-life is measured from issuance. Therefore, END does not consider the call protection period in the way PASTPROT does. This alternative dependent variable yields surprisingly similar results, compared to those reported earlier. The only marked differences are that leverage enters now with a statistically significant coefficient, and the original maturity is no longer connected with the life span of the bond. Our findings regarding CAPRATE remain intact, as firms with speedier investment schedules after issuance tend to have bonds with shorter life spans. Our results are not materially affected by the inclusion of year dummies in our regressions. The *t*-statistics for CAPRATE are 2.898 and 2.853, when PASTPROT or END is used as a dependent variable on regressions without year dummies, respectively. In the interest of space, we do not tabulate these regression results.

In summary, the results in Table 2 suggest that factors related to both optimal call policy and post-issuance growth of investment opportunities play an important effect on the life span of convertible bonds. The findings on yield advantage (YIELDA) and capital expenditure growth (CAPRATE/CAPRATEIND) are consistent across the specifications reported in Table 2. Also, the notion that convertible bond financing is used by marginal bond issuer receives support, as firms with good post-issuance performance and those firms whose credit rating improves tend to call their bonds sooner.

4.3 Time variation in the connection between life span and investment growth

Our findings could be affected by changes in the structure of the convertible market and types of issues during our sample period. For example, Korkeamaki and Moore (2004) report that the dominant type of call protection among U.S. issuers shifts from soft call protection to hard call protection around 1990. Recall the role of financial innovation in changing the landscape of the convertible bond market through time (Lewis and Verwijmeren, 2011). Although the issue-year dummies that we use in all of our regressions should reduce such concerns, we further evaluate whether any such changes in markets and bond design affects our findings reported above, by splitting our sample into two time periods. In the first two columns of Table 3, we rerun the regression specification from column (1) of Table 2, with time-specific sub-samples. We divide our sample somewhat arbitrarily by including issues in years 1980-1986 in column (1) of Table 3, and issues from 1987 to 1998 in column (2).[13] Our findings regarding CAPRATE persist in both time periods, albeit the coefficient loses some of its size and statistical significance in the latter sub-sample. Among other variables, relative proceeds and conversion premium are significant only in the earlier period, whereas yield advantage and post-issuance volatility are significant only in the latter period. Also, the effect of post-issuance rating changes on the life span is much weaker in the latter period.

Another aspect that has changed drastically in the convertible bond market in the last few years is the prevalence of private issues, issued under rule 144A. Brown, Grundy, Lewis, and Verwijmeren (2012) report that in the period from 2000 to 2008, 85% of convertible issues in the SDC database are private issues. The behavior of these private issues might differ from the public market, as a large proportion of the investment in them comes from hedge funds that engage in convertible arbitrage (Brown, Grundy, Lewis, and Verwijmeren, 2012). Within our sample, 153 issues, or about 16%, are private. However, only four of those issues live to either a call announcement or maturity. As mentioned above, in unreported tests we include a dummy variable for those issues. The dummy enters with an insignificant coefficient in our regressions, and alternatively leaving those four issues out of our regression samples has no effect on our findings.

Insert Table 3

[13] Even in these regressions, we include issue-year dummies to control for time variation within each sub-sample.

We repeat some of the robustness tests from Table 2 also in the time-specific sub-samples. Columns (3) and (4) of Table 3 indicate that accounting for industry-effects in investment growth by using industry-adjusted capital expenditures strengthens the connection between capital expenditure growth and convertible bond life span. In columns (5) and (6), the analysis is again repeated for END as the dependent variable. The results weaken, and for the latter time period, they are no longer statistically significant.

The evidence reported in Table 3 suggests that the relative importance of determinants of the life span of convertible bonds has varied somewhat through time. Factors related to firms' post-issuance investment growth (CAPRATE/CAPRATEIND) and performance (RET and RATING+) have weakened over time, with rating changes losing their statistical significance in the latter half of our sample period. Also, the size of the issue affects its subsequent tenure only among earlier issues. In contrast, yield advantage (YIELDA) and post-issuance volatility (POSTVOL) have emerged as significant determinants of convertible bond life span during the latter part of our sample.

4.4 Security design and the connection between life span and investment growth

Korkeamaki and Moore (2004) show that call protection type is related to the subsequent investment patterns of convertible issuers. While our evidence above suggests a minor role for call protection type in determining convertible bonds' tenure past their call protection period, we next study further whether differences among bonds with different call protection types influence our findings. In column (1) of Table 3, we exclude bonds that were issued without call protection, and thus include only bonds with either soft or hard call protection.[14] As bonds without call protection are callable from their issue date, they could introduce a bias into our

[14] Recall that all our regressions exclude bonds with absolute call protection.

measure of PASTPROT. However, the results are very similar to those reported earlier, indicating that presence of bonds with no call protection does not affect our results.

Insert Table 3

In columns (2) and (3) of Table 3, we isolate the effects of call protection type choice by running regressions in sub-samples that include only convertible bonds with soft or hard protection, respectively. Although the effects of some of our control variables, such as firm size, relative proceeds, and post-issuance volatility on convertible bond tenure seem to vary by call protection type, the effect of post-issuance capital expenditure growth remains intact in both sub-samples.

Lewis, Rogalski, and Seward (2003) argue that because convertible bonds contain numerous contract terms that can be used to adjust their implications, it is not meaningful to observe individual contract terms in isolation. They propose compiling a single measure of likelihood of conversion to equity using the Black-Scholes model. Their measure allows them to divide convertible bonds to equity-like and debt-like issues, where the latter group exhibits a lower likelihood of conversion.[15] We follow Lewis, Rogalski, and Seward (2003) work, and classify our convertibles as either bond-like or equity-like.[16] Columns (4) and (5) of Table 3 show the results for regressions with equity-like and debt-like sub-samples, respectively. Unlike Lewis, Rogalski, and Seward (2003), we find debt-like convertibles to be more common than

[15] Lewis, Rogalski, and Seward (2003) use the $N(d_2)$ measure from the Black-Scholes model to determine the likelihood of exercise of the conversion option by the convertible investor. The measure is thus a function of current underlying stock price, conversion price, risk-free rate, dividend yield, volatility of the underlying stock, and time to the bond's maturity.

[16] Unlike Lewis, Rogalski, and Seward (2003), who classify bonds with less than 40% conversion likelihood as debt-like and bonds with higher than 60% likelihood as equity-like, we cut off our sample at the 50% point. We confirm the Lewis, Rogalski, and Seward (2003) notion that varying the cut-off points does not have marked effects on the inferences.

equity-like convertibles in our sample. The two convertible types appear to differ markedly when it comes to determinants of their life span. Ex-post returns and rating changes are statistically significant determinants of bond life span only among debt-like convertibles, and the same holds also for our test variable, CAPRATE. In the equity-like sub-sample, CAPRATE exhibits a positive, albeit insignificant coefficient. It is feasible that sequential financing is not an important issuance motive for equity-like convertibles. Bonds with a higher likelihood of conversion to equity may, for example, be bonds that are used more often in convertible arbitrage, as Brown, Grundy, Lewis, and Verwijmeren (2012) suggest.

5. Conclusions

We study the life cycle of convertible bonds issued between 1980 and 1998 by U.S. firms. Our aim is to study how both security design features and the firms' subsequent performance and investment behavior affect the bonds' tenure. Secondly, we report the life span of the sample of 955 convertible bonds issued during our sample period.

We find that design features, such as call protection type, coupon rate, and yield advantage at issuance have a significant effect on the life span of convertible bonds. We further find that the firm's post-issuance performance is inversely related to convertible bonds' life span. Namely, bonds issued by firms with greater post-issuance stock returns and firms with positive credit rating changes tend to live a shorter period after their call protection expires. Our most interesting finding is that firms with heavy investment schedules soon after the issuance tend to have bonds with shorter life spans. This is consistent with the sequential financing hypothesis (Mayers, 1998).

In checking the robustness of our findings, we confirm that our results are similar when we use alternative measures of the life span of our sample bonds, and they also persist in sub-samples based on time, call protection type, and more general security design measure by Lewis, Rogalski, and Seward (2003).

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Table 1

Characteristics of the sample by bond outcome and protection type

Panel A: Outcomes and delisting information		
Total Issues		955
Called		400
Non-called:	active through maturity or "now"	176
	Merged	249
	exchanged for other issues	19
	liquidations	2
	dropped by stock exchange	109

Panel B: Outcomes by call protection type					
Call Protection Type	No Protection	Soft	Hard	Absolute	Total
Delisted	41	156	180	2	379
Not called	16	58	93	9	176
Called	43	149	208	0	400
Total	100	363	481	11	955

Panel C: Average original and effective realized life span by call protection type and by outcome (in years)				
Call Protection Type		All	Soft	Hard
Avg. orig. life span	Called	17.16	20.23	13.40
	Non-called	16.59	21.08	14.70
Avg. effective life span	Called	7.09	7.78	6.75
	Non-called	7.38	6.43	6.29

Panel D: Average protection period and life span past protection period by call protection type and by outcome (in years)			
Call Protection Type		Soft	Hard
Avg. protection length	Called	2.54	2.87
	Non-called	2.67	2.73
Avg. life past protection	Called	2.82	1.85
	Non-called	6.35	5.58

Table 2

Regression results

The dependent variable PASTPROT is defined as log(1+ (time(in years) to end of life minus time to end of protection)). END is defined as log(1+time to end of life). For called bonds, end of life is the call date; for matured bonds it is the maturity date. LOGSIZE is log(total assets in year of issuance). LOGMAT is log(1+(time to maturity – time to end of call protection). PROCEEDS is the ratio of proceeds to total assets. PROTTYPE is defined as 0 if there is no call protection, 1 if call protection is soft, 2 if it is hard, and 3 if it is absolute. CONVPREM is the conversion premium at issuance. LEVERAGE is the debt ratio in the year of issuance. YIELDA is the issue's yield advantage when new. RET is the cumulative raw returns during the 500 trading days (2 years) after issue, and RET5 is a similar measure for 5 years. COUPON is the coupon rate. CAPRATE is a 5-year weighted average of capital expenditures, and CAPRATEIND is the difference to the industry median for the same measure. TIMING is the number of years it takes for the issuers to spend the issuance proceeds on capital expenditures. POSTVOL is the standard deviation of daily stock returns in the year after issuance. LOGQ is log (Tobin's Q). RATECHG is the change in Moody's AAA corporate bond index yields in three years following the issuance. OUTSTANDING is the amount of the issue outstanding at call/issuance amount. RATING+ is an indicator variable for those issuers whose Moody's credit rating improves from issuance to three years after issuance. Robust *t*-statistics in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%.

	(1)	(2)	(3)	(4)	(5)	(6)
Variables	**PASTPROT**	**PASTPROT**	**PASTPROT**	**PASTPROT**	**PASTPROT**	**END**
LOGSIZE	0.0432	0.0368	0.0516	0.0314	0.0229	0.0333
	(0.699)	(0.620)	(0.849)	(0.530)	(0.379)	(0.844)
LOGMAT	0.3673***	0.2797**	0.2818**	0.2823**	0.3664***	0.0168
	(3.288)	(2.547)	(2.585)	(2.578)	(3.296)	(0.261)
PROCEEDS	0.5956	0.9061	0.7430	0.8883	0.6165	0.4032
	(0.983)	(1.594)	(1.227)	(1.572)	(1.004)	(1.050)
PROTTYPE	-0.0274	-0.0831	-0.0753	-0.0860	-0.0699	0.0913
	(-0.220)	(-0.642)	(-0.576)	(-0.665)	(-0.560)	(1.300)
CONVPREM	0.4093	0.4433	0.4427	0.4233	0.3690	0.2922
	(0.927)	(1.022)	(1.017)	(0.971)	(0.779)	(0.829)
LEVERAGE	0.5628	0.3619	0.3268	0.3597	0.7178*	0.4490*
	(1.403)	(0.873)	(0.780)	(0.867)	(1.811)	(1.830)
YIELDA	-0.0736*	-0.0956**	-0.1011**	-0.0943**	-0.0944**	-0.0624**
	(-1.849)	(-2.386)	(-2.500)	(-2.347)	(-2.383)	(-2.293)
RET	-0.3530***	-0.3692***	-0.3828***	-0.3623***		-0.2259***
	(-3.043)	(-3.264)	(-3.322)	(-3.220)		(-3.229)
RET5					-0.0839***	
					(-2.694)	
COUPON	0.0395	0.0879*	0.0937*	0.0887*	0.0517	0.0415
	(0.738)	(1.666)	(1.763)	(1.690)	(0.935)	(1.227)
CAPRATE	-0.3925***	-0.2486**			-0.4583***	-0.2080**
	(-2.781)	(-2.231)			(-3.812)	(-2.342)
TIMING			0.0291			
			(0.857)			
CAPRATEIND				-0.2249***		
				(-2.802)		
POSTVOL	0.5852	0.5669	0.6315	0.5265	0.7653*	0.2115
	(1.283)	(1.320)	(1.490)	(1.225)	(1.733)	(0.794)
LOGQ	0.2105	0.2177	0.2069	0.2269	0.2437	0.1335
	(1.169)	(1.257)	(1.175)	(1.310)	(1.204)	(1.217)
RATECHG	0.2112	0.2553*	0.2611*	0.1740	-0.0273	0.0674
	(1.435)	(1.868)	(1.877)	(1.222)	(-0.215)	(0.737)
OUTSTANDING	-0.0143	-0.0827	-0.0723	-0.0768	0.0085	-0.1039
	(-0.056)	(-0.327)	(-0.289)	(-0.304)	(0.034)	(-0.797)
RATING+	-0.6554***	-0.4615**	-0.4565**	-0.4578**	-0.6955***	-0.2368**
	(-2.735)	(-2.210)	(-2.138)	(-2.197)	(-2.828)	(-1.985)
CONSTANT	-0.3079	-0.3113	-0.5552	-0.5784	-1.0120	1.2510*
	(-0.314)	(-0.317)	(-0.559)	(-0.588)	(-1.036)	(1.791)
Issue-Year Dummies	Yes	Yes	Yes	Yes	Yes	Yes
Observations	394	447	447	447	394	411
Adjusted R^2	0.237	0.201	0.196	0.204	0.217	0.158

Table 3

Regression for time-specific subsamples

The variables are defined in Table 2. The dependent variable is PASTPROT in columns (1)-(4), and END in columns (5) and (6). Year<1987 are those issued before 1987, and Year>1986 are those issued after 1986. Robust *t*-statistics in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%.

Variables	**(1) Year<1987**	**(2) Year>1986**	**(3) Year<1987**	**(4) Year>1986**	**(5) Year<1987**	**(6) Year>1986**
LOGSIZE	0.1070	0.0147	0.0945	0.0139	0.0770	0.0150
	(1.196)	(0.180)	(1.054)	(0.171)	(1.275)	(0.301)
LOGMAT	0.4092***	0.3382*	0.4202***	0.3377*	0.0038	0.0356
	(2.699)	(1.886)	(2.860)	(1.879)	(0.039)	(0.346)
PROCEEDS	1.3408*	-0.5074	1.2833*	-0.5036	0.8263*	-0.1818
	(1.879)	(-0.490)	(1.832)	(-0.487)	(1.708)	(-0.328)
PROTTYPE	-0.1363	0.1473	-0.1514	0.1404	0.0614	0.0832
	(-0.921)	(0.719)	(-1.026)	(0.686)	(0.709)	(0.722)
CONVPREM	0.8050*	-0.4590	0.7861	-0.4515	0.5100	-0.2247
	(1.716)	(-0.393)	(1.651)	(-0.385)	(1.361)	(-0.315)
LEVERAGE	0.3955	0.7280	0.4192	0.7237	0.5807	0.3053
	(0.650)	(1.326)	(0.686)	(1.318)	(1.424)	(0.999)
YIELDA	0.0316	-0.1234**	0.0341	-0.1210**	-0.0180	-0.0813**
	(0.506)	(-2.392)	(0.547)	(-2.341)	(-0.401)	(-2.327)
RET	-0.5169***	-0.2917**	-0.4788***	-0.2897**	-0.3842***	-0.1571**
	(-4.330)	(-2.078)	(-3.917)	(-2.057)	(-4.966)	(-2.342)
COUPON	-0.0261	0.0836	-0.0262	0.0866	0.0165	0.0513
	(-0.342)	(1.149)	(-0.354)	(1.187)	(0.323)	(1.239)
CAPRATE	-0.5791**	-0.2971**			-0.3134**	-0.1178
	(-2.531)	(-2.006)			(-2.108)	(-1.460)
CAPRATEIND			-0.5451***	-0.2274**		
			(-3.580)	(-2.470)		
POSTVOL	-0.3777	1.1406**	-0.3697	1.0769**	-0.4216	0.5510*
	(-0.503)	(2.156)	(-0.503)	(2.001)	(-0.856)	(1.788)
LOGQ	0.3336	0.2172	0.3588	0.2245	0.3061	0.0116
	(1.250)	(0.920)	(1.357)	(0.949)	(1.650)	(0.106)
RATECHG	0.1168	0.2766	0.1150	0.1489	0.0341	0.0902
	(0.983)	(1.160)	(0.999)	(0.597)	(0.489)	(0.701)
OUTSTANDING	0.1234	-0.0746	0.1604	-0.0701	0.0287	-0.1762
	(0.379)	(-0.156)	(0.494)	(-0.146)	(0.162)	(-0.836)
RATING+	-0.7566**	-0.5961	-0.7417**	-0.5888	-0.3633**	-0.1511
	(-2.558)	(-1.589)	(-2.520)	(-1.567)	(-2.176)	(-0.965)
CONSTANT	-1.4984	0.2675	-1.5759	-0.0476	0.5248	1.8803*
	(-1.292)	(0.157)	(-1.355)	(-0.028)	(0.649)	(1.802)
Issue Year Dummies	Yes	Yes	Yes	Yes	Yes	Yes
Observations	211	183	211	183	221	190
Adjusted R^2	0.144	0.244	0.157	0.245	0.139	0.232

Table 4

Regression for security design-specific sub-samples

The variables are as defined in Table 2. The dependent variable is PASTPROT. Column 1 represents bonds from the sample with either soft or hard call protection. Columns 2 and 3 split the sample by soft or hard call protection. Columns 4 and 5 split the sample by whether the bonds are closer to bonds or equity, in the manner of Lewis, Rogalski, and Seward (2003). Robust *t*-statistics in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%.

Variables	(1) Call Protected	(2) Soft Protection	(3) Hard Protection	(4) Debt-like	(5) Equity-like
LOGSIZE	0.0565	0.2044**	-0.0459	-0.0904	0.0740
	(0.892)	(2.146)	(-0.481)	(-0.530)	(0.994)
LOGMAT	0.3083***	0.2152	0.3635*	0.7107**	0.3633***
	(2.740)	(1.486)	(1.953)	(2.628)	(2.831)
PROCEEDS	0.6981	2.1650**	-1.4359	-2.2092	0.9276
	(1.092)	(2.498)	(-1.306)	(-0.535)	(1.520)
PROTTYPE	0.2929*			0.0679	-0.1526
	(1.893)			(0.172)	(-1.194)
CONVPREM	1.0412*	1.5083***	0.7666	0.1511	0.6039
	(1.893)	(2.621)	(0.613)	(0.240)	(0.927)
LEVERAGE	0.4528	0.0428	0.2511	-1.2675	0.5906
	(1.070)	(0.059)	(0.475)	(-0.687)	(1.373)
YIELDA	-0.0742*	0.0246	-0.1171*	-0.1492*	-0.0676
	(-1.809)	(0.489)	(-1.884)	(-1.876)	(-1.146)
RET	-0.3329***	-0.6544***	-0.2359**	-0.0013	-0.3630***
	(-2.736)	(-3.232)	(-2.145)	(-0.004)	(-2.858)
COUPON	0.0536	0.0063	0.1871**	0.1679	0.0308
	(0.961)	(0.070)	(2.164)	(1.254)	(0.462)
CAPRATE	-0.4305***	-0.5882**	-0.3286**	0.2620	-0.4152***
	(-2.780)	(-2.052)	(-2.105)	(0.306)	(-2.885)
POSTVOL	0.7640*	-0.7672	1.1683*	-0.5173	0.6827
	(1.657)	(-1.013)	(1.961)	(-0.295)	(1.292)
LOGQ	0.0968	0.0825	0.3580	0.2694	0.2800
	(0.504)	(0.234)	(1.316)	(0.445)	(1.400)
RATECHG	0.0394	0.0015	0.4470**	0.7365**	0.1701
	(0.230)	(0.006)	(2.057)	(2.350)	(1.082)
OUTSTANDING	-0.0057	0.0461	0.2247	-0.9124	0.1426
	(-0.019)	(0.125)	(0.402)	(-1.518)	(0.492)
RATING+	-0.6695**	-0.5386	-0.6027	-0.9498	-0.6260**
	(-2.530)	(-1.473)	(-1.602)	(-1.096)	(-2.347)
CONSTANT	-1.8977*	-2.4969	-1.8480	1.5734	-0.8820
	(-1.732)	(-1.579)	(-0.921)	(0.595)	(-0.751)
Issue-Year Dummies	Yes	Yes	Yes	Yes	Yes
Observations	341	166	175	81	319
Adjusted R^2	0.226	0.213	0.261	0.104	0.246