Valuation Beyond NPV

- Corporate Finance revolves around three fundamental questions:
  - what long-term investments should the firm make: the capital budgeting question
  - the second regards the use of debt: the capital structure question
  - how to value the firm: pricing the capital structure
- Today, revisit DCF techniques capital budgeting and extend NPV to a more useful paradigm: real options
  - APV, FTE and WACC
A Refresher on DCF Techniques

• Present Value: adjusting cash flows for
  – numerator:
  – denominator:

• Net Present Value and its extensions
  – NPV: brute force
  – the WACC approach:
  – the Flows-to-Equity approach:
  – Adjusted Present Value:

The Use of DCF Valuation

Adjusted Present Value

\[ APV = NPV + NPVF \]

- The value of a project to the firm can be thought of as the value of the project to an unlevered firm (NPV) plus the present value of the financing side effects (NPVF)
- There are five side effects of financing:
  - The Tax Subsidy to Debt
  - The Costs of Issuing New Securities
  - The Costs of Financial Distress
  - Subsidies to Debt Financing
  - Financial Risk Management gains or losses

APV Example: Pearson

Consider a project of the Pearson Company, the timing and size of the incremental after-tax cash flows for an all-equity firm are:

\[
\begin{array}{ccccc}
-1,000 & 125 & 250 & 375 & 500 \\
0 & 1 & 2 & 3 & 4
\end{array}
\]

The unlevered cost of equity is \( r_0 = 10\% \):

\[
NPV_{10\%} = -1,000 + \frac{125}{(1.10)} + \frac{250}{(1.10)^2} + \frac{375}{(1.10)^3} + \frac{500}{(1.10)^4}
\]

\[ NPV_{10\%} = -56.50 \]

The project would be rejected by an all-equity firm: \( NPV < 0 \).
Adding Debt: The Tax Shield

• Now, imagine that the firm finances the project with $600 of debt at $r_B = 8\%$.

• Pearson’s tax rate is 40\%, so they have an interest tax shield worth $T_cB r_B = 0.40 \times 600 \times 0.08 = 19.20$ each year.

  • The net present value of the project under leverage is:
    
    $APV = NPV + NPVF$
    
    $APV = -56.50 + \sum_{t=1}^{4} \frac{19.20}{(1.08)^t}$
    
    $APV = -56.50 + 63.59 = 7.09$

  • So, Pearson should accept the project with debt.

Debt NPV

• Note that there are two ways to calculate the NPV of the loan. Previously, we calculated the PV of the interest tax shields. Now, let’s calculate the actual NPV of the loan:

  \[
  NPV_{loan} = 600 - \sum_{t=1}^{4} \frac{600 \times 0.08 \times (1 - 0.4)}{(1.08)^t} - \frac{600}{(1.08)^4}
  \]

  \[
  NPV_{loan} = 63.59
  \]

  $APV = NPV + NPVF$

  $APV = -56.50 + 63.59 = 7.09$

  • Which is the same answer as before.
Flows to Equity Approach

• Discount the cash flow from the project to the equity holders of the levered firm at the cost of levered equity capital, \( r_S \).
• There are three steps in the FTE Approach:
  – Step One: Calculate the levered cash flows
  – Step Two: Calculate \( r_S \).
  – Step Three: Valuation of the levered cash flows at \( r_S \).

Step One: Levered Cash Flows

• Since the firm is using $600 of debt, the equity holders only have to come up with $400 of the initial $1,000.
• Thus, \( CF_0 = -$400 \)
• Each period, the equity holders must pay interest expense. The after-tax cost of the interest is \( B \times r_B \times (1-T_C) = $600 \times 0.08 \times (1-0.40) = \$28.80 \)

\[
\begin{align*}
CF_1 &= $125 - 28.80 \\
CF_2 &= $250 - 28.80 \\
CF_3 &= $375 - 28.80 \\
CF_4 &= $500 - 28.80 - 600
\end{align*}
\]

\[
\begin{align*}
0 &\quad -$400 &\quad 1 &\quad 96.20 &\quad 2 &\quad 221.20 &\quad 3 &\quad 346.20 &\quad 4 &\quad -$128.80
\end{align*}
\]
Step Two: Calculate $r_S$

$$r_S = r_0 + \frac{B}{S}(1-T_C)(r_0 - r_B)$$

- To calculate the debt to equity ratio, $B/S$, start with the debt to value ratio. Note that the value of the project is

$$PV = \frac{125}{(1.10)} + \frac{250}{(1.10)^2} + \frac{375}{(1.10)^3} + \frac{500}{(1.10)^4} + \sum_{t=1}^{4} \frac{19.20}{(1.08)^t}$$

$$PV = 943.50 + 63.59 = 1,007.09$$

- $B = 600$ when $V = 1,007.09$ so $S = 407.09$.

$$r_S = .10 + \frac{600}{407.09}(1-.40)(.10-.08) = 11.77\%$$

Step Three: Pearson Valuation

- Discount the cash flows to equity holders at $r_S = 11.77\%$

\[
\begin{array}{cccccc}
0 & 1 & 2 & 3 & 4 \\
-400 & 96.20 & 221.20 & 346.20 & -128.80 \\
\end{array}
\]

$$PV = -\frac{400}{1.1177^1} + \frac{96.20}{1.1177^2} + \frac{221.20}{1.1177^3} + \frac{346.20}{1.1177^4} - \frac{128.80}{1.1177^4}$$

$$PV = 28.56$$
NPV-WACC Valuation for Pearson

\[ r_{WACC} = \frac{S}{S+B} r_s + \frac{B}{S+B} r_B (1-T_c) \]

- To find the value of the project, discount the unlevered cash flows at the weighted average cost of capital.
- Suppose Pearson Inc. target debt to equity ratio is 1.50

\[
1.50 = \frac{B}{S} \quad \therefore 1.5S = B
\]

\[
\frac{B}{S+B} = \frac{1.5S}{S+1.5S} = \frac{1.5}{2.5} = 0.60 \quad \frac{S}{S+B} = 1 - 0.60 = 0.40
\]

\[ r_{WACC} = (0.40) \times (11.77\%) + (0.60) \times (8\%) \times (1 - .40) \]

\[ r_{WACC} = 7.58\% \]

From Cash Flows to NPV

- Cash flows are easy...
  
  ...discount rates are hard
NPV Valuation for Pearson
Using WACC

• To find the value of the project, discount the unlevered cash flows at the weighted average cost of capital

\[
NPV = -1000 + \frac{125}{1.0758} + \frac{250}{(1.0758)^2} + \frac{375}{(1.0758)^3} + \frac{500}{(1.0758)^4}
\]

\[
NPV_{7.58\%} = 6.68
\]

Capital Budgeting with Estimated Discount Rate

• A scale-enhancing project is one where the project is similar to those of the existing firm.

• In the real world, executives would make the assumption that the business risk of the non-scale-enhancing project would be about equal to the business risk of firms already in the business.

• No exact formula exists for this. Some executives might select a discount rate slightly higher on the assumption that the new project is somewhat riskier since it is a new entrant.
Beta and Leverage

• Recall that an asset beta would be of the form:

\[ \beta_{\text{Asset}} = \frac{\text{Cov}(UCF, \text{Market})}{\sigma_{\text{Market}}^2} \]

• Remember
  – unlevering and relevering beta?
  – asset betas?

Beta and Leverage: No Corporate Taxes

• In a world without corporate taxes, and with riskless corporate debt, it can be shown that the relationship between the beta of the unlevered firm and the beta of levered equity is:

\[ \beta_{\text{Asset}} = \frac{\text{Equity}}{\text{Asset}} \times \beta_{\text{Equity}} \]

• In a world without corporate taxes, and with risky corporate debt, it can be shown that the relationship between the beta of the unlevered firm and the beta of levered equity is:

\[ \beta_{\text{Asset}} = \frac{\text{Debt}}{\text{Asset}} \times \beta_{\text{Debt}} + \frac{\text{Equity}}{\text{Asset}} \times \beta_{\text{Equity}} \]
Beta and Leverage: Corp. Taxes

• In a world with corporate taxes, and riskless debt, it can be shown that the relationship between the beta of the unlevered firm and the beta of levered equity is:

\[
\beta_{\text{Equity}} = \left(1 + \frac{\text{Debt}}{\text{Equity}} \times (1 - T_C)\right) \beta_{\text{Unlevered firm}}
\]

• Since \(1 + \frac{\text{Debt}}{\text{Equity}} \times (1 - T_C)\) must be more than 1 for a levered firm, it follows that \(\beta_{\text{Equity}} > \beta_{\text{Unlevered firm}}\).

• If the beta of the debt is non-zero, then:

\[
\beta_{\text{Equity}} = \beta_{\text{Unlevered firm}} + \left(1 - T_C\right) \left(\beta_{\text{Unlevered firm}} - \beta_{\text{Debt}}\right) \times \frac{B}{S_L}
\]

Comparing the APV, FTE, and NPV-WACC Approaches

• All three approaches attempt the same task: valuation in the presence of debt financing.

• Guidelines:
  – Use WACC or FTE if the firm’s target debt-to-value ratio applies to the project over the life of the project.
  – Use the APV if the project’s level of debt is known over the life of the project.

• In the real world, the WACC is the most widely used by far.

• However, APV is the most useful concept
From NPV to APV Capital Budgeting

The basic net present value equation is

\[ NPV = \sum_{t=1}^{T} \frac{CF_t}{(1+K)^t} + \frac{TV_T}{(1+K)^T} - C_0 \]

where:
- \( CF_t \) = expected incremental after-tax cash flow in year \( t \),
- \( TV_T \) = expected after tax cash flow in year \( T \), including return of net working capital,
- \( C_0 \) = initial investment at inception,
- \( K \) = weighted average cost of capital.
- \( T \) = economic life of the project in years.
NPV and Operating Cash Flows

We can use \( CF_t = OCF_t (1 - \tau) + \tau D_t \)
to restate the NPV equation

\[
NPV = \sum_{t=1}^{T} \frac{CF_t}{(1 + K)^t} + \frac{TV_T}{(1 + K)^T} - C_0
\]
as:

\[
NPV = \sum_{t=1}^{T} \frac{OCF_t (1 - \tau) + \tau D_t}{(1 + K)^t} + \frac{TV_T}{(1 + K)^T} - C_0
\]

Incremental Cash Flows

• For our purposes it is necessary to expand
the NPV equation:

\[
CF_t = (R_t - OC_t - D_t - I_t)(1 - \tau) + D_t + I_t (1 - \tau)
\]

\( R_t \) is incremental revenue \( I_t \) is incremental interest expense
\( C_t \) is incremental operating \( \tau \) is the marginal tax rate
\( D_t \) is incremental depreciation
Adjusted Present Value

\[ \text{NPV} = \sum_{t=1}^{T} \left[ \frac{OCF_t (1-\tau)}{(1+K)^t} + \frac{\tau D_t}{(1+K)^t} \right] + \frac{TV_T}{(1+K)^T} - C_0 \]

Can be converted to adjusted present value (APV)

\[ \text{APV} = \sum_{t=1}^{T} \left[ \frac{OCF_t (1-\tau)}{(1+K_a)^t} + \frac{\tau D_t}{(1+i)^t} + \frac{\tau I_t}{(1+i)^t} \right] + \frac{TV_T}{(1+K_a)^T} - C_0 \]

By appealing to Modigliani and Miller’s results.

Adjusted Present Value Model

\[ \text{APV} = \sum_{t=1}^{T} \left[ \frac{OCF_t (1-\tau)}{(1+K_a)^t} + \frac{\tau D_t}{(1+i)^t} + \frac{\tau I_t}{(1+i)^t} \right] + \frac{TV_T}{(1+K_a)^T} - C_0 \]

- The APV model is a value additivity approach to capital budgeting. Each cash flow that is a source of value to the firm is considered individually.
- Note that with the APV model, each cash flow is discounted at a rate that is appropriate to the riskiness of the cash flow.
DCF Methods are Problematic

• Modern approach: APV - multi-step procedure
  – economics: assume that whole project is financed by equity to yield NPV without any adjustments
  – finance: deduct the cost of financing - advantage?

• But: unable to capture the value
  – operational and managerial flexibility
  – future opportunities created through initial investments

• Particularly important in strategic decision making
  – M&A, VC investments: options on future cash flows

Choice and Flexibility

• NPV, APV take all future decisions for granted
  – ability of project managers to make decisions over time in response as uncertainty is resolved
• Option to wait and start investing at the most appropriate time
• Option to reconsider (halt, slow down) construction on the project
• Option to increase or decrease production, close down temporarily, or abandon the project
“Wait and See:” an Illustration

• Suppose that the NPV of a project > 0 today
  – by investing today, realize a project with an expected positive value
  – but what if P (price of output) decreases in future?
• If instead you delay investing in the project:
  – invest later if P increases (even more profitable)
  – don’t invest though if P decreases
  – in deciding to delay, consider lost revenues
• NPV (APV) understates value!

Example: Feasibility Studies

• a (financial) option is the right, not obligation, to transact at a future date at a price fixed today
• Feasibility study: essentially a call option
  – pay up front: option premium (cost of study)
  – once the study is complete: resolution of uncertainty
  – decide to invest additional capital in order to obtain the present value of the project: exercise price
  – compound option (postponement): option on an option - business strategies are compound options!!
Options to Invest: Call Option

- Some opportunities must be seized immediately
- Considerable uncertainty, waiting is feasible
  - usually optimal to delay investment in a project
  - flexibility is valuable: options are expensive!
- Sources of uncertainty:
  - new economy: R&D risk - Viagra example
  - input/output prices; revenues, profits, taxes
  - technical uncertainty, political risk
  - interest rate, exchange rate fluctuations

Post-Completion Options

- Production, output rate may be altered
  - as input or output price changes: maximize profits
  - expand or contract the capacity of the facility.
- Temporary shut down or abandonment options
  - put option: right to sell for a particular price (salvage value) on or before a specified future date
  - mitigates some of the downside risk of a project, in particular if there is some salvage value
  - often ignored in standard NPV calculations, thus downward biasing project valuation
When to Use Real Options?

- Investment irreversibility: market commitment
- Resolution of uncertainty: learning by doing
  - postponement: timing options
  - compound options: on market, pre-emption
- Natural resource extraction projects
  - interaction of risks and options: political risk (expropriation, convertibility) as granting options
- Problem with APV: undervaluation
  - curse or blessing in disguise?

Capital Budgeting Techniques

How frequently does your firm use the following techniques when deciding which project or acquisition to pursue?

Source: Graham Harvey, JFE 2001, n=392
Summary and Conclusions

• DCF valuation techniques
  – Use the NPV-WACC or FTE if the firm’s target debt to value ratio applies to the project over its life.
  – The APV method is used if the level of debt is known over the project’s life.
  – The beta of the equity of the firm is positively related to the leverage of the firm.
• … only provide a partial picture of value
  – cannot capture the value of flexibility
  – particularly important in the context of capital transactions

APV, FTE and WACC

1. The APV formula can be written as:
   \[
   APV = \sum_{t=1}^{\infty} \frac{UCF_t}{(1+r_0)^t} + \frac{\text{Initial effects of debt}}{\text{investment}} - \frac{\text{Initial investment}}{\text{borrowed}}
   \]

2. The FTE formula can be written as:
   \[
   APV_{FTE} = \sum_{t=1}^{\infty} \frac{LCF_t}{(1+r_3)^t} \left( \frac{\text{Initial Amount}}{\text{investment}} - \frac{\text{Amount}}{\text{borrowed}} \right)
   \]

3. The WACC formula can be written as
   \[
   NPV_{WACC} = \sum_{t=1}^{\infty} \frac{UCF_t}{(1+r_{WACC})^t} - \frac{\text{Initial investment}}{\text{borrowed}}
   \]