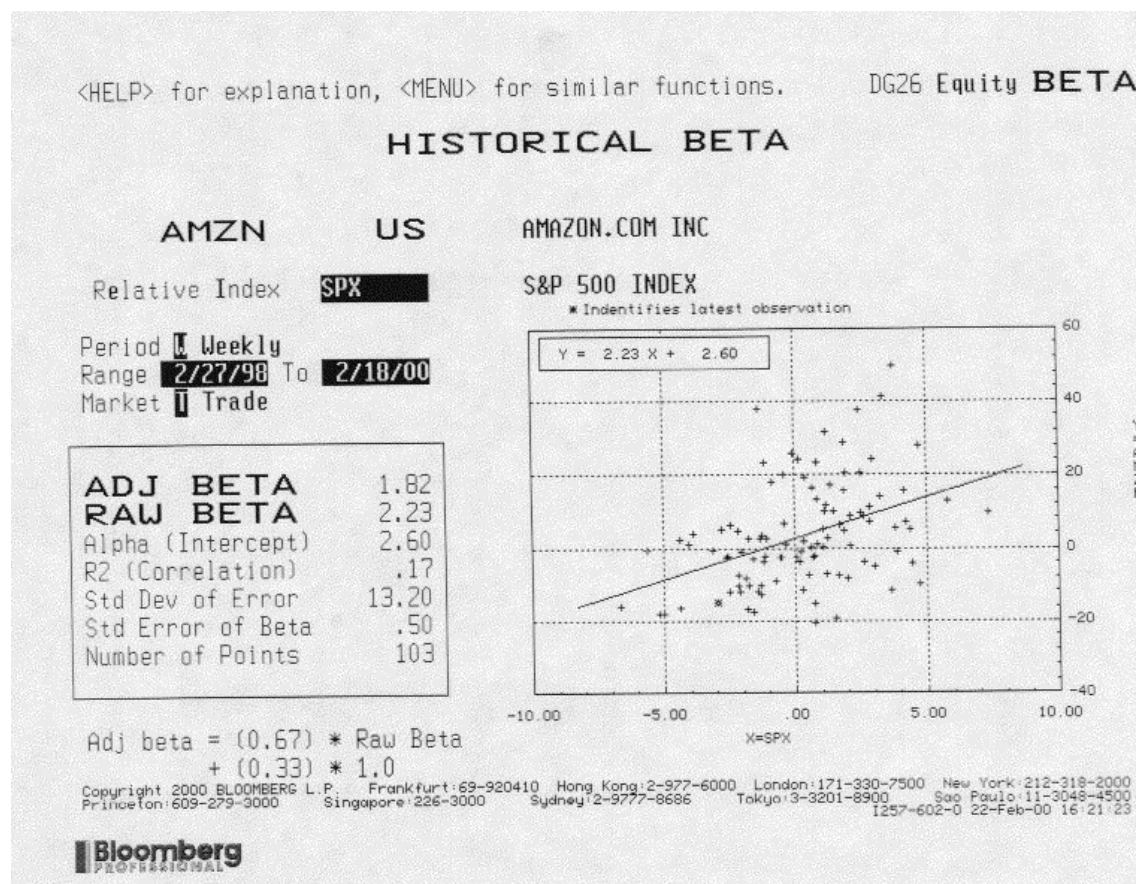# Estimating Beta

■ The standard procedure for estimating betas is to regress stock returns (R_j) against market returns (R_m) -
$$R_j = a + b\ R_m$$
  • where a is the intercept and b is the slope of the regression.

■ The slope of the regression corresponds to the beta of the stock, and measures the riskiness of the stock.

■ This beta has three problems:
  • It has high standard error
  • It reflects the firm's business mix over the period of the regression, not the current mix
  • It reflects the firm's average financial leverage over the period rather than the current leverage.

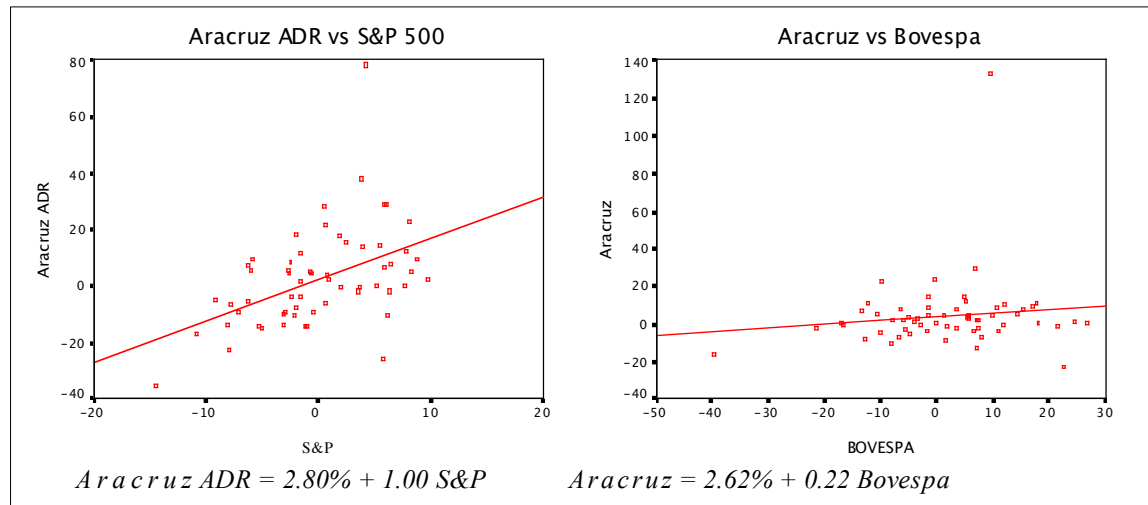# Beta Estimation: The Noise Problem

Beta Estimation: The Index Effect
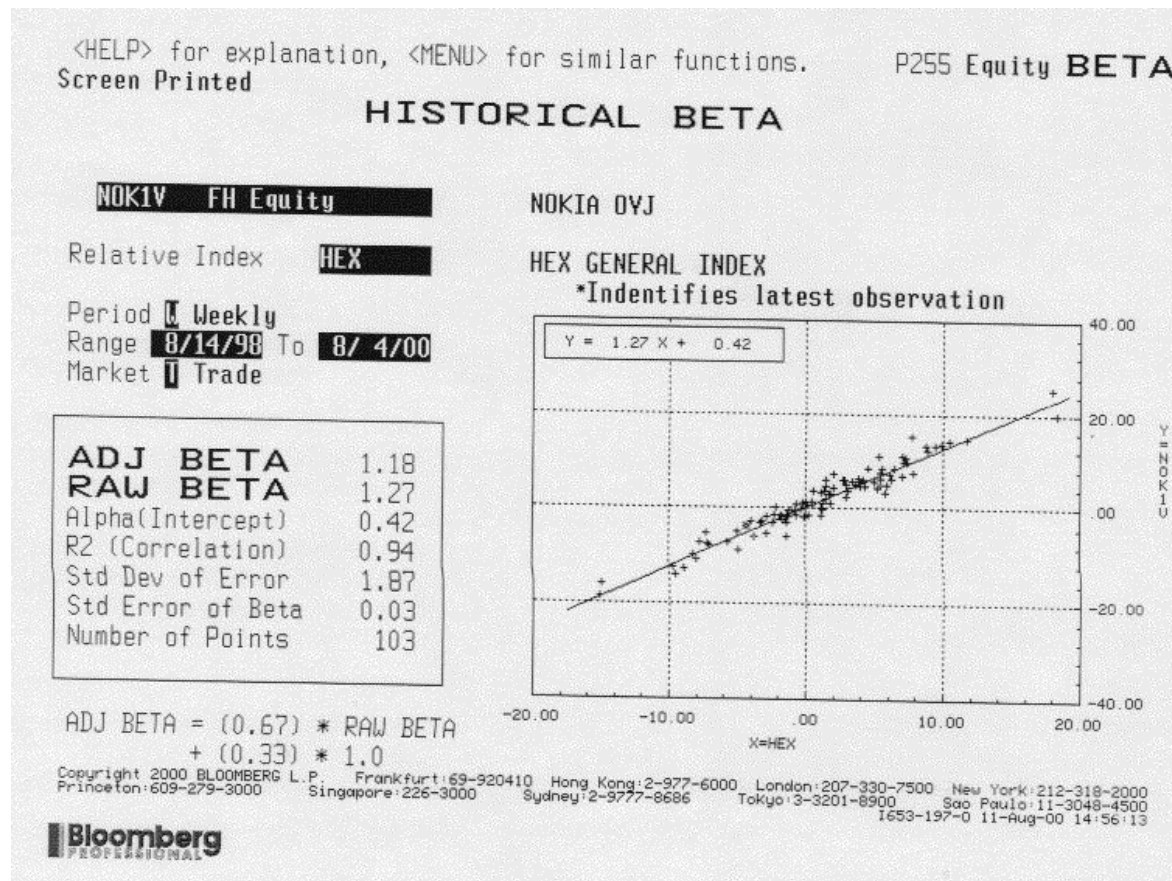
Solutions to the Regression Beta Problem

- **Modify the regression beta by**
  - changing the index used to estimate the beta
  - adjusting the regression beta estimate, by bringing in information about the fundamentals of the company

- **Estimate the beta for the firm using**
  - the standard deviation in stock prices instead of a regression against an index
  - accounting earnings or revenues, which are less noisy than market prices.

- **Estimate the beta for the firm from the bottom up without employing the regression technique. This will require**
  - understanding the business mix of the firm
  - estimating the financial leverage of the firm

- **Use an alternative measure of market risk not based upon a regression.**

The Index Game…

Aracruz ADR vs S&P 500

Aracruz ADR = 2.80% + 1.00 S&P
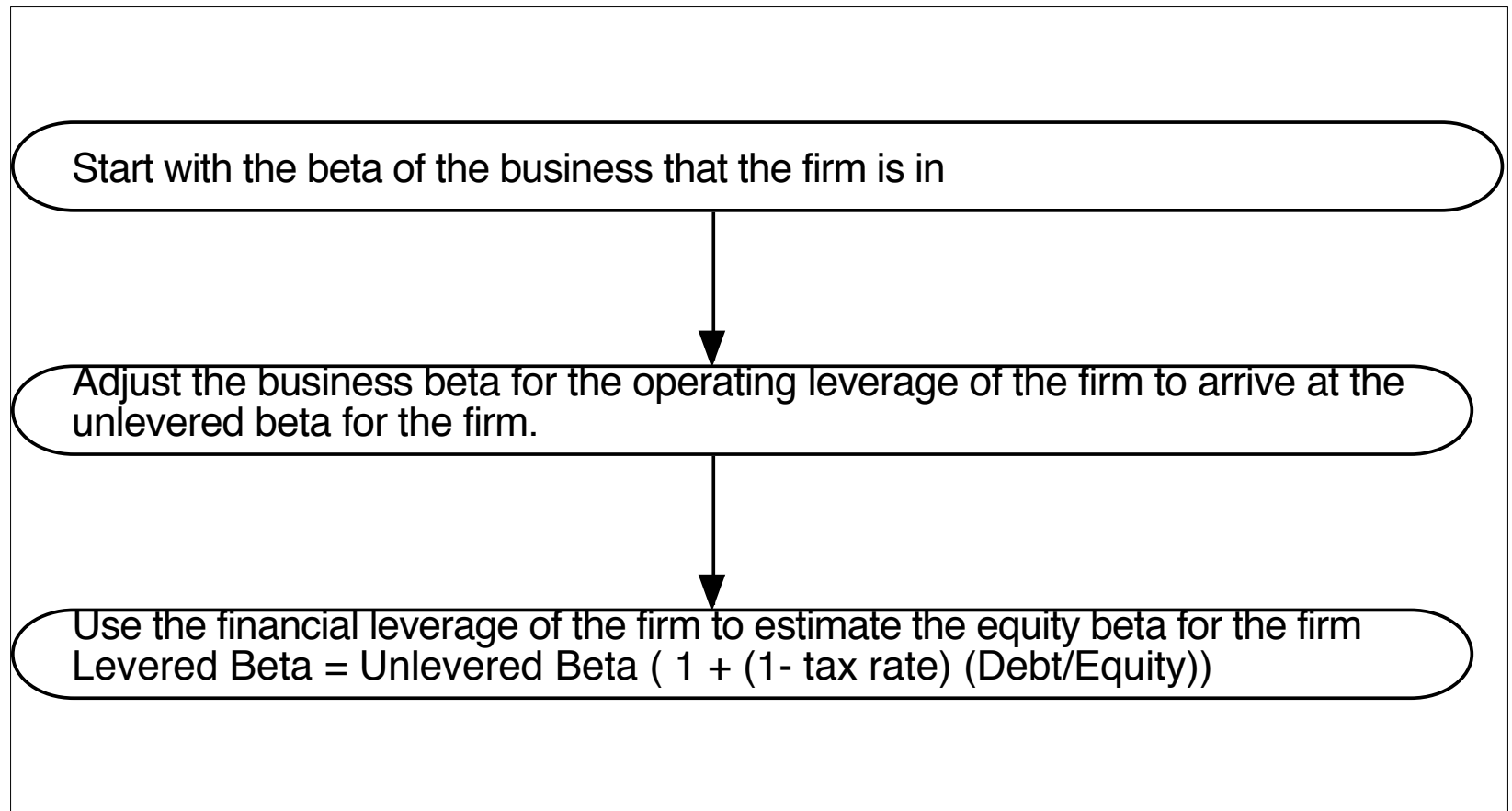
Aracruz vs Bovespa

Aracruz = 2.62% + 0.22 Bovespa

Determinants of Betas

Beta of Equity (Levered Beta)

Beta of Firm (Unlevered Beta)

Nature of product or service offered by company:
Other things remaining equal, the more discretionary the product or service, the higher the beta.

Operating Leverage (Fixed Costs as percent of total costs):
Other things remaining equal the greater the proportion of the costs that are fixed, the higher the beta of the company.

Financial Leverage:
Other things remaining equal, the greater the proportion of capital that a firm raises from debt,the higher its equity beta will be

Implciations
Highly levered firms should have highe betas than firms with less debt.
Equity Beta (Levered beta) =
Unlev Beta $(1 + (1- t) (Debt/Equity Ratio))$

Implications
1. Cyclical companies should have higher betas than non-cyclical companies.
2. Luxury goods firms should have higher betas than basic goods.
3. High priced goods/service firms should have higher betas than low prices goods/services firms.
4. Growth firms should have higher betas.

Implications
1. Firms with high infrastructure needs and rigid cost structures should have higher betas than firms with flexible cost structures.
2. Smaller firms should have higher betas than larger firms.
3. Young firms should have higher betas than more mature firms.

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

Start with the beta of the business that the firm is in

Adjust the business beta for the operating leverage of the firm to arrive at the unlevered beta for the firm.

Use the financial leverage of the firm to estimate the equity beta for the firm
Levered Beta = Unlevered Beta (1 + (1- tax rate) (Debt/Equity))

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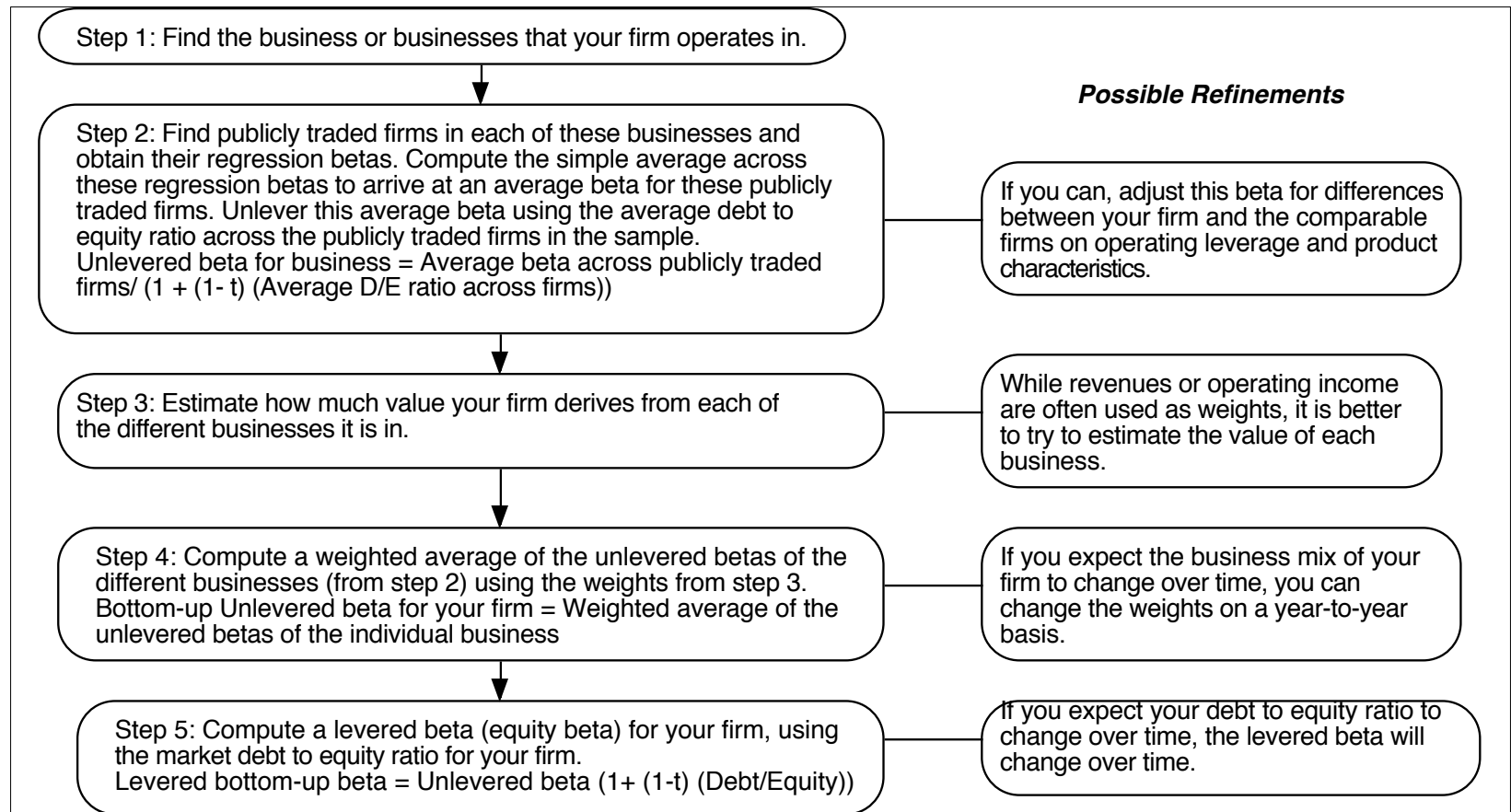
$$\beta_L = \beta_u (1 + ((1-t)D/E))$$

  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

Step 1: Find the business or businesses that your firm operates in.

Possible Refinements

Step 2: Find publicly traded firms in each of these businesses and obtain their regression betas. Compute the simple average across these regression betas to arrive at an average beta for these publicly traded firms. Unlever this average beta using the average debt to equity ratio across the publicly traded firms in the sample.
Unlevered beta for business = Average beta across publicly traded firms/ (1 + (1- t) (Average D/E ratio across firms))

If you can, adjust this beta for differences between your firm and the comparable firms on operating leverage and product characteristics.

Step 3: Estimate how much value your firm derives from each of the different businesses it is in.

While revenues or operating income are often used as weights, it is better to try to estimate the value of each business.

Step 4: Compute a weighted average of the unlevered betas of the different businesses (from step 2) using the weights from step 3.
Bottom-up Unlevered beta for your firm = Weighted average of the unlevered betas of the individual business

If you expect the business mix of your firm to change over time, you can change the weights on a year-to-year basis.

Step 5: Compute a levered beta (equity beta) for your firm, using the market debt to equity ratio for your firm.
Levered bottom-up beta = Unlevered beta (1+ (1-t) (Debt/Equity))

If you expect your debt to equity ratio to change over time, the levered beta will change over time.

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:

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

- 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.

Bottom-up Beta: Firm in Multiple Businesses
SAP in 2004

- **Approach 1: Based on business mix**
  - SAP is in three business: software, consulting and training. We will aggregate the consulting and training businesses

Business	Revenues	EV/Sales	Value	Weights	Beta
Software	$ 5.3	3.25	17.23	80%	1.30
Consulting	$ 2.2	2.00	4.40	20%	1.05
SAP	**$ 7.5**		**21.63**		**1.25**

- **Approach 2: Customer Base**

Revenue Breakdown by Sector
in € millions | percent | change since previous year

Public services 694
9% | +15%

Process Industries 1,469
20% | +6%

Discrete Industries 1,808
24% | +9%

Consumer Industries 1,350
18% | +9%

Service Industries 1,674
22% | +1%

Financial services 519
7% | +9%
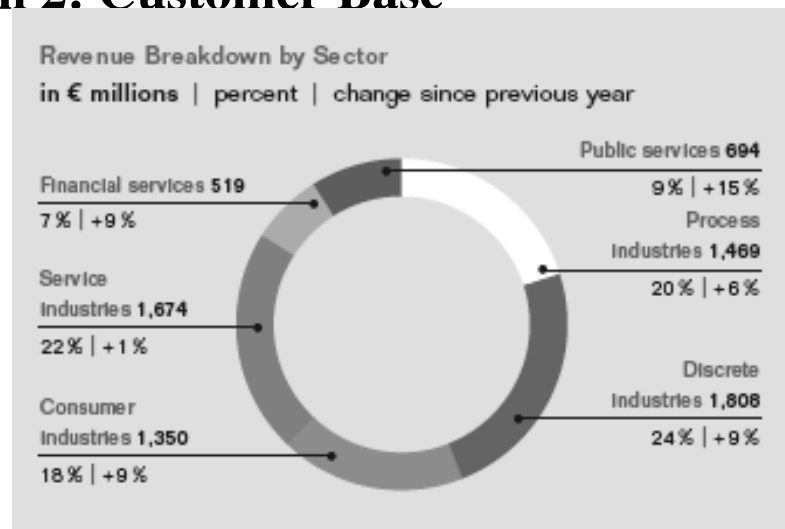
Embraer's Bottom-up Beta

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)

$$= 0.95 (1 + (1-.34) (.1895)) = 1.07$$

Comparable Firms?

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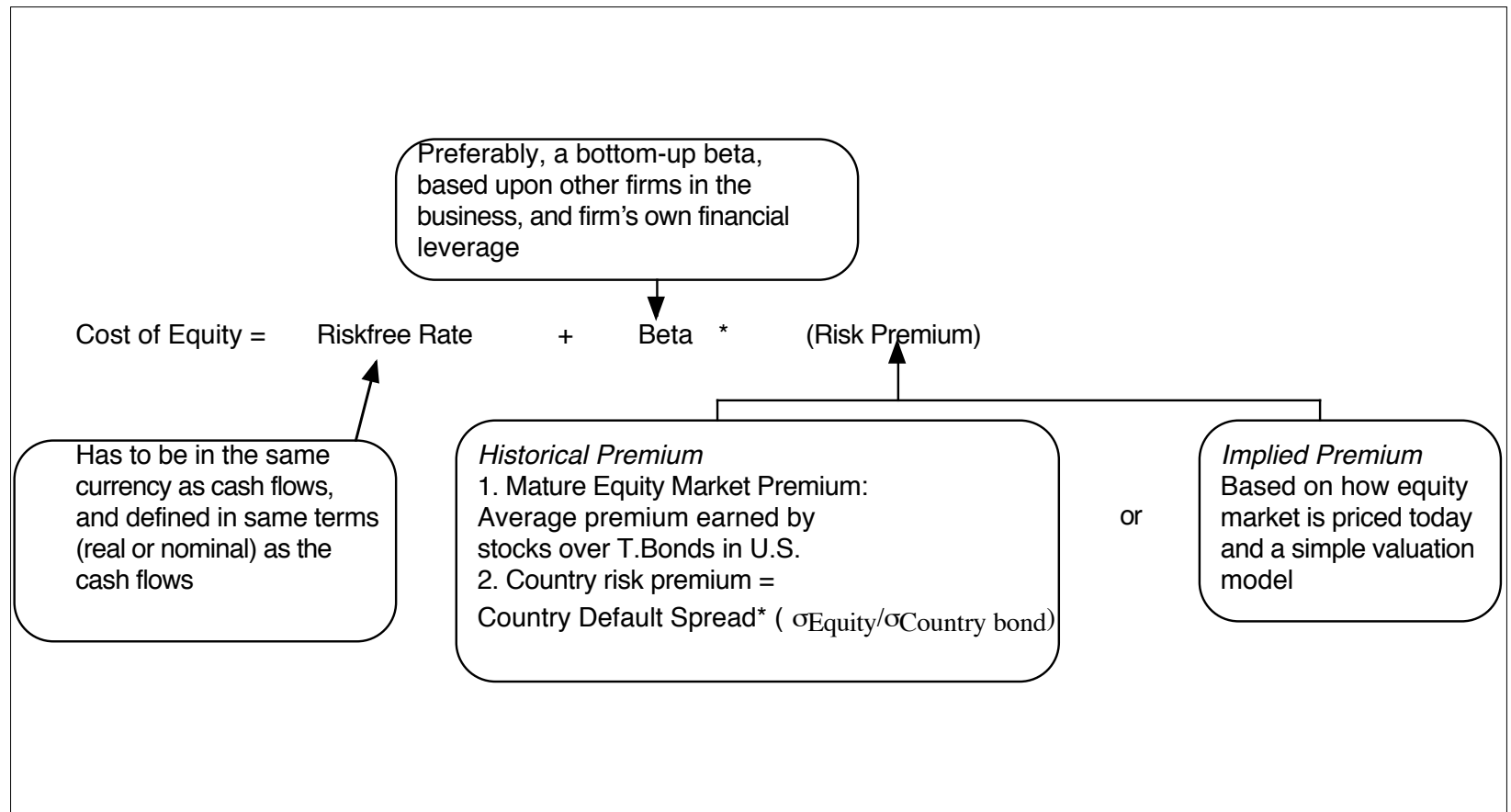
❑ Yes

❑ No

What concerns would you have in making this assumption?

Gross Debt versus Net Debt Approaches

- Gross Debt Ratio for Embraer = 1953/11,042 = 18.95%
- Levered Beta using Gross Debt ratio = 1.07
- 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, though, 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

Preferably, a bottom-up beta, based upon other firms in the business, and firm's own financial leverage

Cost of Equity = Riskfree Rate + Beta * (Risk Premium)

Has to be in the same currency as cash flows, and defined in same terms (real or nominal) as the cash flows

Historical Premium
1. Mature Equity Market Premium: Average premium earned by stocks over T.Bonds in U.S.
2. Country risk premium =
Country Default Spread* ($\sigma_{Equity}/\sigma_{Country\ bond}$)

or

Implied Premium
Based on how equity market is priced today and a simple valuation model

Aswath Damodaran

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

Rating	Default spread over treasury					
	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 2012

Rating	1 year	5 year	10 year	30 year
Aaa/AAA	0.35%	0.70%	0.65%	0.85%
Aa1/AA+	0.45%	0.75%	0.80%	1.10%
Aa2/AA	0.50%	0.80%	0.95%	1.15%
Aa3/AA-	0.60%	0.85%	1.05%	1.20%
A1/A+	0.65%	0.90%	1.15%	1.30%
A2/A	0.80%	1.05%	1.20%	1.40%
A3/A-	0.95%	1.25%	1.45%	1.65%
Baa1/BBB+	1.20%	1.70%	2.00%	2.20%
Baa2/BBB	1.30%	2.05%	2.30%	2.50%
Baa3/BBB-	2.00%	2.80%	3.10%	3.25%
Ba1/BB+	4.00%	4.00%	3.75%	3.75%
Ba2/BB	4.50%	5.50%	4.50%	4.75%
Ba3/BB-	4.75%	5.75%	4.75%	5.25%
B1/B+	5.75%	6.75%	5.50%	5.50%
B2/B	6.25%	7.75%	6.50%	6.00%
B3/B-	6.50%	9.00%	6.75%	6.25%
Caa/CCC	7.25%	9.25%	8.75%	8.25%
CC	8.00%	9.50%	9.50%	9.50%
C	9.00%	10.00%	10.50%	10.50%
D	10.00%	12.00%	12.00%	12.00%

Aswath Damodaran

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 subisidized cost of debt?

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

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

❏ 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?

- ❏ Because the market is usually right
- ❏ Because market values are easy to obtain
- ❏ Because book values of debt and equity are meaningless
- ❏ None of the above

Estimating Cost of Capital: Embraer in 2003

- ■ 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%

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   = 0.1644 or 16.44%

Dealing with Hybrids and Preferred Stock

■ When dealing with hybrids (convertible bonds, for instance), break the security down into debt and equity and allocate the amounts accordingly. Thus, if a firm has $ 125 million in convertible debt outstanding, break the $125 million into straight debt and conversion option components. The conversion option is equity.

■ When dealing with preferred stock, it is better to keep it as a separate component. The cost of preferred stock is the <u>preferred dividend yield</u>. (As a rule of thumb, if the preferred stock is less than 5% of the outstanding market value of the firm, lumping it in with debt will make no significant impact on your valuation).

Decomposing a convertible bond…

■ Assume that the firm that you are analyzing has $125 million in face value of convertible debt with a stated interest rate of 4%, a 10 year maturity and a market value of $140 million. If the firm has a bond rating of A and the interest rate on A-rated straight bond is 8%, you can break down the value of the convertible bond into straight debt and equity portions.

- Straight debt = (4% of $125 million) (PV of annuity, 10 years, 8%) + 125 million/ 1.08^{10} = $91.45 million
- Equity portion = $140 million - $91.45 million = $48.55 million

Recapping the Cost of Capital

Cost of borrowing should be based upon
(1) synthetic or actual bond rating
(2) default spread
Cost of Borrowing = Riskfree rate + Default spread

Marginal tax rate, reflecting tax benefits of debt

Cost of Capital =   Cost of Equity (Equity/(Debt + Equity))   +   Cost of Borrowing   (1-t)   (Debt/(Debt + Equity))

Cost of equity based upon bottom-up beta

Weights should be market value weights