Advanced Topics in Debt Valuation

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Agenda

- Overview of Debt Instruments
- Types of Debt Instruments
- Reasons to Value Debt
- Debt Valuation Models
  - Bond model
  - Bank loan model
  - Market model
- Credit Analysis
  - Covenants and Ratio Analysis
  - Synthetic Credit Rating
  - S&P Method
  - Moody’s Method
  - RMA
- Market Data
- Example DCF
- Adjustments
- WACC
- Distressed Debt
  - Debt, Equity and Asset Volatilities (Merton Model)
  - OPM for Debt
Overview of Debt Instruments

- Contractual obligation to repay a creditor
- Senior to equity, thus, less risky than equity
- Debt obligations include both principal and interest payments
- Interest expense is generally tax deductible to the issuer
- Interest payments may be cash or PIK
- Some debt is amortized: amortized debt is less risky than bullet
- Traded (bonds or syndicated bank loans) or nontraded
- Debt Purchase Agreement is very important

Types of Debt Instruments

- Senior Bank Loans
  - Revolvers
  - Term Loans (some syndicated)
- Debenture/mezzanine unsecured debt (Notes or traded bonds)
- Convertible Bonds: embedded conversion option
  - Usually convertible into common stock
  - Like a below market interest rate bond plus a warrant
- Variable rate debt
- Bank loans: mortgages, commercial, etc.
- Bonds with call and put features: these features may require separate valuation
- In this presentation we will focus on fixed coupon bond or notes
- Variable rate debt and bank loans require their own treatment and are outside the scope of this presentation
Many Reasons to Value Debt

- Financial reporting – impairment, business combinations, disclosures, stock compensation
- Tax reporting – estate, gift, income, charitable deduction
- ESOP formation
- Asset value allocation
- Compensation awards (private companies with complex capital structure)
- Exchange transaction
- Restructuring/recapitalization transaction
- Litigation
- Bankruptcy

Debt Valuation Under ASC 820

- Quoted prices in an active market for an identical debt instrument are Level 1 inputs
- The majority of the liabilities in audited financial statements will be estimated using Level 2 and Level 3 inputs
- The fair value of liabilities issued by a going concern is typically based on the present value of the future expected cash flows
- Using the bond/Yield (DCF) model to value debt and using market inputs such as market determined discount rate is often considered level II
- Exit Price Issues
- Highest and best use
Debt valuation method: Bond/YIELD/CCF model

- Risk can be factored in the cash flows (CFn) or the discount rate (i) or both
- Income-based approach – discounted cash flow model
- Also known as Contractual Cash Flow (CCF) method
  - Most appropriate for investment grade debt and speculative grade debt (high yield)
  - Risk is in the discount rate
- Calculate the expected CFs based on contractual agreements and take the risk in the denominator

\[
\text{Present Value} = \frac{CF_1}{(1+i)^1} + \frac{CF_2}{(1+i)^2} + \frac{CF_3}{(1+i)^3} + \cdots + \frac{CF_n}{(1+i)^n}
\]

where:
- \(CF\) = Cash flow in future period \(t\)
- \(t\) = Period where cash flow is received
- \(i\) = Required market rate of interest (yield)
- \(n\) = Maturity of debt

Debt valuation method: Bond/YIELD/CCF model, continued

- Calculate the contractual cash flows
  - Review debt agreement
  - Consider coupon rate, periodicity of payments, return(s) of capital at maturity, etc.
  - Amortization (if necessary)
  - Model any possible early retirement event (call or put)
- Conduct a “synthetic” credit rating analysis
- Derive a required market yield from similarly rated public debt issues
- Calculate the present value of the expected cash flows
- Apply any appropriate valuation adjustments
Debt valuation method: ECF- Bank Loan model

- **Expected cash flow (ECF) method**
  - **Risk is in the expected cash flows**
  - Popular with bankers, where it is easier to predict expected losses and prepayments
  - Also used for speculative grade debt (significantly distressed)
  - Risk is reflected by subtracting the expected losses from the contractual cash flows
    - Probability of default
    - Loss given default
  - Calculate the expected CFs based on contractual agreements, subtract the expected losses and discount at a discount rate net of credit risks

  \[
  \text{Present Value} = \frac{CF_1 - L_1}{(1+i)^1} + \frac{CF_2 - L_2}{(1+i)^2} + \ldots + \frac{CF_n - L_n}{(1+i)^n}
  \]

  where:
  - \(CF\) = Cash flow in future period \(t\)
  - \(L\) = Expected losses
  - \(t\) = Period where cash flow is received
  - \(i\) = Discount Rate
  - \(n\) = Maturity of debt

DCF models - Comments

- The bond model is most widely used model to value performing debt
- The “bank loan” model is used by banks to value the loans
- Bond model utilizes future contractual cash flows
- Risk is embedded in the discount rate
- For the bank model the ECFs are lower than the CCFs
- Discount rate lower than discount rate in contractual cash flow method since much risk is captured in cash flow adjustments – not risk free, however
- Variable rate debt requires the use of a forward rate curve for the coupon rate (as their coupon is an index + spread)
- The bond, fixed income and interest rate derivatives traders value the debt using a term structure of discount rates (e.g. zero coupon bond yields)
Market Model

- Appropriate when valuing tradable bonds
- Sufficiently similar issues are hard to find
- Sources of information: Bloomberg, Reuters, IDC, FINRA.com
- Sources for debt indices for alternative ratings: Bloomberg, S&P, Ycharts.com
- Not widely used because it is difficult to find sufficiently similar bonds

Estimating discount rate – Credit Analysis

- Credit quality of the debtor
- Credit quality of the debt security
- Characteristics of the debt security
  - seniority in the capital structure
  - collateral
  - put/call features
  - expected term
  - conversion rights
  - current market conditions as of the valuation date
- Credit ratings
- Consider qualitative characteristics along with quantitative analyses
Overview of Credit Analysis

- Credit analysis reviews the creditworthiness of the subject debt security and allows one to select an appropriate yield to maturity for the subject debt security based on its ‘synthetic credit rating’
- Process:
  - Identify similar publicly-traded debt securities:
    - The securities should be rated (e.g., S&P, Moody’s)
    - Exclude debt of municipalities, financial institutions and utilities because they are less comparable to industrial companies
  - Calculate financial ratios related to credit worthiness for the subject company and the selected public companies
  - Estimate a “synthetic” credit ratio for the subject debt security, through comparative analysis with the selected public companies
  - Estimate an appropriate yield to maturity for the subject debt security based on “synthetic” credit rating, time to maturity and terms.
  - If similar publicly-traded, rated debt is not available, use the financial ratios associated with various credit ratings as provided by S&P or Moody’s. We will focus on this in this presentation.

Agency Credit Ratings

- Agency Credit ratings for specific debt issues are based on:
  - Financial ratio analysis
  - Willingness to pay - qualitative
  - Features of the debt contract
  - The priority of the security in the debtor's capital structure
    - Security
    - Seniority
    - Depending on the financial strength of the Debtor, junior obligations may be rated lower than senior obligations, to reflect the higher risk of loss due to their lower priority in bankruptcy
  - Moody’s Global Business and Consumer Industry Rating Methodology (October 2010) presents a credit analysis methodology and rating mapping
  - Weightings are provided for three groups of factors: size and profitability, financial strength, and financial policy
  - There is a scale mapping the score from 1 to 20 to a synthetic rating: Aaa < 1.5 and Ca > 19.5
Credit Analysis - Covenants

- Especially for senior debt, the Debt agreement often includes various covenants
- Analyze collateral
- Breaking covenants are important credit events
- Treat distressed debt differently than performing debt
- Examples of financial covenants:

<table>
<thead>
<tr>
<th>Financial Covenants</th>
<th>Covenant</th>
<th>Actual value</th>
<th>Satisfied</th>
</tr>
</thead>
<tbody>
<tr>
<td>min EBITDA</td>
<td>$ 2.85</td>
<td>$ 3.50</td>
<td>YES</td>
</tr>
<tr>
<td>max Senior Debt to EBITDA</td>
<td>1.50</td>
<td>2.70</td>
<td>NO</td>
</tr>
<tr>
<td>min Fixed Charge Coverage</td>
<td>1.25</td>
<td>0.59</td>
<td>NO</td>
</tr>
</tbody>
</table>

- Enterprise coverage ratio: BEV/Debt

S&P Credit Ratings and Descriptions

<table>
<thead>
<tr>
<th>S&amp;P Rating Grade</th>
<th>Definitions</th>
</tr>
</thead>
<tbody>
<tr>
<td>AA</td>
<td>Investment, Very High Quality. Very strong capacity to meet financial commitments.</td>
</tr>
<tr>
<td>A</td>
<td>Investment, High Quality. Strong capacity to meet financial commitments, but somewhat susceptible to adverse economic conditions and changes in circumstances.</td>
</tr>
<tr>
<td>BBB</td>
<td>Minimum Investment Grade. Adequate capacity to meet financial commitments, but more subject to adverse economic conditions.</td>
</tr>
<tr>
<td>BB</td>
<td>Junk, Speculative. Less vulnerable in the near-term but faces major ongoing uncertainties to adverse business, financial and economic conditions.</td>
</tr>
<tr>
<td>B</td>
<td>Junk, Very Speculative. More vulnerable to adverse business, financial and economic conditions but currently has the capacity to meet financial commitments.</td>
</tr>
<tr>
<td>CCC</td>
<td>Junk, Default Possible. Currently vulnerable and dependent on favorable business, financial and economic conditions to meet financial commitments.</td>
</tr>
<tr>
<td>CC</td>
<td>Junk, Default Probable. Currently highly vulnerable.</td>
</tr>
<tr>
<td>C</td>
<td>Junk, Default Very Probable. Currently highly vulnerable obligations and other defined circumstances.</td>
</tr>
<tr>
<td>D/SD</td>
<td>Junk, In Actual/ Imminent Default. Payment default on financial commitments.</td>
</tr>
</tbody>
</table>
Moody's Credit Ratings and Descriptions

<table>
<thead>
<tr>
<th>Moody's Rating</th>
<th>Definitions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aaa</td>
<td>Obligations rated Aaa are judged to be of the highest quality, subject to the lowest level of credit risk.</td>
</tr>
<tr>
<td>Aa</td>
<td>Obligations rated Aa are judged to be of high quality and are subject to very low credit risk.</td>
</tr>
<tr>
<td>A</td>
<td>Obligations rated A are judged to be upper-medium grade and are subject to low credit risk.</td>
</tr>
<tr>
<td>Baa</td>
<td>Obligations rated Baa are judged to be medium-grade and subject to moderate credit risk and as such may possess certain speculative characteristics.</td>
</tr>
<tr>
<td>Ba</td>
<td>Obligations rated Ba are judged to be speculative and are subject to substantial credit risk.</td>
</tr>
<tr>
<td>B</td>
<td>Obligations rated B are considered speculative and are subject to high credit risk.</td>
</tr>
<tr>
<td>Caa</td>
<td>Obligations rated Caa are judged to be speculative of poor standing and are subject to very high credit risk.</td>
</tr>
<tr>
<td>Ca</td>
<td>Obligations rated Ca are highly speculative and are likely in, or very near, default, with some prospect of recovery of principal and interest.</td>
</tr>
<tr>
<td>C</td>
<td>Obligations rated C are the lowest rated and are typically in default, with little prospect for recovery of principal or interest.</td>
</tr>
</tbody>
</table>

Source: Moody's Investors Service - Moody's Rating Symbols and Definitions, September 2012, p. 5

Sources of Data

- **Standard & Poor's Corporate Ratings Criteria:**
  - Excellent commentary and perspective on the overall credit rating process
  - Formulas and definitions related to calculating credit ratios
- **Moody's Corporate Rating**
- **Bloomberg:**
  - Excellent source for publicly traded debt securities and credit ratings
  - Excel compatible
- **Capital IQ:**
  - Same identification and downloading tasks as Bloomberg
  - Not as comprehensive as Bloomberg
- **FINRA.com**
- **Ycharts.com**
### Credit Analysis – S&P Benchmark ratios

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Oper. income (bef. D&amp;A)/revenues (%)</td>
<td>28.2</td>
<td>25.3</td>
<td>19.5</td>
<td>17.0</td>
<td>17.2</td>
<td>15.8</td>
</tr>
<tr>
<td>Return on capital (%)</td>
<td>34.2</td>
<td>25.4</td>
<td>21.1</td>
<td>14.1</td>
<td>12.2</td>
<td>8.3</td>
</tr>
<tr>
<td>EBIT interest coverage (x)</td>
<td>30.5</td>
<td>18.3</td>
<td>11.0</td>
<td>5.8</td>
<td>3.5</td>
<td>1.4</td>
</tr>
<tr>
<td>EBITDA interest coverage (x)</td>
<td>33.5</td>
<td>20.5</td>
<td>14.3</td>
<td>7.6</td>
<td>5.2</td>
<td>2.3</td>
</tr>
<tr>
<td>Total debt/EBITDA (x)</td>
<td>0.4</td>
<td>1.1</td>
<td>1.5</td>
<td>2.3</td>
<td>3.0</td>
<td>5.3</td>
</tr>
<tr>
<td>No. of companies</td>
<td>4</td>
<td>16</td>
<td>92</td>
<td>213</td>
<td>245</td>
<td>325</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Ratio</th>
<th>Formula</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating income before depreciation</td>
<td>Operating income before depreciation and amortization/revenues and amortization to revenues</td>
</tr>
<tr>
<td>Return on capital</td>
<td>EBIT/average beginning of year and end of year capital</td>
</tr>
<tr>
<td>EBIT interest coverage</td>
<td>EBIT/interest</td>
</tr>
<tr>
<td>EBITDA interest coverage</td>
<td>EBITDA/interest</td>
</tr>
<tr>
<td>Debt to EBITDA</td>
<td>Debt/EBITDA</td>
</tr>
</tbody>
</table>

### S&P Credit Analysis Definitions

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capital</td>
<td>Debt, plus noncurrent deferred taxes, plus equity</td>
</tr>
<tr>
<td>Capital expenditures (CAPEX)</td>
<td>Funds expended to acquire or develop tangible and certain intangible assets. It includes the cost of acquisition of assets through leases and similar arrangements, and excludes capitalized costs that we expense as an analytical adjustment</td>
</tr>
<tr>
<td>Cash flow from operations</td>
<td>This measure reflects cash flows from operating activities, not investment and financing activities. It includes interest received and paid, dividends received, and taxes paid in the period. Additionally, for some items such as postretirement benefits and asset retirement obligations, we include the (net) cost for the period rather than actual cash outflows, in order to separate what we view as financing of these obligations from the operating cost component</td>
</tr>
<tr>
<td>Debt</td>
<td>Total short- and long-term borrowings of the company (including maturities), adjusted by adding a variety of on- and off-balance sheet financing arrangements pursuant to our adjustment methodology, and subtracting surplus cash, where applicable. Borrowings are measured at amortized cost (including remeasurement upon change in ownership of the issuer). Foreign-currency unhedged borrowings are measured at each period-end spot rate</td>
</tr>
<tr>
<td>EBIT</td>
<td>A traditional view of profit that factors in capital intensity. However, it also includes interest income, the company’s share of equity earnings of associates and joint ventures, and other recurring, non-operating items</td>
</tr>
</tbody>
</table>
Credit Analysis – Moody’s Benchmark ratios

<table>
<thead>
<tr>
<th>Moody’s Financial Metrics</th>
<th>Aaa</th>
<th>Aa</th>
<th>A</th>
<th>Baa</th>
<th>Ba</th>
<th>B</th>
<th>Caa-C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating Margin</td>
<td>14.9%</td>
<td>17.0%</td>
<td>13.8%</td>
<td>12.6%</td>
<td>12.2%</td>
<td>8.5%</td>
<td>1.6%</td>
</tr>
<tr>
<td>EBITA Margin</td>
<td>14.8%</td>
<td>17.5%</td>
<td>15.2%</td>
<td>13.9%</td>
<td>13.4%</td>
<td>9.4%</td>
<td>2.4%</td>
</tr>
<tr>
<td>EBITA Int. Exp.</td>
<td>17.0%</td>
<td>13.7%</td>
<td>8.2%</td>
<td>5.1%</td>
<td>3.4%</td>
<td>1.5%</td>
<td>0.3%</td>
</tr>
<tr>
<td>Debt/EBITDA</td>
<td>0.9</td>
<td>1.0</td>
<td>1.7</td>
<td>2.4</td>
<td>3.3</td>
<td>5.0</td>
<td>6.3</td>
</tr>
</tbody>
</table>

Ratio Formula:

- Operating Margin = Operating Profit / Net Revenue
- EBITA Margin = EBITA / Net Revenue
- EBITA Interest Expense = EBITA / Interest Expense
- Debt / EBITDA = (Short-term debt + Long-term debt) / EBITDA
Yields, Ratings and Term to Maturity

Yields on Corporate Bonds

US Govt
AA
A
BBB
BB
B

Yields, Ratings and Term to Maturity (5-year History, Ycharts.com)

AAA
BBB

B
CCC

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Example of Subject Company: DCF

- Subject company issues a five-year (straight non-traded) note:
  - $100,000 par (i.e., purchase price = 100%)
  - The 5% coupon is paid annually
  - Based on a credit analysis of the subject debt relative to comparably-rated straight debt, the analyst determines that the appropriate synthetic rating is B and the required market yield is 9.0%

<table>
<thead>
<tr>
<th>Year</th>
<th>Cash Flows to Creditor:</th>
<th>Required Market Yield</th>
<th>Discount Period</th>
<th>Present Value Factor</th>
<th>Present Value of Cash Flows</th>
<th>Net Present Value (NPV)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Interest: 5.00 $</td>
<td>9.00%</td>
<td>1</td>
<td>0.91743</td>
<td>4.59 $</td>
<td>$ 84.44 $</td>
</tr>
<tr>
<td></td>
<td>Principal: 100.00 $</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Interest: 5.00 $</td>
<td>9.00%</td>
<td>2</td>
<td>0.84168</td>
<td>4.21 $</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Interest: 5.00 $</td>
<td>9.00%</td>
<td>3</td>
<td>0.77218</td>
<td>3.86 $</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Interest: 5.00 $</td>
<td>9.00%</td>
<td>4</td>
<td>0.70843</td>
<td>3.54 $</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Interest: 5.00 $</td>
<td>9.00%</td>
<td>5</td>
<td>0.64993</td>
<td>68.24 $</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>$ 5.00 $</td>
<td>$ 5.00 $</td>
<td>$ 5.00 $</td>
<td>$ 5.00 $</td>
<td>$ 105.00 $</td>
<td></td>
</tr>
</tbody>
</table>

Example of Subject Company: Credit Analysis

<table>
<thead>
<tr>
<th>ABCD Company</th>
<th>2011</th>
</tr>
</thead>
<tbody>
<tr>
<td>EBIT interest coverage (x)</td>
<td>3.1</td>
</tr>
<tr>
<td>EBITDA interest coverage (x)</td>
<td>4.1</td>
</tr>
<tr>
<td>Return on capital (%)</td>
<td>17.4</td>
</tr>
<tr>
<td>Operating income/sales (%)</td>
<td>7.6</td>
</tr>
<tr>
<td>Total debt/EBITDA (x)</td>
<td>2.5</td>
</tr>
<tr>
<td><strong>Concluded Rating:</strong></td>
<td><strong>B</strong></td>
</tr>
<tr>
<td><strong>S&amp;P (2007 to 2009)</strong></td>
<td>AAA</td>
</tr>
<tr>
<td>Operating Income (EBITDA) (x)</td>
<td>26.2</td>
</tr>
<tr>
<td>Return on capital (%)</td>
<td>34.2</td>
</tr>
<tr>
<td>EBIT interest coverage (x)</td>
<td>30.5</td>
</tr>
<tr>
<td>EBITDA interest coverage (x)</td>
<td>33.5</td>
</tr>
<tr>
<td>Total debt/EBITDA (x)</td>
<td>0.4</td>
</tr>
</tbody>
</table>

| Operating Margin | 14.9% | 17.0% | 13.9% | 12.6% | 12.2% | 8.5% | 1.5% |
| EBIT Margin | 14.8% | 17.0% | 13.9% | 13.6% | 13.4% | 9.4% | 2.4% |
| EBITA Int. Exp. | 17.0% | 13.7% | 8.2% | 5.1% | 3.4% | 1.5% | 0.3% |
| Debt/EBITDA | 0.9 | 1.0 | 1.7 | 2.4 | 3.3 | 5.0 | 6.3 |
Synthetic Discount Estimation Issues

- Risk comparisons between public debt and private debt can be difficult
- A lot of public bonds are callable
- Synthetic credit ratings are performed by appraisers rather than credit rating professionals
- Credit ratio analysis doesn’t capture the other factors considered by the agencies
- Market prices and yields could be volatile and affected by liquidity and market volatility (B rated bonds had yields above 15% at the height of the financial crisis, vs around 9% these days)
- Maturity date and coupon rate each have an impact on the discount rate:
  - Zero coupon bonds are more risky than high coupon bonds
  - Discount rates are affected by the expected time to maturity
  - The coupon rate, relative to the required market yield on a debt security, can influence the probability of a call, e.g. 8% coupon and required market YTM is 6%

Debt Valuation Adjustments

- Things to consider if subject debt is different from debt of rated comparables:
  - Liquidity – we will discuss this more
  - Size of issue and divisibility
  - Clearly articulated covenants
  - Cash interest vs PIK
  - Payment schedule
  - Level of subordination
Liquidity Considerations

- Illiquidity is a less significant issue for fixed income investors than for common stock investors; so the methodologies will be different
  - Common stock shares are frequently traded for capital gains and less for income
  - Bonds are not traded frequently and often are held to maturity and are for income
  - Restricted stock studies and pre-IPO studies are not relevant
- Liquidity adjustments for debt may be reflected by:
  - Increasing the required market yield
  - Applying a discount to the implied value

“Components of credit spreads and their importance” Jason Voss, 2012, Enterprising Investor (CFA Institute), provides a good overview of the research on the credit vs illiquidity premium

  - Non-traded debt cost of debt will have a higher illiquidity premium
  - Option-based DLOM models may provide guidance
  - A bond put option model might be more reasonable
  - Black Scholes is not appropriate as bond prices converge to par
  - Bond options are usually valued using the Black (1977) or with a lattice based model of short interest rates
  - Black (1977) model for options on bonds is close to Black-Scholes and used by traders
  - Ideally, you want an average Asian put model (like Finnerty for equity)
WACC and Risky Debt

- Modigliani and Miller assumed debt was riskless
- Hamada’s adjustment to Betas is based on M&M
  - Assumes zero Beta for Debt
  - Reasonable in many applications for companies far from financial distress
- Debt betas are discussed in Pratt and Grabowski’s Cost of Capital, 4th Edition, Ex. 10.12, page 180
Advanced Topics in Debt Valuation

Debt, Equity and Asset Betas

- Asset Beta is the weighted average of the debt Beta and equity Beta
  - Underestimated based on M&M since the assumed riskless debt has zero beta
  - Underestimation may not be significant as debt Betas are low except in times of extreme financial stress or when a company’s credit rating is low and the level of debt is high – see prior chart from Pratt and Grabowski
  - Underestimation of risk will result in an overestimation of the value of the assets and therefore the debt, given the observed or pre-determined equity value.
  - Option theory may provide a solution to estimating debt and asset values

- Page 79 of AICPA’s “Valuation of Privately-Held-Company Equity Securities Issued as Compensation” presents Merton model for the calculation of Asset Volatility when we know Equity Volatility
  - The Merton model can be used to calculate the weights of Debt and Equity as it values the equity using an option model

Risky and Distressed Debt Valuation

- Business Enterprise Value: $1,000,000
- Face value Debt: $1,000,000
- Coupon interest: 5%
- Time to maturity: 3 years
- Use an option pricing model to value the Debt and Equity
- Equity can be thought of as a call option on the assets of a company (BEV) with a strike price equal to the debt
- Value of Debt is BEV less value of equity
- The strike price should be the zero coupon debt which is different from face value
- Zero coupon debt is the expected par value of the debt at the maturity (face plus the accrued interest)
- If the Debt pays 5% coupon strike price = $1m x (1+0.05)^3=$1,157,625
- Use Black-Scholes with the above inputs
Risky and Distressed Debt Valuation

- Business Enterprise Value: $1,000,000
- Zero coupon debt (Strike value): $1,157,625
- Time to maturity or exit: 3 years
- Risk Free rate: 3% (3 years to match maturity)
- Volatility (BEV, asset): 30%
- Calculate the asset volatility using the Hamada model or the Merton model
- Use the Merton model of two equations on the next slides to solve for both Asset Volatility and Equity and Debt Values

Conclusion:
- Value of equity: $183,148 (Black Scholes with above inputs)
- Value of Debt: $1,000,000− $183,148 = $816,852 or 12.75% implied yield
- Equity value is non zero and the debt value is below par
- The term and volatility have a strong impact on equity and debt values

Merton model for Asset Volatility and Equity Volatility

- Beacon, Ghaidarov and Brigida "Volatility Measurement and its Impact on Valuation" Valuation Strategies 2009 present the full Merton model
- Following Merton’s formulation, the relationship between equity volatility and asset volatility can be written as follows:
  1. Equity Volatility = Asset Volatility × (Asset Value × N(d1)) / Equity Value
  2. Equity Value = Asset Value × N(d1) – D × exp(-Rf*T) × N(d2)

  Where N(d1) and N(d2) are from Black-Scholes
  D: zero coupon debt is the expected par value of the debt at the maturity (face plus the accrued interest)
  A time to exit/maturity needs to be considered
  Formulas (1) and (2) need to be solved simultaneously (using SOLVER)
  Unknown: Asset Volatility, and either (i) Equity value, if know Asset Value or (ii) Asset Value, if know Equity volatility
  Note that d1 and d2 are a function of Asset Value, D and Asset Volatility
Merton model for Asset Volatility and Equity Volatility

- **Black Scholes inputs:**
  - Asset value instead of Stock price
  - D : Debt Value (zero coupon instead of strike price)
  - Term: expected debt maturity or exit time
  - Rf risk free rate matching time to maturity
  - Volatility: Asset volatility

- If you know Asset Value (from BEV) then SOLVER will calculate the Asset Volatility, Equity Value, Bond Value (Asset Value less Bond Value)
- But you need Equity Volatility (calculated in the traditional way)
- If you know Equity Value (from traded stock price) then SOLVER will calculate the Asset Volatility and Asset Value
- Merton model (the two interrelated formulas) are also used in deleveraging and releveraging the equity volatility, per the following example from AICPA’s “Cheap Stock” 2012

**Asset Volatility – Merton Model**

AICPA “Cheap Stock” draft 2012
Implications of the OPM for Distressed Companies

- The higher the volatility, the more the equity is worth and the less the debt is worth
- The longer the time to exercise, the more the equity is worth and the less the debt is worth
- There is a transfer of wealth from debt holders to equity holders with an increase in risk
- There is a transfer of wealth from equity holders to debt holders with a decrease in risk
- Using the option pricing framework, there is always a value for the equity
  - Out of the money calls have value
  - Implies that the debt of an ‘insolvent’, but not in liquidation, company is not equal but less than the asset value

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