CHAPTER 2

Project appraisal: net present value and internal   
 rate of return

Learning outcomes

By the end of the chapter the reader should be able to demonstrate an understanding of the fundamental theoretical justifications for using discounted cash flow techniques in analysing major investment decisions, based on the concepts of the time value of money and the opportunity cost of capital. More specifically the reader should be able to:

• calculate net present value and internal rate of return;

• show an appreciation of the relationship between net present value and internal rate of   
 return;

• describe and explain at least three potential problems that can arise with internal rate of   
 return in specific circumstances;

• demonstrate awareness of the propensity for management to favour a percentage measure of   
 investment performance and be able to use the modified internal rate of return.

Key points and concepts

•  *Time value of money* has three component parts each requiring compensation for a delay in   
 the receipt of cash:

• the pure time value, or impatience to consume;

• inflation;

• risk.

•  *Opportunity cost of capital* is the yield forgone on the best available investment alternative

- the risk level of the alternative being the same as for the project under consideration.

• Taking account of the time value of money and opportunity cost of capital in project   
 appraisal leads to discounted cash flow analysis (DCF).

• Net present value (NPV) is the present value of the future cash flows after netting out the   
 initial cash flow. Present values are achieved by discounting at the opportunity cost of   
 capital.

NPV = *CF*0 +

*CF*1

+

1+ *k*

12

*CF* 2

2

(1+ *k*)

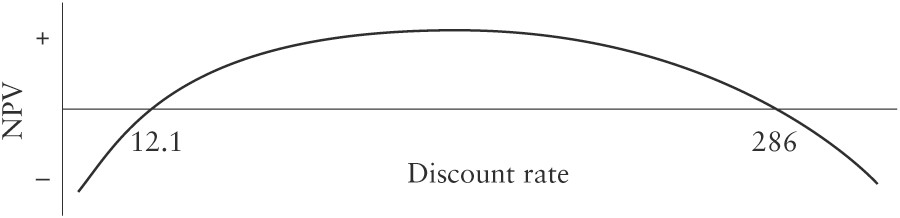
*CF n*

+ 

*n*

(1+ *k*)

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• The net present value decision rules are:

NPV ≥ 0 accept

NPV < 0 reject

• Internal rate of return (IRR) is the discount rate which, when applied to the cash flows of   
 a project, results in a zero net present value. It is an ‘*r*’ which results in the following   
 formula being true:

*CF*0 +

*CF*

1

1+ *r*

*CF CF*

2 *n*

+ +  = 0

(1+ *r*)2 (1+ *r*)*n*

• The internal rate of return decision rule is:   
 IRR ≥ opportunity cost of capital - accept   
 IRR < opportunity cost of capital - reject

• IRR is poor at handling situations of unconventional cash flows. Multiple solutions can be   
 the result.

• There are circumstances when IRR ranks one project higher than another, whereas NPV   
 ranks the projects in the opposite order. This ranking problem becomes an important issue   
 in situations of mutual exclusivity.

• The IRR decision rule is reversed for financing-type decisions.

• NPV measures in absolute amounts of money. IRR is a percentage measure.

• IRR assumes that intra-project cash flows can be invested at a rate of return equal to the   
 IRR. This biases the IRR calculation.

• If a percentage measure is required, perhaps for communication within an organisation, then   
 the modified internal rate of return (MIRR) is to be preferred to the IRR.

Answers to selected questions

3 Confused plc

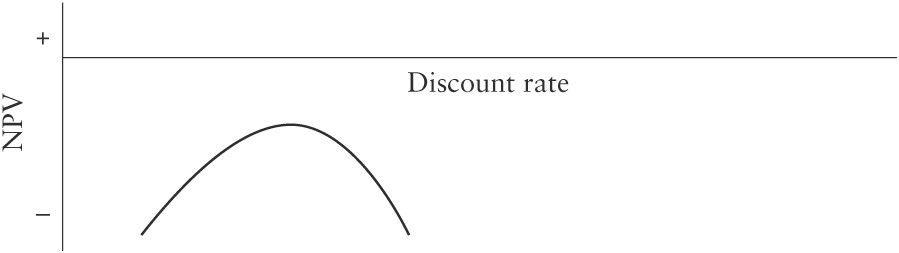
*a Project C*

IRRs at 12.1% and 286%. See Fig. 2.1.

Fig. 2.1

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*Project D*

No solution using IRR. See Fig. 2.2.

Fig. 2.2

b This problem illustrates two disadvantages of the IRR method. In the case of project C   
 multiple solutions are possible, given the non-conventional cash flow. In the case of   
 project D there is no solution, no IRR where NPV = 0.

c NPV

Project C: +£646

Project D: í£200

Using NPV the accept/reject decision is straightforward. Project C is accepted and Project D is rejected.

7 Seddet International

*a Project A*

At 20%:

í5,266 + 2,500 × 2.1065 = 0, ∴ IRR = 20%   
*Project B*

At 7%:

í8,000 + 10,000 × 0.8163 = +163   
At 8%:

í8,000 + 10,000 × 0.7938 = í62

IRR = 7 +

*Project C*

At 22%:

163

163 + 62

(8 − 7) = 7.7%

í2,100 + 200 × 0.8197 + 2,900 × 0.6719 = +12.45   
At 23%:

í2,100 + 200 × 0.8130 + 2,900 × 0.6610 = í20.5

IRR = 22 +

12.45

12.45 + 20.5

(23 − 22) = 22.4%

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*Project D*

At 16%:

í1,975 + 1,600 × 0.8621 + 800 × 0.7432 = í1 ∴IRR is slightly under 16%.

The IRR exceeds the hurdle rate of 16% in the case of A and C. Therefore if all projects can be accepted these two should be undertaken.

b Ranking under IRR:

IRR

Project C 22.4% best project

Project A 20%

Project D 16%

Project B 7.7%

*c Project A*

í5,266 + 2,500 × 2.2459 = 349   
*Project B*

í8,000 + 10,000 × 0.6407 = í1,593   
*Project C*

í2,100 + 200 + 0.8621 + 2,900 × 0.7432 = 228   
*Project D*

í1,975 + 1,600 × 0.8621 + 800 × 0.7432 = í1

Ranking NPV

Project A 349 best project

Project C 228

Project D í1

Project B í1,593

Project A ranks higher than project C using NPV because it generates a larger surplus   
(value) over the required rate of return. NPV measures in absolute amounts of money   
and because project A is twice the size of project C it creates a greater NPV despite a   
lower IRR.

d This report should comment on the meaning of a positive or negative NPV expressed in   
 everyday language. It should mention the time value of money and opportunity cost of   
 capital and explain their meanings. Also the drawbacks of IRR should be discussed:

• multiple solutions;

• ranking problem - link with the contrast of a percentage-based measure and an absolute   
 money-based measure;

• additivity not possible;

• the reinvestment assumption is flawed.