

# **Part Two**

## The Investment Decision

## 2 Capital Budgeting Under Conditions Of Certainty

### Introduction

The decision to invest is the mainspring of financial management. A project's acceptance should produce future returns that *maximise* corporate value at *minimum* cost to the company.

We shall therefore begin with an explanation of capital budgeting decisions and two common investment methods; payback (PB) and the accounting rate of return (ARR).

Given the failure of both PB and ARR to measure the extent to which the utility of money today is greater or less than money received in the future, we shall then focus upon the internal rate of return (IRR) and net present value (NPV) techniques. Their methodologies incorporate the *time value of money* by employing *discounted* cash flow analysis based on the concept of compound interest and a firm's overall cut-off rate for investment.

For speed of exposition, a mathematical derivation of an appropriate cut-off rate (measured by a company's weighted average cost of capital, WACC, explained in Part One) will be taken as given until Chapter Three of the follow up SFM text. For the moment, all you need to remember is that in a mixed market economy firms raise funds from various providers of capital who expect an appropriate return from efficient asset investment. And given the assumptions of a perfect capital market with *no barriers to trade* (also explained in Part One) managerial investment decisions can be separated from shareholder preferences for consumption or investment without compromising wealth maximisation, providing all projects are valued on the basis of their opportunity cost of capital.

As we shall discover, if the firm's cut-off rate for investment corresponds to this opportunity cost, which represents the return that shareholders can earn elsewhere on similar investments of comparable risk:

Projects that generate a return (IRR) greater than their opportunity cost of capital will have a positive NPV and should be accepted, whereas projects with an inferior IRR (negative NPV) should be rejected.

## 2.1 The Role of Capital Budgeting

The financial term *capital* is broad in scope. It is applied to non-human resources, physical or monetary, short or long. Similarly, *budgeting* takes many forms but invariably comprises the detailed, quantified planning of a scarce resource for commercial benefit. It implies a choice between alternatives. Thus, a combination of the two terms defines investment and financing decisions which relate to capital assets which are designed to increase corporate profitability and hence value.

To simplify matters, academics and practitioners categorise investment and financing decisions into long-term (strategic) medium (tactical) and short (operational). The latter define *working capital management*, which represents a firm's total investment in current assets, (stocks, debtors and cash), irrespective of their financing source. It is supposed to lubricate the wheels of fixed asset investment once it is up and running. Tactics may then change the route. However, *capital budgeting* proper, by which we mean *fixed asset formation*, defines the engine that drives the firm forward characterised by three distinguishing features:

Longer term investment; larger financial outlay; greater uncertainty.

Combined with inflation and changing economic conditions, uncertainty complicates any investment decision. We shall therefore defer its effects until Chapter Four having reviewed the basic capital budgeting models in its absence.



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With regard to a strategic classification of projects we can identify:

- *Diversification* defined in terms of new products, services, markets and core technologies which do not compromise long-term profits.
- *Expansion* of existing activities based on a comparison of long-run returns which stem from increased profitable volume.
- *Improvement* designed to produce additional revenue or cost savings from existing operations by investing in new or alternative technology.
- *Buy or lease* based on long-term profitability in relation to alternative financing schemes.
- *Replacement* intended to maintain the firm's existing operating capability intact, without necessarily applying the test of profitability.

## 2.2 Liquidity, Profitability and Present Value

Within the context of capital budgeting, money capital rather than labour or material is usually the scarce resource. In the presence of what is termed *capital rationing* projects must be ranked in terms of their net benefits compared to the costs of investment. Even if funds are plentiful, the actual projects may be *mutually exclusive*. The acceptance of one precludes others, an obvious example being the most profitable use of a single piece of land. To assess investment decisions, the following methodologies are commonly used:

Payback; Accounting Rate of Return); Present Value (based on the time value of money).

*Payback* (PB) is the time required for a stream of cash flows to cover an investment's cost. The project criterion is *liquidity*: the sooner the better because of less uncertainty regarding its worth. Assuming annual cash flows are constant, the basic PB formula is given in years by:

$$(1) \quad PB = I_0/C_t$$

PB = payback period

$I_0$  = capital investment at time period 0

$C_t$  = constant net annual cash inflow defined by  $t = 1$

Management's objective is to accept projects that satisfy their preferred, predetermined PB.

**Activity 1**

*Short-termism* is a criticism of management today, motivated by liquidity, rather than profitability, particularly if promotion, bonus and share options are determined by next year's cash flow (think sub-prime mortgages). But such criticism can also relate to the corporate investment model. For example, could you choose from the following using PB?

Cashflows (£000s)	Year 0	Year 1	Year 2	Year 3
Project A	(1000)	900	100	-
Project B	(1000)	100	900	100

The PB of both is two years, so rank equally. Rationally, however, you might prefer Project B because it delivers a return in excess of cost. Intuitively, I might prefer Project A (though it only breaks even) because it recoups much of its finance in the first year, creating a greater opportunity for speedy reinvestment. So, whose choice is correct?

Unfortunately, PB cannot provide an answer, even in its most sophisticated forms. Apart from risk attitudes, concerning the time periods involved and the size of monetary gains relative to losses, *payback always emphasises liquidity at the expense of profitability.*

*Accounting rate of return (ARR)* therefore, is frequently used with PB to assess investment profitability. As its name implies, this ratio relates annual accounting profit (net of depreciation) to the cost of the investment. Both numerator and denominator are determined by *accrual* methods of financial accounting, rather than cash flow data. A simple formula based on the average undepreciated cost of an investment is given by:

$$(2) \quad ARR = \frac{P_t - D_t}{[(I_0 - S_n)/2]}$$

ARR = average accounting rate of return (expressed as a percentage)

$P_t$  = annual post-tax profits before depreciation

$D_t$  = annual depreciation

$I_0$  = original investment at cost

$S_0$  = scrap or residual value

The ARR is then compared with an investment cut-off rate predetermined by management.

**Activity 2**

If management desire a 15% ARR based on straight-line depreciation, should the following five year project with a zero scrap value be accepted?

$$I_0 = \text{£}1,200,000 \quad P_t = \text{£}400,000$$

Using Equation (2) the project should be accepted since (£000s):

$$\text{ARR} = \frac{400 - 240}{(1,200 - 0) / 2} = 26.7\% > 15\%$$

The advantages of ARR are its alleged simplicity and utility. Unlike payback based on cash flow, the emphasis on accounting profitability can be calculated using the same procedures for preparing published accounts. Unfortunately, by relying on *accrual* methods developed for historical cost stewardship reports, the ARR not only ignores a project's *real* cash flows but also any *true* change in economic value over time. There are also other defects:

- Two firms considering an identical investment proposal could produce a different ARR simply because specific aspects of their accounting methodologies differ, (for example depreciation, inventory valuation or the treatment of R and D).
- Irrespective of any data weakness, the use of *percentage* returns like ARR as investment or performance criteria, rather than *absolute* profits, raises the question of whether a large return on a small asset base is preferable to a smaller return on a larger amount?



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Unless capital is fixed, the arithmetic defect of any rate of return is that it may be increased by reducing the denominator, as well as by increasing the numerator and *vice versa*. For example, would you prefer a £50 return on £100 to £100 on £500 and should a firm maximise ARR by restricting investment to the smallest richest project? Of course not, since this conflicts with our normative objective of wealth maximisation. And let us see why.

**Activity 3**

Based on either return or wealth maximisation criteria, which of the following projects are acceptable given a 14 percent cut-off investment rate and the following assumptions:

Capital is *limited* to £100k or £200k. Capital is *variable*. Projects cannot be *replicated*.

£000s)	A	B	C	D
Investment	(100)	(100)	(100)	(100)
Return	10	15	20	25

We can summarise our results as follows:

Capital	Capital Rationing				Variable Capital	
	(£100,00)		(£200,00)			
Investment criteria	ARR	Wealth	ARR	Wealth	ARR	Wealth
Project acceptance	D	D	D	C,D	D	B,C,D
Return %	25%	25%	25%	22.5%	25%	20%
Profit (£000s)	25	25	25	45	25	60

When capital is *fixed* at £100,000, ARR and wealth maximisation equate. At £200,000 they diverge. Similarly, with access to *variable* funds the two conflict. ARR still restricts us to project D, because the acceptance of others reduces the return percentage, despite absolute profit increases. But isn't wealth maximised by accepting any project, however profitable?

*Present Value* (PV) based on the *time value of money concept* reveals the most important weakness of ARR (even if the accounting methodology was cash based and capital was fixed). By averaging periodic profits and investment regardless of how far into the future they are realised, ARR ignores their timing and size. Explained simply, would you prefer money now or later (a "bird in the hand" philosophy)?

Because PB in its most sophisticated forms also ignores returns after the cut-off date, there is an academic consensus that discounted cash flow (DCF) analysis based upon the time value of money and the mathematical technique of compound interest is preferable to either PB and ARR. DCF identifies that finance is a scarce economic commodity. When you require more money you borrow. Conversely, surplus funds may be invested. In either case, the financial cost is a function of three variables:

- the amount borrowed (or invested),
- the rate of interest (the lender's rate of return),
- the borrowing (or lending) period.

For example, if you borrow £10,000 today at ten percent for one year your total repayment will be £11,000 including £1,000 interest. Similarly, the cash return to the lender is £1,000. We can therefore define the *present value* (PV) of the lender's investment as the current value of monetary sums to be received (or repaid) at future dates. Intuitively, the PV of a ten percent investment which produces £11,000 one year hence is £10,000.

Note this disparity has nothing to do with inflation, which is a separate phenomenon. The value of money has changed simply because of what we can do with it. The concept acknowledges that, even in a certain world of constant prices, cash amounts received or paid at various future dates possess different present values. The link is a rate of interest.

Expressed mathematically, the future value (FV) of a cash receipt is equivalent to the present value (PV) of a sum invested today at a compound interest rate over a number of periods:

$$(3) \quad FV_n = PV (1 + r)^n$$

$FV_n$	=	future value at time period n
PV	=	present value at time period zero (now)
r	=	periodic rate of interest (expressed as a proportion)
n	=	number of time periods (t = 1, 2, ..n).

Conversely, the PV of a future cash receipt is determined by *discounting* (reducing) this amount to a present value over the appropriate number of periods by reference to a uniform rate of interest (or return). We simply rearrange Equation (3) as follows:

$$(4) \quad PV_n = FV_n / (1+r)^n$$

If *variable* sums are received periodically, Equation (4) expands. PV is now equivalent to an amount invested at a rate (r) to yield cash receipts at the time periods specified.

$$(5) \quad PV_n = \sum_{t=1}^n C_t / (1+r)^t$$

$PV_n$	=	present value of future cash flows
$r$	=	periodic rate of interest
$n$	=	number of future time periods ( $t = 1, 2 \dots n$ )
$C_t$	=	cash inflow receivable at future time period $t$ .

When *equal* amounts are received at annual intervals (note the annuity subscript A) the future value of  $C_t$  per period for  $n$  periods is given by:

$$(6) \quad FV_{An} = C_t \frac{(1+r)^n - 1}{r}$$

Rearranging terms, the *present value of an annuity* of  $C_t$  per period is:

$$(7) \quad PV_{An} = \frac{C_t [1 - (1+r)^{-n}]}{r} = C_t/r \text{ for a } \textit{perpetual annuity} \text{ if } n \text{ tends to infinity } (\infty).$$

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If these equations seem daunting, it is always possible formulae tables based on corresponding future and present values for £1, \$1 and other currencies, available in most financial texts.

#### Activity 4

Your bankers agree to provide £10 million today to finance a new project. In return they require a 12 per cent annual compound rate of interest on their investment, repayable in three year's time. How much cash must the project generate to break-even?

Using Equation (3) or compound interest tables for the future value of £1.00 invested at 12 percent over three years, your eventual break- even repayment including interest is (£000s):

$$(3) \quad FV_n = £10,000 (1.12)^3 = £10,000 \times 1.4049 = \underline{£14,049}$$

To confirm the £10k bank loan, we can *reverse* its logic and calculate the PV of £14,049 paid in three years. From Equation (4) or the appropriate DCF table:

$$(4) \quad PV_n = £14,049 / (1.12)^3 = £14,049 \times 0.7117 = \underline{£10,000}$$

#### Activity 5

The PV of a current investment is worth progressively less as its returns becomes more remote and/or the discount rate rises (and vice versa). Play about with Activity 4 data to confirm this.

## 2.3 The Internal Rate of Return (IRR)

There are two basic DCF models that compare the PV of future project cash inflows and outflows to an initial investment. Net present value (NPV) *incorporates a discount rate* ( $r$ ) using a company's rate of return, or cost of capital, which reduces future *net* cash inflows ( $C_t$ ) to a PV to determine whether it is greater or less than the initial investment ( $I_0$ ). Internal rate of return (IRR) *solves for a rate*, ( $r$ ) which reduces future sums to a PV equal to an investment's cost ( $I_0$ ), such that NPV equals zero. Mathematically, given:

$$(8) \quad PV_n = \sum_{t=1}^n C_t / (1+r)^t : NPV = PV_n - I_0; NPV = 0 = PV = I_0 \text{ where } r = IRR$$

The IRR is a *special* case of NPV, namely a *hypothetical* return or *maximum* rate of interest required to finance a project if it is to *break even*. It is then compared by management to a *predetermined* cut-off rate. Individual projects are accepted if:

IRR  $\geq$  a target rate of return: IRR  $>$  the cost of capital or a rate of interest.

Collectively, projects that satisfy these criteria can also be ranked according to their IRR. So, if our objective is IRR maximisation and only one alternative can be chosen, then given:

$IRR_A > IRR_B > \dots IRR_N$  we accept project A.

#### Activity 6

A project costs £172,720 today with cash inflows of zero in Year 1, £150,000 in Year 2 and £64,900 in Year 3. Assuming an 8 per cent cut-off rate, is the project's IRR acceptable?

Using Equation (8) or DCF tables, the following figures confirm a break-even IRR of 10 per cent (NPV = 0). So, the project's return exceeds 8 per cent (i.e. NPV is positive at 8 per cent) more of which later.

Year	Cashflows	DCF Factor (10%)	PV
0	(172.72)	1.0000	(172.72)
1	-	0.9091	-
2	150.00	0.8264	123.96
3	64.90	0.7513	<u>48.76</u>
NPV			Nil

Unsure about IRR or NPV? Remember NPV is today's equivalent of the cash surplus at the end of a project's life. This surplus is the project's *net terminal value* (NTV). Thus, if project cash flows have been discounted at their IRR to produce a zero NPV, it follows that their NTV (cash surplus) built up from compound interest calculations will also be zero. Explained simply, you are indifferent to £10 today and £11 next year with a 10 per cent interest rate.

$$(9) \quad NPV = NTV / (1 + r)^n; NTV = NPV (1 + r)^n; NPV = NTV = 0, \text{ if } r = IRR$$

## 2.4 The Inadequacies of IRR and the Case for NPV

IRR is supported because return percentages are still universally favoured performance metrics. Moreover, computational difficulties (uneven cash flows, the IRR is indeterminate, or not a real number) can now be resolved mathematically by commercial software. Unfortunately, these selling points overstate the case for IRR.

IRR (like ARR) is a *percentage averaging* technique that fails to discriminate between project cash flows of different *timing and size*, which may conflict with wealth maximisation in *absolute cash* terms. Unrealistically, the model also assumes that even if cash data is certain:

- All financing will be undertaken at a borrowing rate equal to the project's IRR.
- Intermediate net cash inflows will be reinvested at a rate of return equal to the IRR.

The implication is that capital cost and reinvestment rates equal the IRR, which remains constant over the project's life to produce a zero NPV. However, relax one or other assumption and IRR changes. So, why calculate a *hypothetical* IRR, which differs from *real world* cut-off rates that can be incorporated into the DCF model to determine whether a project's *actual* NPV or NTV is positive or negative?

The IRR is a "castle built on sand" without economic meaning unless we compare it to a company's desired rate of return or capital cost. Far better to discount project cash flows using one of these rates to establish a *true economic surplus in absolute money terms* as follows:

$$(10) \quad NPV = \sum_{t=1}^n C_t / (1+r)^t - I_0; \quad NPV = PV_n - I_0 = NTV / (1+r)^n = NPV (1+r)^n$$

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*Individual* projects are accepted if:

$NPV \geq 0$ :  $NPV > 0$ ; where the discount rate is either a return or cost of capital.

*Collectively*, projects that satisfy either criterion can also be ranked according to their NPV.

$NPV_A > NPV_B > \dots NPV_N$  we accept project A..

Of course, NPV, like IRR, still requires certain assumptions. Known investment costs, project lives, cash flows and whatever discount rate, must all be factored into the NPV model. But note this is more realistic. Capital cost and intermediate reinvestment rates now relate to prevailing returns, rather than IRR, so there are fewer margins for error. NPV is near the truth by representing the possible money surplus (NTV) you will eventually walk away with.

**Review Activity**

Using data from Activity 6 with its 8 per-cent cut-off rate and Equations 10–11, confirm that the project’s NPV is £7,050 and acceptable to management because the life-time surplus equals an NTV of £8,881.

## 2.5 Summary and Conclusions

We can tabulate the objective functions and investment criteria of PB, ARR, IRR and NPV with respect to shareholder wealth maximisation as follows:

Model	Wealth Max.	Objective	Investment Criteria
Payback	Rarely	Minimise Payback (Maximise liquidity)	Time
ARR	Rarely	Maximise ARR	Profitability percentage
IRR	Rarely	Maximise IRR	Profitability percentage
NPV	Likely	Maximise NPV	Absolute profits

Capital Budgeting Models