Finance 440 - Turbo Finance

Topic 4
Capital Budgeting and Security
Valuation Under Uncertainty

Goals for Topic 4
Apply present and future value concepts, with uncertainty, to more complex valuation problems, specifically capital budgeting (projects) and equities (stocks)
Outline of Topics

- Capital Budgeting under Uncertainty
  - Identifying Cash Flows: Super Project
  - Project Internal Rate of Return (IRR)
  - Optimal Timing
- Valuing Equities
  - Equity values and dividends
  - The Gordon Growth model

I. Project Evaluation

- How do we know which cash flows to include?
- Cash flows…
  - should be incremental to the project
  - are not the same as accounting earnings
A. Some General Rules

- Do not include interest payments
  - Fairly priced debt is zero NPV
- Depreciation is only included for tax purposes
- Treat inflation consistently
- Working capital increases are cash outflows
  - Working capital retirements are cash inflows
- Do not include sunk costs or overhead that would be spent regardless of undertaking the project
- Do include opportunity costs

Cash Flows & Taxes

\[ C_i = \text{Project Cash Inflows} - \text{Project Cash Outflows} = \]

Project Revenues - Actual Project Expenses other than Depreciation - Project Capital Expenditures - Project Income Taxes

Project Income Taxes =
(Tax Rate) \times (\text{Project Revenues} - \text{Project Expenses other than Depreciation} - \text{Depreciation})
B. Internal Rate of Return

The internal rate of return is the interest rate such that the present value of a stream of cash flows equals a prespecified value.

1. In general, the internal rate of return is defined for a:
   a) Given set of cash flows \( C_0, C_1, \ldots, C_n \) (possibly F)
   b) Given current amount \( P \)

2. The internal rate of return, \( r \), solves

\[
P = \frac{C_1}{(1+r)} + \frac{C_2}{(1+r)^2} + \ldots + \frac{C_n}{(1+r)^n}
\]

Example 4-1. Calculating IRR
Suppose that you know that we will get two cash flows from a $410 investment today:

$100 5 years out
$900 10 years out

What is the rate of return on the investment? We must satisfy

\[
P = \frac{100}{(1+r)^5} + \frac{900}{(1+r)^{10}} = 410
\]

We need a table for this problem (the calculator uses a search algorithm):

<table>
<thead>
<tr>
<th>( r )</th>
<th>( 1/(1+r)^5 )</th>
<th>( 1/(1+r)^{10} )</th>
<th>( P )</th>
</tr>
</thead>
<tbody>
<tr>
<td>.08</td>
<td>.681</td>
<td>.463</td>
<td>$484.80</td>
</tr>
<tr>
<td>.09</td>
<td>.650</td>
<td>.422</td>
<td>$444.80</td>
</tr>
<tr>
<td>.10</td>
<td>.621</td>
<td>.386</td>
<td>$409.50</td>
</tr>
<tr>
<td>.11</td>
<td>.593</td>
<td>.352</td>
<td>$376.10</td>
</tr>
</tbody>
</table>

Clearly, the IRR is close to 10%, because at that discount rate our present value equation comes closest to being satisfied.
Now, recall what we know about risk…

What does it mean for a project’s IRR to plot above the Security Markets Line (SML)?

How would you use IRR to evaluate a project?

The IRR Rule is:

Accept all projects whose IRR exceeds $r^*$, where $r^*$ is the expected return on alternative projects having similar risk. Reject the project otherwise.

When IRR and NPV agree:

If a project has a single IRR that is a lending rate, the project’s IRR will exceed $r^*$ if and only if the project’s NPV evaluated at $r^*$ is positive.
Example 4-2: NPV, IRR and Differences in Scale.

<table>
<thead>
<tr>
<th>Project</th>
<th>Cost</th>
<th>Inflow at time 1</th>
<th>IRR</th>
<th>NPV(10%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Large</td>
<td>$100,000</td>
<td>$132,000</td>
<td>32%</td>
<td>$20,000</td>
</tr>
<tr>
<td>Small</td>
<td>$100</td>
<td>$220</td>
<td>120%</td>
<td>$100</td>
</tr>
</tbody>
</table>

Choosing the small project based on the higher IRR would be incorrect:

The fact that the large project is in fact large makes its dollar contribution to firm value greater than the small project’s.

Example 4-3: Multiple IRRs

Consider a project (a nuclear power plant) that costs $5,000 thousand, and produces cash inflows of $1,500 thousand at time 1, 2, ..., 50; but then requires cleanup costs of $200,000 thousand at time 50.

The NPV function of this project is

$$NPV(x) = -5,000 + \frac{1,500}{x}\left(1-\frac{1}{(1+x)^{50}}\right) - \frac{200,000}{(1+x)^{50}}$$

This project has two IRRs: the first is about 4% and the second is about 30%.
Suppose the benchmark for evaluating nuclear power plants is $r^* = 20\%$.

**Should the project be taken?**

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**C. Optimal Timing of a Project**

If a firm has the flexibility to take a project now or postpone it until later, it wants to make the choice in a way that maximizes its current value.

**General approach:**

a) Treat each potential starting date for the project as a distinct project.

b) Evaluate the NPV associated with each starting date.

c) Start the project at the date which produces the highest NPV.

**Example 4-4: When to introduce a new product?**

Intel recently had to decide when to introduce the Pentium chip.

They faced serious competition from Motorola and IBM who were developing the “Power PC” chip.

Advantage of starting now: head-start on the Power PC chip in terms of market share;

Advantage of waiting: they could perfect the chip!
What should Intel have done?

Assume a cost of capital of 12%, and the following cashflows (millions of after-tax dollars):

<table>
<thead>
<tr>
<th>Start Date</th>
<th>Time 0</th>
<th>Time 1</th>
<th>Time 2</th>
<th>PV Time 3 and after</th>
</tr>
</thead>
<tbody>
<tr>
<td>time 0</td>
<td>-10</td>
<td>60</td>
<td>40</td>
<td>50</td>
</tr>
<tr>
<td>time 1</td>
<td>0</td>
<td>-6</td>
<td>30</td>
<td>100</td>
</tr>
<tr>
<td>time 2</td>
<td>0</td>
<td>0</td>
<td>-5</td>
<td>75</td>
</tr>
</tbody>
</table>

II. Valuing Risky Securities: Stocks

A. Basics

Owning stock gives you:

a) A claim to future dividend payments

b) Voting rights (a say in who is on the board)

The reasoning that value is based on the present value of future cashflows applies to all financial contracts, including stocks.

Say you buy a share of stock for $P_0$.
Expect to be able to sell it next year for $P_1$.
Expect end-of-year dividend $DIV_1$.

c) Total return has two components:

Capital gain = $P_1 - P_0$; Cap gain rate = $(P_1 - P_0)/P_0$
Dividend = $DIV_1$; $DIV_1/P_0$

d) If the investors can lend money at a rate of "r" in an alternative opportunity that is similar in risk to the stock, investors are willing to pay

$P_0 = (DIV_1 + P_1)/(1+r)$
But at time 1, investors will be willing to pay

\[ P_1 = \frac{\text{DIV}_2 + P_2}{1+r} \]

for the stock. Substituting this into the equation for \( P_0 \) we get

\[ P_0 = \frac{\text{DIV}_1}{1+r} + \frac{\text{DIV}_2}{(1+r)^2} + \frac{P_2}{(1+r)^2}. \]

Continuing this reasoning implies:

\[ P_0 = \frac{\text{DIV}_1}{1+r} + \frac{\text{DIV}_2}{(1+r)^2} + \frac{\text{DIV}_3}{(1+r)^3} + \ldots. \]

The value of a firm’s stock is the present value of expected future dividends!

(...the challenge is in estimating expected future dividends)

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**B. The “Gordon Growth Model”**

**Assumptions and structure:**

a) Dividends grow at a constant rate, \( g \),

so that \( P_0 = \frac{\text{DIV}_1}{r - g} \)

\( r \) is also called the “market capitalization rate”; it is the rate of return that can be earned on other stocks of similar risk.

b) Rearrange the pricing equation to get the return equation.

The return can be decomposed into two components: the dividend yield and the capital gain:

\[ r = \frac{\text{DIV}_1}{P_0} + g \]
**Estimating value**

a) Observable data
   i) Find \( r \) by looking at comparable stocks
   ii) Observe dividend

b) How to find \( g \)? Use EPS

The Gordon model provides a method to translate basic accounting data into an estimate of the dividend growth rate and hence of firm value.

Earnings per share (EPS) refers to the total cashflows that are available to be paid out as dividends or to be reinvested in the firm.

Use data from

- \( \text{DIV}_1 = \text{dividends per share at time 1} \)
- Payout ratio = \( \frac{\text{DIV}_1}{\text{EPS}_1} \)
- Plowback ratio = \( 1 - \text{payout ratio} \)

Return on equity = \( \text{ROE} = \frac{\text{EPS}_1}{\text{book equity per share}} \)

Then (assuming a stable investment policy):

\( \frac{\text{DIV}_1}{\text{book equity per share}} = \text{payout ratio} \times \text{ROE} \)

and it can be shown that the dividend growth rate is given by:

\( g = \text{plowback ratio} \times \text{ROE} \)
Brealey and Myers emphasize that conceptually, the price of a firm's stock can be divided up into

\[ P_0 = \frac{\text{EPS}_1}{r} + \text{PVGO}, \]

where PVGO is the present value of growth opportunities.

This has the interpretation that the stock price can be decomposed into

i) The value of the firm with a no-growth policy
ii) The present value of all future positive NPV projects.

C. Application: the Gordon Growth Model

*The firm's environment*

a) An ROE of 8% on existing assets, expected to continue indefinitely;

b) book value of assets of $50 per share;

c) a market capitalization rate of 10%, and

d) a payout ratio of 100%.

1. *Earnings per share with no plowback*
2. Plowback at Current ROE

Suppose that instead the plowback ratio is set at 60%. What happens to the share price?

The reason is the plowed back earnings earn the current ROE of 8%, while the market capitalization rate is 10%.

The stockholders devalue the firm, because it is investing their funds (what they could get in dividends) at a rate lower than what they could get in alternative investments (10%).

This is a general proposition: a firm has no business retaining earnings if it cannot invest at a rate higher than that which investors could earn in alternative investments of equivalent risk.
3. **Plowback at an ROE greater than r:**

Suppose now that the firm has an ROE of 12%, which exceeds the 10% discount rate.

The firm has an existing book value of $50 per share, so with a 100% payout ratio:

What happens if the firm again plows back 60%?
4. Price-Earnings (P/E) Ratios and Growth Opportunities:

People often look at the price-earnings ratio of a firm. We can use our analysis above to see what we might expect.

a) In the first case, the firm was no growth. Thus, the earnings/price equals:
\[
\frac{\text{EPS}_1}{P_0} = \frac{4}{40} = .10 = r, \quad \text{or} \quad P/E = 10
\]

Since there are no growth opportunities, the earnings should all be paid out as dividends, and the dividends provide the only return. (A low P/E firm)

b) In the second case, the firm has valuable growth opportunities. Thus, the earnings/price ratio equals:
\[
\frac{\text{EPS}_1}{P_0} = \frac{6}{85.71} = 7\% < 10\%, \quad \text{or} \quad P/E = 14.29
\]

The earnings do not account for the growth opportunities; there will be capital gains.

Thus, growing firms will have an earnings-price ratio below the market capitalization rate (high P-E stocks).

5. Is the Stock Market Overvalued?
(a back-of-the-envelope calculation using the Gordon Model)

\[P = \frac{\text{DIV}_1}{(r-g)} \quad \text{or} \quad r - g = \frac{\text{DIV}_1}{P} = \text{the dividend yield}\]

Which implies \[g = r - \frac{\text{DIV}_1}{P}\]

Is the implied long-run growth rate of dividends, \(g\), reasonable?

From current and historical data, we know:

1. The dividend yield on the S&P 500 is about 2.5%
2. The required return on the market is between 13% and 15% (based on the CAPM)*

This implies a \(g\) of 10.5% to 12.5% in the long-run.

* \(r_t = 6\% \text{ to } 7\%\), historical risk premium, \(E(r_m) - r_t\) is 7% to 8%, beta of market is 1, so \(E(r_m) = .06 + .07\) to \(.07 + .08 = 13\%\) to 15%. 

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I. Summary

Key Concepts:

THE REASONING THAT VALUE IS BASED ON THE PRESENT VALUE OF FUTURE CASHFLOWS APPLIES TO ALL FINANCIAL CONTRACTS, INCLUDING STOCKS.

THE VALUE OF A FIRM’S STOCK IS THE PRESENT VALUE OF EXPECTED FUTURE DIVIDENDS!

Given cashflows and a discount rate, finding the present value is easy. The difficulty is in identifying the correct cashflows.

Definitions:

NPV = PV(REVENUES) - PV(COSTS)

The internal rate of return is the interest rate such that the present value of a stream of cash flows equals a prespecified value.

Notation:

THE RETURN CAN BE DECOMPOSED INTO TWO COMPONENTS: THE DIVIDEND YIELD AND THE CAPITAL GAIN: \( r = \frac{DIV_t}{P_0} + g \)

THE PRICE OF A FIRM’S STOCK CAN BE DIVIDED UP INTO \( P_0 = \frac{EPS_t}{r} + PVGO \), WHERE PVGO IS THE PRESENT VALUE OF GROWTH OPPORTUNITIES.