Chapter 18
"An Analytical Approach to
Investments, Finance and Credit"

Credit Risk Analysis

Credit Analysis Overview

- The chapter follows on from previous sections on understanding and analyzing financial statements.
- This works as the basis for analyzing the company that is planning to borrow.
- The three main areas that this section will go over are the following:
  - Review of financial statements and application of credit-related ratios
  - Debt capacity analysis
  - Risk and credit restructure analysis

Review of financial statements and application of credit-related ratios

The objectives for the credit risk analysis are as follows:

- Use the various ratio analysis methods to measure how well the company manages its debt (solvency ratios), how well it manages its cash (liquidity ratios) and how profitable it is and how it will fair in economic turmoil (profitability ratios) once we run various stress case scenarios.
- Use the specific ratio analysis methods to capture asset efficiency and collateral coverage.
- Use the ratio analysis to structure the debt capacity of any company including the appropriate starting leverage and ongoing coverage of the company's contractual debt obligations.
- Build in warning signal ratios of deterioration such as the Altman Z-score credit parameter.
- Use customized ratios based on industry drivers to measure revenue growth and cost structures and change those to sensitize the company's performance during economic cycles or commodity price fluctuations.

Usefulness of Ratio Analysis

- To complete the full credit risk assessment of a company, the analyst should compare ratio results:
- With past results to establish how well they are trending
- With the company's peers to establish how well they are performing versus the bench mark
- With the company's budget to establish management credibility of meeting its business plan

Five Areas Where the Risk-Credit Analysis Should Focus

A lot of the commercial banks and institutions that lend money to corporations, as well as credit agencies, focus on the following five areas of analysis:

1. Loan-to-value or debt capitalization ratio
2. Leverage ratio of debt to EBITDA
3. Coverage ratios including EBITDA/interest and cash flow to debt service
4. Run a 30% haircut across operating assumptions to test profitability and cash flow
5. Adjust and customize operating ratios based on the company's business that can be cyclical or seasonal or depend on commodity pricing

Five Areas Where the Risk-Credit Analysis Should Focus

1. **Loan-to-value or debt capitalization ratio:**

- This ratio, expressed as a percentage, is the debt amount raised over the total capital or the amount over the total value of the asset or business that is purchased.
- One of the areas of the credit analysis is to assess the debt's position in capital structure in relationship to other capital raised.

Five Areas Where the Risk-Credit Analysis Should Focus

2. Leverage ratio of debt to EBITDA:

- **This solvency-type ratio, well known as the leverage ratio, is one of the most popular ratios to analyze the credit of a company.**
- Even a few government agencies, such as the board of governors of the Federal Reserve System (the "Fed Reserve"), the Federal Deposit Insurance Corporation (FDIC), and the Office of the Comptroller of the Currency (OCC), use this ratio to give guidance to banks to how much debt they should be advancing to companies in a new transaction, such as a leveraged buyout. In March 2013, four years after the financial crisis of 2008-2009, these government agencies sent a letter to all the commercial banks with a subject "*Interagency Guidance of Leveraged Lending*" (2013).
- Page 7 of the letter states the following: "Credit agreement covenant protections, including financial performance (such as debt-to cash flow, interest coverage, or fixed charge coverage), reporting requirements, and compliance monitoring.
- Generally, a leverage level after planned asset sales (that is, the amount of debt that must be serviced from operating cash flow) in excess of 6X Total Debt/EBITDA raises concerns for most industries."
- This ratio is also used by analysts to derive debt capacity, and it's incorporated in a lot of the credit agreements as a covenant ratio to measure ongoing performance of the borrower versus its projections

Five Areas Where the Risk-Credit Analysis Should Focus

3. **Coverage ratios including EBITDA/interest and cash flow to debt service**:

- While the two previous ratios focus on the debt as in relationship to value or other sources of capital or setting up the initial debt as compared to current EBITDA and cash flow, the coverage ratios address the ongoing ability of the company to meet its annual debt obligations.
- These ratios, such EBITDA to interest or EBITDA minus Capex to debt payments are usually found in credit agreements as a covenant ratio. This ratio is very effective when the analyst runs various sensitivity cases to test the ability of the company to pay its debt obligations.
- For example, if the starting EBITDA-to-interest ratio of a transaction is 3x, assuming EBITDA of $90 million and interest expense of $30 million, then even if EBITDA drops in half, from $90 million to $45 million, the $30 million interest expenses can be covered though the risk of the company has significantly changed. In this example, the credit agreement between the company and banks that have given the loan might have a covenant restriction of 2x, which means that at 1.5x the company will have a technical default.
- This technical default will give the bank a reason to increase its interest rate to reflect the new risk before approving to amend a new covenant level or waiving the current level.

Five Areas Where the Risk-Credit Analysis Should Focus

4. Run a 30% haircut across operating assumptions to test profitability and cash flow

- Typically, the company will give the bank a business plan, which will include financial projections before obtaining a loan.
- The analysts working for this bank who are in the process of approving a loan will run various sensitivity cases including a case that adjusts down the top line and bottomline income and cash flow by 30% to test how the company can meet such obligations.
- The 30% threshold is typically used to set up the covenants that will be incorporated in the credit or loan agreement.

Five Areas Where the Risk-Credit Analysis Should Focus

5. Adjust and customize operating ratios based on the company's business that can be cyclical or seasonal or depend on commodity pricing:

- After the four areas of analysis are run and measured, the analyst should focus on the specific operating ratios based on the industry drivers.
- For example, if the credit analyst is analyzing a chemical company where a large portion of its cost of revenue is oil or an oil-related commodity such as benzine, the cost of raw material should be sensitized and adjusted for price fluctuations unless the company has hedging contracts in place to stabilize its cost of materials. I
- n grading the company after applying the measurement ratios, including the leverage and coverage ratios, the analyst allows the adjustments (plus or minus) based on the stability or volatility of the company's revenues and/or costs.

Five Areas Where the Risk-Credit Analysis Should Focus

1. **Loan-to-value or debt capitalization ratio** starts at 35.4%, meeting Standard & Poor's BB- benchmark of 60%.

2. **Leverage ratio of debt to EBITDA** starts at 2.4x, meeting Standard & Poor's BB- benchmark of 4x.

3. **Coverage ratios including EBITDA/interest and cash flow to debt service** starts at 5.2x meeting Standard & Poor's BB- benchmark of 3x.

4. **Run a 30% haircut across operating assumptions to test profitability and cash flow** still meet Standard & Poor's BB- benchmark.

5. **Adjust and customize operating ratios based on the company's business that can be cyclical or seasonal or depend on commodity pricing:** In Figure 18.1 the credit analysis benchmark shows a threshold of 3x beta business volatility as the maximum level. Celerity Technology shows that the businesses in their industry measure volatility or beta at 2.5x, thus no further adjustments need to be made to assess the credit risk.

Celerity Technogy Inc. ("CTI")
Credit Risk Analysis

	HISTORICAL			PROJECTED				
BASE CASE	**Year -1**	**Year 0**		**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**
Revenues	960,000	1,110,000		1,228,140	1,344,200	1,442,919	1,529,268	1,605,161
Revenue Growth		15.6%		10.6%	9.5%	7.3%	6.0%	5.0%
EBITDA	385,000	433,000		493,561	547,928	592,424	629,659	660,688
EBITDA Margin								
Interest Expense				95,450	99,600	113,450	141,750	157,250
Tax Expense				129,769	147,070	156,960	158,461	162,851
Working Capital				(2,870)	4,548	3,869	3,384	2,974
Capex				138,304	151,374	162,491	172,215	180,761
Cash on Balance Sheet	45,000	65,800		118,577	179,246	236,183	267,484	278,544
Total Debt	1,220,000	1,190,000		1,160,000	1,130,000	1,090,000	1,030,000	950,000
Equity Ownerhip	1,746,000	1,919,800		2,114,453	2,335,059	2,570,498	2,808,190	3,052,467
Credit Risk Analysis								
1. Debt Capitalization			✓	35.4%	32.6%	29.8%	26.8%	23.7%
2. Leverage Ratio : Total Debt / EBITDA			✓	2.4x	2.1x	1.8x	1.6x	1.4x
3. Interest Ratio: EBITDA / Interest			✓	5.2x	5.5x	5.2x	4.4x	4.2x
4. 30% EBITDA Haircut:	**Haircut**							
Total Debt / EBITDA (Leveraged Ratio)	30.0%		✓	3.4x	2.9x	2.6x	2.3x	2.1x
EBITDA / Interest (Coverage Ratio)	30.0%		✓	3.6x	3.9x	3.7x	3.1x	2.9x
Bench Mark (Target S&P BB- or higher):								
Debt Capitalization			✓	60.0%	60.0%	60.0%	60.0%	60.0%
Total Debt / EBITDA (Leveraged Ratio)			✓	4.0x	4.0x	4.0x	4.0x	4.0x
EBITDA / Interest (Coverage Ratio)			✓	3.0x	3.0x	3.0x	3.0x	3.0x
5. Industry Designation (Industry Beta Sensitivity - needs to be less than 3x)								
Technology			✓	2.5x	2.5x	2.5x	2.5x	2.5x
Credit Risk Benchmark				3.0x	3.0x	3.0x	3.0x	3.0x

Figure 18.1

Debt-Capacity Analysis

- **The objective of the debt capacity analysis is to measure the ability to borrow.** It refers to the amount of funding that a firm can borrow up to the point where its corporate value no longer increases. There various methods of measuring debt capacity:
- Based on maximum leverage ratio (Total Debt/EBITDA)
- Based on loan to value (Total Debt/Enterprise value or total debt/total assets)
- Based on debt coverage ratio (DCR)

Debt-Capacity Analysis

Based on Maximum-Leverage Ratios (Total Debt/EBITDA)

- **This ratio, which has been one of the most controversial ratios used to measure debt capacity, has been changing every year based on risk appetite of the banks.**
- Prior to the financial crisis of 2008, leveraged buyout transactions were structured on average of 7x times leverage.
- the financial crisis, any deal that got done was done less than 5x, and after the financial crisis the leverage ratio climbed up to 6x, so on a $100-million acquisition of a company with a $10 million EBITDA, the $40 million needs to be paid with equity (40%) because the market capacity is 6 x $10 = $60 million of debt; the extra multiple (4x on a 10x acquisition multiple) needs to come from equity.
- If, for example, the negotiation raises the price to $120 million, the equity needs to make up the difference since the debt level has met its maximum capacity.

Debt-Capacity Analysis

Based on Maximum-Leverage Ratios (Total Debt/EBITDA)

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Debt-Capacity Analysis

Based on Maximum-Leverage Ratios (Total Debt/EBITDA)

Figure 18.2 shows that no matter what the acquisition cost is, the debt capacity stays at the same level. In this case Figure 18.2 shows a maximum senior debt leverage (what a bank will be comfortable lending against EBITDA) and total debt at 6x. If the private equity firm negotiates to buy the company at 8x acquisition multiple of 12x, then the equity adjusts as percentage to the total capital raised.

DEBT CAPACITY BASED ON TOTAL LEVERAGE (6.0X)

	EBITDA Multiple X	% Capital	EBITDA Multiple X	% Capital	EBITDA Multiple X	% Capital
Cost of Acquisition	**8.00x**		**10.00x**		**12.00x**	
Senior Bank Debt	3.50x	43.8%	3.50x	35.0%	3.50x	29.2%
Corporate Bonds	2.50x	31.3%	2.50x	25.0%	2.50x	20.8%
Total Debt	6.00x	75.0%	6.00x	60.0%	6.00x	50.0%
Equity	2.00x	25.0%	4.00x	40.0%	6.00x	50.0%
Total	**8.00x**	**100.0%**	**10.00x**	**100.0%**	**12.00x**	**100.0%**

Fig. 18.2

Debt capacity involves the assessment of the amount of debt that the company can repay in a timely manner without forfeiting its financial viability. It includes the determination of the appropriate limit to the amount of long-term debt that can remain outstanding at any point of time.

Debt-Capacity Analysis

Based on Loan to Value (Total Debt/Total Assets or Total Debt/Enterprise Value)

- **Many commercial banks have developed the asset-based loan business (ABL) where the debt capacity is based on the book value of the company's assets by multiplying the latest reported assets by an assigned advanced rate or loan-to-value rate.**
- The advanced rate is determined at the time based on the company's strength of assets. For example, cash has the strongest coverage with 100% advance rate, and inventory is analyzed closely before applying an advanced rate.
- Raw materials could be viewed as having higher value than work-in-process inventory or lower-than-finished goods inventory.
- These categories of inventory are based on comfort level for each bank.
- The banks develop a list of these assets to loan against, sometimes referred to eligible assets.

Debt-Capacity Analysis

Based on Loan to Value (Total Debt/Total Assets or Total Debt/Enterprise Value)

- Figure 18.3 shows that Celerity Technology can borrow up to $1,642 million against the assets based on this method.
- Many analysts do this type of analysis to determine the strength of secondary source of repayment in addition to other debt-capacity methodologies such as using the leverage ratio or the cash flow capacity method.

Celerity Technogy Inc. ("CTI")
Debt Capacity Analysis based on Loan to Value

	HISTORICAL		Advanced Rates Loan/Value	Debt Capacity
BASE CASE	**Year -1**	**Year 0**		**Year 0**
Current Assets				
Cash	45,000	65,800	**100%**	65,800
Accounts Receivable	45,000	60,000	**85%**	51,000
Inventories	35,000	40,000	**50%**	20,000
Prepaid Expenses	10,000	9,000	**0%**	-
Total Current Assets	135,000	174,800		
Property and Equipment				
Land	2,500,000	2,500,000		
Building	450,000	550,000		
Furniture & Equipment	50,000	75,000		
Total Gross P&E	3,000,000	3,125,000		
Less Accumulated Depreciaition	(300,000)	(365,000)		
Net P&E	2,700,000	2,760,000	**50%**	1,380,000
Long-Term Investments	200,000	250,000	**50%**	125,000
Total Assets	3,035,000	3,184,800	**Debt Capacity =**	**1,641,800**

Fig. 18.3

Debt-Capacity Analysis

Based on Debt-Coverage Ratio (DCR)

- **The debt-coverage ratio (DCR) method of calculating debt capacity is similar a discount cash flow (DCF) method of calculating the firm and equity values.**
- The difference is that the stream of cash flows is before debt service and the discount rate used to calculate the present value of these cash flows is the loan rate that the bank will charge the customer based on its risk rating.

Debt-Capacity Analysis

Based on Debt-Coverage Ratio (DCR)

- Figure 18.4 shows that the maximum debt that can be supported from Celerity Technology's projected cash flows is $4.4 billion pre-adjusted and $3.5 billion adjusted. There is a 20% risk appetite cushion used.

Celerity Technogy Inc. ("CTI")

Debt Capacity based on Debt Coverage Ratio (DCR)

		PROJECTED				
		Year 1	Year 2	Year 3	Year 4	Year 5
Total Revenue		1,228,140	1,344,200	1,442,919	1,529,268	1,605,161
Total Cost of Revenue		(463,078)	(506,823)	(544,053)	(576,709)	(605,474)
Total Operating Expenses		(271,501)	(289,448)	(306,442)	(322,900)	(338,999)
EBITDA		493,561	547,928	592,424	629,659	660,688
Less Capex		(138,304)	(151,374)	(162,491)	(172,215)	(180,761)
Less Working Capital		2,870	(4,548)	(3,869)	(3,384)	(2,974)
Less Taxes		(129,769)	(147,070)	(156,960)	(158,461)	(162,851)
Cash Flow Available for Debt Service		228,358	244,935	269,105	295,599	314,101
	EBITDA Multiple					
Terminal Value (Enteprise Value based on EBITDA Multiple)	7.0x					4,624,814
Cash Flows Available for Debt Service including Terminal Value		228,358	244,935	269,105	295,599	4,938,915
	Loan Rate					
Present Value of Cash Flows Uisng the Loan Rate	7.00%	213,419	213,936	219,670	225,511	3,521,378
Total Present Value of Cash Flows to support Debt Service		4,393,914				
	Cushion %					
Adjusting for cushion	20.00%	(878,783)				
Maximum Debt based on DCR		3,515,131				

Figure 18.4

Risk and Credit Restructure Analysis

- The first part of this chapter focused on credit risks and debt capacity.
- **These analytical methods are designed to focus primarily on the ability of the company to pay back its debt obligations in a timely fashion and are used by the bank to obtain an approval before the loan is funded.**
- This section of the chapter will focus on the risk analysis of companies that have already obtained a loan and are now having a hard time meeting their debt obligations.
- The credit analyst needs to continue its analysis after the transaction is closed.
- In many distress cases, the bank has the following options:
- Calculate the losses if it decides to sell off its debt investment to other lenders for the best possible price, possibly selling at a discount
- Calculate the losses if it decides to stay in the credit and work with the company through their tough times and hopefully have a better outcome
- The objective of the risk and credit restructure analysis is to calculate these possibilities, so the bank can have the highest possible recovery described below.

Risk and Credit Restructure Analysis

Recovery Analysis

- **The basic assumption of any recovery analysis is to assume that if the company files for bankruptcy the debt obligations will be considered as claims.**
- Any value that is created by a possible restructuring is first used to repay the highest-priority claim based on the certain ranking, starting from senior-secured loans such a bank loan, then second-lien loans, then subordinated debt notes, then preferred equity, and last common equity.
- Once the claims meet the first level of debt, the remaining residual value can then be applied to the next most-senior-level of clams, referred to as the "waterfall."
- Most of the time, though, since the bankruptcy process is a lengthy one and the ultimate decision of how the claims are paid is determined by the bankruptcy judge, recovery rates are not immediately known.
- Since time to recovery is dependent on the level of control or influence of different creditors suggesting different plan of reorganization, the enforceability of the "waterfall" of claims is speculative at best. For larger syndicated loans, since there is a secondary market, the price of the loans determines the recovery as it sets the market demand and supply of such distressed loan.

Risk and Credit Restructure Analysis

Recovery Analysis

- The analyst might decide that is better to sell the loan at 70% of par rather than wait until a restructuring occurs post-bankruptcy or after the reorganization is approved by the creditors and the courts.
- Sometimes the company will not pay cash interest during the bankruptcy proceedings, so the loans will be dormant for an unknown length of time.
- To compare the secondary market prices to what the expectation of recovery is post-bankruptcy, the credit analysts should utilize various valuation approaches including the current enterprise value, albeit at distress levels, as well a liquidation value by measuring the fixed asset or examining the current collateral via a collateral analysis.

Risk and Credit Restructure Analysis

Recovery Analysis

- **Valuing the enterprise in a distressed scenario:**
  - If the analyst's view is that the company can continue to operate its business during distressed times and possibly come out of bankruptcy with strong growth, then the credit analyst should prepare an enterprise valuation of the company.
  - In such a case the most likely course of action will be reorganization of the business and credit analysis should measure the business as a going concern.
  - As it was illustrated in previous chapters of valuating the enterprise, the best approach, even in distressed times, is to compare to other companies that are in the same industry (peer analysis).
  - Taking the average EBITDA multiple of the company's peers is fist benchmark used to determine the value of the company.
  - The approach is to value the business, which will continue to operate during and after the restructuring or be sold as going concern.
  - Once this enterprise is estimated using various methods, then these values are compared to the debt outstanding.

Risk and Credit Restructure Analysis

Recovery Analysis

- **Collateral Analysis:**
  - Collateral is an asset provided to secure an obligation.
  - Traditionally, banks might require corporate borrowers to commit company assets as security for loans. Today, this practice is called secured lending or asset-based lending.
  - Collateral can take many forms: property, inventory, equipment, receivables, oil reserves, etc.
  - The collateral analysis is very similar to debt-capacity analysis based on loan to value.
  - Basically, the collateral values are based on certain advanced rates that the bank is comfortable lending against (see figure 18.3 in previous section).

Risk and Credit Restructure Analysis -Cost of Capital Analysis

Restructuring option:

- The analyst will need to calculate both the cost of debt and cost of the equity.
- The cost of debt can be easily found if the debt is trading in the secondary market.
- This price represents the price an investor is willing to pay to take the debt out.
- If there is no secondary price, the analyst should assume the cost of debt is in line with what the rating expectation will be once the company emerges from restructuring. If the loan emerging out of bankruptcy is anticipated to be rated by Standard and Poor's and/or Moody's, this rating should help establish a benchmark for market price and recovery levels.
- If the company has different tranches of debt such as corporate loans, unsecured notes, or subordinated notes, each of these will be priced based on its specific rating. The price of debt is expected to be reduced during restructuring and, depending of what the restructuring looks like, the cost will settle at that price. This is important so the analyst can price in the expected recovery rate.
- The cost of equity is more difficult to measure given that, by definition, it is the last on the waterfall for receiving any payment during the restructuring.
- One of the methods of valuing the equity is using a call option methodology.
- Basically, the equity value thesis is that there is some value for ongoing business on a post-restructuring basis like a call option that is currently out of the money but anticipated that after the restructuring the value will move up from negative to be positive it will be in the money given a certain time.

Risk and Credit Restructure Analysis -Cost of Capital Analysis

Business sale option:

- Despite the distress level that the company is in, the value of the business could be very attractive. More often than not, the company is relatively healthy if you strip out the debt.
- There are plenty of examples where a distress buyer has stepped in and renegotiated with the banks to buy the company at a discount and then the company not only survives after the sale but thrives in the future under new management.
- The credit analyst needs to run this option if the restructuring option does not work.
- The value of such business is calculated based on what is someone willing to pay for the business via the discount cash flow method or the comparable EBITDA multiples.
- Once the enterprise value is calculated, then the analyst can measure the recovery rate, which is the ratio of the enterprise value to debt.

Risk and Credit Restructure Analysis -Cost of Capital Analysis

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Risk and Credit Restructure Analysis -Cost of Capital Analysis

Liquidation option:

- When the restructuring and the sale of the business option are not feasible, the credit analyst will look then to find value in the real assets (instead of financial assets or enterprise value).
- Figure 18.5 shows that the maximum recovery based on Celerity Technology assets is 1x, assuming certain distressed asset-based modified advance rates (discount rates) and subtracting all the trade and tax claims.
- The total claims based on this analysis is $1,244 million against total debt of $1,190 million.

Celerity Technogy Inc. ("CTI")
Liquidation Values

	HISTORICAL		Distress Advanced Rates Loan/Value	Debt Capacity
BASE CASE	**Year -1**	**Year 0**		**Year 0**
Current Assets				
Cash	45,000	65,800	**100%**	65,800
Accounts Receivable	45,000	60,000	**60%**	36,000
Inventories	35,000	40,000	**35%**	14,000
Prepaid Expenses	10,000	9,000	**0%**	-
Total Current Assets	135,000	174,800		
Property and Equipment				
Land	2,500,000	2,500,000		
Building	450,000	550,000		
Furniture & Equipment	50,000	75,000		
Total Gross P&E	3,000,000	3,125,000		
Less Accumulated Depreciaition	(300,000)	(365,000)		
Net P&E	2,700,000	2,760,000	**40%**	1,104,000
Long-Term Investments	200,000	250,000	**40%**	100,000
Total Assets	3,035,000	3,184,800	**Asset Coverage =**	**1,319,800**
Liabilities and Owners Equity				
Current Liabilities				
Accounts Payable	35,000	40,000	**100%**	(40,000)
Accrued Income Taxes	12,000	10,000	**100%**	(10,000)
Accrued Expenses	10,000	8,000	**100%**	(8,000)
Current Portion of Long Term Debt	20,000	10,000		
Total Current Liabilities	77,000	68,000		
Long-Term Debt:	1,200,000	1,180,000		
			Less Trade/Tax Claims =	
Deferred Income Taxes	12,000	17,000	**100%**	(17,000)
Total Liabilties	1,289,000	1,265,000		
Owners' Equity			**Trade/tax Claims**	**(75,000)**
Common Stock	1,000,000	1,000,000		
Paid-in-Capital	-	25,000	**Net Value =**	**1,244,800**
Retained Earnings	746,000	894,800		
Total Owners' Equity	1,746,000	1,919,800	Short Term Debt =	10,000
			Long-Term Debt =	1,180,000
Total Liabilities & Owner's Equity	3,035,000	3,184,800	Total Debt =	1,190,000
Error Check	-	-		
			Value/Total Debt =	**1.046x**

Fig. 18.5

Corporate Credit and Recovery Scores by Rating Agencies and Others

- **Credit rating agencies, such as Standard & Poor's, Moody's, and Fitch grade companies that raised debt in the capital markets.**
- The rating levels represent proxies for default risk and the recovery rates issued are proxies for recovery expectation.
- The combination of the two represents the probabilities of default and expected loss.
- Figure 18.6 shows the rating levels by each of the rating agencies.
- Each level represents an opinion of the creditworthiness of an obligor.
- Even though the symbols differ between rating agencies, the three scales are set the same
- Every year the rating agencies will publish the actual historical probability of default based on rating. As an example, AAA issuer has 0.0% probability of default and CCC has 31% for a year.
- The agencies also place the probability of default for longer maturities.

CREDIT RATING AGENCIES' SCALES

Description		Standard & Poor's	Moody's	Fitch
Highest Quality (Risk Free)	INVESTMENT GRADE	AAA	Aaa	AAA
High Quality		AA+ AA AA-	Aa1 Aa2 Aa3	AA+ AA AA-
Strong Payment Capacity		A+ A A-	A1 A2 A3	A+ A A-
Adequate Payment Capacity		BBB+ BBB BBB-	Baa1 Baa2 Baa3	BBB+ BBB BBB-
Likely to fullfill Obligations	NON-INVESTMENT GRADE (LEVERAGE)	BB+ BB BB-	Ba1 Ba2 Ba3	BB+ BB BB-
High-risk Obligations		B+ B B-	B1 B2 B3	B+ B B-
Current Vulnarable to Default	DISTRESS	CCC+ CCC CCC- CC C	Caa	CCC
Default		D	D	DDD,DD,D

Figure 18.6

Corporate Credit and Recovery Scores by Rating Agencies and Others

- Standard & Poor's recover ratings focuses on expected recovery in the event of a payment default.
- The recovery rating is based on 1+ to 6 numerical rating that corresponds to recovery percentage of the debt outstanding, as described in Figure 18.7.

STANDARD & POOR'S RECOVERY RATES		
Description	**Recovery Rates**	**Recovery % of Outstanding**
Highest Exp[ectation of full recovery in the event of default	1+	100%
Expectaion of Very High	1	90%-100%
Expectaion of substantial	2	70%-90%
Expectation of Meanigful	3	50%-70%
Expectation of Average	4	30%-50%
Expectation of Modest	5	10%-30%
Expectation of Neglible	6	0%-10%

Figure 18.7

Corporate Credit and Recovery Scores by Rating Agencies and Others

- The combination of the probability of default and recovery rates could be used by the credit analyst to calculate the expected losses on the outstanding debt.
- The rating agencies have been publishing annual studies that analyze the behavior of rates during the year that these agencies review and publish the cumulative default rates by rating.
- The general takeaways from these studies that there is clear correlation between ratings and probability of default.
- One observation that is gathered from these studies is the migration of ratings based on the new issuer of debt versus the companies that already managed the debt few years.
- In other words, the probability of default in higher in the early years and it reduces in the later years.

Other Probability of Default and Recovery Models

- Even though the rating agencies are seen as the experts in the credit analysis, academics and risk managers have developed their own sophisticated statistical models to predict the likelihood of bankruptcy.
- Many commercial banks that approve large loans for their customers developed their own internal ratings based on many methodologies.
- Academics have also created statistical models to predict defaults and recoveries.
- **These statistical models include the**
  - **Altman's Z-score,**
  - **the Merton model, and**
  - **KMV.**

Other Probability of Default and Recovery Models

Altman's Z-Score

- A well-known ratio used for measuring the company's ability to manage debt, especially manufacturing companies, is Altman's Z-score. The ratio heavily tests the relationship of the primary source of repayment such as cash and income to the secondary source of repayment such as fixed assets. The Z-score, created and developed by NYU professor Dr. Edward Altman, is the measurement of the likelihood of bankruptcy. This ratio is built to include the ratios profitability, liquidity, solvency, and activity ratios.

$$\text{Z-score} = 1.2A + 1.4B + 3.3C + 0.6D + 1.0E$$

where, A is working capital/total assets; B is retained earnings/total assets; C is earnings before interest and tax/total assets; D is market value of equity/total liabilities; and E is sales/total assets. The weights used next to the individual ratios are based on historical assessment for publicly traded manufacturing companies.

- The lower the score, the higher the probability of bankruptcy. If the Z-score is above 3.0 the likelihood of default is very low. If the score is less than 1.8 the likelihood of default or bankruptcy is high.
- The Z-score formula for private companies was incorporated much later and is as follows:

$$\text{Z-score} = 0.717A + 0.847B + 3.107C + 0.420D + 0.998E$$

where, A is working capital/total assets; B is retained earnings/total assets; C is earnings before interest and tax/total assets; D is book value of equity/total liabilities; and E is sales/total assets. The weights used next to the individual ratios are based on historical assessment for private manufacturing companies.

- For measuring the Z-score for non-manufacturing companies, Altman modified the formula to exclude the last component (E) of sales / to total assets. Taking this last component out of the Z-score formula minimizes the effects of manufacturing-intensive asset turnover.

Other Probability of Default and Recovery Models

Merton Model

- The Merton model developed in 1974 uses basic option pricing that looks at the relationship between credit risk and the financial structure of the company. It assumes that the equity holders hold a call option and the debt holders hold a put option. The default happens at maturity of the debt (similar to a European-type option pricing method such Black-Scholes) if the enterprise value is lower than the strike price or debt levels. Credit analysts use the Merton model to analyze the company's risk of credit default
- The value of the asset adjusted for volatility is based on the Black Scholes Model discussed in the options section (chapter 13) is calculated as follows:

$$E = V_t N(d_1) - K_{e^{-i.t}} N(d_2) \textbf{ where } \mathrm{d1} = \frac{\ln(\frac{V}{K}) + \left(i + \frac{\sigma^2}{2}\right) t}{\sigma\sqrt{t}} \text{ and } \mathrm{d2} = \mathrm{d1} - \sigma\sqrt{t}$$

Where E is **the theoretical value of the company's equity,** is V_t **is the value of the company's assets in period t ,** K **is the value of the company's debt,** i is the interest rate, t is maturity of the loan, and σ is the standard deviation or volatility of the stock returns, N is the cumulative standard normal distribution.

Other Probability of Default and Recovery Models

KMV Model

- Similar to the Merton Model, KMV is a newer model used by banks to analyze the likelihood of default based on expected default frequency, EDF) which is basically a probability of default mechanism to give the credit analyst a warning signal.
- **The hypothesis of the KMV model is that default happens when the value of the firm's assets falls somewhere between the value of short-term debt and the value of total debt**.
- The measurement of KMV, expressed as a suggestive Moody's rating (i.e. Ba1) and assess three factors such the
  - value of the assets adjusted for volatility,
  - the distance to default (DtoD) and
  - determining the expected default frequencies (EDF).

Other Probability of Default and Recovery Models

KMV Model

- **Value of the Assets adjusted for volatility (A_t):** The value of the asset adjusted for volatility is based on the Black Scholes Model discussed in the options section (chapter 13) is calculated as follows:

$$E_t = A_t\, N\,(d_1) - B_{e^{-i.t}}\, N(d_2) \textbf{ where } \mathrm{d1} = \frac{\ln(\frac{\mathrm{A}}{\mathrm{B}}) + \left(\mathrm{i} + \frac{\sigma^2}{2}\right)\mathrm{t}}{\sigma\sqrt{\mathrm{t}}} \text{ and } \mathrm{d2} = \mathrm{d1} - \sigma\sqrt{\mathrm{t}}$$

Where A_t **is the value of the current Asset,** B **is the value of the loan,** i is the interest rate, t is maturity of the loan, and σ is the standard deviation or volatility of the asset value.

- The standard deviation or the volatility (σ) of the asset value is derived based on the volatility of the equity value or the stock price assuming the company is publicly traded. Since the premise of the KMV is the relationship of the value of the firm to the value of the loan using the volatility of the stock price should translate to the volatility of the asset.

Other Probability of Default and Recovery Models

KMV Model

- **Distance of Default (DtoD)**: KMV assumes that the point of default lies between the short-term and total debt. The formula to determine the default point (DPT) is to add the current short-term debt amount and half the long-term debt amount (DPT = STD + 0.5 LTD). The distance to default (DtoD) is the number of standard deviations that the asset has to move lower from the average amount before getting to the default point (DPT). It is calculated as follows:

$$DtoD = \frac{E\ (A_t) - DPT}{\sigma_A}$$

Where $E\ (A_t)$ is the expected value of the assets in future time t.

- The DtoD can also be calculated using the Black-Scholes formula's d_2 as follows:

$$\mathrm{DofD} = \frac{\ln\left(\frac{A_0}{\mathrm{DPT}}\right) + \left(\mathrm{i} - \frac{\sigma^2}{2}\right)\mathrm{t}}{\sigma\sqrt{\mathrm{t}}}$$

- Where i is the mean of the expected asset return, A_0 is the current market value of the firm and σ is the annualized firm value volatility.

Other Probability of Default and Recovery Models

KMV Model

- **Expected Default Frequencies (EDF):** The determination of the expected default frequencies which basically the implied probability of default within a year. The formula for EDF is as follows:

$$EDF_t = N(-DtoD)$$

Where N (-DofD) is the normal distribution of the distance to default result expressed as percentage (0-100%)