**Capital Budgeting – Chapter 5 in RWJJ**

**Capital Budgeting** – the process of choosing the best investment projects.

Because other capital budgeting techniques are either rarely used in practice or are inefficient, we will only concern ourselves with Net Present Value and IRR

**NPV** - Net Present Value - Present value of a project’s future cash flows

**Cost of Capital**

* The appropriate discount rate
* The required rate of return
* The rate of return given up by investing in a project
* The risk-adjusted rate of return
* The rate of return investors could earn on an investment of equal risk

**How to Make a Capital Budgeting Decision**

1. Forecast the project’s incremental free cash flow in each future time period

2. Determine the correct cost of capital to use

3. Discount all incremental free cash flows to time zero at the cost of capital

4. Net out all time zero cash flows not paid or received yet - that’s your NPV

5. If NPV > 0, accept the project

 If NPV < 0, reject the project

Rule of Thumb: Accept **all** positive NPV projects because they give shareholders more than their required rate of return.

**Example**:

Cost: $100,000 at time zero

Free Cash Flow: $25,000 - first year

 $30,000/yr. for the next 4 years

All cash flow projections are certainties.

The alternative is to invest in a 5-year Treasury Note yielding 6%

 -100 25 30 30 30 30

 0 1 2 3 4 5

NPV = -$100,000 + 25,000 + 30,000 + 30,000 + 30,000 + 30,000

 1.06 (1.06)2 (1.06)3 (1.06)4 (1.06)5

 = -$100,000 + 23,585 + 26,700 + 25,189 + 23,763 + 22,418

 = -$100,000 + $121,653.93

 = +$21,653.93 ⇒ Accept the project. It increases the (present) value of the company by $21,653.93

Note that $121,653.93 is the PV of the revenues and $100,000 is the PV of the costs

Note that in Excel, if you enter a string of cash flows, Excel assumes that the first cash flow is at time one – not time zero. With Excel, you need to solve for the NPV of cash flows 1 – N, then separately add or subtract the cash flow at time zero.

NPV = C0 + \_ C1\_\_ + \_C2\_\_ + \_C3\_\_ + \_ C4\_\_ + ....... \_ Ct\_\_

 1+r (1+r)2 (1+r)3 (1+r)4 (1+r)t



Note: NPV is the Best way to decide on Capital Budgeting Projects

**Another Example**:

You have a project with negative cash flows for the first three time periods (years 0, 1, and 2), but positive cash flows forever after that:

CF0 = -$4 million

CF1 = -$2 million

CF2 = -$2 million

CF3-∞ = $1 million

Cost of Capital: 12%

The terminal value is at time 2 and is 1 million/.12 = 8,333,333.33

Adding that to the CF2 of -2 million gives us 6,333,333.33 at time 2

Discounting all the cash flows to time zero at the cost of capital gives us an NPV of

-$736,819.73

Reject the project – it reduces the value of the company by more than $700,000. It will not give the shareholders their required rate of return. This project earns less than 12%.

**Yet Another Example:**

Cost = $10,000

Cost of Capital = 10%

Cash Flows = $3,000/yr. for 5 years

NPV = -$10,000 + 3,000 + 3,000 + 3,000 + 3000 + 3,000

 1.1 (1.1)2 (1.1)3 (1.1)4 (1.1)5

 = -$10,000 + 3,000 [Annuity for 5 yrs. at 10%]

 = -$10,000 + $11,372.36

 = $1,372.36 ⇒ Accept the Project

What if the cost of capital was 17% (Meaning other investment options with similar risk will give you a 17% return)?

NPV = -$10,000 + $3,000 [Annuity for 5 yrs. at 17%]

 = -$10,000 + $9,598.04

 = -$401.96 ⇒ Reject the Project

So, if the cost of capital increases, the NPV decreases because there are better alternatives for the money than this project.

What if the cost of capital is 15%?

NPV = -$10,000 + $3,000 [5 yr. annuity at 15%]

 = -$10,000 + 10,056.47

 = $56.47 ⇒ Accept the project - Barely!

How about 16%?

NPV = -10,000 + 9,822.88

 = -$177.12 ⇒ Reject the project - Barely!

Obviously, somewhere between 15% and 16%, NPV = 0

**Internal Rate of Return** = IRR = The discount rate at which NPV = 0.

NPV = -10,000 + 3,000 + 3,000 + 3,000 + 3,000 + 3,000

 1+r (1+r)2 (1+r)3 (1+r)4 (1+r)5

Find r such that NPV = 0. That’s your IRR.

Use trial and error or Excel.

On Excel, use the IRR function and enter the cash flows, beginning with time zero. You do not have to enter a guess unless you think there may be more than one IRR (more on that later).

Solution: r = IRR = 15.2382%

We can see that this is the value of r which causes the Net Present Value to be zero:

NPV = 0

**Example**:

Find IRR

Cost = $20,500

Cash flows: yr. 1: $15,000; yr. 2: $5,000; yr. 3: $5,000

NPV = 0 = -20,500 + 15,000 + 5,000 + 5,000

 1+r (1+r)2 (1+r)3

Solve for r = 13.56%

If the cost of capital is below 13.56%, you have +NPV

If the cost of capital is above 13.56%, you have -NPV

**Rule for problems like this one**:

Accept project if IRR > Cost of Capital

Reject project if IRR < Cost of Capital

***Potential* Problems with IRR**

**1**. There can be more than one IRR

Example: Initial cost = $4,000

 year 1 - make $25,000

 year 2 - lose $25,000

NPV = -$4,000 + $25,000 - $25,000 = 0

 1+r (1+r)2

Works for r = 25% (.25) and 400% (4)

This is where you can help yourself by filling in the “guess” box in Excel. By default, Excel will start at 10% and search for the nearest rate that causes NPV to be equal to zero. If you put in a guess, it will start its search at that value.

When should you accept the project? When 25% < cost of capital < 400%

**Modified IRR (MIRR)** – a way to overcome the problem of multiple IRRs.

With MIRR, you need to discount all your negative cash flows to time zero and all your positive cash flows to time one. You can now calculate the IRR based on the remaining two cash flows. Note that while you don’t need to know your cost of capital to calculate IRR, you do need to know it to calculate MIRR. You discount the cash flows to times zero and one using your cost of capital.

Example Above:

If the cost of capital is 10%, discount the cashflow at time 2 to zero

(-25,000/(1.1)2 = -20,661.16

Add this to the time zero cash flow of -4,000 to get -24,661.16. at time zero

Now find the IRR: NPV = 0 = -$24,661.16 + $25,000 r = MIRR = 1.37%

 1+r

Since 1.37% < 10% (cost of capital), reject the project.

But if the cost of capital is 30%, discounting the cashflow at time 2 to zero gives us -14,792.90 and a total time zero cash flow of -18,792.90. The MIRR is 33.03% which is greater than the cost of capital (30%), so accept the project.

Note that Excel has a MIRR function which allows for both a finance rate and a reinvestment rate. It uses a slightly different method to calculate the MIRR, but both methods will end up giving you the correct decision as to whether to accept or reject the project.

**2**. When facing mutually exclusive decisions, you do not always want to choose the project with the higher IRR.

**Mutually Exclusive** – Two or more events where the occurrence of one precludes the occurrence of the others. Example: Flip a coin - can’t get both heads and tails.

Two mutually exclusive projects:

NPV rule: Take the one with the highest NPV

IRR rule: If only one project has an IRR > Cost of Capital, do that project. If neither does, don’t do either project. If both do, find the incremental IRR.

**Incremental IRR**

What is the IRR if the initial cost is $10,000 and the project produces a positive cash flow of $15,000 at the end of time 1? (50%)

What is the IRR if the initial cost is $1 million and the project produces a positive cash flow of $1.2 million at the end of time 1? (20%)

Which project should you choose if they are mutually exclusive and your opportunity cost of capital is 15%?

To assess mutually exclusive problems of different scales such as this, you must analyze the incremental cash flows.

If the smaller project would be accepted as a stand-alone, is it a positive NPV project (or, conversely is it a good IRR project) to add the additional size of the other, mutually exclusive project?

In the above example, we know that the first project is good if the cost of capital is

 < 50%. Now the question becomes, what is the NPV (IRR) of investing an additional $990,000?

NPV = -990,000 + 1,185,000

 1+ r

Setting NPV to zero, r = 19.7% which is > 15%, so you should add on the incremental cash flows.

The incremental investment is better than the Cost of Capital, so do it.

Similarly, at r = 15%, the NPV of the incremental cash flows is a positive $40,435

Going with the higher NPV will always result in the correct decision.

## Investing vs. Financing

If a project has an initial cash outflow followed by cash inflows (as most projects do), it is an investment project and you should compare your cash flows to the best alternative investment.

If, however, the project has an initial cash inflow followed by cash outflows, it is a financing project and you need to compare your cash flows to the best alternative borrowing rate.

Example:

 C0 C1 Note that A is an investment (lending)

Project A: -100 115 and B is financing (borrowing)

Project B: 100 -115

The IRR of each project is 15%, but Project A is an investing project, while Project B is a financing project.

Which project should we take if the cost of capital is 10%?

How about if it is 20%.

The answer is intuitive. If the cost of capital (interest rate) is 10%, would you rather borrow at 15%, or lend at 15%?

Lend of course. This is the investing project (A).

If the interest rate is 20%, you would be happy to borrow at 15%.

Project B borrows $100.

So if the cost of capital is less than the IRR, you want the investing project, and if it is greater than the IRR, you want the financing project.

Fortunately, NPV will always give us the correct answer in one step. What is the NPV for each project at a 10% cost of capital? At 20%?

 10% 20%

Project A: $4.55; -$4.17 If the interest rate is 10%, you want to lend at 15%

Project B: -$4.55; $4.17 If the interest rate is 20%, you want to borrow at 15%