Temporal Resolution of Uncertainty and Corporate Debt Yields: an Empirical Investigation

Alexander Reisz*

November 25, 1999

(preliminary; not to be quoted)

---

* Doctoral Student, Finance Department, Stern School of Business, New York University, 44 W. 4th Street, MEC, Suite 9-190P, New York, NY 10012-1126. Tel: (212) 998 0344; fax: (212) 995 4233; e-mail: areisz@stern.nyu.edu. I am grateful to my advisors, Kose John and Marti Subrahmanyam, for their guidance and numerous valuable ideas. I would also like to thank Yaakov Amihud, Edwin Elton, Douglas Gale and Eli Ofek for their helpful suggestions, as well as Chris Mann, Deepak Agrawal and Kim Halverson for their programming help. This paper would not have seen the light of day without the continuous help and invaluable advice from Kenneth Garbade and Claudia Perlich's excellent research assistantship. The usual disclaimer applies.

Temporal Resolution of Uncertainty and Corporate Debt Yield: an Empirical Investigation.

Abstract

This paper is intended to measure Reisz's (1999) empirical implication about bond yields against data: yields demanded on corporate debt should be higher the later the uncertainty facing the firm is resolved. We conduct our study looking at new bond issues made by industrial corporations between 1987 and 1996. Based on this sample, we find strong evidence that firms with more delayed resolution of uncertainty offer higher yields once default and overall risks have been controlled for. We also find that the maturity premium on corporate bonds is monotonic in the pattern of Temporal Resolution of Uncertainty (TRU) facing the firm. Both results are mitigated for firms whose managers enjoy fewer information asymmetries. We also find that firms with more delayed TRU rely less heavily on debt and tend to issue shorter-term bonds.

1. Introduction

Reisz (1999) sets up an agency model where an entrepreneur sells at t=0 claims to shareholders and bondholders. Based on the realization x_1 of a signal she privately observes at t=1, the shareholder-aligned manager decides how to split her total investment expenditure between the risky technology (which yields the return θ) and riskless bonds. The signal X_1 gives her information about θ through ρ, the correlation coefficient between X_1 and θ, both of which are bivariate normally distributed. Hence a larger ρ (the manager knows more at t=1) is referred to as "earlier resolution of uncertainty", following Epstein and Turnbull (1980). In his Theorem 3, Reisz (1999) proves that the later the uncertainty is resolved for a given firm/industry, the higher the yield premium offered at issuance must be. This is due to the fact that bondholders rationally anticipate two distinct effects of a later resolution of uncertainty:

- When making her investment decision, the manager is faced with a higher residual uncertainty and even if she was to make an optimal decision, the value of the firm would be lower than if she had more information; bondholders and equityholders share this loss in value.
- As uncertainty gets resolved later, the discrepancy between the investment policy of a shareholder-aligned manager and the optimal policy (in terms of maximization of the firm's market value) gets larger. In other words, agency problems are made worse the later the uncertainty is resolved and bondholders, as most senior claimants, will be the first ones to suffer from the negative effects of risk-shifting.

However, in his Theorem 1, the author also states that the distribution of the final cash flows of the firm is riskier the later the resolution of uncertainty. In other words, the probability of bankruptcy (and expected bankruptcy costs) are larger the later the temporal resolution of uncertainty (in the sequel: TRU). It is therefore difficult (and not analytically tractable) to determine whether TRU has only an indirect effect on bond yields through an increased riskiness of the final distribution of cash flows or if it also has a direct effect on bond yields. This is the first empirical inquiry we will conduct (as well as whether the maturity premium, i.e. the difference in the yields offered on a long vs short bond, depends on TRU).

The monotonicity of bond yields in the pattern of temporal resolution of uncertainty still holds when outsiders have some partial information about the determinants of the manager's decision and are allowed to optimally contract (write covenants) based on this information. However, bond yields are increasing in the noisiness of the signal outsiders observe, i.e. in the amount of asymmetric information, which is consistent with a number of other models, for instance Duffie and Lando (1998). The second focus of this study is thus to investigate whether bond yields are indeed increasing in the amount of asymmetric information.

Finally, based on our sample of new bond issues, we test whether the pattern of TRU affects both the capital structure of the firm as well as the maturity structure of its debt. The existing literature is rich with papers showing that firms with growth options (which we argue are more numerous in fields where uncertainty is resolved late, e.g. pharmaceutical, software or biotech industries) rely less heavily on debt (see for instance Titman and Wessels (1988), Smith and Watts (1992) or Lang, Ofek and Stulz (1996)). The evidence is more mixed at to whether firms with substantial growth options issue longer- or shorter-term debt (see Barclay and Smith (1995), Stohs and Mauer (1996) or Guedes and Opler (1996)). No paper has, however, investigated whether the pattern of TRU characterizing the investment opportunity set of the firm affects its capital structure or the maturity of its debt obligations.

This study should therefore be seen as an attempt to test a corporate finance theory as well as a trial to further explain the determinants of bond pricing. As Elton, Gruber, Agrawal and Mann (1999) recently concluded, tax and default premia do not explain the cross-rating difference in spreads. They further find that "to explain empirical spreads, the compensation the investor requires for risk must go up as risk and maturity increase" and that "the corporate spread is related to systematic factors that are generally believed to be priced in the market"[1]. We believe that one such "systematic factor" may well be temporal resolution of uncertainty.

The paper is organized as follows: in Section 2, we will expose our data and explain our sample selection process. Section 3 will present our methodology and tests. Section 4 will present results and investigate alternative tests and specification checks. Section 5 concludes.

2. Data and Sample Selection

Our data set merges four different databases. The source of our bond data is the Shearson-Lehman database distributed by Warga (1998). This database provides monthly prices, accrued interest and return data on all investment grade (and for a large number of non-investment grade) corporate and government bonds. In particular, coupon rates, ratings, Macaulay durations and callability/convertibility features are available.

We selected new bond issues in much the same way as Elton, Gruber, Agrawal and Mann (1999) (in the sequel: EGA&M) i.e. we rejected, from the total sample of bonds issued by industrial corporations (i.e. Standard Industrial Classification (SIC) codes from 2000 to 5999) the following:

[1] See p. 4.

1. all the bonds that were matrix-priced rather than trader-priced; this is due to the fact that a matrix price bears the influence of the particular formula used rather than the economic influences at work in the market; moreover, dealer quotes leaves us with the same type of data as is to be found in the standard academic source of government bond data, the CRSP government bond file;
2. all the bonds with embedded options (callable or convertible) or with characteristics that might strongly influence the price: floating-rate bonds, odd frequency of coupon payments (i.e. different from semi-annual), and inflation-indexed bonds;
3. all the bonds not included in the Shearson-Lehman indices because researchers in charge of the database at Shearson-Lehman indicated that the care in preparing the data was much less for bonds not included in their indices. This resulted in eliminating all bonds with maturity less than one year;
4. all bonds of firms going through a reorganization (or less than six months before such a reorganization) that changed the nature of the issue (e.g. seniority of claims, change in coupon rate or in the rating of the company) and for which such a change did not seem to have been recorded immediately; hence these bonds could have been priced as if they had been in a different rating class.

Our sample of bonds therefore includes only plain vanilla, option-free dealer-price bonds without any unusual characteristics, quoted between January 1st 1987 and December 31st 1996[2] by industrial firms. We further removed of all bonds with maturity above 12 years, for reasons explained later (see footnote 17). This last filter eliminated 146 more bonds, leaving us with a total of 713 bonds issued in this ten year period by 360 different firms. The price data in the Shearson-Lehman Tape is the bid data as is the institutional price data reported in DRI or Bloomberg. Following EGA&M and Elton and Green (1998), we conclude that we have introduced an underpricing bias of about 10 cents per $100. Since this is true on average for all our bonds, it should not affect our cross-sectional regressions, and we will not adjust the spreads shown in our tables.

We proceed as follows: for every bond that was kept, we look at the price quote at the end of the second month (i.e. between 30 and 60 days) after issuance. This is done to remove the unusual volatility in the few days following the issue date, as documented heuristically by bond traders. As a bond may be issued on the 29th of a given month, taking the quote at the end of the first month may not be enough to remove the effect

[2] We chose this period since the data up to 1987 is relatively sparse. We are interested in the first quote after issue, preferably in a window of 30 to 60 days after issue (so as to avoid the substantial volatility in bond prices accompanying a new issue); when such a quote is not available, we looked at the first available quote with the restriction that no more than 10% of the original maturity of the bond has elapsed. See next section for further discussion.

of post-issue volatility. For 151 out of the 713 bonds, this end-of-second-month quote is not available. In that case, we take the first quote available, with the restriction that it had to be available before the remaining maturity of the bond had declined to under 90% of the original maturity. Hence the first issue was on August 13th, 1986 (first quote available on January 31st, 1987) and the last one on October 15th, 1996 (first quote available on December 31st, 1996). In other words, our investigation is of the type of event studies, with the event date being the first date available from thirty days after the issue onwards, with a cap set at 10% of the original maturity of the bond. Fortunately enough, such a quote was available for all the bonds in our sample. Table 1 summarizes some important descriptive statistics of our sample. The only detail worth mentioning is that the 15 AAA bonds in our sample (which account for 2.1% of our sample) have a duration significantly lower then the average duration of the other types of bonds (consistent with Diamond (1991)). As we'll mention later, our results are not an artifact of these 15 AAA bonds[3].

A word should be said on what we do *not* control for: no information is available in the database that we use on the seniority of the bonds or on the covenants under which they are written (in particular sinking fund provisions that may reduce the effective maturity). We cannot control either for whether a particular bond is issued by a company undergoing a leverage recapitalization or subject to a LBO: the market may well anticipate those and ask for a higher yield, but there is no simple way to control for that[4].

The reasons we look only at new bond issues as opposed to all the outstanding debt of the firm are the following:

i) "Old" bonds may be mispriced due to the lack of liquidity and this added noise may hide the signals we want to uncover. Looking informally at outstanding issues, it was pretty obvious that matrix quotes were far more numerous, revealing infrequent trading.

ii) Given that the pattern of TRU may well evolve over time, past debt may have been issued based on very different firm characteristics. Looking only at incremental debt issues, we can best isolate the effect of TRU, a state variable that may well fluctuate substantially over time (as firms grow more mature, one could argue that their projects' uncertainty gets resolved earlier; similarly, informational asymmetries become less pronounced).

iii) Finally, this paper's main goal is to test Reisz's (1999) empirical implication about bond yields at issuance, i.e. before any investment decision is made. Conditional on an investment being made, bonds will be repriced, and it is not obvious anymore that the yield demanded is decreasing in ρ, the pattern of

---

[3] All our programs using rating first use Moody's rating; if a particular bond is not rated by Moody's, we use the S&P rating; however, this was the case only for one bond in our remaining sample. In the sequel, we'll indicate the Moody's rating followed, in parentheses, by the S&P rating.

[4] We looked at whether there were significant changes in the leverage of a firm surrounding a bond issue, but did not find any. This is however a weak solution: the market may well anticipate a leverage recapitalization that will only happen, say, 5 years down the road.

TRU facing the firm. If no investment is made, the above quoted model predicts that bonds become riskless and their yield is independent of TRU. Therefore, we want to look at bonds before the firm makes any investment decision using the proceeds of their sale.

Nonetheless, we conducted all our tests on a randomly chosen subset of bonds issued more than one year before the “event date” and for which trader quotes were available. None of our results was lost.

The accounting data is taken from the COMPUSTAT expanded annual and quarterly full-coverage files, as well as the COMPUSTAT research annual industrial files. The latter contains data about firms that have disappeared due to mergers or acquisitions, because they went bankrupt or because they became private companies.

Finally we get some of our proxies for Temporal Resolution of Uncertainty from the I/B/E/S database of earnings forecasts (we will describe in the course of our papers the proxies we'll choose) and share price and number data from the Center for Research in Securities Prices (CRSP) database. Depending on the availability of data in these different databases, our tests will include a variable number of bonds, of course not exceeding 713, the number of bonds extracted from the Warga database.

3. Methodology and Tests

3.1. The Choice of Proxies for Temporal Resolution of Uncertainty

The first problem to be tackled is what proxy to choose for the pattern of temporal resolution of uncertainty. To the best of our knowledge, the proxy used in studies so far has always been an economic one, i.e. research and development (R&D) expenses, scaled by firm value or total sales (see for example Titman and Wessels (1988) who also use the rate at which employees voluntarily leave their jobs as a measure of how “unique” a firm is. Intuition dictates that firms that operate in an industry where uncertainty is resolved only late are, in a Titman and Wessels sense, more “unique”[5]; see also Bradley, Jarrell and Kim (1984) and Long and Malitz (1986)). The underlying assumption is that the higher the R&D expenses are, the more delayed the arrival of information is: a drug company, for instance, will not know much about whether a research product will be successful and, if so, if the drug will be FDA

[5] As, for instance, computer or pharmaceutical firms, whereas firms that operate in a field where uncertainty is resolved earlier tend to offer products that are more substitutable and less characteristic of a given firm and to rely less on human capital.

approved. A paper or lumber company, on the other hand, relies very little (if at all) on R&D expenses, but knows fairly well what will happen in the short- and even medium-term. However, this proxy is also used in most papers dealing with growth options, as a proxy for how important the latter are in the investment opportunity set of the firm.

We opt, therefore, for a more direct way of estimating how quickly the uncertainty is resolved for a given firm by looking at the I/B/E/S database that deals with earnings forecasts (in the sequel, the word "earnings" has to be understood as earnings per share). The idea is the following: the earnings of a firm with more delayed resolution of uncertainty should be much more difficult to forecast when the forecast horizon is extended; however, a firm facing early resolution of uncertainty will not find it so much more difficult to forecast long-term earnings as opposed to short-term ones. We constructed three statistics that we considered most relevant in quantifying how much more difficult it is to forecast the long-term vs. the short-term future:

- From the I/B/E/S summary files, we get the standard deviation across analysts of the last long-term earnings forecast made before the bond issue and we denote it LONGSTD[6]. Similarly, we extract the standard deviation across analysts of the last yearly earnings forecast made before the bond issue and denote it YEARSTD. We argue that the ratio LONGSTD/YEARSTD gives an idea of how much more disagreement there is among analysts about long-term earnings vs. earnings one year from the date the forecast was made. A firm with more delayed resolution of uncertainty should display a larger ratio[7].
- We also look at quarterly earnings forecasts and realizations over 20 quarters (five years[8]) before the event date (defined as t=0). Denoting $F_{t-1,t}$ the forecast made at t-1 for earnings at t, a "standardized forecast error" is defined as: $e_t=(R_t-F_{t-1,t})/S_{t-1}$, where R_t is the actual realization at t and S_{t-1} is the share price at the time the forecast was made. We then define a "root mean square standardized error" as $\sqrt{\sum_{t=-19}^{0} e_t^2 / 20}$ (we do not require the availability of 20 quarters of data; when some data is missing, we replace 20 by n, the number of quarters where data is available, in the denominator, with the restriction that n≥15). We denote this proxy QRTRMSE. We do the same for one-year-ahead forecasts and define

[6] Although the I/B/E/S database does not say how long-term this forecast is, it probably is more than 5 years ahead, since I/B/E/S gives yearly earnings forecasts for up to five years ahead, and then "long-term" forecast.

[7] A similar estimate that could be used is the ratio of the range of forecasts (High-Low) for long-term earnings divided by the range of forecasts for yearly earnings; we conducted our tests with this measure as well and none of our results was substantially modified. Those tables are available upon request from the author.

[8] This estimation period was chosen out of considerations of data availability and relevance (see further).

the proxy YRMSE similarly[9]. We then argue that firms with more delayed resolution of uncertainty should display a larger YRMSE/QRTRMSE ratio.

- Finally, we look at the correlation, over the 20 quarters (or *n* quarters where data is available) before the event date, between the time series of standardized quarterly forecasted innovations $(F_{t-1,t}-E_t)/S_{t-1}$ and the time-series of quarterly standardized actual earnings innovations $(E_t-E_{t-1})/S_{t-1}$ for a particular firm[10] and denote this proxy QRTCORR. We then look at the correlation between yearly forecasted innovations and yearly actual earnings innovations and denote this proxy YRCORR. We expect firms with earlier resolution of uncertainty to display a larger YRCORR/QRTCORR ratio.

The reader should be aware that our last two proxies were computed using data over overlapping intervals. We argue that looking at the firm's pattern of TRU using data going back more than five years before a particular bond issue is of limited relevance. That would leave us with only five non-overlapping one-year periods, obviously not enough to estimate anything in a reliable fashion. Therefore, we follow Hansen and Hodrick's (1980) recommendation and use data over overlapping intervals. However, the standard error of our parameter estimates must be corrected to account for this overlapping. The intuition is straightforward: if a forecast for yearly earnings overshot the actual realization, the next yearly forecast (published a quarter later) will probably also overshoot, since the two forecasts cover periods that have three quarters in common. In order to correct for that, we make the assumption that the MA(3) model[11] that generated our observations for, say, the series $e_t=(R_t-F_{t-1,t})/S_{t-1}$ (following Kleidon (1986)), is the same cross-sectionally and we estimate its coefficients. This enables us in turn to estimate the true standard error of our proxies along Richardson and Smith's (1991) arguments so as to have consistent estimates in our regressions. Details about the procedure are available upon request from the author.

The correlations between our different proxies are presented in Table 2, from where it seems obvious that there won't be any problem of multicollinearity if we use all of them in one regression (for a test of joint-significance). The reason why we look at both the standardized RMSE and the correlation between forecasted earnings innovations and actual earnings innovations is the following: analysts could be fairly acurate in absolute terms if earnings do not move much, in which case the RMSE will be relatively small.

---

[9] The I/B/E/S database also provides two-year-ahead earnings forecasts. However, the data is more sparse and we end up losing a lot of bond-observations. As a consequence, results were not significant any longer. This is reinforced by our correction for overlapping intervals (see next paragraph), that leaves us with quite a large standard error for our 2-year proxies.

[10] Conducting the tests looking at the correlation between the *level* series $F_{t-1,t}/S_{t-1}$ and R_t/S_{t-1} did not result in any significant difference in our coefficient estimates.

[11] When we used two-year ahead forecats, the underlying model is an MA(7), yielding quite a large standard error of our parameter estimates (when we have enough data to estimate this standard error!). This explains why our results were no longer significant.

However, if changes in earnings are hard to predict, analysts will do a poor job in predicting the direction of the change and the correlation will pick up this poor performance, even if the magnitude of earnings innovation is small. Inversely, analysts may have a pretty good feel for the direction of earnings changes, but their forecast may overshoot or undershoot realizations by quite a large number (and consistently so: see Easterwood and Nutt (1999)). The correlation would have us believe that the operations of the firm are quite forecastable, but the RMSE would pick up the difficulty of acurately estimating the firm's earnings.

3.2. Temporal Resolution of Uncertainty and Bond Yields

As mentioned in the introduction, we set out to investigate whether, once risk is controlled for, temporal resolution of uncertainty still has some power in explaining the cross-sectional variation in corporate spreads and whether these spreads are increasing in the amount of asymmetric information between the shareholder-aligned decision-making manager and outsiders (in particular bondholders).

In so doing, we should be aware of a few problems and control for variables that could affect yield spreads along the particular effects we want to isolate. In the following list, “forestry project” stands for any firm operating in a field where uncertainty is resolved early, while “biotech” stands for any firm operating in a field where uncertainty is resolved late. For the sake of clarity, we will refer to these extremes. The reader should however keep in mind that things are more subtle when we look at firms for which uncertainty is resolved at an intermediate speed. Moreover, to keep the model tractable, Reisz (1999) keeps the variance of the risky project constant across firms. Hence, his results are really distinguishing between firms operating in the *same* industry, but which differ *only* through the speed at which their uncertainty is resolved.

a) The first problem is that we may be looking at a bond issued by a forestry firm at the beginning of a project and at the bond of a biotech firm on the verge of completing the development of a new drug. As a consequence, more uncertainty might be resolved in the case of the biotech project! We believe, however, that this is not too much of a problem in the absence of a clear theory of optimal issuing time as a function of the industry in which the firm operates: on average, we are picking a firm that issued a bond at a point where uncertainty is halfway resolved. Of course, “halfway” has a different meaning for biotech and forestry firms (we naturally expect a typical forestry firm halfway through its project to know more than a typical biotech firm halfway through its project), but that is precisely the effect we are out to uncover[12].

[12] A sample selection bias might be present, insofar as firms facing late resolution of uncertainty may postpone issuing debt until closer to the project completion, a behavior that firms facing early resolution of uncertainty may not have. That may be the case, but it would only bias our t's towards 0.

b) A forestry firm will typically be more highly levered than a biotech firm (as a result of a more delayed resolution of uncertainty)[13]. Since the yield demanded on bonds is increasing in the amount of debt outstanding (in most corporate finance models), we might end up with a forestry project having to offer a higher yield than a biotech firm! We will therefore have to control for the cross-sectional variation in capital structure.

c) EGA&M (1999) find that the spreads between corporate bonds of a certain rating and similar Treasury securities are increasing in the maturity/duration of the bond considered[14], except for the BBB rated industrial bonds which display a humped corporate spread term curve. We therefore will have to control for the duration of a particular bond we are looking at, to prevent this "duration" effect to overcome any temporal resolution of uncertainty effect when we look at bonds the duration of which varies between one and twelve years.

d) Finally, since we want to see if temporal resolution of uncertainty has any power in explaining corporate spreads after risk is controlled for, we have to take care of overall business risk (as opposed to bankruptcy risk already taken care of by the Debt/Equity ratio).

We proceed as follows: for every bond, we compute two hypothetical prices, from which we derive "pseudo-yields to maturity":

- The first one is the price the same stream of cash flows (coupons and principal) would have if it was offered, at the same date, by the government; in other words, we discount the promised payments according to the Trasury spot yield curve value at the term of each payment; from this, we infer a "Treasury pseudo-yield to maturity" $y_i^{(T)}$ (of course, we account for accrued interest from the last coupon date, which the buyer must pay to the seller).
- The second price is how much the security would be traded for if it was offered, at the same date, by the "average" firm of the same rating; this gives us the "rating-controlled pseudo-yield to maturity" $y_i^{(r)}$.

We estimate the Treasury yield curve and the yield curves for different corporate rating classes using the methodology put forth by Nelson and Siegel (1987)[15]: using all the Treasury bonds available and *all*

---

[13] This informal statement is in itself the subject of a later test.

[14] Note that this is in itself a confirmation of our intuition: a company knows more about the near future and therefore has to offer a higher "temporal premium" for any uncertainty far down the road. However, their finding is also consistent with a number of other theories, among which the Liquidity Preference Theory and, more generally, risk aversion.

[15] We chose this methodology because, due to the smoothness of the function and the exponential decay, it not only offers a better in-sample fit but also ensures that gaps in the data do not impair our results. This is critical since the last 20-year Treasury bond was issued in December 1985 (matures in February 2006), while the first non-callable 30-year Treasury was issued in February 1985. As a consequence, we do not have any actual datapoint to estimate the yield

corporate bonds satisfying the criteria 2.1 to 2.4[16], we compute, for every month, discount factors M_t for Treasuries as well as for every broad class of bonds (i.e. Aaa, Aa, A, Baa and Ba)[17]. This methodology involves fitting to the data the vector **a**=(a_0, a_1, a_2, a_3)' entering the following set of equations:

$$M_t = e^{-r_t t}$$
$$r_t = a_0 + (a_1 + a_2)\left[\frac{1 - e^{-a_3 t}}{a_3 t}\right] - a_2 e^{-a_3 t}$$

where M_t is the present value, as of our event date (end of a given month), of a payment that is received t years later when discounted at the continuously compounded spot rate r_t. The fitting is done by minimizing the sum of squared errors, using a Gauss-Newton procedure to find the zero of the gradient of this sum with respect to the vector **a**. A typical error is defined as P_i**-**MP_i, where P_i is the actual invoice price and MP_i is our model price:

$$MP_i = \sum_{t=1}^{T} M_t . CF_{it}$$

where CF_{it} are the different cash flows (coupons and principal) promised by a particular bond[18]. Table 3 gives an idea of the number of bonds used each month to estimate the vectors **a**'s, as well as of the Root Mean Square Error incurred[19]. As expected, the estimation of the discount function M_t for Aaa (AAA) bonds is done with few bonds (on average 13.4), but the accuracy is still decent (on average, we are off by \$0.5 or 0.5% of principal). The estimation becomes less and less accurate as we go down the grading, and for Ba (BB) bonds, we are typically \$2.2 or 2.2% off.

---

offered on a Treasury cash flows maturing between February 2006 and February 2015 and must rely on our model's goodness of fit when "pricing" cash flows maturing between those two dates.

[16] i.e. quotes on new issues (our 713 bond issues) as well as quotes on old issues.

[17] We didn't have enough bonds to estimate these parameters in a reliable fashion for B1 (B+), B2 (B) and B3(B-), for which we had, respectively, 3, 3 and 4 bonds. We therefore removed these 10 bonds from our sample, leaving Ba3 (BB-) as the lowest rating in our sample. This is also the reason why we looked only at new issues with maturities lower than 12 years: corporate bonds with longer maturities are not numerous enough to yield reliable parameter estimates for the discounting of any cash flow due more than twelve years from the event date.

[18] The fitting was also done trying to minimize the sum of squared *yield* errors. This was done out of the fear that minimizing the sum of squared price errors would tend to fit too closely the long end of the curve at the expense of the short end. We did not find any significant difference (probably because we typically have more short-term bonds than long-term bonds, which balances the fact that the prices of long term bond are more sensitive to a given variation in yields) and therefore opted for the methodology described above.

[19] The RMSE is given, each month, by the following formula: $RMSE = \sqrt{\frac{1}{n}\sum_{i=1}^{1}(P_i - MP_i)^2}$ where *n* denotes the number of bonds used in the fitting process. There is of course a different RMSE each month, for each category of bonds (Treasuries, Aaa's etc.). In Table 2, we are giving only the average and median RMSE per category of bonds over the whole period of estimation (actually, over all the months where we computed them, i.e. only the months that were event dates for a particular bond of a certain rating category). Figure 1 gives a quicker synopsis of the RMSE's.

The reason for estimating the term curve at every event date for Treasuries as well as for broad classes of rating is the following: we would like to regress the "pseudo Treasury spread" $y_i - y_i^{(T)}$ (y_i denotes the actual yield-to-maturity on the bond) at the event date on a proxy for the pattern of TRU characteristic of the investment opportunity set of the firm issuing the bond, keeping in mind that we have to control for effects a)-d) above. Our regression would therefore assume the following form:

$$y_i - y_i^{(T)} = a_0 + a_1.TRU_i + a_2.(D/E)_i + a_3.RISK_i + a_4.DURATION_i + a_5.SIZE_i + e_i \qquad (1)$$

where y_i denotes the yield to maturity on a particular bond i, $y_i^{(T)}$ its pseudo Treasury yield, $DURATION_i$ its Macaulay duration, (D/E) the Debt/Equity ratio of the firm issuing the bond, RISK a relevant measure of the overall risk of its operations, TRU a relevant measure of the temporal resolution of uncertainty it is facing, SIZE the size of the firm and ν an error term assumed to be homoskedastic and uncorrelated to our independent variables[20]. Firm size is intended to reflect the extent of information asymmetry between insiders of the firm and outsiders (bondholders). Big firms will probably enjoy fewer information asymmetries because more analysts follow them rather than due to significant differences in disclosure requirements between, say, the NYSE and the NASDAQ markets[21]. We therefore expect the estimate of the coefficient α_5 to be negative. It is worth noting that our unit of analysis is a particular bond observed at a particular date, but that some of our dependent variables are characteristics of the entire firm at that date.

Fortunately enough, we don't need to worry about finding proxies for the first three independent variables. There is an instrumental variable that will take care of all three[22]. It is the spread between two pseudo-yields that would be offered on the same stream of cash flows: the one offered by the "typical" firm of the same rating and the one offered by the Treasury: $y_i^{(r)} - y_i^{(T)}$. This variable, which we'll call in the sequel a "pseudo-corporate spread", is intended to control for:

- time variation of corporate spreads: corporate spreads tend to increase as the level of interest rates rises; for instance, in August '98, the spread between junk bonds and Treasury rates shot up from 2% to 6-7%. Since our studies cover a ten year period, it wouldn't make sense to compare the spread of a bond issued in 1987 with the one of a bond issued in 1996.

---

[20] Since more than one bond is typically offered by a firm, ν may show some (nonlinear) dependence on the independent variables. For that reason, we provide White-adjusted t-statistics whenever appropriate.

[21] Bonds issued by larger firms might be more liquid and our estimate of α_5 will bear the effect of both liquidity and asymmetric information.

[22] We are grateful to Eli Ofek for pointing this out.

- risk: given that rating agencies (S&P or Moody's) look at all relevant measures of risk (among which Debt/Equity ratios), but probably not at measures of temporal resolution of uncertainty, this pseudo-spread takes care of default risk (differences in leverage) as well as overall business risk;
- tax considerations: since corporate bonds are taxable at the state level but government bonds are not, one could expect that when the rate on Treasury instruments go up, the rates on corporate ones have to go up by a larger amount to leave the investor no worse off after paying taxes. However, this effet should be trivial, since a large fraction of corporate bonds are held by tax-exempt investors (pension funds and insurance companies);
- duration of a bond: since EGA&M (1999) find that most bonds show a spread over Treasury rates that is increasing in duration (with the exception of Baa (BBB) bonds whose spreads display a humped shape), we consider that any effect linked to duration is also subsumed in the pseudo-spread, which is dependent on the maturity of the bond we look at[23].

Note that when we state that risk (as well default risk as overall business risk) is controlled for by our "pseudo-corporate spread", we are making the implicit assumption that rating agencies can distinguish between the risk due to different factors and the one due to a later temporal resolution of uncertainty. In other words, we are assuming that rating agencies categorize bonds independently of the speed of resolution of uncertainty. *Our test is therefore a joint test of whether temporal resolution of uncertainty has some remaining power in explaining the cross-sectional variation in bond yields once risk is controlled for and of whether rating agencies classify bonds based, among other criteria, on the speed at which uncertainty is resolved for the firm*. However, we have strong reasons to assume that it is indeed the case that rating agencies do not rate firms based on how quickly the uncertainty they face is resolved. To the best of our knowledge, no detailed description of the qualitative and quantitative criteria used by rating agencies mentions a possible proxy for TRU (see, for instance, Belkaoui (1983)).

Our final regression will therefore have the following form:

$$y_i - y_i^{(T)} = a_0 + a_1.TRU_i + a_2.\ln(MVA_i) + a_3.(y_i^{(r)} - y_i^{(T)}) + e_i \qquad (2)$$

where the natural logarithm of market value of assets (ln(MVA)) has been used as a proxy for the size of the firm[24]. In the sequel, we'll refer to regression (1) (resp. (2)) as the "expanded" (resp. "compact") model.

---

[23] We conducted regressions with both duration and our control variable and did not find any significant difference in the coefficient on TRU, but the coefficient on DURATION was insignificant.

[24] The reason for taking logarithms is that if size plays a role, we expect it to be most obvious in the range of low values. Note also that market value of assets is computed as Book Value of Assets (data item number 6 in Compustat) minus the Book Value of Equity (data item number 60) + Market Value of Equity (number of shares outstanding

We expect the estimate of α_2 to be negative (larger firms with fewer asymmetric information asymmetries can offer lower yields) and the estimate of α_1 to be negative if YRCORR/QRTCORR is used for TRU, positive if LONGSTD/YRSTD or YRMSE/QRTRMSE are used (firms with more delayed resolution of uncertainty should offer higher yields, *ceteris paribus*).

3.3. Temporal Resolution of Uncertainty and Capital Structure

Previous research has exposed much evidence that the debt/equity ratio is decreasing in the amount of R&D expenses (see, for instance, Bradley, Jarrell and Kim (1984) or Long and Malitz (1986)), the "uniqueness" of the firm (see Titman and Wessels (1988)) or, more generally, the amount of growth options present in the investment opportunity set of the firm (see Smith and Watts (1992) or Lang, Ofek and Stulz (1996)). However, no research paper links directly the pattern of TRU facing a firm and its capital structure.

In order to investigate whether TRU has an effect on the financing decision of the firm (i.e. its capital structure), we regress the Debt/Equity ratio against our proxies for temporal resolution of uncertainty. The Debt/Equity ratio is defined as the sum of Long-Term Debt (Compustat item 9) and Debt in Current Liabilities (Compustat item 34) divided by the Market Value of Equity[25]. We first constrained a firm not to appear twice in the same quarter (since all our measure for TRU are computed based on quarterly data); we then placed the restriction that a firm could not be taken twice, in which case we consider it at the first time it appears in our dataset[26]. Both methodologies yielded essentially the same results and we report only the result of the second one (no duplicate within the whole period).

Since the existing literature has stressed the negative relation between the presence of growth options and the percentage of debt in the capital structure of the firm, we included in our regressions a market-to-book ratio (market value of assets divided by book value of assets, denoted MKTBOOK) so as not to measure the effect of those growth opportunities in the coefficient on a variable proxying for TRU. The rationale is that stock prices should reflect intangible assets such as growth opportunities while corporate balance

---

[data25] times price: close [data24]). We complemented missing data about share price and number in Compustat by data from CRSP. Note finally that we took averages of MVA over the quarter before the issue date, the quarter of the issue date and the quarter after the issue date to smooth out exceptional variations that may occur.

[25] We take an average of the data at the end of the quarter before issue date, quarter of issue date and quarter after issue date. Expanding this estimation window does not change any of our results. Neither does looking only at Long-Term Debt divided by Market Value of Equity.

sheets do not. Thus, the larger a company's "growth options" relative to its "assets in place", the higher on average will its market value be in relation to its book value. We also included a measure of risk (namely the standard deviation of the changes in the logarithm of Market Value of Assets over 20 quarters before the issue date, which we denoted RISK) since it is an accepted knowledge that a higher operating risk decreases the debt capacity of the firm[27]. We then included ln(MVA) as a proxy for size since numerous articles have shown a positive relation between the Debt/Equity ratio of a firm and its size. Finally, we control for non-debt-related tax shields, since the DeAngelo and Masulis (1980) theory predicts that a firm with more non-debt related tax shields is less likely to be able to use the tax deductibility of debt interest. Our proxy for those tax shields is the sum of depreciation (Compustat item 14), investment tax credits (Compustat item 51) and operating loss carryforwards (Compustat item 52) divided by the operating income (Compustat item 13) and is denoted DEP. Our final regression therefore looked as follows:

$$D/E_i = b_0 + b_1 TRU_i + b_2 \ln(MVA_i) + b_3 RISK_i + b_4 MKTBOOK_i + b_5 DEP_i + h_i \qquad (3)$$

(note that the subscript i is now firm-specific as opposed to bond-specific). We expect the estimate of β_2 to be positive, the estimates of β_3, β_4 and β_5 to be negative and the estimate of β_1 to be positive if YRCORR/QRTCORR is used for TRU, negative if LONGSTD/YRSTD or YRMSE/QRTRMSE are used.

3.4. Temporal Resolution of Uncertainty and the Debt Maturity Structure

3.4.1. Contracting Costs Hypothesis

The conclusions of Reisz (1999) are consistent with Myers (1977) who predicts that firms with more growth options (GO) in their investment opportunity sets will have less long term debt in their capital structure. Myers' rationale is that a stockholder-aligned manager will forego positive NPV projects when the resulting cash flows will go primarily to bondholders, leaving stockholders with a subnormal return. Since this is a problem only if debt matures after the opportunity to exercise the real investment option, Myers suggests the solution of shortening the effective maturity of the firm's debt. Hence firms that rely more heavily on unrealized real options will shy away from long term debt and should issue primarily short term debt. Although Reisz (1999) does not talk about growth options, it seems more or less intuitive that firms which rely more heavily on growth options face a more delayed resolution of uncertainty than firms

---

[26] Only 10 firms in our whole sample showed up more than twice in the 10-year period we considered, but quite a few firms issue several bonds at the same date.

[27] The use of other proxies for risk, such as the standard deviation of the changes in the Market Value of Equity or the coefficient of variation of the series of 20 quarterly EBITDA's before the issue (more closely related to the firm's operations) did not modify our results. Note also that the correlation between our proxy for risk and the market-to-book ratio is 0.066 (p-value=0.20). The use of both variables in the same regression poses therefore no major problem.

that rely primarily on assets in place. His Theorem 2 asserts that the manager of a firm facing more delayed resolution of uncertainty will have a higher incentive to risk-shift. This problem may be solved by shortening debt maturity, rendering suboptimal investment by a shareholder-aligned manager more difficult. We therefore expect firms with more delayed resolution of uncertainty to issue shorter debt[28].

This effect is reinforced by the fact that firms with more delayed resolution of uncertainty will have to reward bondholders with a larger yield (Theorem 3 of Reisz (1999) supported by the empirical evidence as introduced in Section 3.2 of this paper). Hence they will shy away from this high-yield debt and opt for shorter-term instruments, with the flexibility of refinancing at better terms if their operations become more forecastable or if favorable information is revealed.

Finally, this expectation is also in line with the signaling hypothesis of Flannery (1986). In a separating equilibrium, high quality firms will issue the less underpriced short-term debt, while low quality firms will issue the more overpriced long-term debt (especially when the latter cannot afford the cost of rolling over short-term debt). In a pooling equilibrium, both high and low quality firms will issue debt of the same maturity. However, firms with large potential information asymmetries (which we intuitively see as more frequent among the firms facing delayed resolution of uncertainty) are likely to issue short-term debt because of the larger information costs associated with long term debt (more sensitive to changes in firm value).

3.4.2 Liquidity Risk Hypothesis

Diamond's (1991) analysis predicts that more risky firms will issue longer-term debt out of the fear of not being able to roll over short-term debt. Since liquidity risk increases with leverage, firms with higher leverage would be expected to use more long-term debt, all else equal. This theory has been verified empirically (see Barclay and Smith (1995) and Stohs and Mauer (1996)), and it is an established fact that more risky firms issue longer-term debt. The relationship, however, is non-monotonic, since very risky firms will not be given access to public debt markets and will have to rely on shorter-term bank debt.

---

[28] Although this goes against Stulz (1990) and Hart and Moore (1990), who argue that debt *prevents* firms from making bad investments (their models are based on the fact that high levels of interest payments bring about an incentive to invest efficiently), their empirical implication is the same: firms with fewer growth options or less delayed resolution of uncertainty should issue more long-term debt because long term debt is more effective in limiting managerial discretion, which is more of a problem when cash flows are more easily diverted and good investment opportunities are scarce.

To control for those effects, we include a dummy for the rating of the particular bond issued (1 for Aaa, 2 for Aaa-, 3 for Aa+ and so on[29]). Since our sample only goes down to Ba-, we did not include in our regression the square of the bond rating, since Diamond's prediction is that the maturity of the debt should be monotonic in our rating range. We look at the duration of the particular bond issued, as opposed to Barclay and Smith (1995) who aggregate all debt due in more than three years as "long-term debt" and look at the proportion of the firm's total debt it represents. We also depart from the methodology of looking at the average maturity of all outstanding debt**,** since we believe that the pattern of TRU may well evolve over time, and past debt may have been designed based on very different firm characteristics. We also include the Debt/Equity ratio of the firm since refinancing becomes more of a problem the more levered the firm, as pointed out by Morris (1991). The regression we are considering is hence the following:

$$DURATION_i = d_0 + d_1 TRU_i + d_2 D/E_i + d_3 \ln(MVA_i) + d_4 RISK_i + d_5 RATING_i + m_i \qquad (4)$$

We expect the estimate of δ_2 and δ_4 to be positive (firms with more leverage and more risky firms are more concerned with refinancing risk and issue longer-term debt), the estimate of δ_3 to be negative (larger firms use shorter debt since refinancing risk is not an issue for them: in an upward-sloping term curve environment, their only concern is to pay less interest), and of δ_1 to be positive if YRCORR/QRTCORR is used, negative if YRMSE/QRTRMSE or LONGSTD/YRSTD are used (firms with more delayed resolution of uncertainty will value the flexibility of short-term debt, hoping to be able to refinance later at better terms). Note that to the extent that the firm's debt may contain sinking-fund provisions, our measure of duration overstates the effective duration. This measurement-error problem introduces a potential bias if the use of these provisions is correlated with our independent variables. This could be the case if, say, firms with more delayed resolution of uncertainty are required to make sinking fund payments more often. That would imply that the firms that are expected to employ the shortest-term debt will display the largest overstatement and our tests will be biased against finding significant results[30].

A similar problem occurs if more covenants are required from firms with delayed resolution of uncertainty (which Reisz's (1999) Theorem 4 implies). Since the violation of any such covenant is an event giving the lender the right to accelerate the payment of the debt (see Smith (1993)), we overstate the true duration of

---

[29] Alternatively, we specified different rating dummies as follows: the first one takes a value of 1 if and only if the bond considered is rated Aa+ or below; the second one takes a value of 1 if and only if the bond is rated Aa or below; the third one is equal to 1 if the bond is rated Aa- or below and so on. We then test whether every dummy has a coefficient strictly larger than the one on the previous dummy (which is what we expect). This test has the advantage of not fixing the distance between two rating classes, but pairwise tests must be conducted and the result is therefore less appealing intuitively. Our results carry over with this specification; results are available upon request from the author.

[30] Note also that if those firms also tend to include more imbedded options (callability or convertibility), we also suffer from a sample selection bias, given that we discarded all such bonds.

the debt mostly for those firms that we expect to use the shortest-term debt[31]: our tests are biased against finding any significant results.

3.5. On simultaneous equations

In our specification, the duration of the bond issued by the firm depends on the Debt/Equity ratio (a firm with more leverage outstanding will care more about the refinancing risk it may face) and the yield offered on a bond issue is a function of its duration (at least in our "expanded" equation (1)). Moreover, the decision of the firm whether to issue new bonds or, say, use bank debt, will probably depend on the yield the firm has to offer on new bond issue. We are therefore in a typical case of simultaneous equations and, following Greene (1998), our coefficients should be estimated in the following system:

$$\mathbf{y_i}'\tilde{\mathbf{A}} + \mathbf{x_i}'\mathbf{B} = \acute{\imath}_{\mathbf{i}}' \qquad (5)$$

where **y** (resp. **x**) is the vector of endogeneous (resp. exogenous) variables, and **ν** is the vector of structural disturbances. In our model (equations (2)-(4)), $\mathbf{y}' = \left[y - y^{(T)} \quad D/E \quad DURATION \right]$,

$$\tilde{\mathbf{A}} = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & -d_2 \\ 0 & 0 & 1 \end{bmatrix}, \qquad \mathbf{B} = \begin{bmatrix} -a_0 & -b_0 & -d_0 \\ -a_1 & -b_1 & -d_1 \\ -a_2 & -b_2 & -d_3 \\ 0 & -b_3 & -d_4 \\ 0 & -b_4 & 0 \\ 0 & -b_5 & 0 \\ 0 & 0 & -d_5 \\ -a_3 & 0 & 0 \end{bmatrix},$$

$\mathbf{x}' = \left[1 \quad TRU \quad \ln(MVA) \quad RISK \quad MKTBOOK \quad DEP \quad RATING \quad y^{(r)} - y^{(T)} \right]$[32] and $\acute{\imath}\,' = \left[e \quad h \quad m \right]$.

Each column of the parameter matrices (**Γ** and **B**) is the vector of coefficients in a particular equation, while each row applies to a specific variable. Postmultiplying (5) by $\tilde{\mathbf{A}}^{-1}$, we get the familiar representation

$$\mathbf{y}' = \mathbf{x}'\mathbf{Ð} + \mathbf{v}'$$

---

[31] This effect is reinforced by the fact that covenants are more common in private debt agreements, which have typically shorter maturities than public debt. Here a potential sample selection bias creeps up again, given that we have data only for public bond issues.

[32] Entering RATING as an endogenous variable on the basis that it is partly determined by the Debt/Equity ratio and overall risk of the firm does not change our coefficients on our explanatory variables significantly. Besides, $y^{(r)} - y^{(T)}$ is determined based on all outstanding bonds (not only the new issues we look at) and is therefore whithout the slightest doubt an exogenous variable in our system.

where **Đ = -BÃ**$^{-1}$ and **v' = í 'Ã**$^{-1}$ (given **Γ**, the same results would be obtained by just running regressions (3) and (4) in a two-stage procedure).

For the sake of a clear exposition (and because we have different proxies for TRU), we still present the results of regressions (2)-(4) in 3 different tables, but the reader should always think of system (5) as the object of our estimation.

4. Results and Specification Checks

4.1. Temporal Resolution of Uncertainty and Bond Yields

4.1.1. The "compact" model

The results of regression (2), estimated within the system (5), can be found in Table 4. As expected, the coefficients on LONGSTD/YRSTD and YRMSE/QRTRMSE are positive (although only the former is significant at the 5% level), whereas the coefficient on YRCORR/QRTCORR is significantly negative at the 5% level. The coefficient on SIZE is also consistently negative, most of the time at the 5% level (but only at the 10% level when YRCORR/QRTCORR is used). When we include all three proxies in one regression, YRMSE/QRTRMSE is the only one that is not significant, although it is in the right direction. The F-test of joint significance of our three proxies of TRU yields a p-value of less than 0.01%. It is also interesting to note that size becomes insignificant when all three proxies for TRU are used.

It is also of interest to notice that our control variable $y_i^{(r)} - y_i^{(T)}$ is always extremely significant (the smallest t-statistic exceeds 23). Hence, it seems that most of the spread between the yield of a given corporate bond and the hypothetical yield offered by the Treasury on a similar security is explained by the rating of the firm issuing it. This should come as no surprise, since, as explained above, this rating is nothing else than a brief summary of the default and overall risk of the firm, the time variation of spreads and the duration of the particular bond studied.

To derive a better understanding of the economic significance of TRU, we calculate the impact of moving from the tenth to the ninetieth percentile for our most significant proxy for TRU, LONGSTD/YRSTD. The estimated coefficient from regression (2) implies that this move increases the yield spread by 13.7 basis points on an A bond with a maturity of 7 years (close to the average maturity of our sample); this yield increase is only of 9.3 basis points when we take a BBB bond with the same duration. If

YRCORR/QRTCORR is used instead, the yield on the same A (resp. BBB) bond as before moves by 12.9 (resp. 8.7) basis points when our proxy moves from the tenth to the ninetieth percentile.

Overall, the evidence strongly supports our hypothesis that firms with more delayed resolution of uncertainty will have to offer higher yields, ceteris paribus. It seems that this effect is mitigated when the firm is more transparent, i.e. if outsiders can better monitor the actions of the manager.

4.1.2. The "expanded" model

We also ran our "expanded" regression (1) in order to ascertain whether our previous results are the mere artifact of the market pricing the idiosyncratic risk of the firm, once a first coarse classification has been done by the rating agency. Our fear is that within a rating class, a large variation in yields is still to be observed. Keeping the same notation as in (5), we estimated the system $\mathbf{y_i}'\mathbf{\tilde{A}} + \mathbf{x_i}'\mathbf{B} = \mathbf{í}_i'$, where $\mathbf{y}' = \begin{bmatrix} y - y^{(T)} & D/E & DURATION \end{bmatrix}$ as before, but where now[33]

$$\mathbf{\tilde{A}} = \begin{bmatrix} 1 & 0 & 0 \\ -a_2 & 1 & -d_2 \\ -a_4 & 0 & 1 \end{bmatrix}, \qquad \mathbf{B} = \begin{bmatrix} -a_0 & -b_0 & -d_0 \\ -a_1 & -b_1 & -d_1 \\ -a_5 & -b_2 & -d_3 \\ -a_3 & -b_3 & -d_4 \\ 0 & -b_4 & 0 \\ 0 & -b_5 & 0 \\ 0 & 0 & -d_5 \end{bmatrix},$$

$\mathbf{x}' = \begin{bmatrix} 1 & TRU & \ln(MVA) & RISK & MKTBOOK & DEP & RATING \end{bmatrix}$ and $\mathbf{í}' = \begin{bmatrix} e & h & m \end{bmatrix}$.

Those results are summarized in Table 5. We reported only the results for equation (1), since the coefficient estimates for equations (3) and (4) did not change significantly from the ones estimated when equation (2) is used in the system.

Once more, TRU plays a significant role, once other factors such as default and overall risks are accounted for. Note that contrary to EGA&M (1999), *we do not find that the duration of bonds affects monotonically the yield spread*. We checked whether our results were driven by BBB bonds (for which EGA&M (1999) do not find a monotonic relation), but that was not the case. We believe *that the entire duration effect is subsumed by the effect of our proxy for TRU*: if bonds of longer duration pay a higher yield, it is precisely because the uncertainty about whether the firm will be able to service this debt is more delayed! As before, the coefficient on YRMSE/QRTRMSE is not significant, although in the right direction and the F-test for joint significance yields a p-value strictly lower than 0.01%.

---

[33] The parameters in the first column of Γ and B are now taken from equation (1) and should not be confused with those of equation (2).

Two results are even more striking than before:

i) the economic significance increases: after controlling for other factors, when we move from the tenth to the ninetieth percentile for LONGSTD/YRSTD, the yield spread on a 7-year A (resp. BBB) bond increases by 16.8 (resp. 12.2) basis points.

ii) Our prediction that smaller firms (where the extent of information asymmetries is higher)will have to compensate bondholders with higher yields become more relevant: our t-statistics are between 6 and 7 in absolute value and, although they are typically smaller when all three proxies are used, they remain significant in the "pooled" regression.

4.2. Temporal Resolution of uncertainty and Maturity Premium

The fact that firms with more delayed resolution of uncertainty opt for shorter-term debt could be due, as asserted earlier, to the fact that they want to keep the possibility of refinancing at better terms once partial information arrives. It could also be due to the *increasingly* high cost of long-term debt for some firms: following Reisz (1999), the risk-shifting incentives of a shareholder-aligned manager become more acute the more delayed the resolution of uncertainty. A longer-term debt instrument will leave more room for the manager to invest suboptimally. Rational bondholders will anticipate this and demand a higher yield. It would therefore be of interest to investigate whether the maturity premium offered on corporate debt depends on the pattern of TRU facing the firm. In order to do that, we conducted the following study: for every new bond issue, we extracted from the bond database, at the time of issue, another outstanding bond of the same firm with the restrictions that i) the difference in duration between both bonds had to be larger than one year and ii) the shorter bond had at least one year to live. Because outstanding bonds are less liquid than on-the-run ones, the liquidity premium may be of more relevance for those "old" bonds. Given that longer bonds are more sensitive to a change in such a factor, we preferably selected an outstanding bond with shorter duration than the new issue. This was possible for 420 bonds; for 102 other new issues, we had to select an outstanding bond that had a longer remaining maturity than the new issue. We therefore gather data on 522 such pairs. Depending on the independent variables we use, we lose quite a few observations due to missing Compustat or I/B/E/S data.

Our regression will therefore be the following:

$$\frac{y_{iL} - y_{iS}}{\Delta DUR_i} = g_0 + g_1 . TRU_i + g_2 . \ln(MVA_i) + g_3 . \frac{y_{iL}^{(r)} - y_{iS}^{(r)}}{\Delta DUR_i} + J_i \qquad (7)$$

where y_{iL} (resp. y_{iS}) denotes the yield-to-maturity on the long (resp. short) bond issued by the firm, $y_{iL}^{(r)}$ (resp. $y_{iS}^{(r)}$) the yield a typical firm of the same rating as the one considered would offer on the long (resp. short) stream of cash flows, TRU our proxy for Temporal Resolution of Uncertainty and ϑ is a noise assumed to be homoskedastic and uncorrelated to our independent variables[34].

We expect the estimates of γ_2 to be negative (bonds issued by larger firms should enjoy the benefits of both fewer information asymmetries and added liquidity) and the estimate of γ_1 to be positive if YRMSE/QRTRMSE or LONGSTD/YRSTD are used, negative if YRCORR/QRTCORR is used. Results can be found in Table 6.

As was the case in our base test (2), the sign of the coefficient on the proxy for TRU is always the expected one, although YRMSE/QRTRMSE is not significant. The other two proxies for TRU display a coefficient that is significant at the 5% level. When all three proxies are used in a single regression, the F-test of joint significance yields a p-value of less than 0.01% (and LONGSTD/YRSTD crosses the 1% significance level): the maturity premium on corporate debt is larger the later uncertainty is resolved for a particular firm. Our prediction about information asymmetry, i.e. that larger firms whose managers enjoy fewer information asymmetries can offer lower yields on their debt, still holds in all regressions where one proxy is used for TRU. When all three proxies are used, firm size does not affect the maturity premium of corporate debt anymore.

The economic significance of our regression, however, is much lower than before: when we compare a 10-year to a 2-year A-rated bond, the yield-to-maturity per year increases only by 5.6 basis points over the rating average when we move from the tenth to the ninetieth percentile of our proxy LONGSTD/YRSTD.

4.3. Capital Structure and Temporal Resolution of Uncertainty

Results of regression (3) (estimated within the system (5)) are to be found in Table 7. Our proxies for TRU yield mixed results: YRMSE/QRTRMSE and LONGSTD/YRSTD are significant, although the latter only at the 10% significance level (but in the “pooled” regression, it crosses the 5% significance level). YRCORR/QRTCORR is significant neither on its own nor along the other proxies for TRU. The economic significance is also disappointing: going from the tenth to the ninetieth percentile for YRMSE/QRTRMSE (our most significant proxy) decreases the Debt/Equity ratio of the firm by only 3%.

[34] Once more, given that a firm may issue several bonds in our ten-year period, we provide White-adjusted t-statistics.

The lack of strong results may be due to the very strong effect of the Market-to-Book ratio (t's ranging in absolute value from 12 to 14). However, TRU plays a statistically significant role: the F-test of joint significance for our three proxies of TRU yields a p-value strictly lower than 0.01%. Moreover, firm size and risk, which are significant in all individual regressions, become insignificant in the "pooled" regression: their effect is subsumed by TRU. Finally, it is interesting to note that we find significant evidence against the DeAngelo and Masulis (1980) hypothesis: our coefficient on non-debt related tax shields is always positive, and most of the time significantly so! We argue that this is due to the fact that firms (especially the ones issuing public debt) borrow against tangibles. A higher level of fixed capital will induce a higher annual depreciation charge, but it is precisely these fixed assets that the firm will present as collateral for public debt. This corroborates the market-to-book effect: firms with a lot of intangibles (growth options) will shy away from debt financing.

4.4. Debt Maturity Structure and Temporal Resolution of Uncertainty

The results of regression (4), estimated within the system(5), are presented in Table 8. In the regressions using only one proxy for TRU, the coefficient on that proxy is significant at the 5% level in the expected direction, apart for YRCORR/QRTCORR: firms with more delayed resolution of uncertainty tend to shorten the maturity of the bonds they issue. When all three proxies are used in the same regression, they all are significant. The F-test for joint significance again yields a p-value smaller than 0.01%.

Note however the surprising result that larger firms tend also to shorten the maturity of their debt (as opposed to Titman and Wessels' (1988) evidence). This is the case in all our regressions and is surprising since larger firms should be less concerned with refinancing risk and, as noted earlier, try to minimize the interest payment by issuing short-term debt. We believe that this result is due to the fact that smaller firms may want to rely more heavily on long-term debt to minimize the repetitive flotation costs of rolling over short-term debt.

Another surprising result is that firms with more leverage tend also to shorten the maturity of their debt (as opposed to Morris' (1991) evidence and the idea that those firms should be more concerned about refinancing risk). We argue that this is the case since firms that are more levered become more default-risky and may not find it easy to issue long-term debt (or may do so only based on stricter covenants). Worth mentioning that this negative effect of the Debt/Equity ratio disappears when all three proxies for TRU are used in the regression.

Finally, it seems that our measure of risk has no impact on the decision of the firm to issue long- or short-term debt. This may be due to the fact that all of the relevant risk of the firm is already accounted for in the bond rating, which strongly influences the maturity decision in the expected direction (as the grade of the bond worsens, the maturity of debt gets longer). Alternatively, our measure of temporal resolution of uncertainty may well capture all the relevant risk and leave all remaining risk an unrewarded idiosyncratic risk.

Our results contradict the prediction of Goswami, Noe and Rebello (1995). They set up a 3-date, 2-period signaling model with two types of firms (good and bad) and conclude that if more uncertainty surrounds long-term cash flows, long-term debt is optimal regardless of the extent of refinancing risk. However, they do not consider the fact that the term structure is generally upward-sloping, nor do they take dissipative costs or agency games into account. The fact that firms with more delayed uncertainty issue shorter term debt doesn't however invalidate the maturity matching hypothesis (see Goswami, Noe and Rebello (1993) for instance for why firms should match the maturity of assets and liabilities): two firms facing different patterns of TRU may have the same average asset maturity; they only differ by the time at which they get the information about the likely outcome of their investment.

Our results should be taken with due criticism: we do not control for whether the bond issues we look at are used to finance incremental assets or merely to refinance old debt that came to maturity. We do not control either for the fact that firms will commonly launch a staggered issue, i.e. different bonds of different maturity at the same time. One of the multiple issues may be much larger than the other ones, used as a mere complement to the main issue. Not controlling for different issue size may be a severe shortcoming. Finally, a firm may consider past issues in the decision to launch a new one with a certain maturity, with the goal of attaining a certain average maturity of debt outstanding (see for example the recent staggered debt issue by Marriott). More research on the topic is definitely warranted.

4.5. Final Specification Checks

We also ran all of our regressions using slightly different proxies for risk, debt/equity ratio and other explanatory variables. None of the coefficient estimates on our TRU proxies were significantly altered. The only noteworthy result is that as we go from an equity (resp. asset) risk (variance of the changes in the logarithm of market value of equity (resp. assets)) to a more operational risk (coefficient of variation of EBITDA over the 20 quarters before bond issue), we lose significance of that variable in some tests.

As a final test for robustness, we conducted all our regressions with the addition of industry dummy variables to assess the relative importance of firm-specific and industry-specific determinants of bond yields, capital structure and debt maturity. A test of the null hypothesis that industry dummy variable coefficients are equal to zero is easily rejected. However, the coefficient estimates and significance levels for the other explanatory variables in the equation (and in particular TRU) are essentially unaltered.

5. Conclusion

This paper uncovered strong empirical evidence supporting the hypotheses that firms with more delayed resolution of uncertainty rely less heavily on debt and have to reward their bondholders with higher yields, once the effect of the other major determinants of leverage and bond yields (default risk and overall risk of the operations of the firm as well as duration of the bond) have been controlled for. This result is robust to different test specifications and is of no trivial economic significance: moving from the first to the last decile of our TRU proxy, the yield-to-maturity of an A bond of average maturity increases by up to 17 basis points, depending on our test and proxy. We also exposed evidence that the maturity premium is higher the later the uncertainty is resolved: firms with more delayed resolution of uncertainty have to offer *increasingly* higher yields for every additional year in the maturity of the bonds they issue. All those results are mitigated when the firm enjoys fewer information asymmetries (i.e. for large firms).

It also seems that the duration of bonds issued by firms with more delayed resolution of uncertainty is significantly shorter, consistent with our prediction that those firms will not lock into a high interest rate and prefer to keep the flexibility of refinancing at better terms once some information is revealed. However, this last result should be the object of further tests since firms may very well issue bonds designed to reach a target duration, as exemplified by staggered issues made by a given firm.

This paper's outcome is twofold. It offered some positive evidence that TRU affects bond yields and capital structure beyond the added risk that more delayed resolution of uncertainty brings along. But it also provided some normative suggestion for rating agencies: since the market seems to price the speed at which a firm's uncertainty is resolved, this factor should be incorporated into the rating of a firm's bonds. Our paper further identifies one of the “systematic factors generally believed to be priced in the economy”, namely the pattern of temporal resolution of uncertainty characterizing the investment opportunity set of a given firm.

Further research should relate temporal resolution of uncertainty to the type of debt issued (public issues vs. bank debt) and try to refine the data at hand. In particular, we believe that a very promising avenue for future research is the detailed analysis of covenants attached to private as well as public debt. The determinants of sinking fund provisions, the type and maturity of incremental debt issues and investment restrictions may very well be better understood under the light of temporal resolution of uncertainty.

References

Belkaoui, Ahmed, 1983, “Industrial Bonds and the Rating Process”, London: Quorum Books.

Barclay, Michael J. and Clifford W. Smith, 1995, “The Maturity Structure of Corporate Debt”, *Journal of Finance*, vol. 50, no. 2, June, pp. 609-631.

Bradley, Michael, Gregg A. Jarrell and Han Kim, 1984, “On the Existence of an Optimal Capital Structure: Theory and Evidence”, *Journal of Finance*, July, pp.857-880.

DeAngelo, Harry and Ronald W. Masulis, 1980, “Optimal Capital Structure Under Corporate and Personal Taxation”, *Journal of Financial Economics*, March, pp. 3-29.

Diamond, Douglas W., 1991, “Debt Maturity Structure and Liquidity Risk”, *Quarterly Journal of Economics* 106, pp. 709-737.

Duffie, Darrell and David Lando, 1998, “Term Structure of Credit Spreads with Incomplete Accounting Information”, Working Paper, Stanford University.

Easterwood, John C. and Stacey R. Nutt, 1999, “Inefficiency in Analysts' Earnings Forecasts: Systematic Misreaction or Systematic Optimism?”, *Journal of Finance*, vol. 54, no. 5, October, pp. 1777-1797.

Elton, Edwin J., Martin J. Gruber, Deepak Agrawal and Christopher Mann, 1999, “Is There A Risk Premium In Corporate Bonds”, Working Paper, Stern School of Business, New York University.

Epstein, Larry G. and Stuart M. Turnbull, 1980, “Capital Asset Prices and the Temporal Resolution of Uncertainty”, *Journal of Finance*, vol. 35, no. 3, pp. 627-643.

Flannery, Mark J., 1986, “Asymmetric Information and Risky Debt Maturity Choice”, *Journal of Finance* vol. 41, pp. 19-37.

Goswami, Gautam, Thomas H. Noe and Michael J. Rebello, 1993, “Asset Maturity, Debt Maturity and Asymmetric Information“, Working Paper, Georgia State University.

Goswami, Gautam, Thomas H. Noe and Michael J. Rebello, 1995, “Debt Financing under Asymmetric Information“, Journal of Finance vol. 50, no. 2, pp. 633-659, June.

Greene, William H., 1998, “Econometric Analysis”, Prentice Hall, 3rd edition.

Guedes, Jose and Tim Opler, 1996, “The Determinants of the Maturity of Corporate Debt Issues”, *Journal of Finance*, vol. 51, no. 1, December, pp. 1809-1833.

Hansen, Lars and Robert Hodrick, 1980, “Forward Exchange Rates as Optimal Predictors of Future Spot Rates: An Econometric Analysis”, *Journal of Political Economy*, vol. 88, pp. 829-853

Kleidon, A., W., 1986, “Variance Bounds Tests and Stock Price Valuation Models”, *Journal of Political Economy*, vol. 94, October, pp. 953-1001.

Lang, Larry, Eli Ofek and René Stulz, 1996, “Leverage, Investment and Firm Growth”, *Journal of Financial Economics*, vol. 40, pp. 3-29.

Long, Michael S. and Ileen B. Malitz, 1986, "Investment Patterns and Financial Leverage", NBER Study edited by Benjamin Friedman, University of Chicago Press, pp.325-348.

Myers, Stewart C., 1977, “Determinants of Corporate Borrowing”, *Journal of Financial Economics*, vol. 5, pp. 147-175.

Nelson, Charles R. and Andrew F. Siegel, 1987, “Parsimonious Modeling of Yield Curves”, *Journal of Business*, vol. 60, no. 4.

Reisz, Alexander S., 1999, “Temporal Resolution of Uncertainty, the Investment Policy of Leveraged Firms and Corporate Debt Yields”, Working Paper, Stern School of Business, New York University.

Richardson, Matthew and Tom Smith, “Tests of Financial Models in the Presence of Overlapping Observations”, 1991, *Review of Financial Studies*, vol. 4, no. 2, pp. 227-254.

Smith, Clifford W. Jr., 1993, “A Perspective on Accounting-Based Debt Covenant Violations”, *Accounting Review*, vol. 68, pp. 289-303.

Smith, Clifford W. and Ross L. Watts, 1992, “The Investment Opportunity Set and Corporate Financing, Dividend and Compensation Policies”, *Journal of Financial Economics*, vol. 32, pp. 263-292.

Stohs, Mark Hoven and David C. Mauer, 1996, “The Determinants of Corporate Debt Maturity Structure”, *Journal of Business*, vol. 69, no. 3, pp. 279-312.

Titman, Sheridan and Roberto Wessels, 1988, "The Determinants of Capital Structure Choice", *Journal of Finance*, vol. 43, no. 1, pp. 1-19, March.

Warga, Arthur, 1998, Fixed Income Database.

White, H., 1980, "A Heteroskedasticity-Consistent Covariance Matrix Estimator and a Direct Test for Heteroskedasticity", *Econometrica*, vol. 48, pp 817-838.

TABLE 1

Descriptive Statistics of the Sample

This table presents the descriptive statistics of the bonds which were first traded after issuance between January 1st,1987 and December 31st, 1996 and that we kept in our analysis. The sample is categorized by the year of issue (Panel A), size of issue (Panel B), duration (Panel C) and rating (Panel D). When quotes were not available in the desired range of 30 to 60 days after issue, we looked at the first available quote with the restriction that it had to be within 10% of the original maturity of the bond. Hence the first issue was on August 13th, 1986 and the last one on October 15th, 1996.

Panel A: Distribution of the Sample by Year of Issue	
Year of Analysis	Number of Bonds
1987	22 (3.1%)
1988	10 (1.4%)
1989	7 (1%)
1990	55 (7.7%)
1991	90 (12.6%)
1992	100 (14%)
1993	118 (16.5%)
1994	58 (8.1%)
1995	140 (19.6%)
1996	113 (15.8%)
Total (1987-1996)	713 (100%)

Panel B: Distribution of the Sample by Size	
Minimum Issue:	$ 50 MM
Maximum Issue:	$ 1,250 MM
Average Issue:	$ 218.4 MM
Median Issue:	$ 200 MM
Std. Dev. Of Issue	$ 149.9 MM
Size of Issue ($ MM)	Number of Bonds
[50,150)	206 (28.9%)
[150,200)	150 (21%)
[200,250)	119 (16.7%)
[250,300)	84 (11.8%)
≥300	154 (21.6%)
Total:	713 (100%)

Panel C: Distribution of the Sample by Duration (as of first available quote)	
Minimum Duration	1.093
Maximum Duration	7.941
Average Duration	5.979
Median Duration	6.787
Std. Dev. Of Duration	1.686
Duration of Bond (years)	Number of Bonds
[1,2)	16 (2.2%)
[2,3)	56 (7.9%)
[3,4)	50 (7%)
[4,5)	65 (9.1%)
[5,6)	54 (7.6%)
[6,7)	180 (25.2%)
[7,8)	292 (41%)
Total: 1≤duration<8	713 (100%)

Panel D: Distribution of the Sample by Rating					
S&P Rating	Moody's Rating	Number of Bonds	Broader Categories	Median Duration	Median Size of the Issue
AAA	Aaa	15 (2.1%)	15 (2.1%)	4.132	$ 250.0 MM
AA+	Aa1	13 (1.8%)			
AA	Aa2	28 (3.9%)	81 (11.4%)	6.659	$ 200.0 MM
AA-	Aa3	40 (5.6%)			
A+	A1	95 (13.3%)			
A	A2	101 (14.2%)	310 (43.5%)	6.658	$ 175.0 MM
A-	A3	114 (16%)			
BBB+	Baa1	74 (10.4%)			
BBB	Baa2	77 (10.8%)	250 (35.1%)	6.969	$ 150.0 MM
BBB-	Baa3	99 (13.9%)			
BB+	Ba1	28 (3.9%)			
BB	Ba2	17 (2.4%)	57 (8%)	6.508	$ 200 MM
BB-	Ba3	12 (1.7%)			
Total:		713 (100%)		6.787	$ 200 MM

TABLE 2

Correlation Between Proxies for TRU

This table presents the pairwise Pearson correlation between our different proxies for TRU. Those are: i) the ratio of the correlation between forcasted one-year ahead earnings innovations and the actual yearly innovations (both standardized by share price as of the time the forecast was made) over the correlation between forecasted quarterly earnings innovations and actual quarterly innovations in earnings (again standardized by share price as of the time the forecast was made) over 20 quaters before issue date, denoted YRCORR/QRTCORR; ii) the ratio of the standardized root mean square error of analysts' yearly earnings forecasts over the standardized root mean square error of analysts' quaterly earnings forecasts over 20 quarters before the issue date (denoted YRMSE/QRTRMSE) and iii) the ratio of the standard deviation across analysts of the last long term earnings forecast made before the issue date over the standard deviation across analysts of the last one-year ahead earnings forecast made before the issue date (denoted LONGSTD/YRSTD).

Pairwise Pearson correlation between the different proxies for Temporal Resolution of Uncertainty			
	YRCORR/QRTCORR	YRMSE/QRTRMSE	LONGSTD/YRSTD
YRCORR/QRTCORR	1		
YRMSE/QRTRMSE	-0.007	1	
LONGSTD/YRSTD	-0.182	0.092	1

TABLE 3

Average Root Mean Square Error

This table presents the average root mean square error of the difference between actual bond invoice price and theoretical price computed using a yield curve estimated by a Gauss-Newton procedure as explained in the text. For a given class of securities, the RMSE is calculated for every month where an event (bond issuance) occurs. The number reported is the average (median) of all the root mean square errors within a class over the period 1987-1996. We also indicate the average (median) number of bonds of each category used in the estimation procedure every month.

Type of bond	Number of bonds used	RMSE
Treasuries	Average: 125.13 Median: 128	Average: 0.210 Median: 0.180
Aaa (AAA)	Average: 13.4 Median: 11	Average: 0.537 Median: 0.535
Aa (AA)	Average: 43.55 Median: 36	Average: 0.728 Median: 0.668
A (A)	Average: 165.07 Median: 175.5	Average: 0.874 Median: 0.836
Baa (BBB)	Average: 116.33 Median: 92	Average: 1.516 Median: 1.465
Ba (BB)	Average: 60.03 Median: 64.5	Average: 2.187 Median: 2.244

RMSE for the different types of bonds (price error in $)

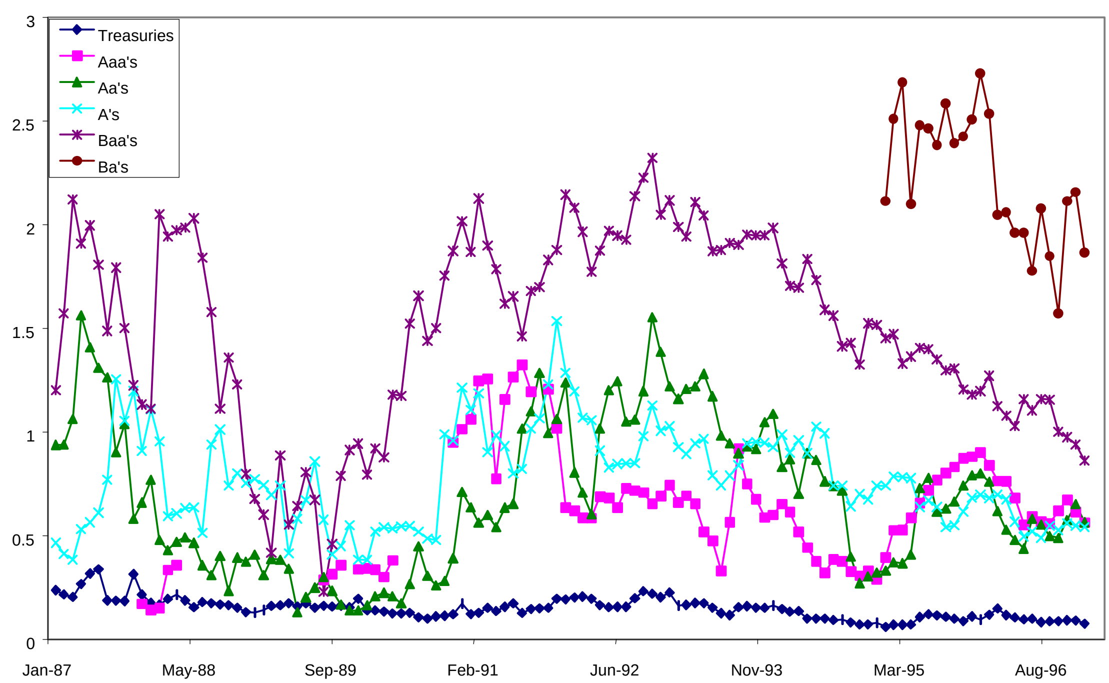

TABLE 4

Bond Yields and Temporal Resolution of Uncertainty: the Compact Model

The spread between the yield offered on a bond issued and what the Treasury would offer on the same stream of cash flows (pseudo Treasury spread) is regressed on a proxy for the pattern of TRU facing the firm, the spread between what the typical firm of the same rating as the firm that issued would offer for the same bond and what the Treasury would offer (pseudo-corporate spread) and the natural logarithm of firm value (market value of equity plus book value of liabilities). Our proxies for TRU are: i) the ratio of the correlation between forcasted one-year ahead earnings innovations and the actual yearly innovations (both standardized by share price as of the time the forecast was made) over the correlation between forecasted quarterly earnings innovations and actual quarterly innovations in earnings (again standardized by share price as of the time the forecast was made) over 20 quaters before issue date, denoted YRCORR/QRTCORR; ii) the ratio of the standardized root mean square error of analysts' yearly earnings forecasts over the standardized root mean square error of analysts' quaterly earnings forecasts over 20 quarters before the issue date (denoted YRMSE/QRTRMSE) and iii) the ratio of the standard deviation across analysts of the last long term earnings forecast made before the issue date over the standard deviation across analysts of the last one-year ahead earnings forecast made before the issue date (denoted LONGSTD/YRSTD). This table presents the results of regression (2) in the text, estimated within the system (5). White-adjusted t-statistics are in parentheses.

Independent Variable	Predicted Sign	(1)	(2)	(3)	(4)	(5)
Intercept		0.134 (1.05)	0.114 (0.89)	0.223 (1.79)	0.178 (1.40)	0.175 (1.40)
YRCORR/QRTCORR	-	-0.005 (-2.22)**				-0.005 (-2.37)**
YRMSE/QRTRMSE	+		0.014 (1.38)			0.019 (1.45)
LONGSTD/YRSTD	+			0.035 (2.42)**		0.040 (3.25)*
Pseudo-Corporate Spread	+	0.952 (24.60)*	0.953 (24.76)*	0.960 (24.45)*	0.937 (23.42)*	0.947 (23.99)*
Log of Market Value of Assets	-	-0.021 (-1.73)***	-0.017 (-1.99)**	-0.028 (-2.40)**	-0.024 (-2.03)**	-0.019 (-1.60)
Adjusted R^2		0.639	0.640	0.636	0.614	0.636
F-Statistic		240.59*	242.90*	248.42*	322.32*	136.33*
Number of observations		407	409	409	388	
Test of joint significance of 3 proxies of TRU: $F = \frac{(R^2_{(5)} - R^2_{(4)})/3}{(1 - R^2_{(5)})/382}$					F=15.323 (p-value=0.000)	

* Significant at the 1% level
** Significant at the 5% level
*** Significant at the 10% level

TABLE 5

Bond Yields and Temporal Resolution of Uncertainty: the Expanded Model

The spread between the yield offered on a bond issued and what the Treasury would offer on the same stream of cash flows (pseudo Treasury spread) is regressed on a proxy for the pattern of TRU facing the firm, the market Debt/Equity ratio of the firm, the variance of the changes in the logarithm of firm value, the duration of the bond and the natural logarithm of firm value (market value of equity plus book value of liabilities). Our proxies for TRU are: i) the ratio of the correlation between forcasted one-year ahead earnings innovations and the actual yearly innovations (both standardized by share price as of the time the forecast was made) over the correlation between forecasted quarterly earnings innovations and actual quarterly innovations in earnings (again standardized by share price as of the time the forecast was made) over 20 quaters before issue date, denoted YRCORR/QRTCORR; ii) the ratio of the standardized root mean square error of analysts' yearly earnings forecasts over the standardized root mean square error of analysts' quaterly earnings forecasts over 20 quarters before the issue date (denoted YRMSE/QRTRMSE) and iii) the ratio of the standard deviation across analysts of the last long term earnings forecast made before the issue date over the standard deviation across analysts of the last one-year ahead earnings forecast made before the issue date (denoted LONGSTD/YRSTD). This table presents the results of regression (2) in the text, estimated within the system (5). White-adjusted t-statistics are in parentheses.

Independent Variable	Predicted Sign	(1)	(2)	(3)	(4)	(5)
Intercept		1.302 (7.13)	1.323 (7.24)	1.517 (7.11)	1.204 (6.51)	1.224 (6.54)
YRCORR/QRTCORR	-	-0.005 (-2.17)**				-0.006 (-2.34)**
YRMSE/QRTRMSE	+		0.023 (1.60)			0.017 (1.09)
LONGSTD/YRSTD	+			0.039 (2.45)**		0.038 (2.38)**
Market D/E Ratio	+	0.370 (13.36)*	0.369 (13.22)*	0.382 (12.05)*	0.372 (13.62)*	0.370 (13.37)*
Variance	+	4.656 (2.66)*	3.478 (2.03)**	4.161 (2.18)**	4.855 (2.70)*	5.094 (2.72)*
Duration	+	0.005 (0.47)	0.004 (0.39)	-0.002 (-0.15)	0.006 (0.61)	0.006 (0.54)
Log of Market Value of Assets	-	-0.099 (-6.27)*	-0.100 (-6.23)*	-0.116 (-6.29)*	-0.090 (-5.59)*	-0.091 (-5.48)*
Adjusted R^2		0.424	0.388	0.420	0.349	0.425
F-Statistic		49.95*	43.01*	49.19*	44.00*	51.20*
Number of observations		333	334	332	323	

Test of joint significance of 3 proxies of TRU: $F = \frac{(R^2_{(5)} - R^2_{(4)})/3}{(1 - R^2_{(5)})/315}$ F=11.917 (p-value=0.000)

* Significant at the 1% level
** Significant at the 5% level
*** Significant at the 10% level

TABLE 6

Maturity Premium and Temporal Resolution of Uncertainty

The maturity premium, standardized by the difference in duration, is regressed on a proxy for the pattern of TRU facing the firm, the maturity premium that the typical firm of the same rating as the firm that issued would offer on the same stream of cash flows (once more standarized by the difference in duration) and the natural logarithm of firm value (market value of equity plus book value of liabilities). Our proxies for TRU are: i) the ratio of the correlation between forcasted one-year ahead earnings innovations and the actual yearly innovations (both standardized by share price as of the time the forecast was made) over the correlation between forecasted quarterly earnings innovations and actual quarterly innovations in earnings (again standardized by share price as of the time the forecast was made) over 20 quaters before issue date, denoted YRCORR/QRTCORR; ii) the ratio of the standardized root mean square error of analysts' yearly earnings forecasts over the standardized root mean square error of analysts' quaterly earnings forecasts over 20 quarters before the issue date (denoted YRMSE/QRTRMSE) and iii) the ratio of the standard deviation across analysts of the last long term earnings forecast made before the issue date over the standard deviation across analysts of the last one-year ahead earnings forecast made before the issue date (denoted LONGSTD/YRSTD). This table presents the results of regression (7) in the text. White-adjusted t-statistics are in parentheses.

Independent Variable	Predicted Sign	(1)	(2)	(3)	(4)	(5)
Intercept		0.313 (1.84)	0.015 (0.13)	0.419 (2.42)	0.262 (1.92)	0.228 (1.65)
YRCORR/QRTCORR	-	-0.007 (-2.32)**				-0.006 (2.50)**
YRMSE/QRTRMSE	+		0.019 (1.51)			0.017 (1.48)
LONGSTD/YRSTD	+			0.021 (2.47)**		0.029 (3.15)*
Corporate Control	+	0.965 (6.79)*	0.775 (8.46)*	1.112 (7.76)*	1.011 (8.82)*	0.990 (8.53)
Log of Market Value of Assets	-	-0.041 (-2.23)**	-0.033 (-1.91)***	-0.055 (-2.95)*	-0.034 (-2.34)**	-0.025 (-1.58)
Adjusted R^2		0.172	0.190	0.169	0.20	0.205
F-Statistic		22.78*	25.33*	20.99*	38.95*	16.64*
Number of observations		318	313	312	304	
Test of joint significance of 3 proxies of TRU: $F = \frac{(R^2_{(5)} - R^2_{(4)})/3}{(1-R^2_{(5)})/298}$					F=13.818 (p-value=0.000)	

* Significant at the 1% level
** Significant at the 5% level
*** Significant at the 10% level

TABLE 7

Debt/Equity Ratio and Temporal Resolution of Uncertainty

The market value of the firm's debt/equity ratio is regressed on a proxy for the pattern of TRU facing the firm, the natural logarithm of firm value (market value of equity plus book value of liabilities), the ratio of market value over book value of assets, the non-debt related tax-shields of the firm and the variance of the changes in the logarithm of firm value. Our proxies for TRU are: i) the ratio of the correlation between forcasted one-year ahead earnings innovations and the actual yearly innovations (both standardized by share price as of the time the forecast was made) over the correlation between forecasted quarterly earnings innovations and actual quarterly innovations in earnings (again standardized by share price as of the time the forecast was made) over 20 quaters before issue date, denoted YRCORR/QRTCORR; ii) the ratio of the standardized root mean square error of analysts' yearly earnings forecasts over the standardized root mean square error of analysts' quaterly earnings forecasts over 20 quarters before the issue date (denoted YRMSE/QRTRMSE) and iii) the ratio of the standard deviation across analysts of the last long term earnings forecast made before the issue date over the standard deviation across analysts of the last one-year ahead earnings forecast made before the issue date (denoted LONGSTD/YRSTD). This table presents the results of regression (3) in the text, estimated within the system (5).

Independent Variable	Predicted Sign	(1)	(2)	(3)	(4)	(5)
Intercept		1.547 (6.39)	1.366 (5.16)	1.460 (5.39)	1.573 (6.42)	1.586 (6.43)
YRCORR/QRTCORR	+	0.003 (1.41)				0.003 (1.51)
YRMSE/QRTRMSE	-		-0.017 (-2.20)**			-0.019 (2.31)**
LONGSTD/YRSTD	-			-0.031 (-1.83)***		-0.042 (-2.12)**
Log of Market Value of Assets	+	0.045 (1.78)***	0.075 (2.61)*	0.053 (1.83)***	0.076 (2.68)*	0.027 (1.00)
Variance	-	-2.327 (-1.71)***	-3.038 (-2.14)**	-0.628 (-0.83)	-2.047 (-1.73)***	-1.814 (-1.24)
Market-to-Book Ratio	-	-0.625 (-12.98)*	-0.727 (-13.55)*	-0.740 (-13.41)*	-0.634 (-12.43)*	-0.642 (-12.37)*
Non-Debt Tax Shields	-	0.199 (2.08)**	0.055 (0.58)	0.060 (0.63)	0.206 (2.15)**	0.211 (2.19)**
Adjusted R^2		0.443	0.429	0.417	0.408	0.459
F-Statistic		44.57*	43.01*	40.92*	54.34*	31.68*
Number of observations		275	281	280	269	
Test of joint significance of 3 proxies of TRU: $F = \frac{(R^2_{(5)} - R^2_{(4)})/3}{(1-R^2_{(5)})/261}$					F=10.026 (p-value=0.000)	

* Significant at the 1% level
** Significant at the 5% level
*** Significant at the 10% level

TABLE 8

Bond Duration and Temporal Resolution of Uncertainty

The duration of the new bond issue is regressed on a proxy for the pattern of TRU facing the firm, the natural log of firm value (market value of equity plus book value of liabilities), the market value of the firm's debt/equity ratio, the variance of the changes in the logarith of firm value and Moody's rating of the bond. Our proxies for TRU are: i) the ratio of the correlation between forcasted one-year ahead earnings innovations and the actual yearly innovations (both standardized by share price as of the time the forecast was made) over the correlation between forecasted quarterly earnings innovations and actual quarterly innovations in earnings (again standardized by share price as of the time the forecast was made) over 20 quaters before issue date, denoted YRCORR/QRTCORR; ii) the ratio of the standardized root mean square error of analysts' yearly earnings forecasts over the standardized root mean square error of analysts' quaterly earnings forecasts over 20 quarters before the issue date (denoted YRMSE/QRTRMSE) and iii) the ratio of the standard deviation across analysts of the last long term earnings forecast made before the issue date over the standard deviation across analysts of the last one-year ahead earnings forecast made before the issue date (denoted LONGSTD/YRSTD). This table presents the results of regression (4) in the text, estimated within the system (5). White-adjusted t-statistics are in parentheses.

Independent Variable	Predicted Sign	(1)	(2)	(3)	(4)	(5)
Intercept		7.924 (7.64)	7.885 (7.55)	8.107 (7.79)	8.134 (7.87)	8.276 (7.95)
YRCORR/QRTCORR	+	0.005 (1.28)				0.013 (2.25)**
YRMSE/QRTRMSE	-		-0.033 (-2.05)**			-0.027 (-1.98)**
LONGSTD/YRSTD	-			-0.011 (-2.37)**		-0.014 (-2.42)**
Log of Market Value of Assets	+	-0.275 (-3.05)*	-0.298 (-3.24)*	-0.296 (-3.22)*	-0.309 (-3.42)*	-0.335 (-3.62)*
Market D/E Ratio	-	-0.498 (-3.32)*	-0.446 (-2.90)*	-0.471 (-3.10)*	-0.450 (-3.00)*	-0.223 (-0.71)
Variance	-	-4.749 (-0.54)	-3.368 (-0.38)	-6.400 (-0.89)	-5.126 (-0.59)	-4.84 (-0.55)
Rating	+	0.152 (3.18)*	0.148 (3.06)*	0.171 (3.55)*	0.163 (3.39)*	0.151 (3.08)*
Adjusted R^2		0.11	0.114	0.121	0.126	0.137
F-Statistic		9.21*	9.64*	10.18*	12.49*	9.41*
Number of observations		332	336	334	320	
Test of joint significance of 3 proxies of TRU: $F = \frac{(R^2_{(5)} - R^2_{(4)})/3}{(1-R^2_{(5)})/312}$					F=12.419 (p-value=0.000)	

* Significant at the 1% level
** Significant at the 5% level
*** Significant at the 10% level