How To Accurately Price And Design Intercompany Debt

Economics Partners, LLC
White Paper Series

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I. Introduction

The standard approach to pricing intercompany debt is to use a variant of the Comparable Uncontrolled Price ("CUP") method. This method estimates an arm’s length range of interest rates solely by reference to the rate of interest on debt for borrowers with credit ratings that are similar to that of the borrower in the controlled (intercompany) loan transaction.

While the simplicity of this approach is appealing, it has three primary weaknesses.

- First, while credit rating is a key determinant of interest rates and yields, it is certainly not the sole determinant. Numerous other characteristics of a debt instrument matter, and are “priced in” when borrowers and lenders agree upon an interest rate. For example, the seniority and security of the debt matters when determining the market rate of interest. The typical “rate the borrower” approach to intercompany debt tends to ignore the quantitative significance of these kinds of contractual features.
- Second, most versions of the “rate the borrower” approach fail to account for the “feedback loop” that exists between the interest rate and the credit rating itself. Once an interest rate is chosen, that rate affects the borrower’s cash flows, which in turn affects the borrower’s credit rating, which in turn affects the equilibrium interest rate. This feedback loop, or “recursiveness” is rarely taken into account by transfer pricing analysts when pricing intercompany debt.
- Third, the “rate the borrower” approach generally does not quantify the rate effect of option-like features embedded in many third party debt instruments. For example, the typical approach does not allow for reliable quantification of the value of callability, putability, or convertibility provisions.

The purpose of this paper is not merely to show how these three weaknesses can be addressed. Rather, we wish to show that the ability to thoughtfully and rigorously price all of the features of intercompany debt allows firms to: 1) design controlled debt transactions in a way that better achieves the cash flow objectives of the borrower and lender (as well as the objectives of the firm’s treasury function), and 2) more readily defend the controlled interest rates used.

In order to evaluate the quantitative significance of contractual features such as loan size, seniority, maturity, loan purpose, time of issuance, whether or not the loan is secured, and the currency in which the loan is issued, we develop a straightforward econometric model that relies upon comprehensive data from third-party debt transactions. This approach can be thought of as a form of the CUP method, as it relies on observed third-party transactions in order to determine an arm’s length interest rate. However, the use of an econometric model allows us to evaluate the impact of numerous variables on the interest rates observed in the third-party data and isolate the terms that have a significant impact on the rate.

As for the recursive relationship between interest rates and credit ratings, we demonstrate how to model this relationship. We show that there generally exists a credit rating and interest rate
that are implied by one another – meaning that the credit rating implies the interest rate and the interest rate implies the credit rating.

Finally, with regard to the value of option features, we will describe a method for valuing put or call options using an option pricing approach first developed by Fabozzi (1993). In the language of the US transfer pricing regulations, this approach is a form of an Income Method.

In summary, we combine a sophisticated version of the CUP method for determining the rate impact of the borrower’s credit rating and the other primary features of the debt instrument, and a form of the Income Method for valuing the instrument’s embedded options. We believe that this combined approach is both more accurate, and more useful, than the standard credit rating-based method.

Economics Partners has developed an Excel application, available to our clients upon request, which embodies the concepts outlined in this white paper. We discuss this model in Section IV.

This paper proceeds as follows. Section II discusses the CUP methodology that we have developed, including choice of dataset, choice of independent and dependent variables, estimation of the borrower’s credit rating, and a discussion of the recursive relationship between rating and interest rate. Section III then discusses the option pricing methodology necessary to price callability, convertibility, and putability provisions in the debt contract. Section IV then describes the Economics Partners debt pricing model, available to clients upon request. Finally, section V discusses the use of our approach to design intercompany debt structures in order to meet treasury objectives.
II. External CUP Method

A. Overview of the Method

Our proposed application of the external CUP method involves the construction of a dataset of third-party debt transactions, including multiple variables for each debt observation, and the development of a regression model that uses the transactional data to determine an arm’s length interest rate. There are various potential sources for publicly available debt data, and certain data sources are more appropriate depending upon the specific characteristics of the intercompany debt at issue. Data services that provide such data include Capital IQ, Bloomberg, and LoanConnector. Capital IQ, a Standard & Poor’s business, provides data on corporate debt issuances. Bloomberg also provides data for corporate bonds and syndicated and institutional loans. Thompson Reuters LPC’s LoanConnector database offers information for third-party loans.

Using data from one or more of these data sources, we can estimate how various debt terms impact the interest rate of a loan using regression analysis. Regression analysis is a standard statistical methodology that produces a mathematical equation that represents the underlying relationship between a dependent variable and one or more independent, or explanatory, variables. Specifically, regression analysis allows us to evaluate how the value of the dependent variable is affected by changes in any one of the explanatory variables, holding the other explanatory variables constant.

In the evaluation of intercompany debt, we are interested in how certain explanatory variables, including but not limited to the credit rating, affect the market interest rate measure (our dependent variable). In other words, we use regression to develop a simple equation that tells us how, within a given industry, borrower credit rating and other debt terms affect the interest rate paid by an uncontrolled borrower. This approach allows us to consider a number of variables, including the credit rating, loan size, term/maturity, seniority, private placement, whether or not the debt is secured, and the effect of the time period during which the debt was issued.

The use of a regression model allows us to evaluate different combinations of independent variables and determine which variables have a statistically significant relationship with the dependent variable in our analysis. For example, if our regression analysis shows that whether or not debt is secured has a statistically significant impact on interest rates and the coefficient on the secured/unsecured dummy variable in regression equation is negative 0.5 percent, we know that, all else equal, secured debt has an interest rate that is 0.5 percentage points lower than unsecured debt.

Thus, the use of regression analysis allows us to make relatively precise adjustments for comparability that cannot be made in the standard benchmarking exercises that simply compare the interest rates on similarly-rated debt. According to Section 482, comparability is of...
paramount importance when evaluating intercompany transactions. In Section 1.482-1(d)(1), it states the following:

*Whether a controlled transaction produces an arm’s length result is generally evaluated by comparing the results of that transaction to results realized by uncontrolled taxpayers engaged in comparable transactions under comparable circumstances. For this purpose, the comparability of transactions and circumstances must be evaluated considering all factors that could affect prices or profits in arm’s length dealings (comparability factors).*

When an uncontrolled transaction is not sufficiently comparable to produce an arm’s length result, adjustments are generally made to improve comparability.\(^1\) The use of regression analysis allows us to make reliable comparability adjustments to ensure that we are making meaningful comparisons to the third-party data.

**B. Developing the Dataset**

In implementing the external CUP method for pricing intercompany debt, it is important that the dataset of transactions selected be comparable to the controlled transaction being priced. It is therefore necessary to apply a number of filters to the data to enhance comparability. We list a number of likely filters below.

1. **Issuance Date**

   For analyses where an historical dataset is used, eliminating older issuances is likely to increase the comparability of the data set. It makes sense to use a long enough time period, however, to incorporate debt issuances over at least one complete business cycle.

2. **Industry**

   An important consideration in assessing the comparability of transactions is to consider the industry of the issuers. To ensure the transactions are sufficiently comparable to the controlled transactions, one should limit the dataset to industry or sub-industry classification of the controlled borrower.

3. **Coupon Type**

   In this paper we are generally assuming that the controlled transaction is specified as having a fixed rate of interest, but it is perfectly reasonable to apply the concepts put forth here to floating rate issuances as well. That said, there is only limited comparability between the interest rates at a given time between floating and fixed rates, so the dataset should be restricted to the coupon type (specifically, fixed or floating interest rate) being studied.

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\(^1\) § 1.482-1(d)(3)
4. Completeness of Data

Lastly, it is important to eliminate transactions from the dataset for which one cannot properly determine the value of all of the dependent and independent variables to be studied. For example, transactions for which there is not credit rating or offering yield information are of little use in the econometric analysis and should be eliminated.

C. Implementation

1. Choice of Dependent Variable

In practice, the interest rate on an uncontrolled debt instrument can be measured in a number of different ways. Thus, there are several decisions that must be made when selecting a measure of the arm’s length rate of interest. These are illustrated in the decision tree in Exhibit II-1 below.

Exhibit II-1: Decision Tree for Selecting Dependent Variable

In what follows, we discuss the selection of the dependent variable in detail.

a) At-issue Yields or Current Yields

Debt yield data from issuances comparable to the controlled transaction may be observed at the initial issuance of the debt, or in terms of their current yield in the secondary securities markets. Current yield data (i.e. yield data from the same date as the controlled transaction) have the
distinct advantage of being current (as the name implies). In other words, current yields are the yields on debt at the present time, which allows for a close correspondence between the valuation date and the date of the intercompany transaction.

However, current yield data are dependent on observations from the secondary market, and careful consideration of the accuracy of such data is required. The current yield data should be based the most recent transaction observed as of the pricing date. However, for thinly traded securities this transaction may itself be dated (or indeed even be based on the offering price). Alternatively, it is commonly the case that most recent observable transaction may be adjusted to “current” by the data provider according to the performance of similar securities in order to estimate current yield. Or, data might simply be unavailable for certain issues as of certain dates, resulting in fewer observations for the regression analysis.

By contrast, an “at-issue” data set is likely to have far more observations than a current yield data set for two reasons. First, the at-issue price and coupon is more likely to be captured by data providers, even if the debt is thinly traded thereafter. Second, an at-issue data set will also include yield data for debt issuances that have been extinguished as of the pricing date and are therefore not in the current yield data set (or, if they are, will obviously be dated; one should check for outstanding balance amounts of zero in current yield data). Perhaps more importantly, at-issue yield data may be more accurate due to the lack of potential reliability issues with secondary market data that were discussed above. The primary disadvantage of at-issue yield data is timeliness. That said, much of the variation in the general level of interest rates over time can be mitigated by using a yield spread (as is discussed below); however, there is still variation in spreads over time as well. This should be taken into consideration when assessing the accuracy and reliability of the available current or at-issue yield data.

**b) Nominal Yield versus Yield Spread**

As was discussed in the preceding section, a problem with using an historic, at-issue yield set is that the general level of interest rates that prevailed when each of the comparable transactions was issued is likely to differ from the general level of interest rates that prevail when the controlled transaction is issued. This problem can be significantly alleviated by using a yield spread measure as the dependent variable, rather than a nominal yield measure.

A yield or interest rate spread is the difference between a particular yield or interest rate (e.g. that of a corporate bond issue) and a reference rate. The choice of reference rate depends on what is being studied, and is discussed further below. For our purposes, we can control for the general level of interest rates by using a reference rate that is generally thought of as being devoid or mostly devoid of credit risk. The spread over the reference rate then represents just the credit risk, or incremental credit risk, of the security. The general level of spreads also varies over time, as is illustrated in Exhibit II-2 below, though this variation is considerably less than that of interest rates generally. This graph shows the spread between Moody’s Baa corporate yields and 30-year U.S. Treasury yields over the last ten years. (Note that corporate bond

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spreads spiked during the financial crisis of 2008-2009. Extraordinary spread environments such as this can be factored into the regression model using a dummy variable.)

**Exhibit II-2: U.S. Corporate Bond Spreads**

The choice of using nominal yields or yield spreads is obvious when using data set of at-issue yields over time: yield spreads are clearly the more reliable measure. When using current yield data, yield spread and nominal yield are equivalent measures for a given tenor (time to maturity), as the reference rate will be equivalent for all observations of that tenor. Therefore, nominal yields may be used as the dependent variable without concern for reliability, as long as tenor is considered in the model as well.

c) **Spread Over Treasury versus Spread Over Swaps**

Spread measures may be used in any instance where the goal is to examine the difference between two rates or yields, such as between two countries’ sovereign debt yields or between different maturities of U.S. Treasury debt. For credit-risky instruments, yields are often cited as spreads over a reference rate that is generally thought of as being devoid or mostly devoid of credit risk, thereby isolating the portion of yield attributable to credit risk. Two of the most commonly used reference rates in credit markets are U.S. Treasury yields and the London Interbank Offer Rate (“LIBOR”) Swap rates. The U.S. Treasury market holds the distinction of being the largest and most liquid debt market in world. Moreover, obligations of the U.S. government are generally treated as free of credit risk by market participants. For these reasons U.S. Corporate debt yields are often quoted as a spread over U.S. Treasuries by convention.

Another common way of quoting credit spreads is as a spread over the LIBOR swap curve. The term “swap” refers to an agreement to exchange payment streams, often in the future, such as a
fixed payment stream for a floating payment stream. Due to the ubiquity of LIBOR in the world financial system, there is a robust market for LIBOR swaps, and market values of the large volume of swaps outstanding together imply future rates of LIBOR. These implied future rates make up the LIBOR swap curve. The swap instruments themselves bear minimal credit risk for a few reasons: First, the agreements themselves are generally between highly rated counterparties. Second, there is no principal to default on, and in the event of default counterparties lose money only if they are a net receiver.\(^2\) LIBOR itself, however, contains an element of credit risk equivalent to the perceived credit risk of the banks that use it to lend and borrow. Therefore, LIBOR will generally be slightly higher than the borrowing rates of well-rated sovereigns. Still, yield spread over the LIBOR swap curve is a common and valid benchmark for credit-risky securities.

\(^{d})\quad\textbf{Additional Considerations}\)

Even once all the above decisions are made, there are still some additional considerations. For instance, there are different types of yield measures, such as Yield-to-Worst ("YTW") and Yield to Maturity ("YTM"). In our view, YTW is a superior measure of yield because it considers the potentially reduced yield to an investor of debt that has a premium coupon (a higher coupon than what the market would require), and is also redeemable prior to its stated maturity date. In such a case, YTW represents the yield to the investor should the security be redeemed at the first possible call date. YTW will not consider calls that improve an investor’s yield (such as for debt selling at discount). Therefore, YTW by definition cannot be higher than YTM, and will be equal to YTM in cases where the debt’s coupon is not at a premium or the debt is not callable.

Also, when using a yield spread measure, it will most likely be necessary to use linear interpolation to estimate the applicable reference rate for transactions in the data set that have maturities other than those published for the reference rate. For an example of such a calculation, please see the exhibit below.

Exhibit II-3: Example Spread Calculation

<table>
<thead>
<tr>
<th>Line</th>
<th>Spread Calculation Inputs</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Issuer</td>
</tr>
<tr>
<td>2</td>
<td>Issue Date</td>
</tr>
<tr>
<td>3</td>
<td>Maturity Date</td>
</tr>
<tr>
<td>4</td>
<td>Tenor (Line 3 - Line 2, in months)</td>
</tr>
<tr>
<td>5</td>
<td>Offering Yield (%)</td>
</tr>
<tr>
<td>6</td>
<td>7-Year CMT as of Oct. 2006 (%)</td>
</tr>
<tr>
<td>7</td>
<td>10-Year CMT as of Oct. 2006 (%)</td>
</tr>
<tr>
<td>8</td>
<td>Estimated 96-mo. CMT as of Oct. 2006 (%)</td>
</tr>
<tr>
<td>9</td>
<td>Yield Spread over CMT (%) (Line 5 - Line 8)</td>
</tr>
</tbody>
</table>

2. Choice of Independent Variables

The following section briefly describes the possible independent variables to be considered in the regression analysis. The choice of independent variables may be largely driven by what is available in the chosen dataset. For any variable selected, it is important to understand the precise meaning of that variable in the dataset so that it may be properly specified for the controlled transaction subsequently.

a) Credit Rating

Credit ratings for each of the comparable debt securities in our comparable data set were assigned by one or several of the Nationally Recognized Statistical Rating Organizations ("NRSROs"), and are intended to capture the likelihood of that issuer of the debt will default on its obligations of timely principal and/or interest payments. Higher yields are required on securities that are perceived to be more likely to default in order to compensate investors for that risk. Therefore, credit rating is an important explanatory variable. Credit ratings in their most common form are issued as letters and “notches,” (e.g. A-, BBB, or BB+). It will be necessary to convert the ratings to a numerical value, such as from from 1 to 21, where one is the likeliest to default (i.e. “D” rated – actually already in default in credit rating parlance), and 21 is the least likely to default (AAA rated).

Especially considering that the numerical equivalent ratings described above are a somewhat artificial construction, it makes sense to explore non-linear relationships between the numerical ratings and interest rate. For instance, we may include the squared or logarithmic version of the variable as well.
b) Market Dislocation Period

As was noted in conjunction with the U.S. Corporate spreads exhibit above, such spreads spiked significantly in the period approximately from July 2008 to July 2009 due to effects from the significant financial crisis that occurred over that period. When using an historic dataset, one may include a dummy variable to account for the impact on the interest rates observed in such periods.

c) Callable

A dummy variable for “callable” is set to one for debt that has a provision that allows the issuer to call, or prepay, the debt prior to maturity. The right to call a debt security is an option often reserved by debt issuers in order to preserve financial flexibility and to allow for opportunistic refinancing should interest rates drop. Since this option retained by issuers has the potential to lower the return to investors, investors will generally demand a higher yield on callable debt relative to equivalent non-callable debt to compensate for this risk. By including this variable, we attempt to account for the higher interest rates likely to prevail on callable debt issuances, relative to otherwise equivalent non-callable debt.

d) Putable

Similarly, a dummy variable for “putable” is set to one for debt that allows the lender, or investor, to demand repayment prior to maturity. By including this variable, we attempt to account for the lower interest rate likely to prevail on putable debt issuances, relative to otherwise equivalent non-putable debt.

e) Tenor / Maturity

The tenor, or time to maturity, is an important variable, especially when seeking to estimate a nominal interest rate (rather than a spread). This is because debt with a longer tenor will generally have a higher interest rate. This effect will partially be captured by the reference rate in cases where we are seeking to estimate an interest rate spread, rather than the rate itself. Either way, it makes sense to consider the tenor as a variable in the analysis.

f) Transaction Size

In the marketplace, loan size may affect the interest rate for reasons relating primarily to liquidity. Small issues may garner less focus from institutional investors, and the lack of demand may result in a higher cost to borrower. It is also theoretically possible that at very large sizes, the loan cost may also increase for the borrower if the issue overwhelms demand in the marketplace.
Companies may issue “tiered” debt such that some debt issuances are senior to others in terms of priority of repayment. In cases of default, the senior issue may have a preferential claim to available assets, and therefore the risk to lenders is lower for these issues. To the extent this information is available in the data, it is an important factor to consider in the regression.

3. Estimation of Controlled Borrower’s Credit Rating

a) Credit Ratings Generally

As noted in the preceding discussion, credit rating is clearly an important independent variable in any debt pricing model. Therefore, estimating the credit rating for the issuer (borrower) of the controlled debt transaction is crucial in order to reliably relate the interest rates from the data set to the controlled transactions. The process of estimating the controlled borrower’s credit rating is described below.

The purpose of a credit rating is to convey information to investors and potential investors regarding the likely performance of a financial security or issuing entity. Numerous companies are in the business of determining credit ratings; nine are designated by the U.S. Securities and Exchange Commission (“SEC”) as Nationally Recognized Statistical Rating Organizations (“NRSROs”), a designation that allows the organizations’ credit rating determinations to be used by others for certain regulatory purposes. The list of NRSROs includes well-known names such as Moody’s and Standard & Poor’s.

Determining a credit rating is a complex and imperfect endeavor even for companies dedicated solely to the task, and is a challenging component of a debt pricing exercise. In creating credit ratings, the NRSROs consider both financial factors and business factors, such as the operating environment and specific competitive advantages of companies. For instance, in explaining its rating methodologies, Moody’s states:

"Quantification is integral to Moody’s rating analysis, particularly since it provides an objective and factual starting point for each rating committee’s analytical discussion. Those who wish further information on the numerical tools we use may consult our written research on industries and specific issuers.

However, Moody’s ratings are not based on a defined set of financial ratios or rigid computer models. Rather, they are the product of a comprehensive analysis of each individual issue and issuer by experienced, well-informed, impartial credit analysts."

However, since the creation of a full credit rating in this manner is beyond the scope of a debt pricing or other similar exercise, it makes sense to compare subject entity financial ratios to

those of similarly situated companies with available credit ratings. Financial data to construct such ratios are readily available from various data providers.

It is important to understand that this process is not, as it is sometimes characterized, a process of creating a “synthetic” credit rating. Rather, the process is one of predicting, analytically, the credit rating that the NRSROs would likely give a controlled borrower if that borrower were operating in a standalone, uncontrolled, way.

Put differently, we are not rating the borrower. Rather, we are predicting the rating that the NRSROs would attach to the borrower. While this may appear to be a distinction without a difference, it is not. Predictions of credit ratings can be based upon objective statistical inference that correlates financial metrics and industry characteristics with observed ratings. This approach separates the transfer pricing analyst from the requirement to make subjective (and possibly indefensible) determinations, and focuses solely on what can be observed statistically.

b) Choosing Financial Ratios to Benchmark Against

Variation exists in credit ratings for companies with similar financial profiles, but operating in different industries. Therefore, when comparing financial data of the controlled borrower to that of other companies for the purposes of estimating a credit rating, it is imperative that the comparison be restricted to companies in the same industry.

The Economics Partners debt pricing model is currently set up to evaluate the nine financial ratios in two broad categories, as shown in the exhibit below.

**Exhibit II-4: Financial Ratios Used**

<table>
<thead>
<tr>
<th>Line</th>
<th>Financial Ratio</th>
<th>Ratio Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>EBIT/Interest</td>
<td>Leverage</td>
</tr>
<tr>
<td>2</td>
<td>EBITDA/Interest</td>
<td>Leverage</td>
</tr>
<tr>
<td>3</td>
<td>Debt/EBITDA</td>
<td>Leverage</td>
</tr>
<tr>
<td>4</td>
<td>Net Debt/EBITDA</td>
<td>Leverage</td>
</tr>
<tr>
<td>5</td>
<td>Return on Capital</td>
<td>Profitability</td>
</tr>
<tr>
<td>6</td>
<td>Return on Assets</td>
<td>Profitability</td>
</tr>
<tr>
<td>7</td>
<td>Return on Equity</td>
<td>Profitability</td>
</tr>
<tr>
<td>8</td>
<td>EBIT Margin</td>
<td>Profitability</td>
</tr>
<tr>
<td>9</td>
<td>Debt/Equity</td>
<td>Leverage</td>
</tr>
</tbody>
</table>

Leverage ratios seek to describe the amount of debt a company employs or interest expense a company incurs relative to income or balance sheet measures. The profitability measures we have included here describe the success a company has at turning its assets, sales, capital and equity into income. Generally speaking, lower leverage and higher profitability reflect lower credit risk and therefore should correspond to better credit ratings.
In order to compare industry ratios to that of the controlled borrower, we pull data for comparable companies from a data provider (CapitalIQ). The relationship between financial ratio and credit ratings will vary from company to company and industry to industry. In our model, we perform a series of single variable regression analysis on each ratio, which accomplishes three things. First, we assess the relationship between the ratios and credit ratings in several ways in order to find the strongest relationship. We examine both the linear and the logarithmic relationship among the one-, three- and five-year average for each ratio, and we can choose to benchmark the controlled borrower according to the strongest of these six measures. Second, we use the regression results to give us a “smoothed” functional relationship between the financial measure and the credit rating. Third, if there is not a strong enough relationship between a financial ratio and the rating in our comparable company dataset, we can choose to exclude the measure altogether.

c) Creation of Subject Entity Pro Forma Financial Ratios

The task of creating dynamic, pro forma financial ratios for the controlled borrower is an important part of estimating the credit rating of an issuing entity. Even if an issuing entity already has a publicly available credit rating, the transaction being studied may affect the credit worthiness of the entity. For instance, consider a company that currently has some debt outstanding, is rated BBB and is considering issuing additional debt. The issuance of additional debt will increase the company’s leverage ratios and decrease its interest coverage ratios, and the implied credit rating of the entity pro forma for the additional debt issuance may well be below BBB.

The key consideration in creation of the pro forma financial ratios is that all aspects of the transaction are considered, including the increase in debt outstanding, any increase in asset balances (such as additional cash from debt proceeds, or other assets that the company intends to acquire in a concurrent transaction, such as with an acquisition), and the increase in interest expense (including tax effects). It is important that if the debt issuance is part of a restructuring or multi-step financing transaction that effects of all planned transactions are considered.

d) Handling the Recursive “Feedback Loop” Between Credit Rating and Interest Rate

The reader will note that in the section above, we referred to the borrower’s pro forma financial ratios as “dynamic.” This is because there is a “feedback loop” between the borrower’s pro forma financial statements, credit rating, and interest rate. Specifically, the borrower’s financial statements affect its credit rating, which affects the interest rate paid by the borrower, which in turn affects the financial statements.

Feedback loops such as this are referred to as “recursive functions.” It is sometimes thought, incorrectly, that recursive functions do not have a solution. In fact, most recursive functions have a solution.
In this case, the solution to the feedback loop from the borrower’s pro forma financial data, to its credit rating, to its interest rate, and back again to its pro forma financial data is simply to find all possible combinations of credit ratings and interest rates that are mutually consistent. In other words, we test every combination of interest rate and credit rating (credit rating is driven by the pro forma financial information given the interest rate), and find only those combinations that are consistent. By this, we mean that the credit rating implies the interest rate and the interest rate implies the credit rating.

The Economics Partners debt pricing model handles this using a simple data table that tests each possible credit rating against the financial ratios that are implied by that rating. The “equilibrium” estimated credit rating is indicated in the data table by instances where the tested credit rating results in financial ratios that in turn imply the tested credit rating – i.e., there is an equilibrium.

D. Summary of the External CUP Method Analysis

We have now described all the components of the external CUP method for pricing the controlled transaction, and it is just a matter of putting the pieces together. Once we have selected an appropriate data set and given consideration to how we define our dependent and independent variables, we perform the econometric analysis, which gives us an equation that relates the studied independent variables to the interest rates.

We then plug in the appropriate values for each variable for our controlled transaction. The result of the regression with our transaction and borrower specific values for independent variables gives us the estimated interest rate.

Importantly, assuming we are using credit rating as an independent variable, we will need to have set up a dynamic, pro forma balance sheet and income statement to estimate the credit rating of the controlled borrower in the manner described above, given the interest rate produced by our econometric model. In other words, our econometric model uses uncontrolled transactions to predict an interest rate given the controlled borrower’s credit rating and the other economically relevant features of the debt transaction. However, the interest rate that the model produces must be “fed into” the borrower’s pro forma financial statements in order to produce a credit rating, which must in turn be “fed back into” the econometric model to produce an interest rate, and so on, until we find an interest rate and credit rating that are implied by one another.
III. Pricing Embedded Options Using an Income Method

As was discussed above, if we want to consider the impact of embedded options on the controlled transaction, we believe a more precise and reliable method of doing so is with an option pricing model. Option pricing models are a form of Income Method, because they model the cash flow effects of the option features, and produce a present value of these features. If the presence of options, such as a call or a put, are among the independents variable used in the regression analysis, we would use a tested party value of zero for these, thereby using the above described method to estimate interest rate result ex-option. We describe how we would then value the option in the section below.

A. Valuing Bond Options - A Brief Overview

An option is a financial instrument that conveys the right to buy or sell another financial instrument, such as a stock or a bond. Equity options are commonly valued using an arbitrage-free model first introduced by Fischer Black and Myron Scholes in 1973, commonly known as the Black-Scholes model.\(^4\) The Black-Scholes equation gives the predicted value for a European call option of a stock whose possible values at the call date are assumed to be lognormally distributed. This assumption regarding the lognormal distribution of the underlying security makes the Black-Scholes formula inappropriate for valuing bond options due to what is known as the “pull-to-par” that bond prices experience as they approach maturity. Put simply, a bond (or other plain debt instrument) by definition involves the return of principal to the investor or lender at maturity. At the precise moment that the bond matures, a rational investor would neither sell the bond for less than par nor buy the bond for more than par; hence, its value at that moment is par. Thus, the expected price of a bond will always “pull to par” as maturity approaches, and therefore cannot be described by a lognormal distribution.

The canonical model for valuing bonds, including those that contain option-like features, was developed in a 1993 article by Kalotay, Williams and Fabozzi.\(^5\) The model takes the form of binomial interest rate tree, and is described below.

B. Valuing Bonds Using a Binomial Interest Rate Tree

In order to describe how the binomial interest rate tree model is used to value the embedded options of a debt instrument, we start by briefly describing how a debt instrument without option-like features is priced. Assume a “plain-vanilla” debt instrument. The cash flows of a plain-vanilla debt instrument consist of a series of regular coupon interest payments and the return of principal at maturity. The value of the instrument is the present value of this series of cash flows, discounted using a rate that accounts for the riskiness of each payment. Given that


the coupon interest rate is fixed for the life of the security, the present value of the known schedule of cash flows (and thus of the instrument itself) rises when interest rates fall, and falls when interest rates rise. In other words, future interest rate environments are uncertain, which means that future bond values are uncertain.

In an efficient market, the price of a bond therefore reflects the appropriate rate of return for each cash flow, which reflects expectations about future interest rates. For instance, if we observe from bond markets that a 1-year zero coupon bond has an interest rate of 4%, and that a 2-year zero-coupon bond has an interest rate of 5%, this implies that the market expects the 1-year interest rate in one year to be 6.0096%. This is the rate at which a risk-neutral investor is indifferent between owning the 2-year bond, or owning the 1-year bond and investing the proceeds in another 1-year bond in one year. Note that if we introduce an assumption of volatility around expected future rates, the result is no different for a rational investor. Given volatility, we understand that the reinvestment rate in one year may be higher or lower than 6.0096%, but the probability-weighted expected return is unchanged, so even with the introduction of volatility, the risk-neutral investor is indifferent between the two investment scenarios.

Lastly, consider the expected value in one year of the above 2-year zero-coupon bond. If we specify that the expected cash flow of this bond is $100 at the end of year two, this implies that our investor would have paid $90.7030 for the bond at time zero, because

\[ \$90.7030 \times (1+5\%)^2 = \$100 \]

At the end of year one, we expect that the same bond, with one year remaining until maturity and given that we expect the one-year interest rate to be 6.0096%, to be worth $94.3311, because

\[ \$94.3311 \times (1+6.0096\%) = \$100 \]

Now consider the probability-weighted value of the bond in time zero, if we assume that interest rates have an equal chance of varying 20% from their expected value. That is, after the first year, one-year interest rates have an equal probability of being 7.2115% and 4.8077%. In the first instance, the bond would be worth $93.2735, while in the second instance it would be worth $95.4128 at the end of the first year. At time zero, the probability-weighted expected price of the security at the end of the first year is the average of the two values, or $94.3432 –

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6 Of course, investors are not risk-neutral, and if presented with only those two possible investment scenarios, a risk-adverse investor would choose the guaranteed two-year return over the uncertain return with the same expected value. That said, a risk-neutral assumption is not only mathematically convenient in many instances, it is also economically sound in scenarios where investment outcomes can be replicated using various instruments. For instance, if our hypothetical investor was presented with a two-year zero-coupon bond at 5%, and the ability to lock in the 1-year forward 1-year rate at 6.0069% (such as with an interest rate forward contract), any 1-year zero-coupon rate other than 4% would violate the principles of no-arbitrage.

7 Also note that over the first year, in which the investor received no cash flow, the unrealized return on investment was 4%, because $90.7030 \times (1+4\%) = $94.3311.  

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approximately the same as the expected price in the absence of volatility. Again we have shown that at time zero, the investor risk-neutral investor unaffected by the introduction of volatility.

C. Introducing Optionality

Although we have not yet introduced optionality to our illustration, what we have described above provides the conceptual basis for using a binomial interest rate tree model for valuing bonds with embedded options. When we introduce optionality, we change the expected value of the bond in the future under certain interest rate scenarios to reflect the exercise of the option.

Once again, consider the 2-year zero-coupon bond under the above interest rate scenario, but now assume that the issuer has the right, but not the obligation, to redeem the security after one year for $95. The addition of this option changes the probability-weighted expected value for the investor at time zero, because in the scenario where interest rates are 20% below their expected value, the investor expects that the security will be called away, and instead of owning a security worth $95.4128 at that time, the investor will be left with $95 in cash. The probability-weighted expected value of the callable security after the first year therefore decreases to $94.3468. Discounting this back to time zero (at 4%), the security at the time of issuance is worth $90.5161, rather than the $90.7030 for the non-callable version.

The binomial interest rate tree model functions in the manner described above. It calculates the value of a bond at time zero as the discounted average of the values in the next period under two scenarios: one where interest rates go up and one where interest rates go down. The model then can easily consider put or call options by simply assessing the future values relative to the strike price of the embedded option. For instance, if the strike price of a call is $100, then in the future we would expect the issuer to exercise the call for any value greater than $100. (Note that while up to this point we have only considered call options, the same concept works for put options as well. If the bond is “putable” at $100, the investor (who has been granted the right to force repayment for $100) will exercise the option for any values lower than that, and this of course can increase the probability-weighted expected value at time zero.)

1. Constructing the Tree

It should now be apparent that the binomial interest rate tree method of valuing bonds allows for the consideration of embedded options in a manner that is simple and logical. Before that is possible, though, we must step back and discuss how to construct the binomial interest rate tree itself. Put simply, the binomial interest rate tree will seek to value our bonds at a series of points in time, which we will refer to hereinafter as “nodes.” We note that our model the options can only be exercised at each “node,” so in this way we are not in fact modeling

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8 The outcomes are not exactly equivalent due to the second order effect of the relationship between interest rates and bond prices, known as convexity. The positive convexity that bonds exhibit mean that the rate of change of bond prices for a given change in interest rates increases as interest rates decrease, so the price effect of a 20% decrease in interest rates is slightly greater than that of 20% increase in interest rates.

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“American” style options (continuously exercisable), but rather “Bermudan” or “European” style options that are exercisable at discrete points in time. The nodes need not be spaced one year apart, however, and the simplification is not detrimental to our results. There is actually no constraint how “tightly packed” our nodes are, other than computing power.

We also note here that our illustration thus far has featured zero-coupon bonds in order to keep their cash flows simpler, but going forward we will be considering bonds with coupons. This is both because the controlled transactions we are pricing are more likely to be structured as coupon bearing, but also because the tree is much easier to implement (and explain) in terms of hypothetical “par” bonds of the issuer. We will explain what we mean below.

In order to value the bonds in our previous illustration, we needed to know what interest rates were expected to be in the future (e.g. the 1-year rate one year forward of 6.0096%), but recall that these were simply implied by market observations the one- and two-year bonds. Similarly, forward rates will be implied by our model without our having to calculate them directly; we do, however, need to know the term structure of our controlled borrower’s debt.

Conveniently, we have already described a way to estimate this in the preceding section, using regression analysis. Our regression equation (the equation that predicts the interest rate for the borrower) includes a variable for term. We thus know from the data for uncontrolled transactions how term affects the interest rate. For an interest rate tree with nodes spaced one year apart, we simply input a term of one-year, two-years, etc., and observe the resulting interest rate predicted for the borrower by the regression equation. Similarly, if our regression model estimates a spread over a reference rate, we simply estimate the spread at each maturity and add it to the reference rate yield at the appropriate maturity. We emphasize here that it is the term structure of the tested party that is required, rather than of interest rates, such as the risk-free rate, generally.9

The other input required to build the interest rate tree is the expected volatility of interest rates. Recall that we assume that the set of possible next-period interest rates is normally distributed around the mean, or expected, rate, which means that interest rates are as likely to be higher as lower than the expected rate. The volatility input represents the standard deviation of that distribution. Here we use a measure of general interest rate volatility that is implied by financial markets. Recall from the preceding section that pricing in LIBOR swap markets conveys information about the expected level of LIBOR in the future. There is also a robust market for options on these swaps (the so-called “swaption” market). As with all options, such as those for equities, the market value of the options imply an expected level of volatility in the underlying instrument. The swaption market-implied level of expected interest rate volatility can be retrieved from data providers such as Bloomberg.

We will require additional inputs regarding the options later, but for the purposes of constructing the interest rate tree, the issuer term structure and expected volatility is all we

9 Also, if “callable” or “redeemable” is an independent variable in our regression model, we must be sure to set this coefficient to zero when estimating the term structure for the controlled borrower.

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need. Assume we are constructing a 5-year tree, with nodes at every year, and that we have the five-year term structure for the issuer given below.
We begin by considering the second bond in the term structure (i.e. the two-year bond) which has a yield of 4.0016%. When priced at $100, this coupon will pay annual coupons of $4.0016 and return $100 at maturity. The value at time zero, which we assume to be $100, will be equal the discounted average value at year one (which consists of both the value of the bond, and the $4.0016 coupon received) under the higher and lower interest rate scenarios. We know that the appropriate discount rate used in time zero is 3.8316% (taken from the yield of the one-year bond in the term structure). We also know that the value of the bond at year two will be $100 by definition, since this is its maturity. Therefore, the value of the bond at year one will be $104.0016 (the principal at maturity plus the second annual coupon), discounted by the lower rate in the “down scenario” and the higher rate in the “up scenario.” We don’t know these interest rates yet, but we know their relationship to each other. Without knowing the expected one-year interest rate in one year, we know that the relationship between the lower rate and the higher rate may be given as:

\[ r_u = r_d(e^{\Theta}) \]

where

- \( r_u \) = interest rate in the “up” scenario,
- \( r_d \) = interest rate in the “down” scenario, and
- \( \Theta \) = expected constant one-year volatility of interest rates

That is, since we are calculating the value of the bond in one year where the interest rate has moved up one standard deviation and down one standard deviation, the “up scenario” rate will be two standard deviations higher than the “down scenario” rate. Therefore, we are left with only one unknown, which is the lower rate. We use the solver function in Excel to solve for the value of the lower rate (“\( r_u \)”) that makes the value at time zero equal to $100. The “solved” three node tree is given in the exhibit below (with volatility set to 21.8%).
Exhibit III-2: Determining Rate at the Second Node

Again, most of the numbers in the above tree are either set according to our term structure, or by definition (e.g. the $4.0016 coupon payments, the $100 value of the bond for t = 2, and the 3.832% one-year interest rate at time zero) or calculated ($rd$ and the bond values at t = 1). We only needed solve for the $rd$ value that gives us a V at time zero of 100. The result was an $rd$ of 3.288%.

What we have above is a complete interest rate tree for a two-year bond, and it is easy to repeat the process for additional nodes. We first look to the term structure for the appropriate three-year bond coupon (4.1916%), and replace all the Coupon values with that value. We change the bond values at t = 2 so that they are no longer set to 100 (that was done just for the purposes of calculating the t = 1 rates), but instead are set to the discounted average of the next periods value plus coupons, in the same manner as in the last iteration. Finally $ru$ and $ruu$ are calculated in relation to $rdd$ in the same manner as was done for t = 1 above. Note that interest rates for each scenario across a given time period are two standard deviations from the adjacent scenarios; thus $ruu$ and may equivalently be formulated as two standard deviations from $ru$, or four standard deviations from $rdd$. We then solve for the $rdd$ value that again makes our bond value at t = 0 equal to 100.

Note that as we proceed, solving for the lowest interest rate at each node, the rates we solved for previously are static. The process is reiterated for each time value until we reach the maturity of the bond we are pricing. For the five-year bond, we do this a total of four times. The fourth time involves setting the bond values at t = 5 to 100 and all of the coupon values to 4.7816, both of which reflect the actual cash flows the bond we are pricing. The resulting tree is shown on the following page.
2. Using the Binomial Interest Rate Tree to Value Bonds with Options

With the binomial interest rate tree created, it is now possible to model an embedded call or put option for the five-year bond. To do so, we need to know the strike price of the option, and when it is exercisable. As was previously noted, the model is set up to only assess the impact of an option at the nodes; but, it is easy to specify if the option is not exercisable for a period of time. If that is the case, we simply do not assess the bond value at the nodes for which it is not exercisable. For each period t where the option is exercisable (i.e. if there is no lock-out period, or if a given t is greater than the lock-out period), we compare the bond value at the node to the strike price. For call options, the call is exercised if the value at the node is greater than the strike price. For put options, the put is exercised if the value at the node is less than the strike price. Strike prices need not be at par; in fact, call options often have strike prices above par. This makes it less likely that the call is exercised. It is therefore less expensive for the issuer, but also provides less benefit to the issuer, as rates have to drop further for the call to be economical.

It is easy to model this process in Excel. We simply create a second tree next to the first, which references the first tree for all of the interest rates and has its own calculation for bond values. Then, in the second tree, we add an “if” statement to the bond value formula in each node, such that if the bond value for the corresponding node in the first tree is such that the option is
economical, the bond value in the second tree is replaced with the option strike price. Assuming that somewhere in the tree an option is exercised, the bond values at each node will “feed back” to the previous nodes so that the value at $t = 0$ will no longer be $100. The new value in the second tree at time zero is the value of the bond with the embedded option, and the difference between this value and 100 is the value of the option.

Below we show the results for our hypothetical five-year bond, again with volatility set to 21.8%. The first exhibit below represents the “solved” interest rate tree, while the second tree values the option. In this case we have specified that the option is a call option with a strike price at $100$, exercisable immediately. Note that on the nodes down the left side of this tree (representing the lower rate scenarios), the bond is immediately called, so the Value at (1,d) is 100. The Value at (1,u) is also lower than in the no-option tree, because the bond is also called in the “up-down-down” scenario, which feeds back to the Value at (1,u). The value of the bond at time zero has dropped to $98.5504$ because of the addition of the call option. To put it another way, the call option has a value equal to 1.45% of par for the issuer.

**Exhibit III-4: Interest Rate Tree with Call Option Considered**

<table>
<thead>
<tr>
<th>t</th>
<th>V</th>
<th>98.550413</th>
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<tbody>
<tr>
<td></td>
<td>C</td>
<td>0</td>
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<tr>
<td></td>
<td>r0</td>
<td>3.832%</td>
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<tr>
<td>1.0</td>
<td>V</td>
<td>100</td>
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<tr>
<td></td>
<td>C</td>
<td>4.7816</td>
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<tr>
<td></td>
<td>rd</td>
<td>3.288%</td>
</tr>
<tr>
<td>2.0</td>
<td>V</td>
<td>100</td>
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<td></td>
<td>C</td>
<td>4.7816</td>
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<tr>
<td></td>
<td>rdd</td>
<td>2.853%</td>
</tr>
<tr>
<td>3.0</td>
<td>V</td>
<td>100</td>
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<td></td>
<td>C</td>
<td>4.7816</td>
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<td></td>
<td>rddd</td>
<td>2.682%</td>
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<tr>
<td>4.0</td>
<td>V</td>
<td>100</td>
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<tr>
<td></td>
<td>C</td>
<td>4.7816</td>
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<tr>
<td></td>
<td>rdddc</td>
<td>2.391%</td>
</tr>
<tr>
<td>5.0</td>
<td>V</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>rdddc</td>
<td>2.630%</td>
</tr>
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</table>

Lastly, for the purposes of pricing the controlled transaction, we are most likely not interested in the nominal value of the option, but rather the implications on the interest rate for the borrower. In the present example, we have solved for a yield spread that, when added to the coupon payment at each node, makes the present value of the option adjusted cash flow equal to 0.0.
$100. In this case the resulting coupon spread is 0.6721, meaning that the coupon on our five-year bond must be raised from $4.7816 to $5.4537 in order to make the probability-weighted present value of the bond at time zero equal to $100, given the option exercise outcomes we have already determined. This result is illustrated in the interest rate tree in the exhibit below.

**Exhibit III-5: Interest Rate Tree with Call Impact Solved in Coupon**

![Interest Rate Tree](image)

We conclude based on these results that for the five-year bond specified as we described, the cost to the borrower of including a call option, exercisable annually with a strike price at par, is an additional 0.6721% of annual interest expense for the life of the loan.
IV. Using the Economics Partners, LLC Debt Pricing Model

At Economics Partners we have created a tool in Excel that allows users to implement the methodology that we have described in this paper. In this section we illustrate the tool (with actual screen shots from the model) and describe in more detail how to use it.

The model is controlled from a central “dashboard,” shown in the exhibit below. This is where the user enters the main debt parameters and tested party variables, and also may view the results. Command buttons take you from the dashboard to the three primary working areas, which allow the user to (1) estimate a credit rating, (2) price the interest rate given the standard (non-option) terms (using the regression model) and (3) estimate the impact of embedded options using the binomial interest rate tree.

Exhibit IV-1: Model Dashboard
We walk through the usage of each of these sections below.

A. Estimating a Credit Rating

As described in the preceding sections, the estimation of the controlled borrower’s credit rating is an important part of the debt pricing process. The credit rating section of our model allows the user to easily control this process by displaying the benchmarking results of each financial ratio. The user simply drops a list of comparable company identifiers in the data section, which is shown in Exhibit IV-2. The model is currently set up to interface with Capital IQ, such that all other characteristic and ratio data are automatically pulled from Capital IQ based on the company identifier. In the exhibit below, one can see the five year results and averages for the EBIT/Interest ratio and a count of the observations to the right of the company information. To the right of that is the first three columns of information for EBITDA/Interest. Further to the right, not shown in this exhibit, is similar information for the rest of the nine ratios that the model is currently set up to use.

The resulting financial ratio information feeds into the credit rating benchmarking tool, which is shown in Exhibit IV-3. In this tool, the user is allowed to select the relationship that yields the best correlation between each ratio and credit rating (i.e. linear or logarithmic, using a one-, three- or five-year average), as well as choose to ignore any ratios that exhibit a poor relationship with credit rating. Of the six choices, the relationship with the highest correlation coefficient is highlighted in green. These correlation results are viewable just to the right of this table (though not shown in this exhibit). Once the user has established which financial ratio relationships are to be used, the implied rating is shown on the bottom of the table (the user can choose to use either the simple average or the median of the ratio-implied ratings).

The financial ratios for the controlled borrower are calculated on the left side of the table, using financial data that is found on the central dashboard. Recall from the previous discussion on the credit rating estimation process that there can be more than one equilibrium credit rating result due to recursive feedback loops between rating and financial ratios. The calculated financial ratios of the controlled borrower are therefore calculated based on financial data that are pro-forma for the transaction being studied. Note that there is only one credit rating implied by a set of financial ratios, which is what this table illustrates. However, the credit rating used to calculate the financial ratios is determined by a data table that tests each possible rating, and the credit rating implied by the resulting financial ratios. The data table, which we refer to as a “Nash solver,” is shown in Exhibit IV-4.
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<tr>
<td><strong>1</strong> EBIT/Interest</td>
<td></td>
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<tr>
<td><strong>1033</strong> REGRESSION OBSERVATIONS</td>
<td>61</td>
<td>IQ_COMPANY_NAME</td>
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<td>IQ_SP_LC_LT</td>
<td>IQ_SP_LC_LT</td>
<td>IQ_SP_LC_LT</td>
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### Exhibit IV-3: Synthetic Credit Rating Benchmarking Tool

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<td>3.164</td>
<td>Linear-3Y AVG</td>
<td>9.05</td>
<td>9.83</td>
<td>9.05</td>
<td>9.14</td>
<td>12.61</td>
<td>11.71</td>
<td>11.86</td>
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<td>2 EBITDA/Interest</td>
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<td>Linear-3Y AVG</td>
<td>8.77</td>
<td>9.33</td>
<td>8.77</td>
<td>8.95</td>
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<td>3 Debt/EBITDA</td>
<td>11.034</td>
<td>Linear-3Y AVG</td>
<td>7.49</td>
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<td>8.46</td>
<td>7.49</td>
<td>20.99</td>
<td>20.99</td>
<td>21.15</td>
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<tr>
<td>4 Net Debt/EBITDA</td>
<td>1.379</td>
<td>Log-3Y AVG</td>
<td>11.63</td>
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<td>9.44</td>
<td>10.00</td>
<td>12.43</td>
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<td>5 Return on Capital</td>
<td>0.022</td>
<td>Linear-3Y AVG</td>
<td>8.47</td>
<td>8.66</td>
<td>8.99</td>
<td>8.97</td>
<td>8.05</td>
<td>8.44</td>
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<td>Linear-3Y AVG</td>
<td>8.62</td>
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<td>7 Return on Equity</td>
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<td>8 EBIT Margin</td>
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<td>8.46</td>
<td>9.06</td>
<td>9.38</td>
<td>9.01</td>
<td>8.51</td>
<td>8.92</td>
<td>8.46</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9 Debt/Equity</td>
<td>1.333</td>
<td>Linear-3Y AVG</td>
<td>11.09</td>
<td>10.75</td>
<td>11.09</td>
<td>10.31</td>
<td>11.77</td>
<td>12.13</td>
<td>11.24</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**FINAL:** Average 10
BB
As the table in the above exhibit illustrates, each tested rating produces an implied rating. In this illustration we find that the equilibrium result is a “10,” or a BB rating. To elaborate on this process, the table implies that if the tested borrower was charged a “AAA interest rate” on its debt it would have financial ratios that imply a BBB credit rating, and if it was charged a “D interest rate” it would have financial ratios that imply a BB-interest rate. This is because at the lower rating, it has less interest expense and therefore better interest coverage and higher earnings. At the higher interest rate, it has greater interest expense and therefore worse interest coverage and lower earnings. It is the equilibrium result of 10 (i.e. BB), and the resulting financial ratios that are actually displayed in the module illustrated previously in Exhibit IV-3. If there were multiple equilibria, the model is currently set up to take the higher of the equilibrium ratings.

Lastly, note that the credit rating model is dependent on the results of the standard debt term regression analysis, since it is this regression equation that determines the resulting interest rate for each rating, which feeds into the credit rating estimation. Therefore, any time the user changes the regression equation, this data table must be refreshed by hitting F9 in Excel. (We assume here that Excel is set to not automatically update data tables to ensure better performance.) Importantly, the data table also should be refreshed any time any of the specifications of the credit rating model itself are updated. Changes such as choosing to ignore a ratio, using the log instead of the linear estimation for a ratio, or changing from the median to the average implied ratio, have the potential to change the result.
B. Pricing the Standard Debt Terms

Our model also contains a working module for the regression analysis used to price the standard debt terms. The user first obtains a dataset of comparable transactions, and drops it into the appropriate section of the model. A snapshot of this area is shown in Exhibit IV-5. The model is currently structured to handle a set of transaction data from Capital IQ, and the user drops the set for the appropriate industry in a designated spot in this tab (shown here under the black headers; there are additional fields to the right not shown in this exhibit). Certain other fields that are specific either to the pricing date or to the issue date of each transaction are pulled automatically by formula (under the blue headers). To the left of this data are columns that allow the user to exclude a transaction, which is important since we find transactional data to be “noisy.” The user should first examine the observations for data completeness and redundancy, and may then also assess comparability.

The resulting dataset of comparable transactions is pulled automatically into the Regression Dashboard part of the model, which is where the user can begin to analyze the relationships between variables using regression analysis. With this tool, the user simply puts enters an “X” over the dependent variable and “Y” over the independent variables, and the resulting coefficient and t-stat values from the regression analysis appear in the space above for each variable, along with the overall R-squared and adjusted R-squared values for the model. See Exhibit IV-6 below for a screenshot of this tool.

We stress here that the user should take care when performing the regression analysis, especially in terms of considering the impact of heteroskedasticity and multicollinearity among variables, for instance. The tool in our model does not address such issues. Still, the tool is a good starting point for such an analysis, especially since it allows the user to easily toggle variables on and off to get an indication of which variables may be significant, and of the overall success of the regression.

The results of the regression feed back into other areas of the model, such as the credit rating module and the option pricing model, both of which require the interest rate or spread results as an input.
## Exhibit IV-5: Comparable Transaction Data Screen

**LIVE CAPIQ FORMULAS**

<table>
<thead>
<tr>
<th># (All)</th>
<th># (Useable)</th>
<th>REMOVE</th>
<th>Yield to Worst Current</th>
<th>Price Current</th>
<th>Security Rating at Issuance</th>
<th>Security Rating Current</th>
<th>Issuer Rating at Issuance</th>
<th>Issuer Rating Current</th>
<th>Maturity Date</th>
<th>CDS Term</th>
<th>Issuer</th>
<th>Exchange/Ticker</th>
<th>CUSIP</th>
<th>Fixed Income Security Type</th>
<th>Seniority Level</th>
<th>Coupon Rate (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>495</td>
<td>REMOVE</td>
<td>0</td>
<td>0 B-</td>
<td>B-</td>
<td>B</td>
<td>B</td>
<td>B</td>
<td>B</td>
<td>Feb-01-2019</td>
<td>-</td>
<td>Oasis</td>
<td>NYSE:OAS</td>
<td>674215AB4</td>
<td>Corporate DebentureSenior Unsecured</td>
<td>7.25</td>
<td></td>
</tr>
<tr>
<td>496</td>
<td>52</td>
<td>6.4288</td>
<td>103.5 B-</td>
<td>B-</td>
<td>B</td>
<td>B</td>
<td>B</td>
<td>B</td>
<td>Feb-01-2019</td>
<td>-</td>
<td>Oasis</td>
<td>NYSE:OAS</td>
<td>674215AA4</td>
<td>Corporate DebentureSenior Unsecured</td>
<td>7.25</td>
<td></td>
</tr>
<tr>
<td>498</td>
<td>REMOVE</td>
<td>19.9809</td>
<td>68</td>
<td>0 D</td>
<td>0 SD</td>
<td>0 B</td>
<td>0 B</td>
<td>0 B</td>
<td>Feb-15-2019</td>
<td>-</td>
<td>GMX</td>
<td>NYSE:GMXR</td>
<td>784966AA9</td>
<td>Corporate DebentureSenior Unsecured</td>
<td>6.625</td>
<td></td>
</tr>
<tr>
<td>500</td>
<td>REMOVE</td>
<td>0</td>
<td>0 BB</td>
<td>BB</td>
<td>BB</td>
<td>BB</td>
<td>BB</td>
<td>BB</td>
<td>Feb-15-2019</td>
<td>-</td>
<td>Oasis</td>
<td>NYSE:OAS</td>
<td>674215AA6</td>
<td>Corporate DebentureSenior Unsecured</td>
<td>7.25</td>
<td></td>
</tr>
<tr>
<td>502</td>
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<td>8.0413</td>
<td>106</td>
<td>0 CCC+</td>
<td>0 B</td>
<td>0 B</td>
<td>0 B</td>
<td>0 B</td>
<td>Feb-15-2019</td>
<td>-</td>
<td>Landao</td>
<td>-</td>
<td>510075AB0</td>
<td>Corporate DebentureSenior Unsecured</td>
<td>9.5</td>
<td></td>
</tr>
<tr>
<td>504</td>
<td>57</td>
<td>8.0413</td>
<td>106</td>
<td>0 CCC+</td>
<td>0 B</td>
<td>0 B</td>
<td>0 B</td>
<td>0 B</td>
<td>Feb-15-2019</td>
<td>-</td>
<td>Landao</td>
<td>-</td>
<td>510075AA6</td>
<td>Corporate DebentureSenior Unsecured</td>
<td>9.5</td>
<td></td>
</tr>
<tr>
<td>506</td>
<td>58</td>
<td>19.9809</td>
<td>68</td>
<td>0 D</td>
<td>0 SD</td>
<td>0 B</td>
<td>0 B</td>
<td>0 B</td>
<td>Feb-15-2019</td>
<td>-</td>
<td>GMX</td>
<td>NYSE:GMXR</td>
<td>10022VA84</td>
<td>Corporate DebentureSenior Unsecured</td>
<td>11.375</td>
<td></td>
</tr>
<tr>
<td>510</td>
<td>61</td>
<td>3.4756</td>
<td>131.039 BBB</td>
<td>BBB</td>
<td>BBB</td>
<td>BBB</td>
<td>BBB</td>
<td>BBB</td>
<td>Mar-01-2019</td>
<td>-</td>
<td>Noble</td>
<td>NYSE:NBL</td>
<td>493644AD7</td>
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<td>8.25</td>
<td></td>
</tr>
<tr>
<td>511</td>
<td>62</td>
<td>4.2067</td>
<td>127.67 BBB</td>
<td>BBB</td>
<td>BBB</td>
<td>BBB</td>
<td>BBB</td>
<td>BBB</td>
<td>Mar-01-2019</td>
<td>-</td>
<td>Anadarko</td>
<td>NYSE:APC</td>
<td>032518BC0</td>
<td>Corporate DebentureSenior Unsecured</td>
<td>8.7</td>
<td></td>
</tr>
<tr>
<td>512</td>
<td>63</td>
<td>8.8694</td>
<td>100 CCC+</td>
<td>CCC+</td>
<td>B</td>
<td>B</td>
<td>B</td>
<td>B</td>
<td>Mar-15-2019</td>
<td>-</td>
<td>Goodrich</td>
<td>NYSE:ZGP</td>
<td>382405AD0</td>
<td>Corporate DebentureSenior Unsecured</td>
<td>8.675</td>
<td></td>
</tr>
<tr>
<td>513</td>
<td>64</td>
<td>REMOVE</td>
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<td>CCC+</td>
<td>B</td>
<td>B</td>
<td>B</td>
<td>Mar-15-2019</td>
<td>-</td>
<td>Goodrich</td>
<td>NYSE:ZGP</td>
<td>382405AA5</td>
<td>Corporate DebentureSenior Unsecured</td>
<td>8.675</td>
<td></td>
</tr>
</tbody>
</table>

**CAPIQ OUTPUT (PASTE AS VALUES INTO CELL N8, INCLUDING HEADERS)**
Exhibit IV-6: Regression Dashboard

Regression Dashboard

### REGRESSION STATISTICS:

- **R^2:** 0.792474164
- **Adj. R^2:** 0.788424879
- **F-Test:** 195.7072029

### REGRESSION RESULTS:

- Number of Y variables: 1
- Number of X variables: 4
- Number of Observations: 210
- Maximum Observations: 10,000

<table>
<thead>
<tr>
<th>X1</th>
<th>Y</th>
<th>X2</th>
<th>X3</th>
<th>X4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rating Code</td>
<td>Callable</td>
<td>Rating^2</td>
<td>Date Dummy</td>
<td>Data Density</td>
</tr>
</tbody>
</table>

**PLACE A "Y" or "X" above your variables:**

- Intercept
- B1
- B2
- B3
- B4

**INSERT RAW DATA BELOW:**

**LABELS:**
- Rating
- Rating Code
- Deal Active Date
- Tenor/Maturity
- Secured/Unsecured
- Deal Amount
- Fixed/Float
- Fixed Rate
- Spreads/Margin
- Callable
- 144A
- Guaranteed
- Rating^2
- Date Dummy
- In (Rating)

**DATA:**

<table>
<thead>
<tr>
<th>Rating</th>
<th>Rating Code</th>
<th>Deal Active Date</th>
<th>Tenor/Maturity</th>
<th>Secured/Unsecured</th>
<th>Deal Amount</th>
<th>Fixed/Float</th>
<th>Fixed Rate</th>
<th>Spreads/Margin</th>
<th>Callable</th>
<th>144A</th>
<th>Guaranteed</th>
<th>Rating^2</th>
<th>Date Dummy</th>
<th>In (Rating)</th>
</tr>
</thead>
<tbody>
<tr>
<td>AA</td>
<td>18</td>
<td>4/6/2001</td>
<td>24</td>
<td>0</td>
<td>500,000,000</td>
<td>Fixed</td>
<td>4.7</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>324</td>
<td>0</td>
<td>2.890372</td>
<td></td>
</tr>
<tr>
<td>AA</td>
<td>18</td>
<td>7/6/2001</td>
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<td>Fixed</td>
<td>4.652</td>
<td>4.12</td>
<td>0</td>
<td>0</td>
<td>324</td>
<td>0</td>
<td>2.890372</td>
<td></td>
</tr>
<tr>
<td>AA</td>
<td>18</td>
<td>7/6/2001</td>
<td>24</td>
<td>0</td>
<td>1,500,000,000</td>
<td>Fixed</td>
<td>4.652</td>
<td>4.12</td>
<td>0</td>
<td>0</td>
<td>324</td>
<td>0</td>
<td>2.890372</td>
<td></td>
</tr>
<tr>
<td>AA</td>
<td>18</td>
<td>3/4/2002</td>
<td>39</td>
<td>0</td>
<td>500,000,000</td>
<td>Fixed</td>
<td>4.21</td>
<td>-0.5</td>
<td>0</td>
<td>0</td>
<td>324</td>
<td>0</td>
<td>2.890372</td>
<td></td>
</tr>
<tr>
<td>AA</td>
<td>18</td>
<td>7/26/2001</td>
<td>60</td>
<td>0</td>
<td>1,500,000,000</td>
<td>Fixed</td>
<td>5.493</td>
<td>75.3</td>
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<td>0</td>
<td>324</td>
<td>0</td>
<td>2.890372</td>
<td></td>
</tr>
<tr>
<td>AA</td>
<td>18</td>
<td>7/26/2001</td>
<td>60</td>
<td>0</td>
<td>1,500,000,000</td>
<td>Fixed</td>
<td>5.493</td>
<td>75.3</td>
<td>0</td>
<td>0</td>
<td>324</td>
<td>0</td>
<td>2.890372</td>
<td></td>
</tr>
<tr>
<td>A+</td>
<td>16</td>
<td>3/5/2003</td>
<td>60</td>
<td>0</td>
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<td>0</td>
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</tr>
<tr>
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</tr>
<tr>
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<td></td>
</tr>
<tr>
<td>A+</td>
<td>16</td>
<td>6/12/2002</td>
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<td>0</td>
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<td>Fixed</td>
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<td>0</td>
<td>2.772589</td>
<td></td>
</tr>
<tr>
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<td>1/12/2003</td>
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<td>0</td>
<td>1,000,000,000</td>
<td>Fixed</td>
<td>4.11</td>
<td>40</td>
<td>0</td>
<td>0</td>
<td>324</td>
<td>0</td>
<td>2.890372</td>
<td></td>
</tr>
<tr>
<td>AA</td>
<td>18</td>
<td>6/2/2003</td>
<td>61</td>
<td>0</td>
<td>1,250,000,000</td>
<td>Fixed</td>
<td>4.142</td>
<td>36.825</td>
<td>0</td>
<td>0</td>
<td>324</td>
<td>0</td>
<td>2.890372</td>
<td></td>
</tr>
<tr>
<td>AA</td>
<td>18</td>
<td>8/3/2003</td>
<td>60</td>
<td>0</td>
<td>800,000,000</td>
<td>Fixed</td>
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<td>65.9</td>
<td>0</td>
<td>0</td>
<td>324</td>
<td>0</td>
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<td></td>
</tr>
<tr>
<td>AA</td>
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<td>2/10/2004</td>
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<td>0</td>
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<td>Fixed</td>
<td>4.195</td>
<td>60.5</td>
<td>0</td>
<td>0</td>
<td>324</td>
<td>0</td>
<td>2.890372</td>
<td></td>
</tr>
</tbody>
</table>
C. Pricing Embedded Options

Lastly, in this section we walk through the model for pricing embedded options. We showed pieces of the binomial interest rate tree in Section III of this paper; we give a view of the model “from ten thousand feet” in the exhibits on the following pages. First, in Exhibit IV-7, there are actually two interest rate trees shown: the first builds the interest rate tree and future bond values without embedded options, and the second values the bond when a call option is added. There is a third tree as well (not shown) that separately values a put option. (It is also possible to value convertible bonds within this framework with some additional inputs, though we do not address this in the current paper.)

Then, Exhibit IV-8 shows the primary interest rate tree closer up. The node on top row represents time zero; we’ve built 30 rows here, but can easily expand the tree if necessary. Thirty rows can handle 30-year debt with nodes spaced annually, or 15-year debt with nodes spaced at six-month intervals, etc. Recall that building the interest rate tree is an iterative procedure. Our model automates this process, and clicking on the “Price Put and Call Options” button starts the iterative solving process. The bronze colored bar provides an indication of what iteration the model is on, setting the “V” values of that row to 100 and solving for the rates in the previous node that make the time-zero “V” value equal to 100. The bronze bar moves down the rows until it reaches the maturity of the bond.

The necessary inputs, shown in Exhibit IV-9 below, reside to the left of the tree. Some of these are pulled in from the model dashboard (such as term and payments per year) or elsewhere within the model (such as the pre-option spread). There are also option-specific information that the user inputs here, such as the strike price, period of first call/put, and refinancing costs. Finally, the controlled borrower’s term structure is required as an input in the model. Below, it is constructed by pulling in Treasury rates at a given maturity and adding to it a constant spread (that was solved for in the regression analysis). Alternatively, if the regression analysis is specified to estimate the nominal interest rate, this table could instead be populated with the resulting interest rates at each maturity, and spread would not be a required input.

Refinancing costs have not been mentioned previously in this paper, but simply represent a “hurdle” margin by which the option must be in the money before it is assumed to be exercised. This is intended to capture refinancing costs that a borrower may likely consider before deciding to exercise a call option in a lower rate environment.
Exhibit IV-7: Option Pricing Model
Exhibit IV-8: Binomial Interest Rate Tree
Lastly, results of the value for the call and put options are found above their respective tree. We have specified the model to output the impact of the interest rate of the option by solving for a constant spread over the coupon that makes the bond again worth $100 in time zero given the option adjusted cash flows. The resulting spread then feeds back into the interest rate results in the central dashboard, such that if the user toggles either of the “use option” fields to “Yes,” the resulting interest rate will be adjusted according to the solved-for spread from the option model, as shown in Exhibit IV-11. Note in this exhibit that the Redeemable (or call) option is set to “Yes” while the Putable option is set to “No.” Therefore, only the value of the call option of 0.67 is added to the pre-option interest rate of 5.87 to reach the final estimated interest rate of 6.54%.
### Exhibit IV-10: Call Option Results

**Call Value**
- **Spread per Node**: 0.67%
- **Spread Annualized**: 0.67%
- **Percent of Par** (0.00)

To view in par terms, set Spread per Node to zero.

**Interest Rate Tree (Callable)**

<table>
<thead>
<tr>
<th>t</th>
<th>C</th>
<th>V</th>
<th>r0</th>
<th>V</th>
<th>r0</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0</td>
<td></td>
<td>100</td>
<td>3.832%</td>
<td>0.67%</td>
<td>0.67%</td>
</tr>
<tr>
<td>1.0</td>
<td></td>
<td>102</td>
<td>92.58143</td>
<td>6.5407987</td>
<td>6.5407987</td>
</tr>
<tr>
<td>2.0</td>
<td></td>
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</tr>
<tr>
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<td>6.0</td>
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<td>102</td>
<td>6.5407987</td>
<td>6.5407987</td>
</tr>
</tbody>
</table>

### Exhibit IV-11: Interest Rate Results

**Interest Rate - Loan A**

<table>
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<th>12/31/2011</th>
</tr>
</thead>
<tbody>
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</tr>
<tr>
<td>Term (Months)</td>
<td>120</td>
</tr>
<tr>
<td>Treasury</td>
<td>2.15</td>
</tr>
<tr>
<td>Premium over Treasury</td>
<td>3.72</td>
</tr>
<tr>
<td>Initial Rate (before Options)</td>
<td>5.87</td>
</tr>
<tr>
<td>Add Options:</td>
<td>Yes</td>
</tr>
<tr>
<td>Redeemable?</td>
<td>Yes</td>
</tr>
<tr>
<td>Value of Redeemable Option</td>
<td>0.67</td>
</tr>
<tr>
<td>Puttable?</td>
<td>No</td>
</tr>
<tr>
<td>Value of Puttable Option</td>
<td>1.23</td>
</tr>
<tr>
<td>Final Interest Rate on Loan</td>
<td>6.54%</td>
</tr>
</tbody>
</table>
V. Designing Intercompany Debt

It should be clear from the foregoing that the approach that we have developed to pricing intercompany debt has two advantages. First, it is more consistent with the emphasis in most countries’ transfer pricing regulations on reliability. The comparability adjustments embedded in our regression approach price all of the economically relevant features of an intercompany debt instrument in the most accurate (and transactional) way possible. Further, our approach is the first (to our knowledge) to provide a reliable means of handling the feedback loop that exists between the predicted interest rate and the credit rating that (in part) determines that interest rate.

However, in addition to enhanced reliability, our debt pricing approach and model can be used by companies to design intercompany debt structures that better suit their treasury and cash management needs. Because debt features such as seniority, size, currency, etc., can be priced in isolation (i.e., holding other features constant), these features can be added to the intercompany debt contract as needed in order to achieve an interest rate target. Correspondingly, callability, convertibility, or putability provisions can be added as well in order to ensure that cash flows move in response to interest rate environments in a way that is consistent with a company’s treasury objectives.

Importantly, consistent with the provisions in most countries’ regulations that economic substance and contractual form correspond to one another, every contractual term that is included in an intercompany debt instrument must be monitored and, where rational, exercised. For example, if debt is callable, and is deep in the money (meaning it is optimal to call the debt), the only way that substance (i.e., behavior) and form (i.e., the contract) correspond to one another is if the debt is in fact called. This may not be optimal at the time, from either a tax or treasury perspective, but if the contract was honored for purposes of determining the interest rate at the time of issue, it must also be honored ex post.