UNIVERSITY OF CALGARY
HASKAYNE SCHOOL OF BUSINESS

Corporate Finance

WACC

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Agenda

An all equity firm

Issues with beta

- When estimating the beta of the firm
- Business risks
- Financial leverage
- The bottom-up beta
- Betas and leverage by industry

The Weighted Average Cost of Capital ('WACC')

Practitioners' perspective

Liquidity and trading costs

Chapter 13 of the textbook

Appropriate discount rate for an all equity firm

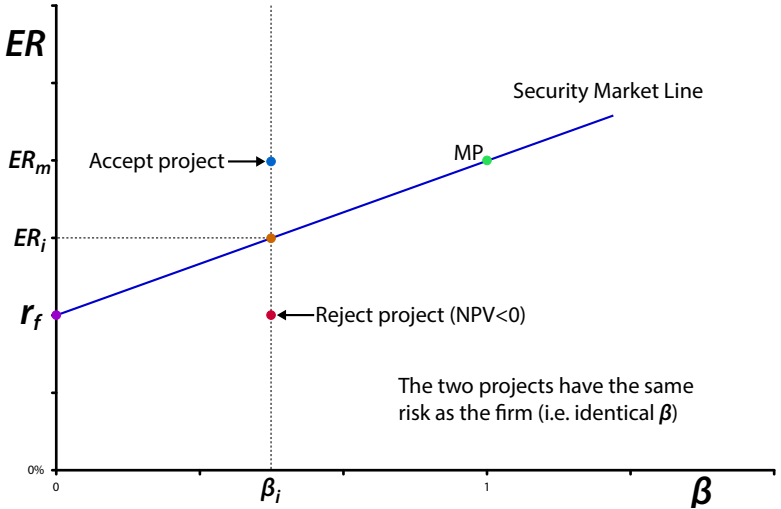
For an all-equity firm, projects are 'financed' using 100% equity (since the firm has no debt).

- The appropriate discount rate for a given project is the return shareholders could earn on another investment carrying the same risk (e.g. buying a security having the same β as the said project).
- If the firm is unable to find projects that meet the risk-adjusted return expectations of the shareholders, then the firm should return available free cash flows to the shareholders (e.g. under the form of dividends or share buybacks, allowing shareholders to invest these as they see fit).

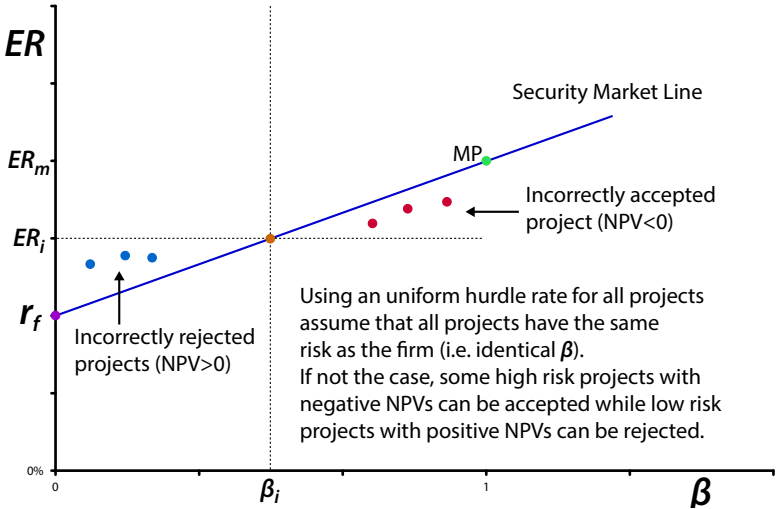
How to estimate the 'appropriate discount rate'?

- If the project has the same risk as the firm, then calculate the cost of equity using an asset pricing model (e.g. CAPM).
- If the project has higher or lower risk than the firm, then adjust accordingly (but what is the β of the project?).

Decision rule for an all equity firm: same risk



Decision rule for an all equity firm: different risk



Issues with estimating the β of the firm

The β of a firm is estimated by running a regression using historical data.

$$\beta_i = \frac{\sigma_{R_i,R_M}}{\sigma^2_{R_M}} = \rho_{R_i,R_M}\frac{\sigma_{R_i}}{\sigma_{R_M}} \quad \rightsquigarrow \quad R_{i,t} - r_{f,t} = \alpha_i + \beta_i\left[R_{m,t} - r_{f,t}\right] + \epsilon_{i,t}$$

Therefore, β is backward-looking estimated with error...

- The noisier the data, the less reliable is the β estimate of a firm.
- Typically β estimates tend to mean-revert toward 1.
- Using a past β for a forward looking purpose assumes that financial leverage and business risk of the firm remain the same.

The above issues need to be addressed, somewhat subjectively

- Compare the firm's β with industry peers' β, and adjust accordingly.
- Anticipate the mean reversion of the β over the investment horizon.
- Anticipate financial leverage and business risk changes and adjust β.

Business risks

How tied-in to the business cycle are the cash flows of the firm?

- If sales are growing faster than GDP through an economic expansion (and are falling faster than GDP in a recession), the industry/firm is a 'cyclical' (e.g. cars).
- If sales are growing slower than GDP through an economic expansion (and are falling slower than GDP in a recession), the industry/firm is a 'defensive' (e.g. funeral parlors).

How volatile are the the cash flows of the firm?

- The more tied-in to the business cycle, the more volatile the cash flows of the firm are likely to be.
- The higher the fixed costs of the firm and the lower its ability to manage down its operating costs when needed (i.e high 'operating leverage'), the more volatile its cash flows are likely to be.

If its business risks are such that the firm will register a poorer financial performance than most firms at the time most firms are registering a poor financial performance, then it is likely that its β is high.

Financial leverage

As a firm incurs more debt (i.e. increases its financial leverage), the magnitude of the debt-related contractual obligations through interest and principal payments increases.

Debt magnifies the risk-return relationship for the shareholders and increases the firm's levered beta.

- As the cost of debt is fixed, in periods of high cash flows, each unit of equity will earn more.
- But in periods of low cash flows, each unit of equity will earn less.
- And if the firm defaults, the shareholders might lose everything.

$$\beta_{Asset} = \frac{Debt}{Debt + Equity}\beta_{Debt} + \frac{Equity}{Debt + Equity}\beta_{Equity}$$

$$\beta_{Equity} = \beta_{Asset}\left(1 + \frac{Debt}{Equity}\right) \quad assuming\ \beta_{Debt} = 0$$

$$\beta_{Equity} = \beta_{Asset}\left(1 + (1 - T_c)\frac{Debt}{Equity}\right) \quad assuming\ \beta_{Debt} = 0\ and\ T_c \neq 0$$

The so-called bottom-up beta

If the firm is private (since its stock is not traded, no data is available to run a regression) or the beta as estimated with a regression is not statistically significant (e.g. the stock is thinly traded), a substitute to the beta estimated using a regression is the bottom-up beta.

- Identify the lines of businesses the firm is involved in;
- For each line of business, construct a panel of comparables (ideally only 'pure-plays', i.e. firms involved in a single line of business);
- For each member of the panels estimate its beta using a regerssion, de-leverage it on a cash-adjusted basis, and calculate a mean unlevered beta for each panel;
- Using the split of businesses the firm is involved in (by revenue or assets, see notes of the accounting statements), calculate business line weights;
- Calculate the unlevered bottom-up beta by summing up the multiplications of the average unlevered beta of a business from the panels with the business line weights of the firm;
- Using the appropriate debt-to-equity ratio of the firm, lever the unlevered bottom-up beta to get the estimated bottom-up beta of the firm.
- Anticipate leverage and business line changes and adjust accordingly.

Example of estimating a bottom-up beta

A private firm has two divisions. One is manufacturing household appliances while the other is publishing video games (respectively $1.5B and $1B of revenues). The actual debt to equity ratio of the firm is 0.5 which is optimal while the corporate tax income for all firms is 40%. Estimate the beta of each division as well as the beta for the firm.

Firm lines of business	Revenue	Weights	Unl. Beta	D/E	Beta
Household appliances	1.5	0.6	**1.38**	0.5	**1.79**
Video games	1.0	0.4	**1.22**	0.5	**1.58**
Tax rate	40%				
Beta of firm					**1.71**

Household appliances	Beta	Debt	Cash	Equity (MV)	Unl. Beta
Stanley Black & Decker	1.49	5.89	0.31	23.04	1.31
AB Electrolux	1.10	15.11	7.88	65.84	1.10
Libbey Inc.	2.27	0.50	0.16	0.35	2.25
National Presto	0.57	0.04	0.15	0.65	0.71
Whirlpool	1.98	7.70	1.18	9.30	1.52
Average	1.48				**1.38**

Video game publishers	Beta	Debt	Cash	Equity (MV)	Unl. Beta
Activision Blizzard, Inc	0.94	2.96	4.83	35.96	1.03
Electronic Arts Inc.	1.20	0.99	5.45	26.37	1.48
Nintendo Co.	1.55	0.00	0.00	43.65	1.55
Ubisoft Entertainment	1.15	1.34	1.05	8.48	1.20
Take-Two Interactive	0.72	0.00	1.57	13.40	0.82
Average	1.11				**1.22**

Betas and leverage by industry (US)

Industry	Beta	D/E (%)	Tc (%)	Un. Beta
Steel	1.82	36.23	7.05	1.42
Biotech	1.44	15.83	1.36	1.29
Oil & Gas Int.	1.37	15.29	10.96	1.23
Construction	1.27	29.72	13.37	1.04
Pharma	1.21	14.63	2.11	1.09
Air transport	1.01	71.00	24.57	0.66
Retail Grocery	0.71	83.68	21.04	0.43
Food processing	0.68	30.82	15.13	0.55
Power	0.50	76.36	20.31	0.32
Water Utilities	0.34	38.14	15.09	0.27

Source: Damodaran website

Weighted Average Cost of Capital (WACC)

While the β_{Equity} of the firm might be higher as debt is used (and therefore shareholders expect a higher return), there are advantages in debt as it is less costly than equity, especially on an after-tax basis.

$$r_{WACC} = \frac{Debt}{Debt + Equity} r_{Debt} (1 - T_c) + \frac{Equity}{Debt + Equity} r_{Equity}$$

> *Once the firm is using debt, the appropriate discount rate to calculate the project's NPV is the weighted average cost of capital (WACC), as calculated from the perspective of the providers of capital.* ***The ratios are calculated using market values.***

If 'flotation costs' or 'underwriting fees' are incurred out of raising debt or equity for a given project, such costs shall be ascribed to the project as and when incurred (e.g. in CF_0).

Textbook Example 13.3

	Interest	Tax rate	Cost (AT)	
Debt	10%	34%	6.60%	
	Rf	Beta	MRP	Re
Equity	5.71%	1.41	4.59%	12.18%
	Market value	Weights	Cost	WACC
Debt	40,000,000	40%	6.60%	2.64%
Equity	60,000,000	60%	12.18%	7.31%
Enterprise	100,000,000	100%		9.95%

WACC: which weights?

Even if specific sources of capital is used to seemingly finance a given project, using project specific weights is not justified.

The book-value weights as per the accounting balance sheet shall not be used to calculate WACC since they do not reflect the current capital market conditions (i.e. market price of equity and current required return for debt-holders).

Academic finance suggests that **the appropriate weights to be used to calculate WACC shall reflect the optimal capital structure of the firm** (i.e. the debt to equity mix which minimizes WACC and therefore simultaneously maximizes the market value of the firm).

If one assumes that the current capital structure of the firm is close to its optimal capital structure, then the weights can be calculated using the market value of equity and debt.

WACC: fallacies in favor of book values

Book values are more useful since market value are simply too volatile.

- It is true that market values are more volatile than book values as market values reflect better the evolving value of firms than book value as new information manifest itself about firms and the economy. Decision making must use the best information available.

Book values provide for more conservative debt ratios than market values.

- For most firms the market value of equity is higher than its book value while both are similar for debt, so debt to equity ratios calculated using book values will be higher than for market values. But, since the cost of equity is much higher than debt, using book values ratios will result in a lower cost of capital, a less conservative estimate likely to lead a firm to accept too many marginal projects.

Since accounting returns are calculated using book values, consistency requires using also book values when calculating the cost of capital.

- Capital is owned by investors and the risk-adjusted return they can earn on their capital by investing as they see fit is the appropriate benchmark. Therefore, the cost of capital for a given firm shall be calculated at market rates using market value weights.

WACC: Estimating the hurdle rate for a specific project

If the project is of identical or similar risk as the firm, use the WACC of the firm as discount rate when calculating the NPV (and as threshold for IRR).

If the project is of a different risk profile than the firm:

- Look for firms with risk profiles comparable or similar to the project and use their β (adjust for differences in financial leverage, if any, i.e. de-lever and then re-lever).
- Using the project β, estimate the required rate of return like a project-specific WACC.

Practitioners' perspective

Survey evidence shows that current market-value weights and target capital structure weights are the most common methods used by firms to calculate the cost of capital.

Survey	Country	% of firms using each method				
		Cost of specific financing source	Book-value weights	Current market value weights	Target capital structure weights	Other
Gitman & Vand. (2000)	U.S.	8	20	34	50	2
Baker & Al. (2009)	Canada	-	-	58	23	18
Arnold & Hatz. (2000)	U.K. (I.)	-	19	42	39	-

Liquidity and Trading Costs

'Liquidity' in a capital markets context refer to the all-in cost of trading (i.e. buying or selling) a security incurred by investors. Such trading cost is comprised of three components:

- Commissions, the bid-ask spread, and the market impact.

Commissions are paid by investors when trading to support various infrastructure costs required for a market to exist (the exchange, the compensation chamber, the brokers, the regulators, etc.).

Modern financial markets usually use a limit order book ('LOB') through which bid (i.e. buy) and ask (i.e. sell) offers are posted. It informs investors at what price securities can be bought and sold.

- Informed investors who know more about the 'true' value of a given security can take advantage of a LOB by selling (buying) when the market price is higher (lower) than the 'true price'.
- For protection, market makers post small orders at such prices that a spread exists between the best bid and the best ask (i.e. the bid-ask spread)
- This spread is a cost to market orders to compensate limit orders for adverse selection.

Liquidity and Trading Costs

The small quantities posted at the best price create a cost to immediacy: the faster and larger you wish to trade, the largest the cost of trading as your orders deplete quickly the best price and force you to trade at less advantageous prices (i.e. your trading is moving the price, creating a market impact).

The trading costs as incurred correspondingly decrease the net return received by investors.

- If the liquidity for securities of a given firm is low (i.e. trading costs are high), investors expect to receive higher gross returns from the firm to compensate accordingly.
- Markets can deliver higher gross returns by lowering the price of existing securities, which negatively impacts the enterprise value of the firm and increases its WACC.

A firm shall ensure sufficient liquidity exists for its securities to maximize its enterprise value.

- Carefully controlling confidential information to avoid leaks (reduce adverse selection);
- Simultaneously releasing information to all investors at once (reduce asymmetric information);
- Having a good investor relations program in place (ensure two-way information flows);
- Subsidizing market makers if required and allowed (to improve liquidity for firm's securities).

Chapter 13 of the textbook

Textbook sections covered

- 13.1 to 13.8

Worked examples

- Eleven worked examples are provided in chapter 13 of the textbook.

Exercises

- 25 exercises are provided in chapter 13 of the textbook.
- You should practice your Excel skills with a few of those.
- Suggest 13.10, 13.17, 13.18, 13.21 and 13.24
- Hints
  - 13.10: ~20/80; ~76/24
  - 13.18: maximum investment of ~41.97 millions
  - 13.21: 6.05% vs. 13.01%

13.10 Solution

	Debt	Equity	Total
	$70,000,000	$4	
	$60,000,000	8,300,000	
	$130,000,000	$33,200,000	$163,200,000
a)	80%	20%	100%
	$70,000,000		
	108.3%		
	$75,810,000		
	$60,000,000		
	108.9%	$53	
	$65,340,000	8,300,000	
	$141,150,000	$439,900,000	$581,050,000
b)	24%	76%	100%

The market value weights are more relevant in order to reflect the opportunity cost of capital.

13.17 Solution

	Debt	Preferred	Equity	Total
Weight	30%	5%	65%	100%
Flotation	3%	6%	9%	
Amount raised	$13,917,526	$2,393,617	$32,142,857	$48,454,000
Flot. Costs	$417,526	$143,617	$2,892,857	$3,454,000
Net received	$13,500,000	$2,250,000	$29,250,000	$45,000,000

13.18 Solution

$$
\begin{aligned}
WACC &= \left[\frac{D}{D+E}\right] R_D + \left[\frac{E}{D+E}\right] R_E \\
&= \left[\frac{0.55}{0.55+1}\right] 0.055 + \left[\frac{1}{0.55+1}\right] 0.13 = 0.1034
\end{aligned}
$$

$$
Hurdle\ Rate = WACC + Adj. = 0.1034 + 0.02 = 0.1234
$$

$$
Present\ Value = \frac{Cash\ Flows}{Hurdle\ Rate - Growth\ Rate} = \frac{3{,}500{,}000}{0.1234 - 0.04} = 41{,}972{,}921
$$

NPV is positive as long as investment is less than 41,972,921.

13.21 Solution

$$P_0 = \frac{D_1}{R_E - g} \rightarrow R_E = \frac{D_1}{P_0} + g = \frac{0.95 \times 1.045}{64} + 0.45 = 0.0605$$

$$R_E = r_f + \beta\left(R_M - r_f\right) = 0.043 + 1.3\left(0.11 - 0.043\right) = 0.1301$$

When using the dividend growth model or the CAPM, you must remember that both are estimates for the cost of equity.

Additionally, and perhaps more importantly, each method of estimating the cost of equity depends upon different assumptions.

13.24 Solution

a)	**Debt**	**Preferred**	**Equity**	**Total**
Weight (see b)	28.43%	4.01%	67.56%	100%
Flotation	3.0%	4.5%	6.5%	
Amount raised	$11,722,003	$1,680,550	$28,903,457	$42,306,010
Flot. Costs	$351,660	$75,625	$1,878,725	$2,306,010
Net received	$11,370,343	$1,604,925	$27,024,732	$40,000,000

Assume working capital needs are addressed without raising new capital.

Opportunity cost for land	-$7,100,000
Plant and equipment	-$40,000,000
Flot. Costs	-$2,306,010
Working capital	-$1,400,000
Initial cash flow	-$50,806,010

13.24 Solution

b)	Debt	Preferred	Equity	Total
Price	$1,030	$84	$67	
Quantity	260,000	450,000	9,500,000	
Total market value	$267,800,000	$37,800,000	$636,500,000	$942,100,000
Weights	0.2843	0.0401	0.6756	1.0000
Maturity	25			
Coupon (semi)	6.80%			
YTM	6.55%			
Pref. Div		$5.25		
Rp		6.25%		
Rf			3.60%	
Beta			1.25	
MRP			7%	
Re			12.35%	
Tc	35%			
WACC	4.26%	6.25%	12.35%	9.81%
Risk adjustment				2.00%
Project required return				11.81%

13.24 Solution

c)

Plant and equipment	$40,000,000
Depreciation (years)	8
Net book after 5 years	$15,000,000
Salvage value	$8,500,000
Aftertax salvage	$10,775,000

13.24 Solution

d)

Units	18,000
Price per unit	$10,900
Revenues	$196,200,000
Variable costs per unit	$9,450
Variable costs	$170,100,000
Fixed costs	$7,900,000
Depreciation	$5,000,000
NIBT	$13,200,000
Tax	$4,620,000
NI	$8,580,000
OCF	$13,580,000

13.24 Solution

f)

	0	1	2	3	4	5
Investment + W/C	-$50,806,010					
Land						$7,400,000
Salvage						$10,775,000
W/C recovery						$1,400,000
OCF		$13,580,000	$13,580,000	$13,580,000	$13,580,000	$13,580,000
Net Cash Flows	-$50,806,010	$13,580,000	$13,580,000	$13,580,000	$13,580,000	$33,155,000
NPV	$9,587,638					
IRR	18.16%					