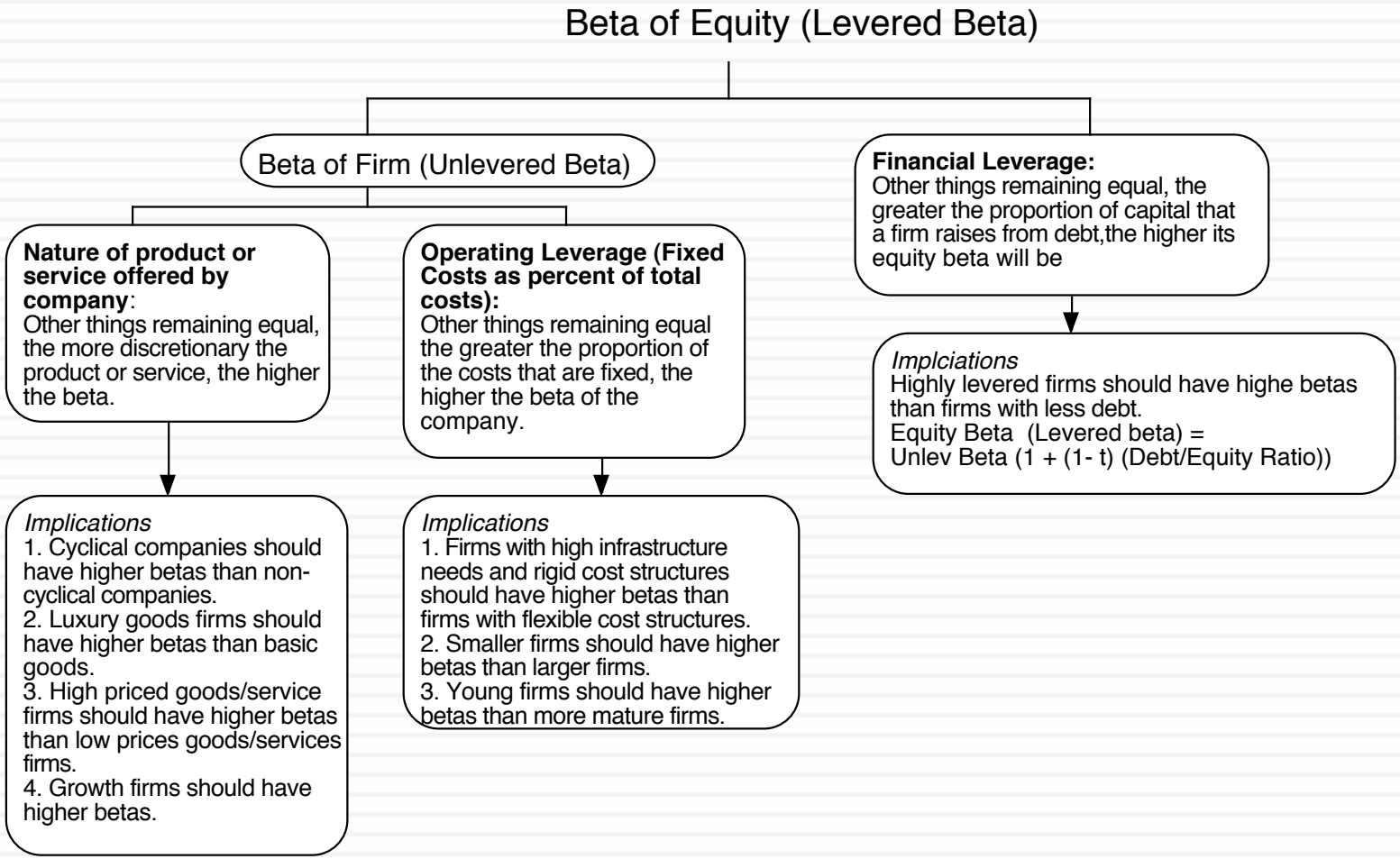
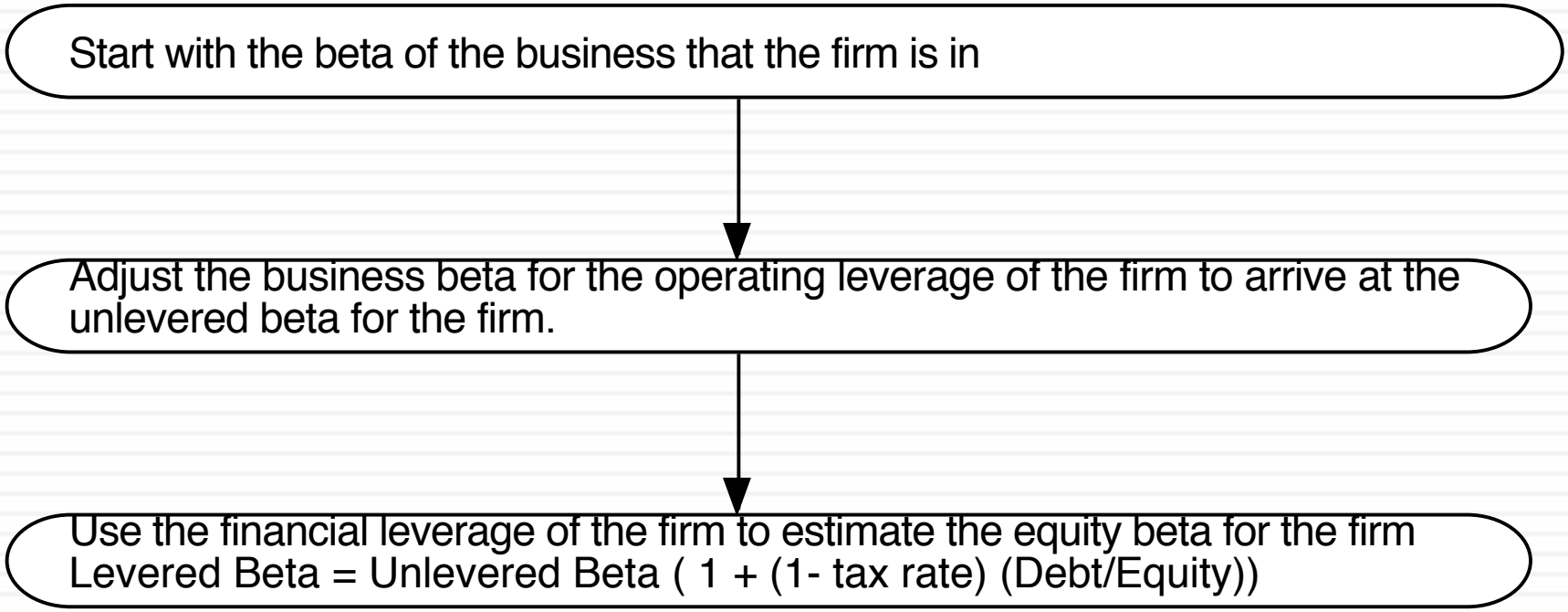
Determinants of Betas & Relative Risk



In a perfect world… we would estimate the beta of a firm by doing the following



Adjusting for operating leverage…

- Within any business, firms with lower fixed costs (as a percentage of total costs) should have lower unlevered betas. If you can compute fixed and variable costs for each firm in a sector, you can break down the unlevered beta into business and operating leverage components.
  - Unlevered beta = Pure business beta * (1 + (Fixed costs/ Variable costs))
- The biggest problem with doing this is informational. It is difficult to get information on fixed and variable costs for individual firms.
- In practice, we tend to assume that the operating leverage of firms within a business are similar and use the same unlevered beta for every firm.

Adjusting for financial leverage…

- Conventional approach: If we assume that debt carries no market risk (has a beta of zero), the beta of equity alone can be written as a function of the unlevered beta and the debt-equity ratio

  $\beta_L = \beta_u (1+ ((1-t)D/E))$

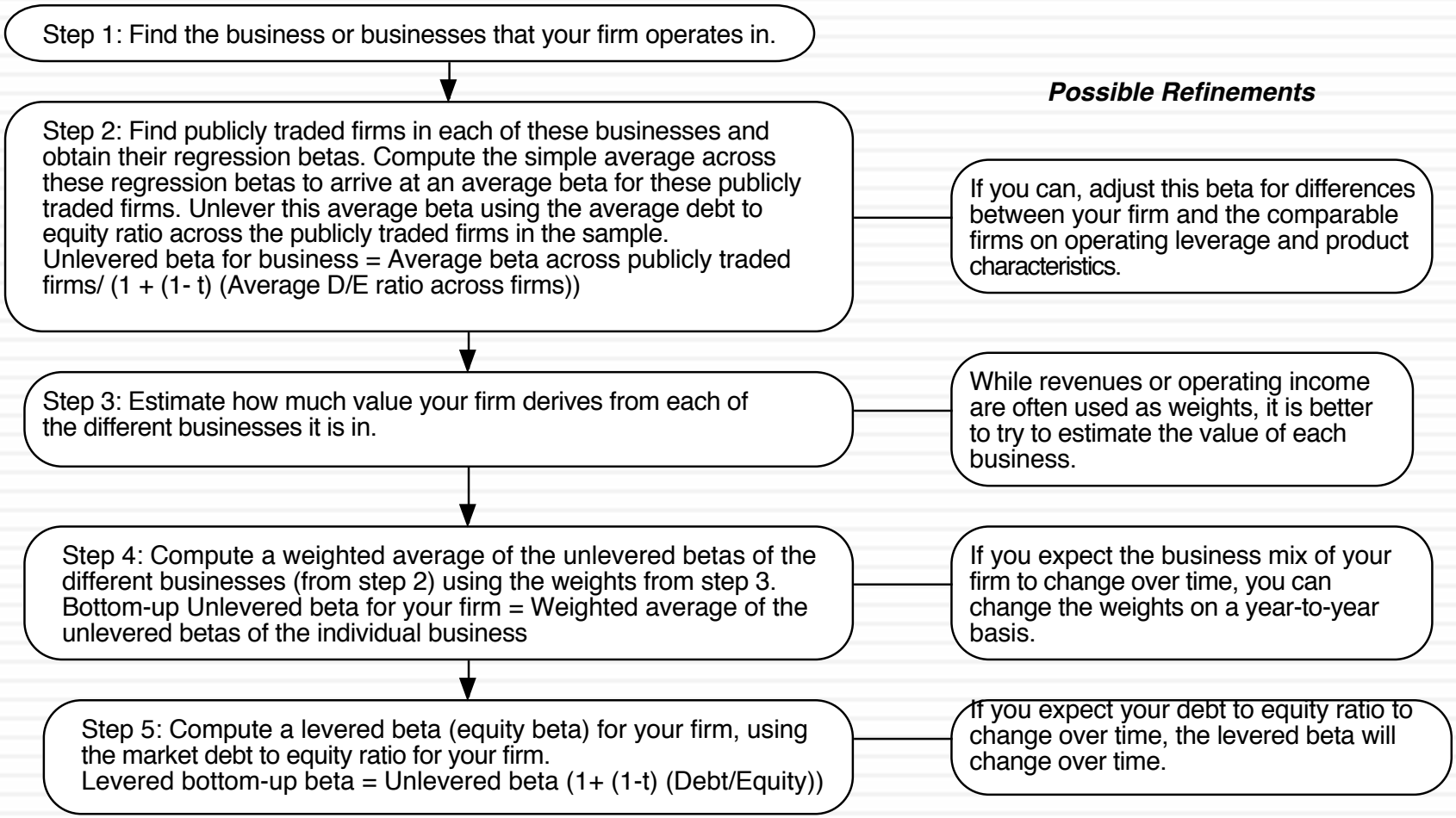
  In some versions, the tax effect is ignored and there is no (1-t) in the equation.

- Debt Adjusted Approach: If beta carries market risk and you can estimate the beta of debt, you can estimate the levered beta as follows:

  $\beta_L = \beta_u (1+ ((1-t)D/E)) - \beta_{debt} (1-t) (D/E)$

  While the latter is more realistic, estimating betas for debt can be difficult to do.

Bottom-up Betas



Why bottom-up betas?

- The standard error in a bottom-up beta will be significantly lower than the standard error in a single regression beta. Roughly speaking, the standard error of a bottom-up beta estimate can be written as follows:

Std error of bottom-up beta = $$\frac{\text{Average Std Error across Betas}}{\sqrt{\text{Number of firms in sample}}}$$

- The bottom-up beta can be adjusted to reflect changes in the firm's business mix and financial leverage. Regression betas reflect the past.
- You can estimate bottom-up betas even when you do not have historical stock prices. This is the case with initial public offerings, private businesses or divisions of companies.

Estimating Bottom Up Betas & Costs of Equity: Vale

Business	*Sample*	*Sample size*	*Unlevered beta of business*	*Revenues*	*Peer Group EV/Sales*	*Value of Business*	*Proportion of Vale*
Metals & Mining	Global firms in metals & mining, Market cap>$1 billion	48	0.86	$9,013	1.97	$17,739	16.65%
Iron Ore	Global firms in iron ore	78	0.83	$32,717	2.48	$81,188	76.20%
Fertilizers	Global specialty chemical firms	693	0.99	$3,777	1.52	$5,741	5.39%
Logistics	Global transportation firms	223	0.75	$1,644	1.14	$1,874	1.76%
Vale Operations			*0.8440*	*$47,151*		*$106,543*	*100.00%*

Business	Unlevered beta	D/E ratio	Levered beta	Risk free rate	ERP	Cost of Equity
Metals & Mining	0.86	54.99%	1.1657	2.75%	7.38%	11.35%
Iron Ore	0.83	54.99%	1.1358	2.75%	7.38%	11.13%
Fertilizers	0.99	54.99%	1.3493	2.75%	7.38%	12.70%
Logistics	0.75	54.99%	1.0222	2.75%	7.38%	10.29%
Vale Operations	0.84	54.99%	1.1503	2.75%	7.38%	11.23%

Embraer's Bottom-up Beta

Business	Unlevered Beta	D/E Ratio	Levered beta
Aerospace	0.95	18.95%	1.07

- Levered Beta = Unlevered Beta (1 + (1- tax rate) (D/E Ratio)
  = 0.95 (1 + (1-.34) (.1895)) = 1.07

- Can an unlevered beta estimated using U.S. and European aerospace companies be used to estimate the beta for a Brazilian aerospace company?

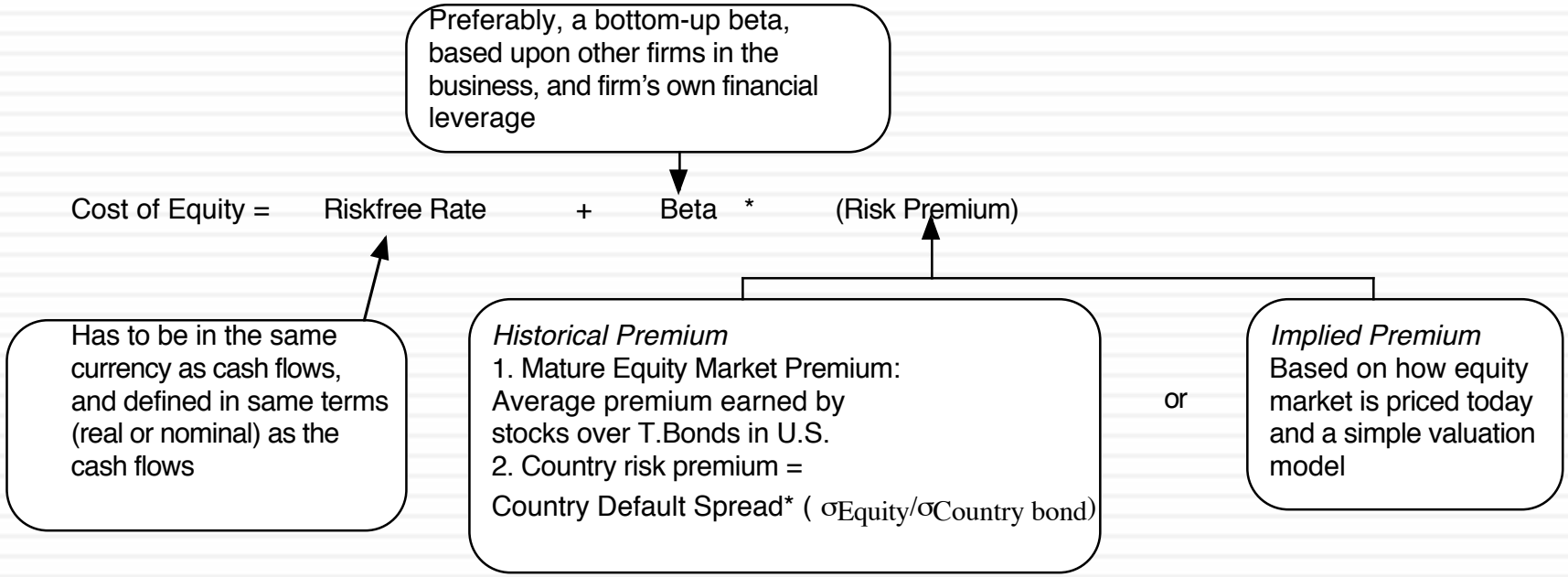
a. Yes
b. No

What concerns would you have in making this assumption?

Gross Debt versus Net Debt Approaches

- Analysts in Europe and Latin America often take the difference between debt and cash (net debt) when computing debt ratios and arrive at very different values.
- For Embraer, using the gross debt ratio
  - Gross D/E Ratio for Embraer = 1953/11,042 = 18.95%
  - Levered Beta using Gross Debt ratio = 1.07
- Using the net debt ratio, we get
  - Net Debt Ratio for Embraer = (Debt - Cash)/ Market value of Equity
    = (1953-2320)/ 11,042 = -3.32%
  - Levered Beta using Net Debt Ratio = 0.95 (1 + (1-.34) (-.0332)) = 0.93
- The cost of Equity using net debt levered beta for Embraer will be much lower than with the gross debt approach. The cost of capital for Embraer will even out since the debt ratio used in the cost of capital equation will now be a net debt ratio rather than a gross debt ratio.

The Cost of Equity: A Recap



Estimating the Cost of Debt

- The cost of debt is the rate at which you can borrow at currently, It will reflect not only your default risk but also the level of interest rates in the market.
- The two most widely used approaches to estimating cost of debt are:
  - Looking up the yield to maturity on a straight bond outstanding from the firm. The limitation of this approach is that very few firms have long term straight bonds that are liquid and widely traded
  - Looking up the rating for the firm and estimating a default spread based upon the rating. While this approach is more robust, different bonds from the same firm can have different ratings. You have to use a median rating for the firm
- When in trouble (either because you have no ratings or multiple ratings for a firm), estimate a synthetic rating for your firm and the cost of debt based upon that rating.

Estimating Synthetic Ratings

- The rating for a firm can be estimated using the financial characteristics of the firm. In its simplest form, the rating can be estimated from the interest coverage ratio

  Interest Coverage Ratio = EBIT / Interest Expenses

- For Embraer's interest coverage ratio, we used the interest expenses from 2003 and the average EBIT from 2001 to 2003. (The aircraft business was badly affected by 9/11 and its aftermath. In 2002 and 2003, Embraer reported significant drops in operating income)

  Interest Coverage Ratio = 462.1 /129.70 = 3.56

Interest Coverage Ratios, Ratings and Default Spreads: 2003 & 2004

If Interest Coverage Ratio is		Estimated Bond Rating	Default Spread(2003)	Default Spread(2004)
> 8.50	(>12.50)	AAA	0.75%	0.35%
6.50 - 8.50	(9.5-12.5)	AA	1.00%	0.50%
5.50 - 6.50	(7.5-9.5)	A+	1.50%	0.70%
4.25 - 5.50	(6-7.5)	A	1.80%	0.85%
3.00 - 4.25	(4.5-6)	A–	2.00%	1.00%
2.50 - 3.00	(4-4.5)	BBB	2.25%	1.50%
2.25- 2.50	(3.5-4)	BB+	2.75%	2.00%
2.00 - 2.25	((3-3.5)	BB	3.50%	2.50%
1.75 - 2.00	(2.5-3)	B+	4.75%	3.25%
1.50 - 1.75	(2-2.5)	B	6.50%	4.00%
1.25 - 1.50	(1.5-2)	B –	8.00%	6.00%
0.80 - 1.25	(1.25-1.5)	CCC	10.00%	8.00%
0.65 - 0.80	(0.8-1.25)	CC	11.50%	10.00%
0.20 - 0.65	(0.5-0.8)	C	12.70%	12.00%
< 0.20 (<0.5)		D	15.00%	20.00%

- The first number under interest coverage ratios is for larger market cap companies and the second in brackets is for smaller market cap companies. For Embraer , I used the interest coverage ratio table for smaller/riskier firms (the numbers in brackets) which yields a lower rating for the same interest coverage ratio.

Cost of Debt computations

- Companies in countries with low bond ratings and high default risk might bear the burden of country default risk, especially if they are smaller or have all of their revenues within the country.
- Larger companies that derive a significant portion of their revenues in global markets may be less exposed to country default risk. In other words, they may be able to borrow at a rate lower than the government.
- The synthetic rating for Embraer is A-. Using the 2004 default spread of 1.00%, we estimate a cost of debt of 9.29% (using a riskfree rate of 4.29% and adding in two thirds of the country default spread of 6.01%):

Cost of debt

= Riskfree rate + 2/3(Brazil country default spread) + Company default spread =4.29% + 4.00%+ 1.00% = 9.29%

Synthetic Ratings: Some Caveats

- The relationship between interest coverage ratios and ratings, developed using US companies, tends to travel well, as long as we are analyzing large manufacturing firms in markets with interest rates close to the US interest rate
- They are more problematic when looking at smaller companies in markets with higher interest rates than the US. One way to adjust for this difference is modify the interest coverage ratio table to reflect interest rate differences (For instances, if interest rates in an emerging market are twice as high as rates in the US, halve the interest coverage ratio.

Default Spreads: The effect of the crisis of 2008.. And the aftermath

	Default spread over treasury					
Rating	1-Jan-08	12-Sep-08	12-Nov-08	1-Jan-09	1-Jan-10	1-Jan-11
Aaa/AAA	0.99%	1.40%	2.15%	2.00%	0.50%	0.55%
Aa1/AA+	1.15%	1.45%	2.30%	2.25%	0.55%	0.60%
Aa2/AA	1.25%	1.50%	2.55%	2.50%	0.65%	0.65%
Aa3/AA-	1.30%	1.65%	2.80%	2.75%	0.70%	0.75%
A1/A+	1.35%	1.85%	3.25%	3.25%	0.85%	0.85%
A2/A	1.42%	1.95%	3.50%	3.50%	0.90%	0.90%
A3/A-	1.48%	2.15%	3.75%	3.75%	1.05%	1.00%
Baa1/BBB+	1.73%	2.65%	4.50%	5.25%	1.65%	1.40%
Baa2/BBB	2.02%	2.90%	5.00%	5.75%	1.80%	1.60%
Baa3/BBB-	2.60%	3.20%	5.75%	7.25%	2.25%	2.05%
Ba1/BB+	3.20%	4.45%	7.00%	9.50%	3.50%	2.90%
Ba2/BB	3.65%	5.15%	8.00%	10.50%	3.85%	3.25%
Ba3/BB-	4.00%	5.30%	9.00%	11.00%	4.00%	3.50%
B1/B+	4.55%	5.85%	9.50%	11.50%	4.25%	3.75%
B2/B	5.65%	6.10%	10.50%	12.50%	5.25%	5.00%
B3/B-	6.45%	9.40%	13.50%	15.50%	5.50%	6.00%
Caa/CCC+	7.15%	9.80%	14.00%	16.50%	7.75%	7.75%
ERP	4.37%	4.52%	6.30%	6.43%	4.36%	5.20%

Updated Default Spreads - January 2015

Rating	*1 yr*	*2 yr*	*3 yr*	*5 yr*	*7 yr*	*10 yr*	*30 yr*
Aaa/AAA	0.05%	0.08%	0.12%	0.18%	0.28%	0.42%	0.65%
Aa1/AA+	0.09%	0.20%	0.28%	0.38%	0.48%	0.60%	0.87%
Aa2/AA	0.13%	0.32%	0.44%	0.58%	0.68%	0.78%	1.09%
Aa3/AA-	0.18%	0.39%	0.51%	0.66%	0.76%	0.87%	1.19%
A1/A+	0.23%	0.45%	0.58%	0.74%	0.85%	0.96%	1.28%
A2/A	0.29%	0.49%	0.61%	0.76%	0.86%	0.97%	1.31%
A3/A-	0.40%	0.61%	0.74%	0.89%	0.99%	1.10%	1.44%
Baa1/BBB+	0.54%	0.79%	0.93%	1.12%	1.23%	1.36%	1.75%
Baa2/BBB	0.65%	0.96%	1.14%	1.36%	1.51%	1.67%	2.15%
Baa3/BBB-	1.04%	1.39%	1.60%	1.87%	2.04%	2.22%	2.72%
Ba1/BB+	1.93%	2.06%	2.21%	2.36%	2.48%	2.61%	2.83%
Ba2/BB	2.23%	2.37%	2.53%	2.70%	2.83%	2.97%	3.16%
Ba3/BB-	2.52%	2.68%	2.85%	3.03%	3.17%	3.33%	3.50%
B1/B+	2.87%	3.04%	3.22%	3.41%	3.57%	3.74%	3.92%
B2/B	3.17%	3.35%	3.54%	3.75%	3.92%	4.10%	4.29%
B3/B-	3.47%	3.66%	3.87%	4.08%	4.26%	4.45%	4.66%
Caa/CCC+	3.81%	4.02%	4.23%	4.46%	4.65%	4.86%	5.08%

Subsidized Debt: What should we do?

- Assume that the Brazilian government lends money to Embraer at a subsidized interest rate (say 6% in dollar terms). In computing the cost of capital to value Embraer, should be we use the cost of debt based upon default risk or the subsidized cost of debt?

a. The subsidized cost of debt (6%). That is what the company is paying.

b. The fair cost of debt (9.25%). That is what the company should require its projects to cover.

c. A number in the middle.

Weights for the Cost of Capital Computation

- In computing the cost of capital for a publicly traded firm, the general rule for computing weights for debt and equity is that you use market value weights (and not book value weights). Why?
  a. Because the market is usually right
  b. Because market values are easy to obtain
  c. Because book values of debt and equity are meaningless
  d. None of the above

Estimating Cost of Capital: Embraer in 2004

- Equity
  - Cost of Equity = 4.29% + 1.07 (4%) + 0.27 (7.89%) = 10.70%
  - Market Value of Equity =11,042 million BR ($ 3,781 million)
- Debt
  - Cost of debt = 4.29% + 4.00% +1.00%= 9.29%
  - Market Value of Debt = 2,083 million BR ($713 million)
- Cost of Capital

Cost of Capital = 10.70 % (.84) + 9.29% (1- .34) (0.16)) = 9.97%

  - The book value of equity at Embraer is 3,350 million BR.
  - The book value of debt at Embraer is 1,953 million BR; Interest expense is 222 mil BR; Average maturity of debt = 4 years
  - Estimated market value of debt = 222 million (PV of annuity, 4 years, 9.29%) + $1,953 million/$1.0929^4$ = 2,083 million BR

If you had to do it….Converting a Dollar Cost of Capital to a Nominal Real Cost of Capital

- Approach 1: Use a BR riskfree rate in all of the calculations above. For instance, if the BR riskfree rate was 12%, the cost of capital would be computed as follows:
  - Cost of Equity = 12% + 1.07(4%) + 0.27 (7.89%) = 18.41%
  - Cost of Debt = 12% + 1% = 13%
  - (This assumes the riskfree rate has no country risk premium embedded in it.)
- Approach 2: Use the differential inflation rate to estimate the cost of capital. For instance, if the inflation rate in BR is 8% and the inflation rate in the U.S. is 2%

$$\text{Cost of capital} = (1+\text{Cost of Capital}_{\$})\left[\frac{1+\text{Inflation}_{BR}}{1+\text{Inflation}_{\$}}\right]$$

$$= 1.0997\ (1.08/1.02)-1 \quad = 0.1644 \text{ or } 16.44\%$$