Chapter 7: Investment decision rules

In this section we will discuss various investment decision rules (**capital budgeting techniques**) other than the NPV rule that we have already discussed. These rules allow us to formalize the process and specify what conditions need to be met for a project to be acceptable. Although we will be looking at a variety of investment decision rules, we should be aware of the characteristics a good rule should have:

1. A good investment decision rule should be compatible with the objective in corporate finance, which is to maximize the value of the firm. Thus, projects that are acceptable should increase the value of the firm when adopting them, while projects that do not meet the requirements of the rule would destroy value if they are adopted.
2. A good investment decision rule should allow a manager to bring in his/her subjective assessments into the decision and ensuring that different projects are judged consistently.
3. A good investment decision rule should work across a variety of investments, for example, revenue-generated or cost-saving ones.

In this chapter we are going to analyse the following four investment decision rules:

1. **Accounting income-based decision rules**: These are based on income generated for operations or on income to equity investors. In each case, the return is compared to an appropriate cost of capital or cost of equity capital.
2. **Cash flow-based decision rules**: This is modification of the accounting income-based decision rules, in which instead of using accounting earnings we use cash earnings.
3. **Payback period**: The number of years it takes to recover the initial investment.
4. **Internal rate of return (IRR)**: The rate which equates the present value of the cash outflows and inflows, the rate that makes the NPV = 0.

7.1. Accounting income-based decision rules

7.1.1. Return on capital (ROC)

When project analysis is based on the return on capital the after-tax return on capital is compared to the opportunity cost of capital (OCC). If it exceeds the OCC, the project is viewed as a good project. The return on capital is defined as:

$$\text{Return on capital (pre-tax)} = \frac{\text{Earnings before interest and taxes}}{\text{Average book value of total investment in project}}$$

$$\text{Return on capital (after-tax)} = \frac{\text{Earnings before interest and taxes} \times (1-\tau_c)}{\text{Average book value of total investment in project}}$$

Example: Consider a 1-year investment with an initial investment of $1,000,000. This investment can be sold after 1 year for $800,000 (salvage value). The project generates \$300,000 earnings before interest and taxes and the tax rate is 40%. The pre-tax and after-tax return on capital can be estimated as follows:

$$\text{ROC (pre-tax)} = \frac{300,000}{900,000} = 33.3\%$$

$$\text{ROC (after-tax)} = \frac{300,000(1-0.4)}{900,000} = 20\%$$

where $900,000 = (800,000 + 1,000,000)/2$ is the average book value of investment.

Although these calculations are straightforward for 1-year investment, they become more involved for multiyear projects, for which operating incomes are book values changes over time. In these cases, either the return on capital can be estimated each year and then averaged across time, or the average operating income over the life of the project can be used with the average investment during the period to estimate the average ROC.

Example: The following table shows the data for a 4-year project.

Period	0	1	2	3	4
BV of Inv.	1,500	1,300	1,100	900	700
EBIT		300	400	500	600
EBIT(1-τ_c)		180	240	300	360

The ROC of the first year is calculated as:

$$\text{ROC (pre-tax)} = \frac{300}{1,400} = 21.43\%$$

$$\text{ROC (after-tax)} = \frac{180}{1,400} = 12.86\%$$

where $1,400 = (1,500 + 1,300)/2$. Similarly, the ROC if the second year is:

$$\text{ROC (pre-tax)} = \frac{400}{1,200} = 33.3\%$$

$$\text{ROC (after-tax)} = \frac{240}{1,200} = 20\%$$

where $1,200 = (1,300 + 1,100)/2$. Similarly, the after-tax ROC of the third and fourth year is equal to 30% and 40%, respectively. The average after-tax ROC is equal to:

$$\text{Average ROC (after-tax)} = \frac{12.86\% + 20\% + 30\% + 40\%}{4} = 26.96\%$$

Alternatively, the ROC can be estimated from average operating income and average book value of assets over time:

$$\text{Average ROC (after-tax)} = \frac{270}{1,100} = 24.54\%$$

The after-tax ROC on a project has to be compared to the OCC. The idea is to compare the incomes that the project generates with respect to the required investment, to the cost that the firm should pay to the markets to acquire this investment. Thus, if the after-tax ROC > OCC, the project should be accepted. For instance, in the previous example, if the OCC = 12%, then the project should be accepted. When choosing between mutually exclusive projects of equivalent risk, the project with the higher return on capital will be viewed as the better project.

7.1.2. Return on equity (ROE)

The return on equity measures the return to equity investors, using the accounting net income as a measure of this return. It can be defined as:

$$\text{ROE} = \frac{\text{Net income}}{\text{Average book value of equity investment in project}}$$

Example: The following table shows the data for a 4-year project. The last line of the table reports the yearly ROE, estimated in the same way as the ROC in the previous example.

Period	0	1	2	3	4
BV of Inv.	800	700	600	500	400
Net income		140	170	210	250
		18.67%	26.15%	38.18%	55.56%

The average ROE is equal to 34.64%.

Just as the appropriate comparison for the return on capital is the cost of capital, the appropriate comparison for the return on equity is the cost of equity, which is the return equity investors demand. Thus, if ROE > cost of equity, then the project should be accepted. In the preceding example, assume that the cost of equity is 14%, which is lower to the average ROE, thus the project should be accepted. When choosing between mutually exclusive projects of similar risk, the firm should view the project with the higher ROE as the better one.

The two techniques that we have shown are based on accounting measures. There are several drawbacks on this approach. First, it is significantly affected by accounting choices. For example, changing from straight-line to accelerated depreciation affects both the earnings and the book value over time, thus altering returns. Second, it is not necessarily true that projects which earn accounting returns exceeding the cost of capital will lead to an increase in firm value. This comes from the fact, that the value of the firm is the present value of expected cash flows on the firm over its life time. Since accounting returns are based on earnings rather than cash flows and ignore the time value of money, investing in projects that earn a return greater than the cost of capital will not necessarily increase firm value. Finally, the accounting returns works better for projects that have a large up-front payment and generate income over time. For projects that do not require a significant initial investment, these measures have less meaning.

7.2. Cash flow-based decision rules

In the previous section we have seen how accounting earnings deviate from cash flows, and we argued that when the two are different, cash flows should be used to measure returns. Thus, we can modify the two accounting income-based decision rules, so that we measure returns based on cash earnings rather than accounting earnings.

7.2.2. Cash return on capital (ROC)

One simple modification to the accounting returns on capital is to use the cash earnings to measure these returns, instead of the accounting earnings. We define the cash operating income as:

$$\text{Cash operating income} = \text{EBIT}(1-\tau_c) + \text{Depreciation and other noncash charges}$$

The cash ROC is then defined as:

$$\text{Cash ROC} = \frac{\text{Cash operating income}}{\text{Average book value of capital}}$$

This cash ROC can be compared to the cost of capital to yield a decision rule. Thus, when cash ROC > OCC, then the project should be accepted.

7.2.2. Cash return on equity (ROE)

This approach can be generalized to look at the return to equity investors. The cash equity income is given as:

$$\text{Cash equity income} = \text{Net income} + \text{Depreciation and other noncash charges}$$

The cash ROE is then estimated as:

$$\text{Cash ROE} = \frac{\text{Cash equity income}}{\text{Average book value of equity}}$$

This cash return can be compared to the cost of equity to yield a decision rule. Thus, when cash ROE > cost of equity, then the project should be accepted.

Although cash returns solve some of the problems faced by accounting returns, they still have several drawbacks. First, even if noncash expenses are added back, as they should be, other cash expenses (such as capital maintenance expenditures) are not subtracted. Consequently, this approach will lead to overstating the returns of projects. This will mean that investing in projects with a cash flow return on capital greater than the cost of capital will not necessarily yield decisions that increase firm value. In addition, the returns are still computed based on book value of capital and do not indicate that this book value may not reflect the cash value of the investment in the project.

7.3. Payback period

The payback period measures how quickly the cash flows generated by the project cover the initial investment. Intuitively, projects that return their investments sooner can be considered more attractive, since all cash flows earned beyond that point in time can be considered as profit on the project. It can also be argued that projects with a lower payback period are less risky, since a significant component of risk is the possibility that the firm may lose some all of the money it has invested in the project. The computation of the payback period is extremely simple and it is shown in the following example.

Example: The following table shows the cash flows for three projects A, B and C.

Project	Cash flows C_0	C_1	C_2	C_3	Payback period
A	-2,000	500	500	5,000	3
B	-2,000	500	1,800	0	2
C	-2,000	1,800	500	0	2

The payback period for project A is 3 years, and for B and C is 2 years. Thus, following the payback period rule we should accept one of the projects B and C.

This decision rules has obvious drawbacks. First, it does not take into consideration all the cash flows. Second, it does not account for the time value of money, considering all cash flows equivalent and it does not account for the cost of capital. Recouping the initial investment is not quite enough to create value for the firm, since this amount of money could have been invested elsewhere and earned a significant return. Finally, the payback rule is designed to cover the conventional project that involves a large up-front investment followed by positive operating cash flows. It breaks down, however, when the investment is spread over time or when there is no initial investment.

7.4. Internal rate of return (IRR)

The internal rate of return is that discount rate that makes the NPV equal to zero. Intuitively, it is a measure of the return that you are earning on an investment, considering both how much the cash flows on the investments will be and when they will be received. To illustrate its calculation consider the following example.

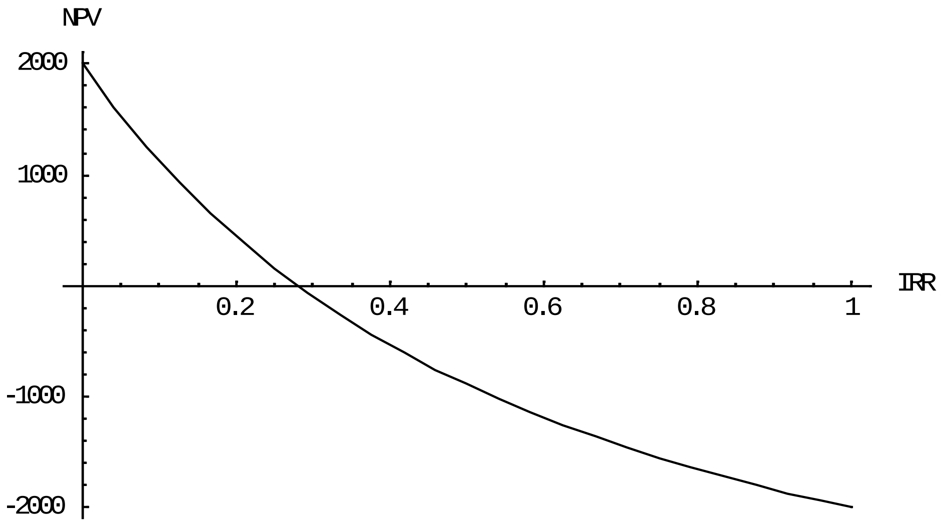
Example: The table reports the cash flows of a 2-year project.

Cash flows C_0	C_1	C_2
-4,000	2,000	4,000

The IRR is the solution of the following equation:

$$-4,000+\frac{2,000}{1+\mathrm{IRR}}+\frac{4,000}{(1+\mathrm{IRR})^2}=0$$

This is a second order equation, thus its solutions are given in closed form. Alternatively, it can be solved numerically by a computer program (you can use the Microsoft Excel function IRR) or by constructing the following graph:



Inspecting the graph we observe that the IRR lies between 20% and 30%. To be precise it is equal to 28%.[1]

Based on the IRR, we can set a decision rule. If IRR > OCC then we should accept the project. In other words, when the return generated by the project exceeds the cost of capital then the project can be viewed as a good one. Inspection of the previous graph also indicates that this rule coincides with the NPV rule. When the IRR > OCC, then the NPV > 0.
The calculation of the IRR lies to the calculation of the root (or roots) of a polynomial of order equal to the lifetime of the project. For example, for a 10-year project the IRR is the root of polynomial of order 10. Does this polynomial have a real root? Is this root unique? The following proposition helps us to answer these questions.

Definition: An investment project is called **simple** when there exist a time period t for which $C_i < 0$ for i < t and $C_i > 0$ for i > t.

Proposition: Consider a simple project with $C_0 + C_1 + ... + C_N > 0$. Then it exists a unique IRR in the interval [0, 1] such as the NVP = 0. Also for OCC < IRR the NVP > 0 and for OCC > IRR the NPV < 0.

The previous example is a straightforward application of this proposition. It is a simple project with $C_0 + C_1 + C_2 = 2,000 > 0$ so we have a unique IRR = 28% between 0 and 100%. If the OCC < IRR then we know that the NPV > 0 and the project should be accepted. Thus, in this framework *and only in this*, the two decision rules are equivalent.

The IRR rule has several drawbacks. First, it is possible to have multiple IRRs. This happens when there is more than one sign change in the cash flows. This might be the case with long-lived projects that require substantial reinvestments at intermediate points in the project, which can cause the cash flows in those years to be negative. In that case, it is not clear which IRR should be used in the decision making. For these

[1] The quadratic equation has a second solution equal to -178%, but it has no economic meaning.

cases the calculation of the IRR can be used in order to retrieve the *NPV profile*. This is what the previous graph illustrates. It can give us an idea for which discount rates the NPV is positive. Second, the IRR decision rule fails when the firm should choose between two, or more, mutually exclusive projects. In that case, the IRR decision rule states that you should accept the one with the largest IRR. Two main reasons cause this failure: (a) differences in scale, and, (b) differences in the pattern of cash flows over time. To understand (a) consider the following example:

Example: Consider the following mutually exclusive projects:

Project	C_0	C_1	IRR	NPV (10%)
A	-10,000	20,000	100%	8,182
B	-20,000	35,000	75%	11,818

The fourth column gives the IRR of these two projects, while the last column gives the NPV estimated with an OCC = 10%. We observe that the IRR rule favours project A, while the NPV rule favours project B. If you follow the IRR rule you have the satisfaction of earning a 100% rate of return; if you follow the NPV rule, you are $11,818 richer. The main reason for that contradiction is that the IRR rule prefers the least expensive project to generate the highest return, while the NPV rule prefers the project with the highest cash flow to generate the highest present value.

The second point is related to the fact that the IRR rule is unreliable in ranking projects of different patterns of cash flows over time. Consider the following example.

Example: Consider the following two mutually exclusive projects:

Project	C_0	C_1	C_2	C_3	C_4	C_5	Etc.	IRR	NPV (10%)
A	-9,000	6,000	5,000	4,000	0	0	…	33%	3,592
B	-9,000	1,800	1,800	1,800	1,800	1,800	…	20%	9,000

Project A has the highest IRR, but project B, which is a perpetuity, has the higher NPV. The reason that the IRR is misleading is that the total cash inflow of B is larger but tends to occur later. Therefore, when the discount rate is low, B has the higher NPV (we can easily show that if the discount rate is larger than 15.6%, the NPV of A is larger than that of B). The IRR of the two projects tells us that at a discount rate of 20% B has a zero NPV, but A has a positive NPV. Thus, if the OCC were 20%, investors would place a higher value on the short-lived project A. But in our example the cost of capital is 10%, so investors prefer the long-lived asset.

EXERCISES-7

1. A firm plans a new 5-year project with the following information:

a. The initial investment in the project will be $25 million, the investment will be depreciated straight line, down to a salvage value of $10 million at the end of the 5^{th} year.

b. The revenues are expected to be $20 million next year and to grow 10% a year after that for the remaining 4 years.

c. The cost of goods sold is expected to be 50% of the revenues.
d. The tax rate is 40%.

Answer the following questions:

a. Estimate the pre-tax return on capital, by year and on average, for the project.
b. Estimate the after-tax return on capital, by year and on average, for the project.
c. If the firm has a cost of capital of 12%, should it take on this project?

2. Consider again the project described in question 1. Assume that 40% of the initial investment for the project will be financed by debt, with an annual interest rate of 10% and the repayment of the principal at the end of the 5^{th} year.

a. Estimate the return on equity, by year and on average, for this project.
b. If the cost of equity is 15%, should the firm take the project?

3. You are provided with the following income statement (in millions) for a project:

Income Statement

Year	Revenues	Cost	Depreciation	EBIT
1	10	4	4	2
2	11	4.4	3	3.6
3	12	4.8	2	5.2
4	13	5.2	1	6.8

Also consider the following information:

- The tax rate is 40%.
- The project requires an initial investment of $15 million and an additional investment $2 million at the end of year 2.
- The working capital is anticipated to be 10% of revenues, and the investment has to be made at the beginning of each period.

Answer the following questions:

a. Estimate the cash flow to the firm for each year.
b. Estimate the payback period for investors in the firm.
c. Estimate the NPV if the cost of capital is 12%. Would you accept the project?
d. Estimate the IRR. Would you accept the project?