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Strategic Financial Management: Part I

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Introduction & The Investment Decision

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PART ONE: AN INTRODUCTION

1. Finance – An Overview

Introduction

In a world of geo-political, social and economic uncertainty, strategic financial management is in a process of change, which requires a reassessment of the fundamental assumptions that cut across the traditional boundaries of the subject.

Read on and you will not only appreciate the major components of contemporary finance but also find the subject much more accessible for future reference.

The emphasis throughout is on how strategic financial decisions *should* be made by management, with reference to classical theory and contemporary research. The mathematics and statistics are simplified wherever possible and supported by numerical activities throughout the text.

1.1 Financial Objectives and Shareholder Wealth

Let us begin with an idealised picture of investors to whom management are ultimately responsible. All the traditional finance literature confirms that investors *should* be rational, risk-averse individuals who formally analyse one course of action in relation to another for maximum benefit, even under conditions of uncertainty. What *should* be (rather than *what is*) we term *normative theory*. It represents the foundation of modern finance within which:

> Investors maximise their wealth by selecting *optimum* investment and financing opportunities, using financial models that *maximise* expected returns in absolute terms at *minimum* risk.

What concerns investors is not simply maximum profit but also the *likelihood* of it arising: a *risk-return trade-off* from a portfolio of investments, with which they feel comfortable and which may be unique for each individual. Thus, in a sophisticated mixed market economy where the ownership of a company's portfolio of physical and monetary assets is divorced from its control, it follows that:

> The normative objective of financial management should be:
>
> To implement investment and financing decisions using risk-adjusted wealth maximising criteria, which satisfy the firm's *owners* (the shareholders) by placing them all in an equal, optimum financial position.

Of course, we should not underestimate a firm's financial, fiscal, legal and social responsibilities to all its other *stakeholders*. These include alternative providers of capital, creditors, employees and customers, through to government and society at large. However, the satisfaction of their objectives should be perceived as a *means to an end*, namely shareholder wealth maximisation.

As employees, management's own *satisficing* behaviour should also be *subordinate* to those to whom they are ultimately accountable, namely their shareholders, even though empirical evidence and financial scandals have long cast doubt on managerial motivation.

In our ideal world, firms exist to convert inputs of physical and money capital into outputs of goods and services that satisfy consumer demand to generate money profits. Since most economic resources are limited but society's demand seems unlimited, the corporate management function can be perceived as the future allocation of scarce resources with a view to maximising consumer satisfaction. And because money capital (as opposed to labour) is typically the limiting factor, the strategic problem for financial management is how limited funds are allocated between alternative uses.

The pioneering work of Jenson and Meckling (1976) neatly resolves this dilemma by defining corporate management as agents of the firm's owners, who are termed the *principals*. The former are authorised not only to act on the behalf of the latter, but also in their best interests.

> Armed with *agency theory*, you will discover that the function of strategic financial management can be deconstructed into four major components based on the mathematical concept of expected *net present value* (ENPV) maximisation:
>
> *The investment, dividend, financing and portfolio decision.*
>
> In our ideal world, each is designed to maximise shareholders' wealth using the market price of an ordinary share (or common stock to use American parlance) as a performance criterion.

Explained simply, the market price of equity (shares) acts as a control on management's actions because if shareholders (principals) are dissatisfied with managerial (agency) performance they can always sell part or all of their holding and move funds elsewhere. The *law of supply and demand* may then kick in, the market value of equity fall and in extreme circumstances management may be replaced and takeover or even bankruptcy may follow. So, to survive and prosper:

> The over-arching, normative objective of strategic financial management should be the maximisation of shareholders' wealth represented by their ownership stake in the enterprise, for which the firm's current market price per share is a disciplined, universal metric.

1.2 Wealth Creation and Value Added

Modern finance theory regards capital investment as the springboard for wealth creation. Essentially, financial managers maximise stakeholder wealth by generating cash returns that are more favourable than those available elsewhere. In a mature, mixed market economy, they translate this strategic goal into action through the capital market.

Figure 1:1 reveals that companies come into being financed by external funding, which invariably includes debt, as well as equity and perhaps an element of government aid.

If their investment policies satisfy consumer needs, firms should make money profits that at least equal their overall cost of funds, as measured by their investors' desired rates of return. These will be distributed to the providers of debt capital in the form of interest, with the balance either paid to shareholders as a dividend, or retained by the company to finance future investment to create capital gains.

Either way, managerial ability to sustain or increase the investor returns through a continual search for investment opportunities should then attract further funding from the capital market, so that individual companies grow.

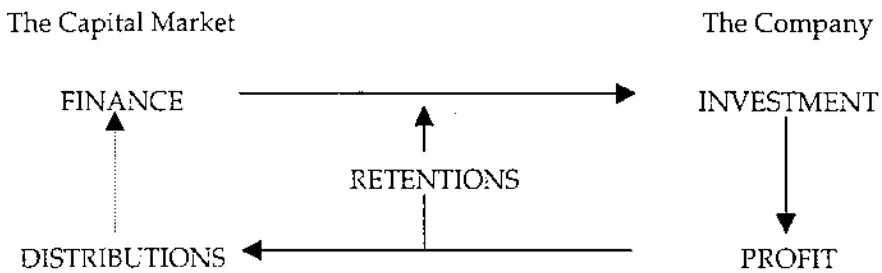

Figure 1.1: The Mixed Market Economy

If firms make money profits that *exceed* their overall cost of funds (positive ENPV) they create what is termed *economic value added* (EVA) for their shareholders. EVA provides a financial return to shareholders in excess of their *normal* return at no expense to other stakeholders. Given an efficient capital market with no barriers to trade, (more of which later) demand for a company's shares, driven by its EVA, should then rise. The market price of shares will also rise to a higher equilibrium position, thereby creating *market value added* (MVA) for the mutual benefit of the firm, its owners and prospective investors.

Of course, an old saying is that "the price of shares can fall, as well as rise", depending on economic performance. Companies engaged in inefficient or irrelevant activities, which produce periodic losses (negative EVA) are gradually starved of finance because of reduced dividends, inadequate retentions and the capital market's unwillingness to replenish their asset base at lower market prices (negative MVA).

Figure 1.2 distinguishes the "winners" from the "losers" in their drive to add value by summarising in financial terms why some companies fail. These may then fall prey to take-over as share values plummet, or even implode and disappear altogether.

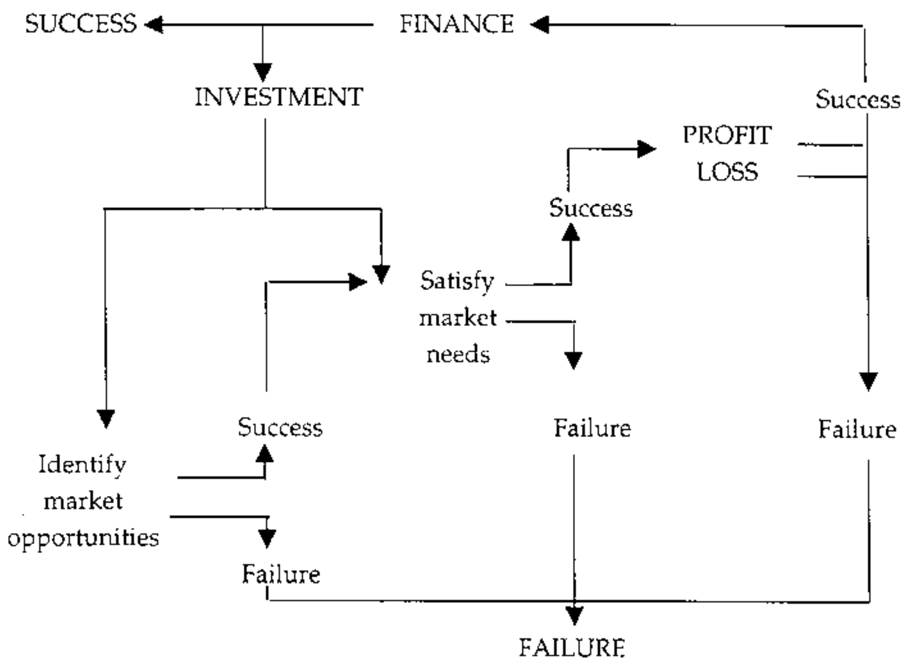

Figure 1:2: Corporate Economic Performance, Winners and Losers.

1.3 The Investment and Finance Decision

On a more optimistic note, we can define successful management policies of wealth maximisation that increase share price, in terms of two distinct but inter-related functions.

> *Investment* policy selects an optimum portfolio of investment opportunities that *maximise* anticipated net cash inflows (ENPV) at *minimum* risk.
>
> *Finance* policy identifies potential fund sources (equity and debt, long or short) required to sustain investment, evaluates the risk-adjusted returns expected by each and then selects the *optimum* mix that will *minimise* their overall weighted average cost of capital (WACC).

The two functions are interrelated because the *financial* returns required by a company's capital providers must be compared to its *business* returns from investment proposals to establish whether they should be accepted.

And while investment decisions obviously *precede* finance decisions (without the former we don't need the latter) what ultimately concerns the firm is not only the profitability of investment but also whether it satisfies the capital market's financial expectations.

Strategic managerial investment and finance functions are therefore inter-related *via* a company's weighted, average cost of capital (WACC).

From a financial perspective, it represents the overall costs incurred in the acquisition of funds. A complex concept, it embraces *explicit* interest on borrowings or dividends paid to shareholders. However, companies also finance their operations by utilising funds from a variety of sources, both long and short term, at an *implicit or opportunity* cost. Such funds include trade credit granted by suppliers, deferred taxation, as well as retained earnings, without which companies would presumably have to raise funds elsewhere. In addition, there are implicit costs associated with depreciation and other non-cash expenses. These too, represent retentions that are available for reinvestment.

In terms of the corporate investment decision, a firm's WACC represents the overall *cut-off* rate that justifies the financial decision to acquire funding for an investment proposal (as we shall discover, a *zero* NPV).

In an ideal world of wealth maximisation, it follows that if corporate cash profits exceed overall capital costs (WACC) then NPV will be *positive*, producing a *positive* EVA. Thus:

- If management wish to increase shareholder wealth, using share price (MVA) as a *vehicle*, then it must create positive EVA as the *driver*.
- Negative EVA is only acceptable in the short term.
- If share price is to rise long term, then a company should not invest funds from any source unless the *marginal* yield on new investment at least equals the rate of return that the provider of capital can earn elsewhere on comparable investments of equivalent risk.

Figure 1:3 overleaf, charts the strategic objectives of financial management relative to the investment and finance decisions that enhance corporate wealth and share price.

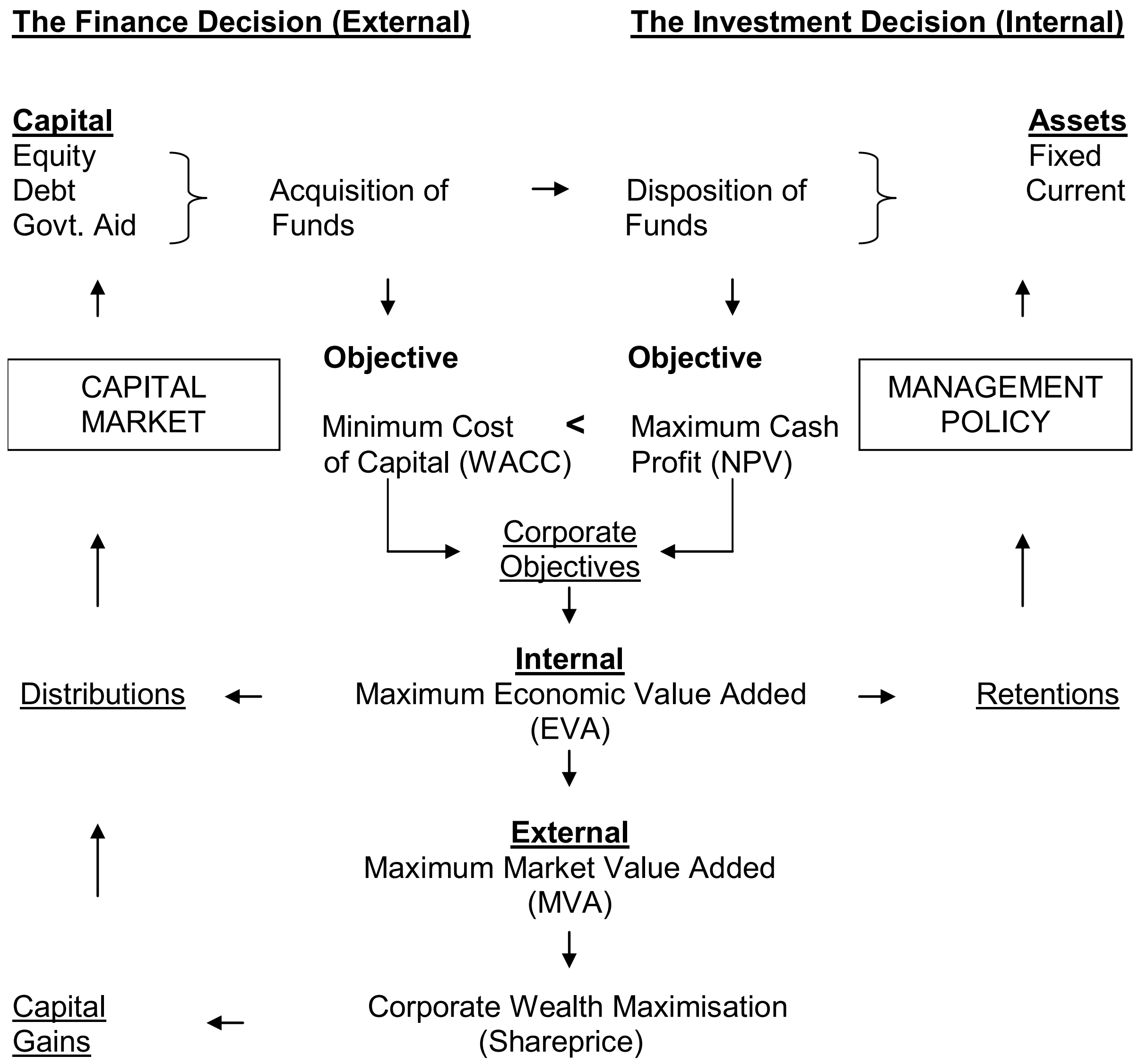

Figure 1.3: Strategic Financial Management

1.4 Decision Structures and Corporate Governance

We can summarise the normative objectives of strategic financial management as follows:

> The determination of a maximum inflow of cash profit and hence corporate value, subject to acceptable levels of risk associated with investment opportunities, having acquired capital efficiently at minimum cost.

Investment and financial decisions can also be subdivided into two broad categories; longer term (strategic or tactical) and short-term (operational). The former may be unique, typically involving significant fixed asset expenditure but uncertain future gains. Without sophisticated periodic forecasts of required outlays and associated returns, which incorporate *time value of money* techniques, such as ENPV and an allowance for risk, the subsequent penalty for error can be severe; in the extreme, corporate death.

Conversely, operational decisions (the domain of working capital management) tend to be repetitious, or infinitely divisible, so much so that funds may be acquired piecemeal. Costs and returns are usually quantifiable from existing data with any weakness in forecasting easily remedied. The decision itself may not be irreversible.

However, irrespective of the time horizon, the investment and financial decision process should always involve:

- The continual search for investment opportunities.
- The selection of the most profitable opportunities, in absolute terms.
- The determination of the optimal mix of internal and external funds required to finance those opportunities.
- The establishment of a system of financial controls governing the acquisition and disposition of funds.
- The analysis of financial results as a guide to future decision-making.

Needless to say, none of these functions are independent of the other. All occupy a pivotal position in the decision making process and naturally require co-ordination at the highest level. And this is where *corporate governance* comes into play.

We mentioned earlier that empirical observations of agency theory reveal that management might act irresponsibly, or have different objectives. These may be sub-optimal relative to shareholders wealth maximisation, particularly if management behaviour is not monitored, or they receive inappropriate incentives (see Ang, Rebel and Lin, 2000).

To counteract *corporate mis-governance* a system is required whereby firms are monitored and controlled. Now termed corporate governance, it should embrace the relationships between the ordinary shareholders, Board of Directors and senior management, including the Chief Executive Officer (CEO).

In large public companies where *goal congruence* is a particular problem (think Enron, or the 2007-8 sub-prime mortgage and banking crisis) the Board of Directors (who are elected by the shareholders) and operate at the interface between shareholders and management is widely regarded as the key to effective corporate governance. In our ideal world, they should not only determine *ethical* company policies but should also act as a *constraint* on any managerial actions that might conflict with shareholders interests. For an international review of the theoretical and empirical research on the subject see the *Journal of Financial and Quantitative Analysis 38* (2003).

1.5 The Developing Finance Function

We began our introduction with a portrait of rational, risk averse investors and the corporate environment within which they operate. However, a broader picture of the role of modern financial management can be painted through an appreciation of its historical development. Chronologically, six main features can be discerned:

- Traditional
- Managerial
- Economic

- Systematic
- Behavioural
- Post Modern

Traditional thinking predates the Second World War. *Positive* in approach, which means a concern with *what is* (rather than normative and what should be), the discipline was Balance Sheet dominated. Financial management was presented in the literature as merely a classification and description of *long term* sources of funds with instructions on how to acquire them and at what cost. Any emphasis upon the use of funds was restricted to *fixed asset* investment using the established techniques of *payback* and *accounting rate of return* (ARR) with their emphasis upon liquidity and profitability respectively.

Managerial techniques developed during the 1940s from an American awareness that numerous wide-ranging military, logistical techniques (mathematical, statistical and behavioural) could successfully be applied to *short term* financial management; notably inventory control. The traditional idea that long term finance should be used for long term investment was also reinforced by the notion that wherever possible current assets should be financed by current liabilities, with an emphasis on credit worthiness measured by the *working capital ratio*. Unfortunately, like financial accounting to which it looked for inspiration; financial management (strategic, or otherwise) still lacked any theoretical objective or model of investment behaviour.

Economic theory, which was *normative* in approach, came to the rescue. Spurred on by post-war recovery and the advent of computing, throughout the 1950s an increasing number of academics (again mostly American) began to refine and to apply the work of earlier economists and statisticians on *discounted revenue theory* to the corporate environment.

The initial contribution of the financial literature to financial practice was the development of capital budgeting models utilising *time value of money* techniques based on the *discounted cash flow* concept (DCF). From this arose academic suggestions that if management are to satisfy the objectives of corporate stakeholders (including the shareholders to whom they are ultimately responsible) then perhaps they should maximise the net inflow of cash funds at minimum cost.

By the 1960s, (the *golden era* of finance) an *econometric* emphasis upon investor and shareholder welfare produced competing theories of share price maximisation, optimal capital structure and the pricing of equity and debt in capital markets using *partial equilibrium analysis*, all of which were subjected to exhaustive empirical research.

Throughout the 1970s, rigorous analytical, *linear* techniques based upon investor *rationality*, the *random* behaviour of economic variables and stock market *efficiency* overtook the traditional approach. The managerial concept of working capital with its emphasis on solvency and liquidity at the expense of future profitability was also subject to economic analysis. As a consequence, there emerged an academic consensus that:

> The normative objective of finance is represented by the maximisation of shareholders' welfare measured by share price, achievable through the maximisation of the expected net present value (ENPV) of all a company's prospective capital investments.

Since the 1970s, however, there has also been a significant awareness that the ebb and flow of finance through investor portfolios, the corporate environment and global capital markets cannot be analysed in a *technical vacuum* characterised by mathematics, statistics and equilibrium analysis. Efficient financial management, or so the argument goes, must relate to all the other functions within the *system* that it serves. Only then will it optimise the benefits that accrue to the system as a whole.

Systematic proponents, whose origins lie in management science, still emphasise the financial decisions-maker's responsibility for the maximisation of corporate value. However, their most recent work focuses upon the interaction of financial decisions with those of other business functions within imperfect markets. More specifically, it questions the economist's assumptions that investors are rational, returns are random and stock markets are efficient. All of which depend upon the *instantaneous* recognition of interrelated flows of information and non-financial resources, as well as cash, throughout the system.

Behavioural scientists, particularly communications theorists, have developed this approach further by suggesting that perhaps *we can't maximise anything*. They analyse the reaction of individuals, firms and stock market participants to the impersonal elements: cash, information and resources. Emphasis is placed upon the role of competing goals, expectations and choice (some *quantitative*, others *qualitative*) in the decision process.

Post-Modern research has really taken off since the millennium and the dot.com-techno crisis, spurred on by global financial meltdown and recession. Whilst still in its infancy, its purpose seems to provide a better understanding of how adaptive human behaviour, which may not be rational or risk-averse, determines investment, corporate and stock market performance in today's volatile, chaotic world and *vice versa*.

So, what of the *future*?

Obviously, there will be new approaches to financial management whose success will be measured by the extent to which each satisfies its stated objectives. The problem today is that history tells us that every school of academic thought (from traditionalists through to post-modernists) has failed to convince practising financial managers that their approach is always better than another. A particular difficulty is that if their objectives are too broad they are dismissed as self evident. And if they are too specific, they fail to gain general acceptance.

Perhaps the best way foreword is a *trade-off between flexibility and uniformity*, whereby none of the chronological developments outlined above should be regarded as *mutually exclusive*. As we shall discover, a particular approach may be more appropriate for a particular decision but overall each has a role to play in contemporary financial management. So, why not focus on how the various chronological elements can be combined to provide a more *eclectic* (comprehensive) approach to the decision process? Moreover, an historical perspective of the developments and changes that have occurred in finance can also provide fresh insights into long established practice.

As an example, consider investors who use *traditional* published accounting data such as dividend per share without any reference to *economic* values to establish a company's performance. In one respect, their approach can be defended. As we shall see, evidence from statistical studies of share price suggests that increased dividends per share are used by companies to convey positive information concerning future profit and value. But what if the dividend signal contained in the accounts is designed by management to mislead (again think Enron)?

As *behaviourists* will tell you, irrespective of whether a positive signal is false, if a sufficient number of shareholders and potential investors believe it and purchase shares, then the demand for equity and hence price will rise. *Systematically*, the firm's *total market capitalisation of equity* will follow suit.

Post-modernists will also point out that irrespective of whether management wish to maximise wealth, stock market participants combine periodically to create "crowd behaviour" and *market sentiment* without reference to any rational expectations based on actual trading fundamentals such as "real" profitability and asset values.

1.6 The Principles of Investment

The previous section illustrates that modern financial management (strategic or otherwise) raises more questions than it can possibly answer. In fairness, theories of finance have developed at an increasing rate over the past fifty years. Unfortunately, unforeseen events always seem to overtake them (for example, the October 1987 crash, the dot.com fiasco of 2000, the aftermath of 7/11, the 2007 sub-prime mortgage crisis and now the consequences of the 2008 financial meltdown).

To many analysts, current financial models also appear more abstract than ever. They attract legitimate criticism concerning their real world applicability in today's uncertain, global capital market, characterised by geo-political instability, rising oil and commodity prices and the threat of economic recession. Moreover, post-modernists, who take a *non-linear* view of society and dispense with the assumption that we can maximise anything (long or short) with their talk of *speculative bubbles, catastrophe theory and market incoherence*, have failed to develop comprehensive alternative models of investment behaviour.

Much work remains to be done. So, in the meantime, let us see what the "old finance" still has to offer today's investment community and the "new theorists" by adopting a historical perspective and returning to the fundamental principles of investment and shareholder wealth maximisation, a number of which you may be familiar with.

We have observed broad academic agreement that if resources are to be allocated efficiently, the objective of strategic financial management should be:

- To maximise the wealth of the shareholders' stake in the enterprise.

Companies are assumed to raise funds from their shareholders, or borrow more cheaply from third parties (creditors) to invest in capital projects that generate maximum financial benefit for all.

> A capital project is defined as an asset investment that generates a stream of receipts and payments that define the total cash flows of the project. Any immediate payment by a firm for assets is called an initial cash outflow, and future receipts and payments are termed future cash inflows and future cash outflows, respectively.

As we shall discover, wealth maximisation criteria based on expected net present value (ENPV) using a *discount rate* rather than an *internal rate of return* (IRR), can then reveal that when fixed and current assets are used efficiently by management:

> If ENPV is positive, a project's anticipated future net cash inflows should enable a firm to repay cheap contractual loans with accumulated interest and provide a higher return to shareholders. This return can take the form of either *current* dividends, or *future* capital gains, based on managerial decisions to distribute or retain earnings for reinvestment.

However, this raises a number of questions, even if initial issues of *cheap* debt capital increase shareholder *earnings per share* (EPS).

- Do the contractual obligations of larger interest payments associated with more borrowing (and the possibility of higher interest rates to compensate new investors) threaten shareholders returns?
- In the presence of this *financial* risk associated with increased borrowing (termed *gearing* or *leverage*) do rational, risk-averse shareholders prefer *current* dividend income to *future* capital gains financed by the retention of their profit?
- Or, irrespective of leverage, are dividends and earnings regarded as *perfect economic substitutes* in the minds of shareholders?

Explained simply, shareholders are being denied the opportunity to enjoy current dividends if new capital projects are accepted. Of course, they might reap a future capital gain. And in the interim, individual shareholders can also sell part or all of their holdings, or borrow at an appropriate (market) rate of interest to finance their preferences for consumption, or investment in other firms.

But what if a reduction in today's dividend is not matched by the profitability of management's future investment opportunities?

To be consistent with our overall objective of shareholder wealth maximisation, another fundamental principle of investment is that:

> Management's minimum rate of return on incremental projects financed by retained earnings should represent the rate of return that shareholders can expect to earn on comparable investments elsewhere.
>
> Otherwise, corporate wealth will diminish and once this information is signalled to the outside world *via* an efficient capital market, share price may follow suit.

1.7 Perfect Markets and the Separation Theorem

Since a company's retained profits for new capital projects represent alternative consumption and investment opportunities foregone by its shareholders, the corporate cut-off rate for investment is termed *the opportunity cost of capital.* And:

> If management vet projects using the shareholders' opportunity cost of capital as a cut-off rate for investment:
>
> - It should be irrelevant whether future cash flows paid as dividends, or retained for reinvestment, match the consumption preferences of shareholders at any point in time.
> - As a consequence, dividends and retentions are *perfect substitutes* and dividend policy is *irrelevant*.

Remember, however, that we have assumed shareholders can always sell shares, borrow (or lend) at the market rate of interest, in order to transfer cash from one period to another to satisfy their needs. But for this to work implies that there are no *barriers to trade*. So, we must also assume that these transactions occur in a *perfect capital market* if wealth is to be maximised.

> *Perfect markets, are the bedrock of traditional finance theory* that exhibit the following characteristics:
>
> - Large numbers of individuals and companies, none of whom is large enough to distort market prices or interest rates by their own action, (i.e. *perfect* competition).
> - All market participants are free to borrow or lend (invest), or to buy and sell shares.
> - There are no material transaction costs, other than the prevailing market rate of interest, to prevent these actions.
> - All investors have free access to financial information relating to a firm's projects.
> - All investors can invest in other companies of equivalent relative risk, in order to earn their required rare of return.
> - The tax system is neutral.

Of course, the real world validity of each assumption has long been criticised based on empirical research. For example, not all investors are risk-averse or behave rationally, (why play national lotteries, invest in techno shares, or the sub-prime market?). Share trading also entails costs and tax systems are rarely neutral.

But the relevant question is not whether these assumptions are observable phenomena but *do they contribute to our understanding of the capital market*?

According to seminal twentieth century research by two Nobel Prize winners for Economics (Franco Modigliani and Merton Miller: 1958 and 1961), of course they do.

> The assumptions of a perfect capital market (like the assumptions of perfect competition in economics) provide a sturdy *theoretical* framework based on *logical* reasoning for the derivation of more sophisticated *applied* investment and financial decisions.
>
> Perfect markets underpin our understanding of the corporate wealth maximisation process, irrespective of a firm's distribution policy, which may include interest on debt, as well as the returns to equity (dividends or capital gains).

Only then, so the argument goes, can we relax each assumption, for example tax neutrality (see Miller 1977), to gauge their differential effects on the real world. What economists term *partial equilibrium* analysis.

To prove the case for normative theory and the insight that logical reasoning can provide into contemporary managerial investment and financing decisions, we can move back in time even before the *traditionalists* to the first economic formulation of the impact of perfect market assumptions upon the firm and its shareholders' wealth.

The *Separation Theorem*, based upon the pioneering work of Irving Fisher (1930) is quite emphatic concerning the *irrelevance* of dividend policy.

> When a company values capital projects (the managerial investment decision) it does not need to know the expected future spending or consumption patterns of the shareholder clientele (the managerial financing decision).

According to Fisher, once a firm has issued shares and received their proceeds, it is neither directly involved with their subsequent transaction on the capital market, nor the price at which they are traded. This is a matter of negotiation between current shareholders and prospective investors.

So, how can management pursue policies that perpetually satisfy shareholder wealth?

> *Fisherian* Analysis illustrates that in perfect capital markets where ownership is divorced from control, dividend distributions should be an irrelevance.
>
> The corporate investment decision is determined by the market rate of interest, which is separate from an individual shareholder's preference for consumption.

So finally, let us illustrate the dividend *irrelevancy hypothesis* and review our introduction to strategic financial management by demonstrating the contribution of Fisher's theorem to the maximisation of shareholders' welfare with a simple numerical example.

Review Activity

A firm is considering two mutually exclusive capital projects of equivalent risk, financed by the retention of current dividends. Each costs £500,000 and their future returns all occur at the end of the first year.

Project A will yield a 15 per cent annual return, generating a cash inflow of £575,000, whereas Project B will earn a 12 per cent return, producing a cash inflow of £560,000.

All individuals and firms can borrow or lend at the prevailing market rate of interest, which is 14 per cent per annum.

Management's investment decision would appear self-evident.

- If the firm's total shareholder clientele were to lend £500,000 elsewhere at the 14 per cent market rate of interest, this would only compound to £570,000 by the end of the year. -It is financially more attractive for the firm to retain £500,000 and accumulate £575,000 on the shareholders' behalf by investing in Project A, since they would have £5,000 more to spend at the year end.
- Conversely, no one benefits if the firm invests in Project B, whose value grows to only £560,000 by the end of the year. Management should pay the dividend.

But suppose that part of the company's clientele is motivated by a policy of distribution. They need a dividend to spend their proportion of the £500,000 immediately, rather than allow the firm to invest this sum on their behalf.

Armed with this information, should management still proceed with Project A?

1.8 Summary and Conclusions

Based on economic wealth maximisation criteria, corporate financial decisions should always be *subordinate* to investment decisions, with dividend policy used only as a means of returning surplus funds to shareholders.

To prove the point, our review activity reveals that shareholder funds will be misallocated if management reject Project A and pay a dividend.

For example, as a shareholder with a *one per cent* stake in the company, who prefers to spend now, you can always borrow £5,000 for a year at the market rate of interest (14 per cent).

By the end of the year, one per cent of the returns from Project A will be worth £5,750. This will more than cover your repayment of £5,000 capital and £700 interest on borrowed funds.

Alternatively, if you prefer saving, rather than lend elsewhere at 14 per cent, it is still preferable to waive the dividend and let the firm invest in Project A because it earns a superior return.

In our Fisherian world of perfect markets, the correct investment decision for wealth maximising firms is to appraise projects on the basis of their shareholders' *opportunity cost of capital*.

Endorsed by subsequent academics and global financial consultants, from Hirshliefer (1958) to Stern-Stewart today:

- Projects should only be accepted if their post-tax returns at least equal the returns that shareholders can earn on an investment of equivalent risk elsewhere.
- Projects that earn a return less than this opportunity rate should be rejected.
- Project yields that either equal or exceed their opportunity rate can either be distributed or retained.

- The final consumption (spending) decisions of individual shareholders are determined independently by their personal preferences, since they can borrow or lend to alter their spending patterns accordingly.

> From a financial management perspective, dividend distribution policies are an irrelevance, (what academics term a *passive residual*) in the determination of corporate value and wealth

So, now that we have separated the individual's *consumption* decision from the corporate *investment* decision, let us explore the contemporary world of finance, the various functions of strategic financial management and their analytical models in more detail.

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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 Chapter One) will be taken as given until Chapter Four (Strategic Financial Management – Part II – Finance & Wealth Decisions). 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 Chapter 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.

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) $PB = I_0/C_t$

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) $ARR = P_t - D_t / [(I_0 - S_n)/2]$

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 = £1,200,000 P_t = £400,000

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

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

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?

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 Rationing				Variable Capital	
Capital	(£100,00)		(£200,000)			
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) $FV_n = PV (1 + r)^n$

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

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 …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) $PV_{An} = C_t \dfrac{1 - (1 + r)^{-n}}{r} = C_t/r$ for a *perpetual annuity* if n tends to infinity (∞).

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) FV_n = £10,000 $(1.12)^3$ = £10,000 x 1.4049 = £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) PV_n = £14,049/$(1.12)^3$ = £14,049 x 0.7117 = £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) $PV_n = \sum_{t=1}^{n} C_t / (1+r)^t$: $NPV = PV_n - I_0$; $NPV = 0 = PV = I_0$ *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 ≥ 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:

$IRR_A > IRR_B > ...IRR_N$ 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	48.76
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) $NPV = NTV / (1 + r)^n$; $NTV = NPV (1 + r)^n$; $NPV = NTV = 0, \quad if \; r = IRR$

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:

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

Individual projects are accepted if:

NPV ≥ 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.

$NPV_A > NPV_B > ...NPV_N$ 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:

Capital Budgeting Models

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

3. Capital Budgeting and the Case for NPV

Introduction

IRR is rarely easy to compute and in exceptional cases is not a real number. But management often favour it because profitability is expressed in simple percentage terms. Moreover, when a project is considered in isolation, IRR produces the same accept-reject decision as an NPV using a firm's cost of capital or rate of return as a discount rate (r). To prove the point, let:

I_0 = Investment; PV_r and PV_{IRR} = future cash flows discounted at r and IRR respectively.

By combining the NPV and IRR Equations from Chapter Two, projects are acceptable if they generate a lifetime cash surplus i.e. a positive net terminal value (NTV) since:

(1) $PV_r > PV_{IRR} = I_0$ when $r < IRR$ and $NTV/(1+r)^n = NPV > 0 = NTV/(1+IRR)^n$

A project is unacceptable and in deficit if its IRR (break-even point) is less than r, since:

(2) $PV_r < PV_{IRR} = I_0$ when $r > IRR$ and $NTV/(1+r)^n = NPV < 0 =. NTV/(1+IRR)^n$

But what if a choice must be made between *alternative* projects (because of capital rationing or mutual exclusivity).Does the use of IRR, rather than NPV, rank projects differently? And if so, which model should management adopt to maximise shareholder wealth?

We have already observed that the difference between IRR and NPV maximisation hinges on their respective assumptions concerning borrowing and reinvestment rates. Moreover, the former model only represents a *relative* wealth measure expressed as a *percentage*, whereas NPV maximises *absolute* wealth in *cash* terms.

So, let us explore their theoretical implications for wealth maximisation and then focus upon the real-world application of DCF analyses that must also incorporate *relevant* cash flows, taxation and price level changes.

3.1 Ranking and Acceptance Under IRR and NPV

You will recall from Chapter One (Fisher's Theorem and Agency theory) that if a project's returns exceed those that shareholders can earn on comparable investments elsewhere, management should accept it. DCF analyses confirm this proposition.

If a project's IRR *exceeds* its opportunity cost of capital rate, or the project's cash flows discounted at this rate produce a *positive* NPV, shareholder wealth is maximised.

However, where capital is *rationed*, or projects are *mutually exclusive* and a choice must be made between alternatives, IRR may *rank* projects differently to NPV. Consider the following IRR and NPV £000 (£k) calculations where the capital cost (r) of both projects is 10 per cent

Project	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	IRR(%)	NPV
1	(135)	10	40	70	80	50	20%	45.4
2	(100)	40	40	50	40	-	25%	34.3

Consider also, the effects of other discount rates on the NPV for each project graphed below.

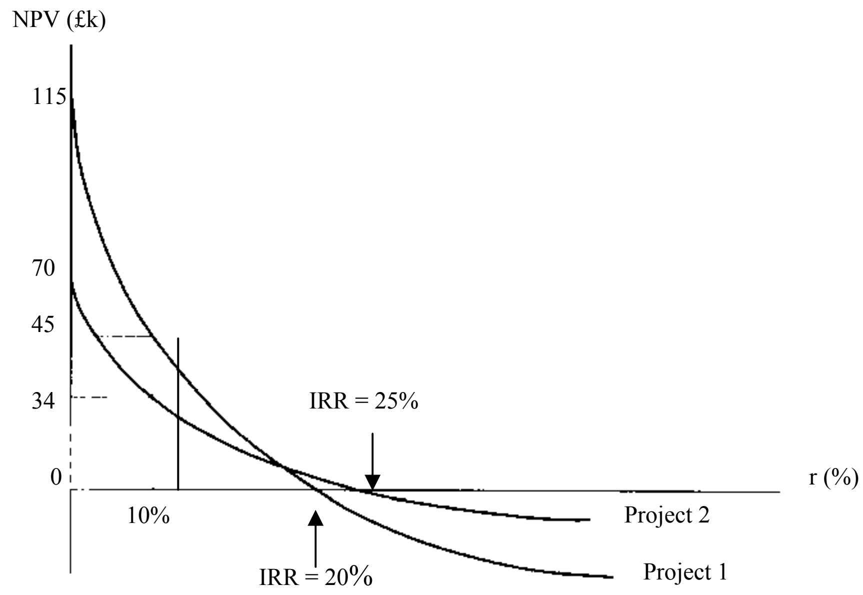

Figure 3.1: IRR and NPV Comparisons

The table reveals that in *isolation* both projects are acceptable using NPV and IRR criteria. However, if a *choice* must be made between the two, Project 1 maximises NPV, whereas Project 2 maximises IRR. Note also that IRR favours this smaller, short-lived project.

Activity 1

Figure 3:1 reveals that at one extreme (the vertical axis) each project NPV is maximised when *r* equals zero, since cash flows are not discounted. At the other (the horizontal axis) IRR is maximised where *r* solves for a zero break-even NPV. Thereafter, both projects under-recover because NPV is negative. But why do their NPV curves intersect?

Between the two extremes, different discount rates determine the slope of each NPV curve according to the *size* and *timing* of project cash flows. At relatively low rates, such as 10 per cent, the later but *larger* cash flows of Project 1 are more valuable. Higher discount rates erode this advantage. Project 2 is less affected because although it delivers smaller returns, they are *earlier*. At 15 per cent, the relative merits of each project (size and time) compensate to deliver the same NPV. So, we are indifferent between the two. Beyond this point, Project 2 is preferred. Its shallower curve intersects the horizontal axis (zero NPV) at a higher IRR.

Projects with different cash patterns produce NPV curves with different slopes and indifference points (intersections). Thus, IRR and NPV *maximisation* rarely coincide when a choice is required. IRR is an *average percentage* break- even condition that favours speedy returns. Unlike NPV, which maximises absolute wealth, IRR also fails to discriminate between projects of different size.

3.2 The Incremental IRR

Despite their apparent wealth maximisation defects, IRR project rankings that conflict with NPV can be brought into line by a *supplementary* IRR procedure whereby management:

Determine the *incremental yield* (IRR) from an *incremental* investment, which measures *marginal* profitability by subtracting one project's cash inflows and outflows from those of another to create a *sub-project* (sometimes termed a *ghost* or *shadow* project).

To prove the point, let us incrementalise the data from Section 3.1.Two projects that not only differ with respect to their cash flow patterns (*size* and *timing*) but also their investment cost.

Project	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	IRR(%)	NPV (10%)
1 less 2	(35)	(30)	-	20	40	50	15%	11.1

You will recall that IRR maximisation favoured a higher *percentage* return on the smaller more liquid investment (Project1), whereas NPV maximisation focussed on higher *money* profits overall (Project 2). Now see how the incremental IRR (15%) on the incremental investment (Project 1 minus Project 2 = £35k) exceeds the discount rate (10%) so Project 1 is accepted. Moreover, this corresponds to Equation (1) on single project acceptance. The incremental NPV is positive (£11.1k) because its discount rate r < incremental IRR.

3.3 Capital Rationing, Project Divisibility and NPV

If finance is unconstrained, management should accept all projects with a positive NPV. But if capital is rationed and smaller projects with smaller NPVs can be *replicated*, or projects are *divisible* into fractional investments, we need to compare investments of different size by *indexing* their *NPV per £1 invested* using the following formula.

(3) $NPV_I = NPV / I_0$

The Profitability Index ($NPV_{I)}$) then ranks projects, or *proportions* of them that maximise *total* NPV, relative to their cost, rather than their absolute surplus.

Activity 2

Using data from our previous Activity plotted in Figure 3.1, confirm the following (£k).

Project	I_0	NPV (10%)	NPV_I
1	(135)	45.4	0.336
2	(100)	34.3	0.343

Now assume the company has only £180,000 to invest. The projects are *not* mutually exclusive but they are infinitely divisible. Tabulate management's optimum strategy.

The following table confirms that ranking projects by the NPV per £ method, rather than their individual NPV, maximises overall NPV and hence total corporate wealth.

Method	Ranking	Capital Cost	NPV
NPV (£)	1	(135)	45.4
	2 (45/100)	(45)	15.4
Sub-optimal		(180)	60.8
NPV_I	2	(100)	34.3
	1 (80/135)	(80)	26.9
Optimal		(180)	61.2

3.4 Relevant Cash Flows and Working Capital

So far, we have taken as *given* the cash flows that underpin DCF analyses. However, management need to determine those that are *relevant* to a project's appraisal.

Relevant cash flows are based on the *opportunity* cost concept which defines the *incremental* net inflows if a project is accepted. The analysis incorporates outflows that are *unavoidable*, or inflows which are *sacrificed* elsewhere, if a project is accepted.

Thus, accounting concepts of historical cost and net book value (NBV) are irrelevant because they are *sunk* costs. Likewise, forecast income and expenses based on *accrual* accounting are irrelevant. Assets purchased five years ago for £10k with an NBV of £1k may be surplus to current requirements but with a market (opportunity) value of £9k and as a *substitute* for assets costing £12k they can reduce future project costs by £3k. Likewise, if the assets are used for this project, rather than another, then the project cash foregone must be included in the selected project's opportunity flows if it is the next highest valued alternative (say £9.5k).

With regard to accounting income there is a timing issue; periodic turnover rarely corresponds to cash inflow because of credit sales. Expenses too, may be accrued or prepaid. There is also depreciation to consider.

Depreciation should always be added back to net accounting profits when they are used for project selection. It is a *non-cash* expense, not an *incremental* outflow; that part of earnings retained to recoup an investment's cost (I0)) over its useful life. Since NPV analyses already subtract I0 from project cash flows (NPV = PV - I0) the use of profit after depreciation as a proxy for net cash inflow in project appraisal obviously *double counts* the investment's cost.

Since our test for opportunity cost focuses upon differential costs, we must also incorporate adjustments for working capital investment designed to fuel projects when up and running.

Working capital is basically stock (inventory), debtors, plus cash, *minus* creditors. This *net* investment in current assets may differ for different project proposals, vary from year to year, or build up gradually Disinvestment may also occur beyond a project's life, for example when debtors repay, creditors are satisfied and surplus inventory is sold on.

Working capital should be regarded as a *cash outflow* at the outset of a project's life with adjustments in subsequent years for the net investment caused by project acceptance. At the end of a project's life, the funds still tied up will be released for use elsewhere. Therefore, we show this amount as a *cash inflow* in the last year or whenever it is made available. The net effect of these working capital adjustments are to charge the project with the interest foregone (opportunity cost of capital) on the funds, which are invested throughout its entire life.

Activity 3

Never under estimate the role of working capital management in project appraisal. Select a random sample of published company accounts and you will observe that current assets represent more than 50 per cent of total capital investment for a significant number.

3.5 Capital Budgeting and Taxation

Another incremental cash flow, which we haven't touched on, that may involve timing discrepancies affecting project selection and shareholder wealth, is corporate taxation.

We know that in the absence of tax, depreciation should be added back to accounting profits for DCF appraisal. It is a *non-cash* expense and not an *incremental* outflow. But if depreciation is a *capital allowance* that reduces taxable profits and because tax represents a cash outflow, we must include both in our calculation of *net tax* cash inflows.

Consider a project with an annual £100k cash return on a five year investment costing £300k with a 100 per cent straight-line capital allowance and a corporate tax rate of 25 per cent. We can compare the project's annual post-tax profits with its true cash position as follows:

Annual Data(£k)	**Taxable Income**	**Taxable Income (without any capital allowance)**	**Cashflow**
Profit before depreciation	100	100	100
Capital allowance (20%)	60		
Pre-tax profit	40	100	
Corporation tax (25%)	10	25	(10)
Post-tax profit	30	75	90

If we do not deduct a capital allowance from the profit before depreciation (Column 2) the tax liability would be £25k (i.e. 25 per cent of £100k). And post-tax profit and net cash inflow would both equal £75k. However, with the capital allowance, an extra £15k cash flow is retained because the 25 per cent tax rate is applied to a profit figure of £40k adjusted for the annual capital allowance (£60k / 5). Consequently, the true annual cash flow is £90k.

> Depreciation therefore acts as a *tax shield* if it is a capital allowance because it reduces a company's net tax liability and increases its net cash inflow.

Of course, we have still not considered the timing discrepancy associated with deferred tax payments. These too, exert a positive bias on our DCF calculations. For example, assuming a twelve month delay, an accurate picture of the cash flow pattern for our five year project adjusted for relief, prior to any periodic net working capital adjustments, would be:

Cash Flows (£k)	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6
Inflow	-	100	100	100	100	100	-
Outflow	(300)	-	(10)	(10)	(10)	(10)	(10)
Net Flow	(300)	100	90	90	90	90	(10)

Once we incorporate working capital (if any) into the schedule, all that is required is to discount the net cash flows at the project's opportunity cost of capital adjusted for inflation.

3.6 NPV and Purchasing Power Risk

If a firm seeks to maximise shareholder wealth and their consumption-investment preferences, its capital budgeting decisions must be inoculated from two types of *purchasing power risk*.

- *Specific price rises* that erode the *real* value of a project's future net cash flows and diminish a firm's operating capability and share value. Management must uplift *current* (real) cash flows by specific price adjustments if necessary, to produce a project's forecast *money* flows.
- *Inflation*, that erodes consumption of goods and services *generally*, which must be reinstated by an upward revision of project discount rates if they ignore purchasing power losses. *Nominal* (real) interest rates that reflect zero inflation must be adjusted to *money* rates which reflect the expectations of investors who determine the *market* rate to compensate for this.

Irving Fisher (1930 *op cit*) defined the relationship between a market (money) interest rate (m) and a nominal (real) rate(r) given an annual compound inflation rate (i) as follows:

(4) $(1 + m) = (1 + r)(1 + i)$

So, that re-arranging terms:

(5) $m = (1 + r)(1 + i) - 1$ = the money rate,

(6) $r = [(1 + m) / (1 + i)] - 1$ = the real rate.

For example, if a project's real (nominal) discount rate is 7.5 per cent and the annual rate of inflation is 7 per cent, the money (market) rate of interest used to discount a project's *money* cash flows to determine a project's NPV is given by Equation (5):

$m = (1.075)(1.07) - 1 = 15\%$

Activity 4

Armed with this information, use Equation (6) to reverse the *Fisher effect* on the money rate (m = 15%) with an inflation rate (i= 7%) and prove that the real rate (r) equals 7.5 percent.

Review Activity

Your University intends to market a financial text priced at £60 over four years with the following demand pattern, forecast money flows and a 15 percent money cost of capital.

	Year 1	Year 2	Year 3	Year 4
Annual Demand	6,200	7,200	4,000	2,800

- Capital set-up investment of £100k with a residual value of £20k in year 4
- Variable production costs of £40 per text
- Royalty costs of £20k in year one, £15k in year two and £10k in years three and four
- Working capital investment of £80k recoverable in year 4
- Fixed cost recovery of £60,000 per annum that includes depreciation

Using NPV and NTV criteria, establish whether the University should proceed with the project.

First, the data needs to be reformulated in terms of *relevant* cash flows.

- Depreciation must be removed from fixed costs because it is not a cash flow.
- Fixed costs should only be included if relevant i.e. incurred only if the project is undertaken.
- Residual asset values including working capital are always relevant because they defray the final project cost through their future opportunity value to the company, or sale on the market.
- Because universities (at least in the UK) are *charities* that do not pay tax, we can ignore it.

Second, let us assume fixed cost *relevancy* (the worst case scenario) whereby:

Fixed costs *minus* depreciation = £60k - £20k = £40k per annum

[Annual depreciation = capital cost *less* residual value / project life = £100k-£20k / 4 = £20k]

Finally, we can tabulate the data to calculate NPV and NTV.

The table overleaf reveals the project is profitable, even if burdened with fixed costs. The NTV confirms an NPV surplus in terms of *economic value added* four years from now. Obviously, if fixed costs are genuinely "fixed" (incurred irrespective of project acceptance) they should be ignored. And in this case the NPV and NTV would be higher still (£137.57k and £240.6k respectively).

Perhaps you can confirm this?

Relevant Money Cash Flows (£k)

Year	0	1	2	3	4	**Points to note**
Capital Cost	(100)				20	(residual value)
Contribution	-	124	144	80	56	(sales less variable costs)
Fixed Costs	-	(40)	(40)	(40)	(40)	(less depreciation)
Royalties	-	(20)	(15)	(10)	(10)	(given)
Working Capital	(80)				80	(residual value)
Net Inflow	(180)	64	89	30	106	
DCF Factors	1.0	0.870	0.756	0.658	0.572	[(1 / (1+0.15)^t]
Net DCF	(180)	55.68	67.28	19.74	60.63	
NPV and NTV	23.33				40.80	[NTV=NPV (1+r)^n]

3.7 Summary and Conclusions

Unless management is confronted by a *single* project with one initial outflow followed by subsequent net inflows, the IRR may produce sub-optimal investment decisions, whereas the NPV maximisation of *all* a firm's projects, which discounts relevant incremental money cash flows at the money (market) rate of interest, should maximise wealth. Differences arise because the latter is a measure of absolute wealth, whilst the former is a relative measure. The validity of the two models also hinges upon their respective assumptions concerning borrowing and reinvestment rates. NPV calculations use the opportunity cost of capital, whilst IRR assumes that capital cost and re-investment rates equal a project's IRR, usually without any economic foundation whatsoever.

Of course, we must remember that even if NPV incorporates relevant cash flows, taxation and price changes it is still only a model that simplifies a complex world of risk and uncertainty. So, how do management deal with these phenomena to maximise shareholder wealth?

4. The Treatment of Uncertainty

Introduction

So far, our capital budgeting analyses have assumed complete certainty, whereby relevant money cash flows and money discount rates can be specified in advance. But what if a plurality of future cash flows and discount rates are possible? How do management select investments that maximises shareholder wealth in this real world of risk and uncertainty?

Let us begin with a conceptual clarification and a few definitions.

> Risk and uncertainty both refer to situations with more than one outcome. However, risk defines future events that can be objectively specified in advance based on prior knowledge; an obvious example being the throw of a dice. *Uncertainty*, which characterises most business decisions, relates to events whose probabilities cannot be predicted with accuracy.
>
> What management require, therefore, are quantitative techniques that transform uncertainty to *quasi-risk*, which *assumes* a range of possible outcomes and assigns subjective probabilities to the likelihood of each occurring.

We should also note that a project's overall uncertainty or *total* risk embraces:

- *Business* risk that relates to the variability of future cash flows arising from an investment's fundamental characteristics, as well as changing economic conditions.
- *Financial* risk associated with a project's funding and how the earnings distributed to investors determine the company's cost of capital (discount rate).

Since the former determines the latter (without profits how can you reward investors?) financial risk need not concern us yet. Cost of capital is also better left until we deal with security pricing in Part Three. So, first let us focus on the treatment of business risk,

4.1 Dysfunctional Risk Methodologies

The following risk techniques are popular with management. But unfortunately they fail to maximise shareholder wealth.

- *Modifications* to the cut-off rate for investment that adds a *risk premium* the discount rate.
- *Point estimates* such as best, worst or most likely net cash inflow; *Minimax*, which focuses upon the *best* outcome under the most *adverse* conditions; *Laplace* criteria, which select the most favourable *simple* average of a three point estimate; *Probability* estimation which applies probabilities to three point forecasts to produce the best *weighted* average (subject to the proviso that the sum of the probabilities equals one).

Suffice it to say that if the cut-off (discount) rate is based on a *market* rate, it already factors in business risk. So, adding a premium *duplicates* uncertainty. Turning to the variability of cash flows point estimations and their derivatives may also be counterproductive. The worst scenario may be improbable, but if it materialises then it may be catastrophic for the firm.

4.2 Decision Trees, Sensitivity and Computers

Look at any financial text and you will also find decision trees, sensitivity analyses and computer simulation techniques. However, these do not *quantify* risk. Rather they *manipulate* risk-adjusted data to assess their effect on an investment's viability.

Decision trees provide a *mind map* of uncertain project cash flows branch out from an investment (hence its name) and may proliferate beyond a three-point analysis. *Conditional* probabilities are attached to a sequence of likely future events. The branches of the trunk arise from previous managerial decisions (control factors) and chance (uncontrollable factors).

Sensitivity analysis deconstructs cash data that comprise an initial NPV computation into estimates of its component parts. Each variable is then analysed sequentially, using *partial equilibrium analysis*. By holding all other variables constant and gauging the impact on the appropriate investment criteria of percentage changes to the variable under observation, its critical value is established.

Computer simulation can be used in conjunction with decision trees, sensitivity analysis, or any technique, to calculate quickly innumerable permutations of probabilistic cash flows.

As tools, however, decision trees, sensitivity analyses and computer simulation are only as sound as the data upon which they are based. So, let us move beyond three point estimation.

4.3 Mean-Variance Methodology

Forecast data that extends beyond point estimations to multi-valued outcomes may be converted to quasi-risk using the more sophisticated technique of *mean-variance analysis*. Based on classical probability theory, management assume cash flows are *random* variables, which conform to a *normal* distribution with a *symmetrical* bell-shaped curve as follows:

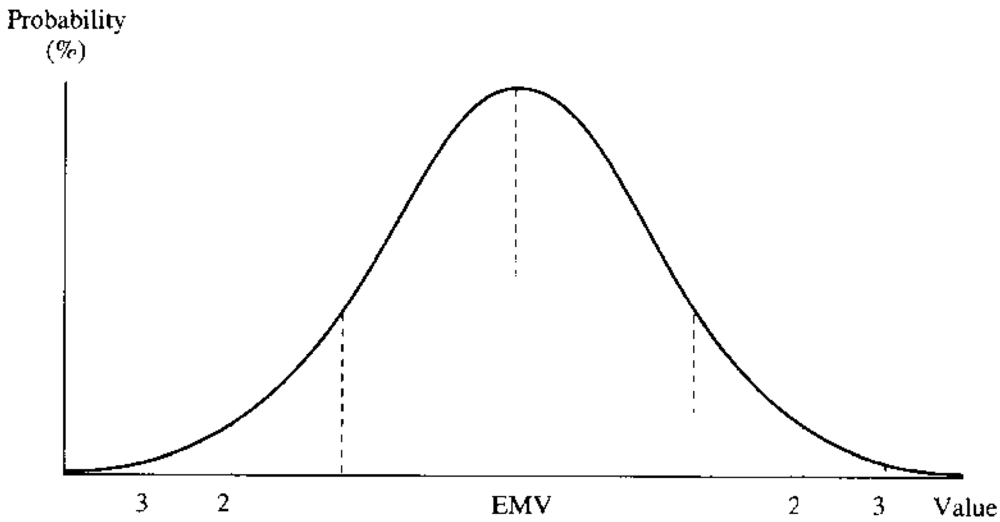

Figure 4.1: The Symmetrical Normal Distribution, Area under the Curve and Confidence Limits

The *mean* is derived by first multiplying a spectrum of annual cash flows C_i by respective probabilities P_i (subject to the proviso that $\sum P_i = 1.0$). Then the products $C_i P_i$ for any number of cash flows (n) are summated to derive an *expected monetary value* (EMV) at time period t:

$$(1) \quad EMV_t = \sum_{t=1}^{n} C_i P_i$$

Next, the annual EMV series is discounted over the appropriate periods at a *risk-free* rate (avoiding double-counting) to determine its expected PV, (EPV). From this we subtract the investment cost, I_o, to obtain a project's *expected* NPV, (ENPV) in the usual manner:

(2) $$ENPV = \left[\sum_{t=1}^{n} EMV_t / (1+r)^t \right] - I_0 = EPV_n - I_0 = ENTV / (1 + r)^n$$

Obviously, EMV time-series and ENPV analyses improve upon point estimates. But project selection using ENPV maximisation alone cannot minimise risk because it doesn't calibrate the degree to which cash flows vary around their mean (business risk) or managerial reaction to this variability. To resolve the dilemma, the *standard deviation* is used to measure the *average* dispersion of cash flows from their EMV. Management then compare the standard deviation with the expected return to assess a project's risk-return profile; the interpretation being that for a given return, the lower the standard deviation the lower the risk and *vice versa*.

Assuming statistically normal returns, the standard deviation is determined as follows:

- Calculate the mean of the distribution (EMV) by multiplying each variable's value by its probability of occurrence and adding the products.
- Subtract the EMV from each possible value and square the result.
- Multiply each squared deviation around the mean by its probability to determine certainty equivalents and add them together. This sum is the variance.
- Calculate the square root of the variance. This is the standard deviation

In most texts the standard deviation (SD) is denoted by the Greek letter σ or the term √VAR and the variance by σ^2 and VAR respectively. Using these conventions we can express the risk characteristics of a cash flow distribution algebraically given:

$$(1) \quad EMV_t = \sum_{t=1}^{n} C_i P_i$$

$$(3) \quad VAR\ (C_i) = \sigma^2 = \sum_{t=1}^{n} (C_i - EMV)^2\ Pi$$

$$(4) \quad \sqrt{VAR\ (C_i)} = \sigma = \textit{the standard deviation}$$

The project variance equals the weighted average of the sum of the *squared* deviations of each observable cash flow (C_i) from its mean cash flow (EMV) where each weight is represented by the cash flow's probability of occurrence (P_i). Because normal distributions are symmetrical (Figure 4.1) we square the deviations, otherwise their summation would be *self-cancelling* with a mean deviation of *zero*. However, squaring also introduces a scale change to the variables in relation to the EMV. This is remedied by calculating the *square root* of the variance to produce the standard deviation, which is a measure of dispersion expressed in identical units to the mean of the distribution (£say).

4.4 Mean-Variance Analyses

To understand the role of mean-variance calculations in capital budgeting, consider the following calculations of EMV, σ^2 and σ for a project's possible contribution per unit.

C_i	P_i	C_iP_i	$(C_i - EMV)^2$	P_i	$(C_i - EMV)^2 P_i$
£		£			
8	0.1	0.80	3.61	0.1	0.361
7	0.2	1.40	0.81	0.2	0.162
6	0.4	2.40	0.01	0.4	0.004
5	0.3	1.50	1.21	0.3	0.363
				(1.0)	
Expected Monetary Value (EMV) £6.10			Variance (VAR = σ^2) = 0.890		
			S.D. ($\sqrt{VAR} = \sigma$) = £0.943		

The first point to note is that best, worst and most likely *states of the world* all differ from the EMV of the cash flow distribution. Second, the most optimistic outcome is least likely to occur (£8 with a probability of 0.1).There is also a 70 percent chance of cash flows falling short of their EMV. So, what does the standard deviation of £0.943 tell us?

Refer back to Figure 4.1 which sketched the *area under the standard normal curve* and the probability that a variable's value lies within a number of standard deviations away from the mean. Because these probabilities are *the same* for any normal distribution they have long been quantified in tables based on the *z statistic,* which standardises any variable's actual deviation from the mean by reference to the standard deviation. For a particular cash flow (C_i) drawn from a distribution with known mean and variance:

(5) $z = C_i - EMV / \sigma (C_i)$

We then consult the table to establish the area under the normal curve between the right *or* left of z (plus or minus) to estimate the probability that the expected cash flow will be a given number of standard deviations away from the mean. Since a normal distribution is symmetrical, the probability of a variable deviating above *and* below the mean is given by 2z.

Activity 1

Seek out a z table, and with the previous sample data (EMV of £6.10 and σ of £0.943) let us establish the probability of project contributions ranging from £6.50 to £5.50.

To determine the probability of contributions deviating above or below the mean as specified, we must first calculate the following z statistics using Equation (5).

£6.10 is (6.10 - 6.10) / 0.943 = zero σ from the mean (obviously)

£6.50 is (6.50 - 6.10) / 0.943 = +0.42 σ from the mean

£5.50 is (5.50 - 6.10 / 0.943 = -0.64 σ from the mean

Next we consult the table for the area under the standard normal curve where *z* equals zero, 0.42 and 0.64 (i.e. 0.5000, 0.3372 and 0.2611).The *mean-z* areas are 0.1628 and 0.2389 respectively (i.e. 0.5000-0.3372 and 0.5000-0.2611). Thus, the *total* area under the curve, between +0.42 and -0.64, equals 0.4017 (i.e. 0.1628+0.2389). So, there is a roughly a 40 percent probability of the contribution ranging from £6.50 to £5.50.

Activity 2

Over many years, surveys reveal that probability analysis has gained ground (see Arnold and Hatzopoulus, 2000). One reason is that the *risk-return* profile for any normal distribution conveniently conforms to predetermined *confidence limits*.

Referring to Figure 4.1 and your z table, confirm that the percentage probability of any cash flow lying one, two, or three standard deviations above or below the EMV is given by the following confidence limits:

2	x	0.3413	for	$-\sigma$	to	$+\sigma$	=	68.26%
2	x	0.4772	for	-2σ	to	$+2\sigma$	=	95.44%
2	x	0.4987	for	-3σ	to	$+3\sigma$	=	99.74%

Applied to our previous Activity, now confirm there is a 99.74 percent probability that the distribution with an EMV of £6.10 and a standard deviation of £0.943 will have a contribution within the following range:
EMV $\pm$ 3σ = £6.10 + [3 (£0.943)] to £6.10 - [3 (£0.943] = <u>£8.93</u> to <u>£3.27</u>

4.5 The Mean-Variance Paradox

Returning to the normative objective of financial management, if capital is rationed or investments are mutually exclusive and choices must be made, project selection using *either* the highest expected return *or* the lowest standard deviation does not necessarily maximise wealth or minimise risk. Consider the risk-return profiles of two projects (A and B):

$$ENPV_A = £50k \text{ and } \sigma NPV_A = £30k \qquad ENPV_B = £200k \text{ and } \sigma NPV_B = £90k$$

ENPV selects B but σNPV selects A. But which maximises wealth and which is less risky?

To resolve the paradox, what we need is a *relative* rather than *absolute* statistical measure of project variability around its mean value that builds on confidence limits. One lifeline is the *coefficient of variation*:

(6) Coeff. V = σNPV / ENPV

This is interpreted as the smaller the coefficient, the lower the risk. Applied to the data:

$$\text{Coeff } V_A = 30/50 = \underline{£0.60} > \text{Coeff } V_B = 90/200 = \underline{£0.45}$$

Thus, Project A seems more risky than Project B because it involves £0.60 of risk ((σ NPV) for every £1.00 of ENPV, rather than £0.45 (σ NPV) for every £1.00 of ENPV.

The *coefficient of variation* is important because it tries to encapsulate the fundamental, twin objectives of corporate wealth maximisation, which we can summarise as follows:

WEALTH MAXIMISATION: MAX: ENPV and MIN: □NPV

MAX: ENPV, given □NPV
(i.e. maximise the ENPV for a given degree of variability)

MIN: □NPV, given ENPV
(i.e. minimise the variability of returns for a given ENPV).

Unfortunately, the coefficient of variation is not a *selection* criterion because it ignores investment *size*, thereby assuming that managerial risk attitudes are *constant*, even though intuitively we know that rational investors become more risk averse as their stake increases. Add zeros to the previous project data and note that the coefficients remain the same.

To remove this anomaly, management must predetermine a desired *minimum* ENPV for any investment (I_o) expressed as a *profitability index* to satisfy all their corporate investors.

Then comparison must be made to *expected* indices for proposed investments, incorporating *confidence limits* based upon an appropriate number of standard deviations. These define *subjective* managerial risk attitudes. So, the objective function for project selection becomes:

$$\text{(7) MAX: (ENPV - n}\sigma\text{NPV) / } I_0 \;\geq\; \text{MIN: NPV / } I_0$$

Activity 3

Assume management require a benchmark [MIN:NPV / I_0] = £0.15 to satisfy stakeholders. Use the previous data to derive the left-hand side of Equation (7) three standard deviations from the mean for each project (A and B) that cost £100k and £120k, respectively.

Which project, if either, is acceptable?

Recall that Project B was preferable using the coefficient of variation. Note now, however, that if management require almost complete certainty (99.74%) neither project is acceptable using the expected profitability index, although Project A *minimises* losses.

Project	£(ENPV - 3σNPV) / I_0	≥	MIN: £NPV / I_0	Decision
A	50-90/100 = (0.40)	>	0.15	Reject
B	200-270/120= (0.58)	>	0.15	Reject

4.5 Certainty Equivalence and Investor Utility

The ultimate test of mean-variance analysis depends upon investor risk attitudes. In our previous example, risk aversion signals rejection. Yet risk-seekers (speculators) might actually accept Project B because investing £120k rather than £100k might yield £470k as opposed to £140k three standard deviations *above* the mean, whilst the equivalent downside loss is only £70k compared with £50k. So, how do we circumvent this risk-return paradox?

One solution is to dispense with the standard deviation altogether and calibrate an individual's subjective attitude towards risk expressed in terms of units of *utility*, rather than monetary gains and losses, associated with investments. Given this *utility function*, we then calculate the *certain cash equivalent* of the distribution of uncertain cash flows discounted at the *risk- free* rate for any project and assess its viability for the investor using wealth maximisation criteria.

Consider the data set overleaf that signals a project acceptance using Equation 2 as follows:
ENPV = Σ EPV-I_0 = £67.5k - £50k = £17.5k

Cash Flows	**Investment**		**Discounted Gains and Losses**					**Decision**
PV (£000)	(50)		200	100	50	(10)	(15)	
Probability (P_i)	1.0		0.1	0.3	0.4	0.1	0.1	
EPV ($PV_i P_i$)	(50)	<	[20	30	20	(1)	(1.5)]	**Accept**
Equivalent Utility (U_i)	0.65		1.67	1.00	0.65	(0.75)	(1.52)	
Weighted Utility (U_iP_i)	0.65	>	[0.167	0.300	0.260	(0.075)	(0.152)]	**Reject**

Now look at the utility data, which *rejects* the project. To understand why, assume you ask the investor to enter a game with a 50/50 chance of receiving nothing or £100k to which we attach arbitrary utility values of zero and one respectively. Next you ask what the game is worth. The investor's response is £40k. This represents their *indifference* between certain cash and the game. Thus, three points on the individual's utility *curve* associated with *certain cash equivalents* can be obtained (shown in bold) based on the following *equation of indifference*:

(8) Certain Utility = Probabilistic Utility + Probabilistic Utility
U (£40,000) = [0.5 U (£0) = 0.5(**0**)] + [0.5 U (£100,000) = 0.5 (**1.0**)] = **0.5**

If the game's entry price was £50k he would walk away. However, other scale points, such as £50k (with a value of **0.65** say) can be established by gaming cash amounts for known utilities. If the procedure is repeated exhaustively, the investor's utility function consistent with his risk attitude will emerge, like the profile plotted in Figure 4.2 overleaf.

The curve's *geometry* (if not its specific values) applies to any *rational* investor. Except for small gambles relative to current wealth, it reveals risk aversion, denoted by the *convex* shape of the function (looking from above). Near the origin, the *concave* sector denotes risk preference. Note that the utility of one for £100k is *only* twice that of 0.5 for £40k (which we originally calculated) but *more* than half the utility of £200k, as risk aversion sets in.

Returning to our example, the application of Equation (8) using the investor's utility curve reveals that despite a positive ENPV the project should be *rejected*. The utility of its cost exceeds the cash equivalent of the expected utility of the discounted cash flow distribution.

U (£50,000) = **0.65** > Σ{0.167+0.300+0.260+(0.075)+(0.152)} = **0.5** = U (£40,000)

Review Activity

Summarise the problems that confront practising financial managers who use certainty cash equivalents, rather than mean-variance as a basis for investment appraisal.

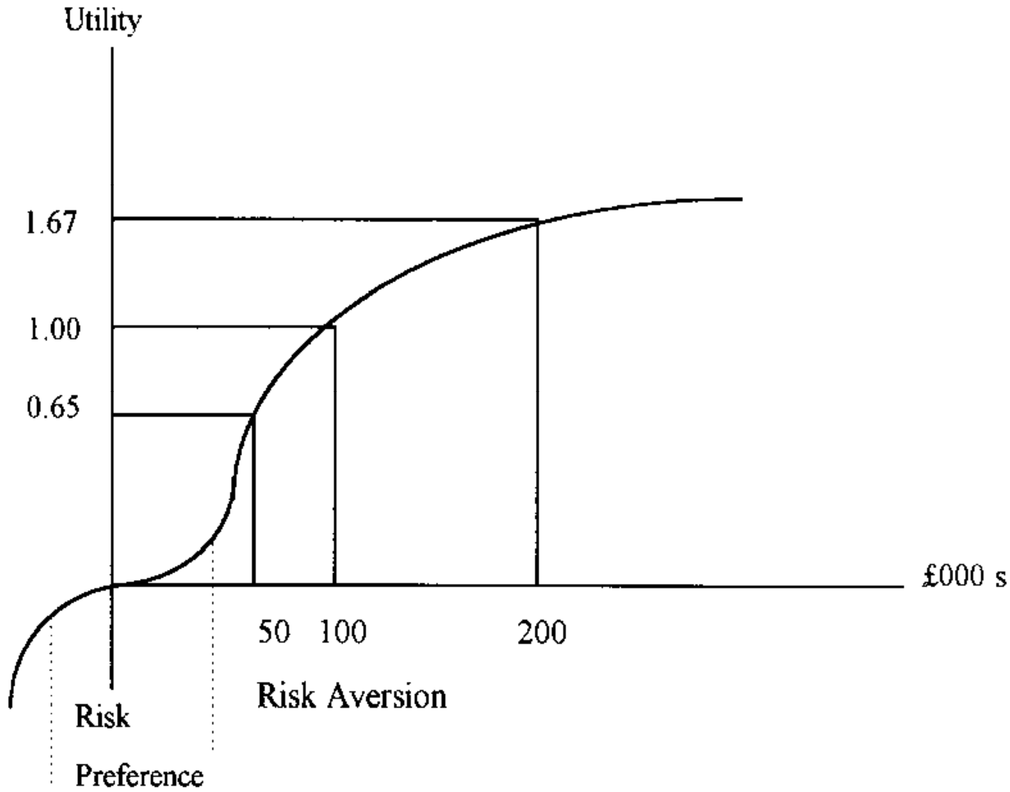

Figure 4.2: The Investor Utility Curve

4.6 Summary and Conclusions

ENPV maximisation using the certainty cash equivalents of expected utilities is more sophisticated than mean-variance analysis because it not only incorporates probabilistic estimates of a project's outcomes but also the investor's risk psychology. But remember:

- Utility functions, like project probability distributions, are subjective, differ from individual to individual, susceptible to change and must be combined (somehow) for group decisions.

- Certainty cash equivalents, like mean-variance analyses, not only depend upon the borrowing and reinvestment assumptions of the basic NPV model but must also utilise gains and losses discounted at a risk-free rate to avoid the duplication of risk

4.7 Reference

Arnold, G. C. and Hatzopoulos, P. D., “The Theory-Practice Gap in Capital Budgeting: Evidence from the United Kingdom”, *Journal of Business Finance and Accounting,* Vol. 25 (5) and (6), June / July, 2000.