CHAPTER 12: RISK, COST OF CAPITAL, AND CAPITAL BUDGETING

Assigned problems are 1, 3, 6, 7, 11, 12, and 15. Skip "advanced" example on pp. 321-322. Read Economic Value Added section on pp 343-345.

I. Introduction

From prior lectures: $NPV = CF_0 + \frac{CF_1}{(1+r)} + \frac{CF_2}{(1+r)^2} + \frac{CF_3}{(1+r)^3} + \frac{CF_4}{(1+r)^4} + \frac{CF_5}{(1+r)^5} .....$

The *discount rate* or cost of capital *r* of a project should be the expected return on a financial asset of equivalent or comparable risk.

Financial theory posits that the only relevant risk of an asset should be its level of *systematic* risk, as this risk cannot be diversified away. The cost of capital *r* is a *linear* function of systematic risk. In this chapter we employ the **Capital Asset Pricing Model**, which uses *one* systematic risk factor — the *market* risk. Under the **CAPM**, an asset's exposure to market risk is measured by its **Beta**.

II. Risk and Cost of Capital for *All Equity* Firms

Let firm ABC be 100% equity financed (no debt is used). ABC's common stock has a Beta β=1.2. The risk free rate of interest is r_F=5%. The required return on the *market* portfolio is r_M=10%. Using the Capital Asset Pricing Model or CAPM, we can estimate the required return on ABC common stock.

$r_{ABC} = r_F + \beta_{ABC}[r_M - r_F] = 0.05 + (1.2)[0.10 - 0.05] = 0.05 + 0.06 = 0.11$ or **11%**

This firm is 100% equity financed. The common stockholders have a 100% claim on the firm and the cash flow produced by ABC's assets. However, the original source of ABC's market risk is the Beta of ABC's *assets*. When a firm is all equity (unlevered), the asset and equity Betas are equal.

$$\beta_{assets} = \beta_{equity}$$

In this example, ABC is 100% financed by equity at a cost of equity of 11%. Thus ABC's total existing cost of financing is also 11%. Here, ABC's existing *weighted average cost of capital* or **WACC** is 11%.

Asset Betas are a function of the *systematic* risk (Beta) of a firm's assets. The asset Beta will change only when the Beta of the firm's assets changes. Changing

the proportions of equity and debt used to finance these assets (capital structure) does not change the asset Beta.

Capital structure, i.e., how the assets are financed with debt and equity, just merely allocates the asset risk to the firm's debt and equity investors. As we will later see, debt does introduce a new issue in that the interest paid on debt is a tax deductible expense of doing business in most countries.

New Project Financing (all equity firm)

Treat any new project as a separate *mini-firm*. A project's cost of capital should depend on the asset risk (asset Beta) of the project and the *optimal* debt to equity ratio for that project. In this section, we only examine the all equity case.

ABC has a new project with an asset Beta of $\beta_{assets}=0.8$. This project is *less risky* than the existing asset Beta. The project cost of capital is calculated as follows:

$r_{project} = r_F + \beta_{proj}[r_M - r_F] = 0.05 + (0.8)[0.10 - 0.05] = 0.05 + 0.04 = 0.09$ or **9%**

The project has the following estimated after-tax cash flows:

CF_0	CF_1	CF_2	CF_3	CF_4
-950	300	300	300	300

The *correct* cost of capital of this project is r=9%. Now the NPV is calculated.

$NPV = -950 + 300/(1+0.09) + 300/(1+0.09)^2 + 300/(1+0.09)^3 + 300/(1+0.09)^4 =$ **$21.915**

Also, the IRR of this project is **10.0466%**. Since the NPV is positive (and the IRR > r), this project should be accepted.

However, *what if* this project were evaluated at an *incorrect* cost of capital, i.e., something other than r=9%. What if ABC used its existing cost of capital or WACC=11% to evaluate the NPV? The NPV @ r=11% equals **-$19.27**. Thus the project would be falsely rejected under this scenario.

You can use the *existing* WACC only if **(1)** the project matches the existing firm's asset Beta *and* **(2)** existing firm and project should be financed with identical debt and equity proportions. If (1) or (2) do not hold, then you must use a project's unique asset Beta and/or financing proportions to find a project's cost of capital.

III. WACC, Betas, Leverage, and Cost of Capital

Note the following terms:

- D ≡ market value of Debt (not the accounting *book* value)
- E ≡ market value of Equity (not the accounting *book* value)
- r_D ≡ cost of debt (before taxes)
- r_E ≡ cost of equity, where $r_E = r_F + \beta_E[r_M - r_F]$
- A ≡ market value of assets ≡ D + E
- β_A ≡ Beta of assets (fixed and independent of capital structure)
- β_U ≡ Beta of *unlevered* equity ($\beta_U = \beta_A$, since these are equivalent)
- β_E ≡ Beta of equity (see equation below for explanation)
- β_D ≡ Beta of debt (often assumed to be zero in this chapter)
- T_C = Corporate tax rate

Assuming a zero debt Beta, β_D=0, the following equation relates the *asset* Beta β_A to the *equity* Beta β_E.[1] The equation can be used for either the entire firm or an individual project (treating project as a mini-firm).

$$\beta_E = \beta_A[1 + (1 - T_C)D/E]$$

Next, we calculate the combined cost of debt and equity financing in order to find the total *after-tax* cost of capital. The before tax cost of debt r_D must be multiplied by $(1 - T_C)$ in order to calculate the after-tax cost of debt. The terms D/(D+E) and E/(D+E) represent the *proportions* of debt and equity financing, respectively.[2]

$$\text{Cost of Capital} = [D/(D+E)](1 - T_C)r_D + [E/(D+E)]r_E$$

When the above equation is used for the entire *existing* firm, then the result is the weighted average cost of capital or **WACC**. When done for a *project*, the result is the project's cost of capital. When done for a *division*, the result is the divisional cost of capital. The main intuition here is that the cost of capital used to evaluate any asset or business unit must be a function of that asset or business unit's specific asset Beta (risk) and optimal proportions of debt and equity financing.

[1] The version of this equation that allows for nonzero debt Betas is covered in Chapter 17.

[2] Using market values of debt and equity and using the current market required rates of return on the existing bonds and equity gives us the most accurate estimate of the firm's *current* cost of capital. Using historical accounting book values produces a (often much) less accurate estimate of the current cost of capital.

Example of WACC calculation for a levered firm:

XYZ Corp. is financed with $100 million of equity and $50 million of debt, at current market values. Let the debt Beta β_D=0 and the asset Beta β_A =1.30. Let T_C=40%, r_M=12%, and r_F=6%. Calculate the existing WACC for XYZ Corp. Based on this given information, finding the WACC is a three-step process.

(1) $\beta_E = \beta_A[1 + (1 - T_C)D/E] = 1.3[1 + (1 - 0.4)(50/100)] = \mathbf{1.69}$

(2) $r_E = r_F + \beta_E[r_M - r_F] = 0.06 + \mathbf{1.69}[0.12 - 0.06] = 0.06 + 0.1014 = \mathbf{16.14\%}$

$r_D = r_F + \beta_D[r_M - r_F] = 0.06 + \mathbf{0}[0.12 - 0.06] = 0.06$ or **6%**

(3) $WACC = [D/(D+E)](1 - T_C)r_D + [E/(D+E)]r_E$

$WACC = [50/(50+100)](1 - 0.4)(\mathbf{0.06}) + [100/(50+100)](\mathbf{0.1614}) = \mathbf{11.96\%}$

XYZ is 1/3 and 2/3 financed with debt and equity, respectively. The following figure illustrates the firm, its risk, and the capital structure.

The source of the firm's risk is the *market* risk of the assets, as defined by the asset Beta.

ASSETS	DEBT
Asset β = 1.30	Debt β = 0 Market value of debt equals $50 million
Market value of firm equals $150 million	EQUITY Equity β = 1.69 Market value of equity equals $100 million

The asset market risk or Beta just becomes allocated to the debt and equity.

What if XYZ were actually 100% financed by equity? In such a case, β_A=β_E=1.3, since no debt or leverage would stand between the assets and equity. The required return on the equity in this hypothetical *all-equity* scenario is thus:

$$r_E = r_F + \beta_E[r_M - r_F] = 0.06 + \mathbf{1.3}[0.12 - 0.06] = 0.138 \text{ or } 13.8\%$$

Example of estimating a project cost of capital for XYZ:

XYZ has a new project to consider. The project has an asset Beta β_A=1.0. Treating the project as a mini-firm, assume the optimal proportions of financing are 1/3 debt and 2/3 equity (same proportions as existing firm). The debt/equity ratio is thus D/E=(1/3)/(2/3)=0.5. Assume that the Beta of any new debt is β_D=0.

The project has the following estimated after-tax cash flows:

CF_0	CF_1	CF_2	CF_3
-1000	400	500	400

The **IRR** of these cash flows is **14.33%**. Now, calculate the project cost of capital:

(1) $\beta_E = \beta_A[1 + (1 - T_C)D/E] = 1.0[1 + (1 - 0.4)(0.5)] =$ **1.30**

(2) $r_E = r_F + \beta_E[r_M - r_F] = 0.06 +$ **1.30**$[0.12 - 0.06] = 0.138$ =or **13.8%**

$r_D = r_F + \beta_D[r_M - r_F] = 0.06 +$ **0**$[0.12 - 0.06] = 0.06$ or **6%**

(3) project cost of capital = $[D/(D+E)](1 - T_C)r_D + [E/(D+E)]r_E$

project cost of capital = $[1/3](1 - 0.4)$(**0.06**) + $[2/3]$(**0.138**) = **10.40%**

This project cost of capital is *less* than the IRR, therefore the NPV is **positive** (NPV = $69.82) and thus this project should be **accepted**.

The only *correct* cost of capital for this project is 10.40%, based on the project's asset Beta and its optimal proportions of debt and equity financing. Any other cost of capital is *incorrect* and may lead to an incorrect decision.

IV. More on Asset and Equity Betas

From Chapter 10, the Beta of any asset with the *market* portfolio is defined as:

$$\beta_i = \text{covariance}(r_i, r_{market})/\text{variance}(r_{market})$$

For a project, think about the *market* or *systematic* risk of the project's *unlevered* cash flows, i.e., how the project's cash flows are correlated to the aggregate corporate cash flows of the economy.

$$\beta_{assets} = \text{covariance(project CFs, market CFs)/variance(market CFs)}$$

Asset Beta: determined by the systematic or market risk of a firm or project. Market risk refers to how the EBIT or earnings before interest and taxes is affected by the future state of the economy. Since the focus is on EBIT, the use of operating leverage (increased use of fixed, as opposed to variable costs of production) is also incorporated into the Asset Beta. The Asset Beta is *independent* of the proportions of debt and equity actually used to finance the assets or firm.

Equity Beta: a function of the Asset Beta, taxes, and the proportion of debt (financial leverage) that is used. As the D/E ratio *increases*, the Equity Beta *increases*; however, the Asset Beta remains *constant*.

Estimating equity Betas of publicly traded firms:

Betas are traditionally estimated from a linear regression of the firm's stock returns on the returns of a market index, typically the Standard and Poors 500 Index. The following example uses an ordinary least squares (OLS) regression to estimate the Beta of General Electric's common stock.

General Electric monthly common stock *excess* returns for Jan. 1997 through Dec. 1999 (36 months) are regressed against the *excess* returns to the CRSP value weighted market index.[3] Microsoft Excel's regression tool is used to estimate the regression model. The regression results are shown in the table below.

$$[R_{GE,t} - r_{F,t}] = \alpha_{GE} + \beta_{GE}[r_{M,t} - r_{F,t}] + e_{GE,t}$$

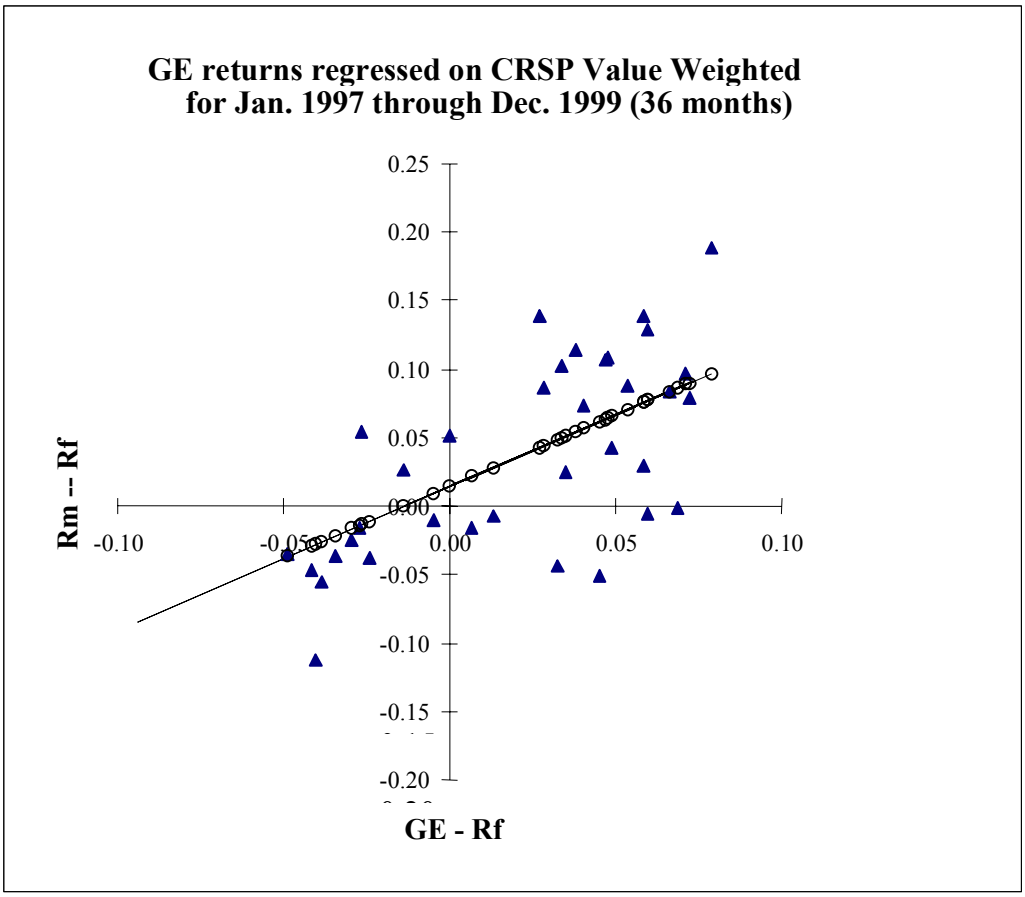
Regression Statistics	
R Square	0.49578
Adjusted R Square	0.48095
Standard Error	0.05342
Observations	36

	Coefficients	Standard Error	t Stat	P-value
Intercept	0.01456	0.00940	1.54823	0.13083
Rm-Rf	**1.04727**	0.18113	5.78195	0.00000

The $[R_m - R_f]$ coefficient above is the estimate of General Electric's **Beta**; here we estimate β_{GE} = **1.0473**. The R-square of 0.4958 denotes that the market index returns can explain about 49.6% of GE stock's total variance, so the remaining 51.4% of total variance is assumed to be firm specific.

[3] *Excess* refers to returns in excess of the risk free rate of return. The return on one-month T-bills is used as the risk free rate of return. CRSP is the Center for Research in Security Prices at the University of Chicago.

The Security Characteristic Line is plotted below. The slope of this SCL is GE's Beta. The small circles on the line represent the fitted values of GE returns, based on the market index return, Beta, and intercept. The small triangles represent the actual monthly GE stock returns. The difference between the actual and fitted returns represents the error or residual terms.



V. Economic Value Added (EVA™)

The EVA method (or something similar) is often used to assess financial performance in *nontraded* corporations or divisions of corporations.[4] [5] The intention is to employ a system that can evaluate what a business unit contributes to the firm's providers of capital.

[4] EVA is a registered trademark of Stern Stewart & Co.

[5] An alternative method to evaluate the performance of a division of a publicly traded corporation is to issue a *tracking stock* for the division. The parent firm owns a majority of the tracking stock and public investors hold the remaining amount. Current examples of tracking stocks are Sprint PCS (for the cellular division) and General Motors H class shares (for the Hughes division). The intent is to allow the market to assess the performance of the business unit. The division's managerial and employee compensation can then be linked to the tracking stock.

EVA = After-tax operating profit – After-tax cost of capital invested in firm

EVA = EBIT(1 – Corporate tax rate) – (Total capital employed)(WACC)

The after-tax operating profit is calculated as if the firm is all equity financed, i.e., the cost of interest is not included (this is the correct technique for any Capital Budgeting exercise). The after-tax cost of capital is defined as the firm's Weighted Average Cost of Capital or WACC of its mix of debt and equity financing, represented as:

$$WACC = [D/(D+E)](1 - T_C)r_D + [E/(D+E)]r_E$$

An example of calculating the WACC for a fictitious PDQ Corp would be as follows, using the figures provided below:

D = \$40,000 of debt (*book* value)[6]

E = \$100,000 of equity (*book* value)

D+E = \$140,000 or total amount of capital contributed to the firm

r_D = 5% cost of debt capital

r_E = 12% cost of equity capital

T_C = 40% corporate tax rate

WACC = [40/140](0.05)(1 – 0.40) + [100/140](0.12) = 0.0943 or 9.43%

The WACC would be PDQ's after-tax cost of capital for calculating EVA. PDQ has \$140,000 of capital that is invested into the firm. Let PDQ have Earnings Before Interest and Taxes or EBIT of \$30,000. The estimated EVA for PDQ is:

EVA = EBIT(1 – Corporate tax rate) – (Total capital)(WACC)

= (30,000)(1 – 0.40) – (140,000)(0.0943) = **\$18,000** – **\$13,202** = **\$4798**

\$13,202 is the total dollar amount required by the firm's debt and equity contributors of capital. The EVA technique makes the cost of both debt *and* equity capital explicit. The firm's EVA of **\$4798** shows that PDQ has returned more than what the bondholders and stockholders require.[7]

[6] Note the use of accounting *book* value, as opposed to *market* value, here with EVA. Why? EBIT is an accounting entity, so the accounting book values of debt and equity are used to achieve consistency. This is a characteristic of the EVA method. Every topic *prior* to Section V on EVA in these lecture notes always utilizes the market values.

[7] The compensation is usually linked to *changes* in EVA rather than the absolute EVA.