Capital Budgeting Under Uncertainty

- The Capital Budgeting Process
- Project Selection
- Estimating BETA

The Capital Budgeting Process

Should a firm undertake a certain project?

To answer this question you should follow these steps:

1. Using the project's BETA and the CAPM, calculate the appropriate **discount rate** for the project's cash flows
   - The BETA and discount rate for the rest of the firm's cash flows do not matter.
2. **Discount** the project's expected cash flows using the discount rate you calculated to get the NPV of the project.

Why can we neglect idiosyncratic risk?

3. If the NPV is positive then adopt the project. By doing so you are increasing the return of your (well diversified) investors. If the NPV is negative then do not adopt the project.

Project Selection

A firm with existing businesses X is considering to undertake project P, should it do so?

If the firm doesn't take the project then the value of the firm, V_X *, is:*

Cash flow from existing businesses

$$V_X = CF_0^X + \frac{CF_1^X}{1+r_X} + \ldots + \frac{CF_N^X}{(1+r_X)^N}$$

$$r_X = r_f + \beta_X (r_m - r_f)$$

BETA of cash flows from existing businesses

Project Selection

If the firm adopts the project then the value of the firm is, $V=V_X+V_P$ where,

Cash flow from project P

$$V_P = CF_0^P + \frac{CF_1^P}{1+r_P} + \ldots + \frac{CF_N^P}{(1+r_P)^N}$$

$$r_P = r_f + \beta_P (r_m - r_f)$$

BETA of cash flows from project P

Project P should be adopted only if $V_P>0$

Example 1: Company A (which is all equity financed) has current businesses that generate expected annual cash flows of $10M, forever. The BETA of these cash flows is zero. The Company can raise $90M in cash to invest in a project that generates annual cash flows of $20M, forever. The BETA of the project's cash flows is 1.5. The expected return on the market is 15% and the risk free rate is 5%. Should the project be adopted?

What is the appropriate discount rate for the current businesses' cash flows?

What is the value of the current businesses?

What is the appropriate discount rate for the project's cash flows?

What is the NPV of the project?

What is the value of the firm, after the project is adopted?

What is the BETA of the firm's cash flows after the project is adopted?

What is the rate of return required by the share holders of Company A, after the project is adopted?

What is the total expected annual cash flows of the firm, after the project is adopted?

Calculate the value of the firm using the rate of return calculated above to verify that it is the same you got earlier.

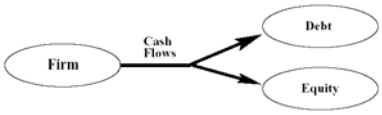
Example 2: Company B is considering a very risky project. The project will cost $10,000 and will generate in one year from now $100,000 with probability 0.20 and generate $0 otherwise. The BETA of the project's cash flows is 0.7. The expected return on the market is 15% and the risk free rate is 5%. Should the project be adopted?

What is the appropriate discount rate for the project's cash flows?

What is the expected CF from the project?

What is the NPV of the project?

BETA of a leveraged firm



- Cash flows are divided between "debt" and "equity" holders.
- The value of the **Firm**, "V", is the PV of cash flows
- The value of **Debt**, "D", is the PV of debt payments
- The value of **Equity**, "E", is the PV of equity payments (dividends)

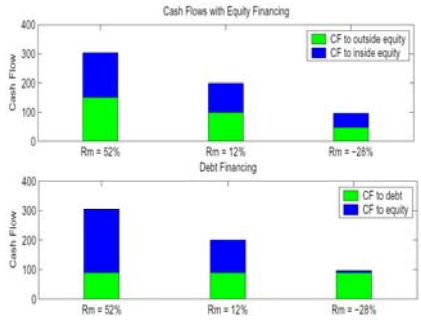
V= D+E

Example 3: An entrepreneur has no cash but has a project the requires an initial investment of $100,000 and generates an expected cash flow of $200,000 one year from now (300K, 200K, and 100K with equal probabilities). The entrepreneur can either raise the required funds by

(i) **EQUITY**: selling 50% of the firm to an investor (that is, the investor holds equity and owns 50% of all future cash flows).

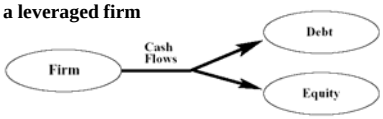
(ii) **DEBT**: Borrowing from a bank and paying back $100,000 (note that future cash flows are always above $100,000)

Lets look at the entrepreneur's payoffs in the two cases as a function of the market return (assuming only three outcomes for simplicity).



- *In what case is the return on equity more sensitive to the return on the market?*
- *Is $BETA_{equity}$ the same as $BETA_{Assets}$?*
- *Is $BETA_{Assets}$ affected by the capital structure?*

BETA of a leveraged firm



BETA of equity measures the risk of the return on the firm's stock,

$$r_E = r_f + \beta_E (r_m - r_f)$$

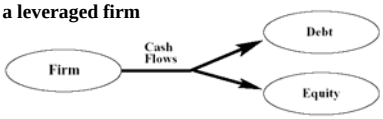
BETA of debt measures the risk of the return on the firm's debt,

$$r_D = r_f + \beta_D (r_m - r_f)$$

BETA of assets measures the risk associated with the firm's cash flows,

$$r_A = r_f + \beta_A (r_m - r_f)$$

BETA of a leveraged firm



The BETA's of equity, debt and assets satisfy

$$\beta_A = \beta_D \times \left(\frac{D}{V}\right) + \beta_E \times \left(\frac{E}{V}\right)$$

The return on equity r_E, debt r_D and assets r_A satisfy

$$r_A = r_D \times \left(\frac{D}{V}\right) + r_E \times \left(\frac{E}{V}\right)$$

"D" is the value of debt, "E" the value of equity and "V" is the total value of the firm (V=D+E).

Changing Capital Structure and Beta

- Beta of *Assets* is not affected by capital structure but Beta of *Equity* and *Debt* are affected by capital structure.

Example: Consider a firm with Beta of assets 1.7, risk less debt (i.e. beta of debt is zero) and a debt to assets ratio (i.e. D/V) of 0.4.

- Calculate Beta of equity:

- Suppose that the firm increases its leverage to 0.5 (while the debt remains risk less). Calculate Beta of equity after the change:

Estimating BETA of a project with comparable firm

1. Identify a *comparable public firm* with similar projects. The BETA of the assets of this firm is our estimate for the BETA of the project.

$$\beta_{project} = \beta_A^{comparable\ firm}$$

2. To get the BETA of assets of this comparable public firm we first calculate the BETA of equity of this firm. We can do so by using the CAPM and the average of past returns on equity.

$$r_E = r_f + \beta_E^{comparable\ firm} (r_m - r_f)$$

3. Once we have BETA equity we estimate the BETA of the assets using the BETA of debt. This gives us the BETA of the project.

$$\beta_A^{comparable\ firm} = \beta_D^{comparable\ firm} \times \left(\frac{D}{V}\right) + \beta_E^{comparable\ firm} \times \left(\frac{E}{V}\right)$$

Example 4: You are considering a project that requires an initial investment of $100K and generates expected annual cash flows of $20K, for the next ten years. The project is in the same line of business of corporation X and the risk of the project's cash flows is the same as the risk of corporation X's cash flows. The debt to equity ratio (D/E) of X is 2, its debt is risk free and its equity has expected return of 20%. The expected return on the market is 15% and the risk free rate is 5%.

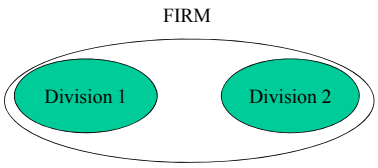
What is the $BETA_{Equity}$ of corporation X?

What is the $BETA_{Assets}$ of corporation X?

What is the appropriate discount rate for the project's cash flows?

Should the project be adopted?

Calculating BETA of multi division firms



The value of the firm V satisfies:

Calculating BETA of multi division firms

Example: Consider the same project as before (initial investment of $100K and cash flows of $20K for the next ten years). Now assume that the project is in the same line of business as Division 1 of corporation Y. Corporation Y, is all equity financed (that is the value of debt is zero) with market value of equity $100K and $BETA_{equity}$ of 1.7. The expected return on the market is 15% and the risk free rate is 5%. Division 2 generates expected cash flows of $15K forever, with BETA of 1.5.

What is the value of Division 2?

What is the value of corporation Y?

What is the value of Division 1?

What is the BETA of Division 1?

What is the appropriate discount rate to discount the project's cash flows?

Should the project be adopted?