A ‘Triple Bottom Line’ Approach to Advanced Project Evaluation

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PREFACE

This book is about calculating and interpreting the triple bottom line for buildings and infrastructure. The triple bottom line is not something that exists and can be identified, isolated and measured. Rather it is something we construct from a wide range of data, measuring different things in different ways. It requires a lot of data, it is time-consuming, and as a result, expensive.

The importance of what the triple bottom line measures cannot be overstated. We have, with our expanding economies, caused global climate change, depletion of resources, destruction of habitats, and serious problems regarding unequal income distribution. The triple bottom line is our best hope to reverse these trends, thus restoring environmental balance and promoting social well-being. This is why we need to persevere, to employ the methods and standards we have, and to work on improving them so that they become more efficient.

The triple bottom line is still a confusing concept that has grown out of our emerging concern for the environment. It aims to create a better future within a framework where we can balance the need for the profitability of investments with our concern for the environment and the well-being of society when evaluating potential investments in buildings and infrastructure. The three bottom lines refer to economic, environmental and social evaluations. It is confusing because the components of the three approaches are measured in different metrics, using different methods and methodologies, and there is no obvious way to compare the results.

While we now live in a world where most people are aware of the importance of our environment, the way to achieve this awareness, in hindsight, has not been as simple as could have been expected. Systematic evaluations of the economic viability of projects using discounting date back to the beginning of the last century and have been readily accepted, especially over the last few decades. However, an integrated approach including environmental and social aspects is much more recent, and even now, methods and methodologies are still being developed.

The book aims to put, in one place, the state of the development of an approach towards the triple bottom line. We have indicated where there is still debate about fundamental principles, and what the issues are. We point out where theory has been "overlooked" in the name of convenience and where there are still disagreements and unresolved problems. However, the emphasis of the book is not on theories and methodologies, it is about interpreting what we do in our calculations, what they mean and what the limitations are.

In particular, we look at how we can maximise the well-being of society when there is no way we can measure the well-being of individuals in an absolute way. Without the ability to compare individuals' well-being, there is, of course, no way we can amalgamate our three bottom lines into one in a way that we can rank and compare different projects in an absolute way. However, a systematic evaluation of all the information we have on economic, environmental and social impacts goes a long way towards an absolute ranking of projects, and the way we approach the evaluations are continuously being refined and improved. There is really no substitute to the triple bottom line.

About the Authors

Grace Ding is an Associate Professor at the University of Technology Sydney, Australia. She is passionately interested in sustainability and sustainable development, and has spent the last 25 years researching, writing and teaching on sustainability and environmental protection. She is a recognised authority on green building and the author of nearly a hundred book chapters, journal articles and conference papers on environmental topics. She is also the successful supervisor of many PhD students.

Göran Runeson is a retired renowned academic and is now an Adjunct Professor at several universities in Sydney, Australia. He started academic life as an economist after having worked in the construction industry for several years but saw the opportunity to combine his interests and transferred into the built environment. His research and teaching have revolved around various aspects of building economics and investment evaluation and, in particular, methodology. In a long career, he has published some 200 journal and conference papers, books and book chapters, and supervised many PhD students.

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List of Abbreviations

AHP	Analytic hierarchy process
BCR	Benefit-cost ratio
CBA	Cost-benefit analysis
CBD	Central business district
CEA	Cost-effectiveness analysis
CO_2	Carbon dioxide
CRITIC	Criteria importance through intercriteria correlation
DCF	Discounted cash flow
EIA	Environmental impact assessment
ELCA	Environmental life cycle assessment
ELCC	Environmental life cycle costing
ELECTRE	Elimination and choice expressing reality
EOL	End-of-life
ESD	Ecologically sustainable development
FV	Future value
GDP	Gross domestic product
GFA	Gross floor area
GHG	Greenhouse gas
GJ	Gegajoule
GRI	Global reporting initiative
HIA	Health impact assessment
IRR	Internal rate of return
ISO	International Standard Organisation
LCA	Life cycle assessment
LCC	Life cycle costing
LCSA	Life cycle sustainability assessment
MADM	Multi-attribute decision-making
MCA	Multi-criteria analysis
MCDM	Multi-criteria decision-making
MJ	Megajoule
MODM	Multi-objective decision-making
NPV	Net present value
NSW	New South Wales
PP	Uniform payments each period
PPP	Public-private partnership

PROMTHEE	Preference ranking organisation methods for enrichment evaluation
PV	Present value
SCBA	Social cost-benefit analysis
SD	Standard deviation
SETAC	Society of Environmental Toxicology and Chemistry
SLCA	Social life cycle assessment
TOPSIS	Technique for order of preference by similarity to ideal solution
UNEP	United Nations Environment Programme
UNIDO	United Nations Industrial Development Organisation

CHAPTER ONE

WHY BOTHER?

1.1 Introduction

This book is about evaluating investments in terms of economic, social and environmental aspects, the triple bottom line, or as it is sometimes referred to: the three Ps—Profit, the Planet and People. While techniques regarding economic evaluations have been around since the end of the nineteenth century, the idea of a comprehensive evaluation including both environmental and social aspects in addition to profitability is quite new. The idea of a triple bottom line is more of a statement of intent than a clearly defined and developed concept. The techniques for environmental evaluations are in the process of being standardised, although there are still many important issues outstanding. Social evaluations are still in the early stages of development.

In the literature, the different forms of evaluation are normally discussed in isolation. The reasons for this include that we began using them at different times. Economic evaluations were developed quite early and from an existing theoretical foundation that meant a reasonably rapid acceptance. The need for an environmental assessment was perceived more recently, but it was not generally accepted, and there is no overarching theoretical framework to join together the various aspects into a unified body of techniques. Hence development has been slower. Social evaluations are still in the early stages of development without even being able to approach a consensus of what should be included or how. There is no carry-over of techniques between the different types of evaluations.

We aim to indicate where there is still debate about fundamental principles, where theory has been overlooked in the name of convenience and where there are still unresolved problems. It is not, however, an attempt to introduce unnecessary complexities as regards the techniques. The discussions are there to help understand what we do in our calculations, and what the limitations are.

1.2 Why bother?

The fact that we appear to have done quite well over the last two or three hundred years, at least in economic terms, without these techniques, inevitably leads to the question: *Why bother?* Why not continue to do what we have always done in the past?

Before we answer this question, we will have a look at some projects where the techniques we discuss in this book were not applied and look at some of the potential consequences of not using them. We will do that in a historical context, as nowadays, most investors use at least some of the techniques we discuss in this book for economic evaluations, and some use versions of social and environmental techniques or have developed Corporate Social Responsibility programs.

Sometimes we are confronted by history that makes us ask *how* and *why*. This is never truer than when we stand in front of some of the marvels of the past like the Pyramids of Giza, the Colosseum of Rome, the Great Wall of China or Stonehenge in Great Britain. We simply cannot help being impressed and we ask *how* was it possible to build these monuments with the technology available at the time? The size of the stones that went into the pyramids or Stonehenge, the enormous extent of the Great Wall or the design and construction skills needed for the Colosseum cannot fail to impress us.

Cheops, the biggest and oldest of the Giza pyramids was the tallest building in the world for almost 4,000 years until we started to construct the great cathedrals of the 14th century in Europe. It was built using blocks of stone weighing up to 80 tonnes, which were transported from quarries 800 km from the site. The Great Wall of China, almost 22,000 km long including all its branches, occupied a workforce of more than a million for most of its construction. The Colosseum was built to seat 80,000 spectators at a time when estimates of the population in Rome start at 400,000, while no one is quite sure of the purpose for which Stonehenge was built. Even with modern technology, these would be formidable projects.

The *why* is equally puzzling. We know, of course, that the pyramids were tombs for the pharaohs, the rulers of Egypt. The Great Wall was part of China's defence system, shutting out the barbarians to the north, while the Colosseum was built to house all forms of entertainment, including innovative ways to kill early Christians and other troublesome people. Only the purpose of Stonehenge is uncertain. However, that does not answer the most important question: *why* were these societies prepared to spend so many resources on these oversized and unproductive projects?

At the time these projects were constructed, food production was very inefficient. Feeding a population in medieval Europe required something like 97 to 99 per cent of them to be fully occupied in the production of food, and things would not have been all that much better when these projects were undertaken. May be it was a little bit better in China and Egypt, while Rome could import from the rest of its empire.

However, the size of the projects and the labour required for each of them meant that virtually everyone not needed for food production was employed on these projects. There was no additional surplus of food and therefore no one available to develop trade or industry, extend irrigation systems, improve land and sea transport or promote science and education. Yet someone in command deemed these projects to be more important than any of these alternatives.

China may be the best illustration of the potential cost. When it built the Great Wall, using a labour force of more than a million workers, which happened around the same time as it restored the Grand Canal and kept an enormous standing army, it had developed most of the technical preconditions for an industrial revolution like that of Great Britain three hundred years later. It had responded to the same problem and developed the same machinery that got industrialisation underway in Great Britain, but in China it stalled.

It is interesting to speculate on what could have happened if the Chinese financial system had been as sophisticated as the British one was three hundred years later, so that the resources had not been used for an essentially wasteful project, but instead been employed in something like textile production which initially powered British industrial development. May be China could have continued as the richest, most powerful and developed country in the world rather than start the economic decline that allowed Europe and North America to take up this position.

It is difficult to say how successful these projects were for their intended purpose. The Colosseum continued to be used for more than four centuries, although it was damaged by earthquakes that severely limited its capacity. The Great Wall certainly stopped the raids from the Mongols until a conquering army bought its way through one of the gates in the Great Wall. It is, however, doubtful if it actually saved lives by ending the raids, as more than a million workers are estimated to have died during the construction. The purpose of Stonehenge was eventually forgotten and there are few criteria for the success of tombs like the pyramids.

Now, these projects have had a renaissance of sorts. As they have become part of the tourist industry, we enjoy, or even plan our travel around these projects and they are visited by hundreds of thousands of tourists every year. However, before that, they stood without purpose for hundreds, in some cases thousands of years, serving only as sources for building materials for more immediately needed construction. There are many lessons we can learn from this. One of the most powerful lessons is that we must carefully evaluate if the benefits of any project, big or small, exceed the costs. These projects were not systematically evaluated for their benefits or costs or for how they affected society at large. There were no comparisons with any alternatives. It is unlikely that any of them could have been justified when compared to projects that would have added to economic or social development.

Now things are in the process of changing. When deciding on large projects, we must be able to answer *why*: why these projects and not any of the hundreds or thousands of alternative projects? We must ensure firstly that the economic benefits exceed the costs more efficiently than the projects we decide not to build. Secondly, more and more importantly, we must ensure that the impact on society at large is beneficial. Thirdly, we are also starting to look at ways to reduce the environmental impact of investments and ensure, as far as possible, that our projects contribute to a sustainable society. Implicitly or explicitly, we compare all different alternatives and try different solutions to ensure the best possible outcome.

1.3 What are the problems?

However, no one can pretend that it is easy to calculate the value of a project. There are problems every step of the way, some theoretical, others practical. Many people are using the problems as excuses for not applying the techniques as rigorously or as often as possible. They point to the fact that to do the calculations, we are firstly forced to generate information about what will happen to the project and the market it operates in, in an unknown and uncertain future, which is another way of saying that we are guessing about all the inputs into our formulas. Secondly, we have to simplify assumptions about how the economy works and how long the projects will be functional. That is, we create a model of the actual environment that is so simple that we can operate it.

Making forecasts is difficult. Who would, for instance, have accurately estimated current house prices in Sydney 50 years ago? IBM, in their famous pronouncement about the demand for computers, estimated that there would be a total world demand for two. Even 30 years ago, mobile telephones existed only in comic strips and no one had even thought of smartphones. Even the relatively simplest things, like construction time and costs, are difficult to estimate accurately. It is not likely, for instance, that the people that started building Stonehenge thought that it would take a thousand years to finish the job, and if they had a cost estimate, it is likely that they underestimated the actual cost in the same way. Things are better now, but far from perfect. The original cost estimate for the Sydney Opera House was $7 million while it ended up costing $102 million, an over-run of almost 1,400 per cent. The construction period was extended from 4 to 14 years, or 250 per cent (Hall 1980).

1.4 Why we bother

Some people are using this as an excuse for not doing the evaluations. The argument goes something like: *Why bother when we know that the probability that we will get it right is virtually zero?* However, this misses the point, or rather, several points. First of all, we build very few opera houses and other very unconventional designs where we have no experience of how to build and therefore how long it will take and what it will cost. Mostly, we build fairly conventional buildings where we have a lot of experience to draw on, so the errors we make are relatively small. Secondly, we do not really try to evaluate the actual net value of a project. We do it to see what we should invest in, and that is quite a different proposition.

We do the evaluations firstly to establish the *relative* net economic benefits of buildings, their *relative* social impact and their *relative* cost to the environment. Then we can *rank* the buildings we are considering. This is a lot easier than establishing the absolute costs or benefits because if we make systematic errors like underestimating future costs or overestimating future benefits, that will affect most of the buildings in much the same way and not have much impact on the order of merit. Secondly, the techniques we will discuss here may not be perfect but they are the best techniques we currently have for a systematic ranking and there is no doubt, even if it is not one hundred per cent accurate, that it is far superior to no ranking.

Our estimates are also, of course, the most accurate estimates of the actual value of projects, economically, socially and environmentally, which is nice to know, but on its own, this is in most cases not very interesting. It becomes interesting only when we compare several different projects.

The economic benefits are obviously of great interest to investors, but why should we care if by making the right investment decisions, they get a little bit richer than they would otherwise have been? Well, economic growth depends on two things—productivity and innovation. Both depend on investment—the right kind of investment. The right kind of investment increases the amount of capital each of us has to work with. Better equipment and machinery, better buildings, and better infrastructure make us produce more efficiently and use fewer resources. New investments almost always mean new embodied technology or innovation that also makes us able to produce more. The overall benefit of these exercises is that we select the most profitable projects, the ones that make us most productive and introduce the best technology. It is good for the investor, whether that is a private or a public investor, but it is also good for the rest of us. For the same reason, the common good of new investments, it is equally important that we evaluate social and environmental effects of investments so that the efficiency of all investments goes up and the costs—monetary and non-monetary—go down. For society at large, it means a more efficient use of all resources so that we as a community can produce what we consume more efficiently and therefore be better off.

So, this is the answer to the question in the chapter heading: *Why bother*? A proper analysis of new projects makes us all more efficient, and therefore richer, and the community we live in better, whether we make the investments ourselves or not. That is why we should bother.

Unfortunately, we have to discuss the different kinds of assessment separately. We cannot make an integrated assessment of economic, social and environmental merits of an investment. All we can do is assess them separately and then apply some sort of rule for how to determine the importance or weight of the three assessments. The reason for this is that there is no generally agreed method to compare the three criteria. For some, economics is by far the most important aspect and environmental and social aspects should be considered only when the economics of the two alternatives are equal. For others, environmental aspects are the only consideration as profit does not matter once the planet is destroyed. In the absence of any agreement, we have to compromise and adjust our expectations. We are doing this through a political process.

The fact that, in the end, we have to rely on a political process, a national election, voting on a company board or informal discussions with stakeholders to determine what we want (Arrow 1951 & 1963)[1], does not make the assessment less important. Rather the opposite. Before we start the decision-making process, it is essential that we know exactly what the characteristics of the alternatives are.

1.5 Sustainable development—myth or reality?

For the last 50 or 60 years or so, the debate has been framed in terms of sustainability. The debate about sustainability was originally activated by the Club of Rome's report, "The Limits to Growth" during the 1960s and 1970s. The debate led to the First United Nations Conference on the Human Environment held in Stockholm in 1972, where an international agreement on the desired behaviour and responsibilities to ensure environmental protection was discussed. The discussion was followed by the World Conservation Strategy in 1980 when the term "sustainable development" was first expressed (Rees 1999).

The concept of sustainable development was further discussed at the Earth Summit held in Rio de Janeiro in 1992 by the United Nations Conference on Environment and Development (UNCED 1992). The Earth Summit was the first international conference attended by world leaders on environmental issues to promote international co-operation for global agreements and partnerships for environmental protection.

According to the discussion in the literature, it is not the difficulty of defining sustainable development that is the major issue, but rather the difficulty of determining ways to achieve the goal. The concept of sustainable development has emerged to describe a new framework for development aimed at achieving economic and social balance while

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[1] Theoretically, there are, for several reasons, problems with voting when it comes to maximising the total welfare or utility of a group of people. A good starting point for anyone interested in the reasons is Arrow's impossibility theorem, first discussed in Arrow 1951 and extended in 1963.

maintaining the long-term integrity of ecological systems. The concept is firmly embedded in government policy, legislation and the environmental policies of private organisations. That, however, does not mean that we agree on a definition.

According to Goodland and Daly (1995), sustainability has three levels: weak, strong and absurdly strong. Weak sustainability requires that man-made and natural capital do not decline and are close substitutes. Strong sustainability is based on a disagreement of the degree of substitution and natural and man-made capital are not substitutable but complementary in most production functions. Absurdly strong sustainability tends to stress the limits of sustainability. Accordingly, non-renewable resources could never be used at all and renewable resources could only be harvested at the net annual growth. With these three levels of sustainability, controversy about the meaning and definition of sustainable development is inevitable.

Sustainable means the ability to be maintained indefinitely within limits while development implies the pursuit of continuous growth (Cooper 2002). This appears contradictory, as development tends to destroy the ability to sustain. However, many believe that as long as development is sustained, economic growth will continue and environmental issues will be dealt with through technology. As such, economic activities could continue without long-term damage to the natural environment or general human well-being. This viewpoint indicates that economic growth will continue to thrive while the environment will never be deprived, or even used, at all. However, it is highly unlikely that this will happen, as economic growth requires the consumption of environmental resources to sustain its activities.

Over the years, many research studies have tried to define the meaning of sustainable development. There have been frequent debates concerning the meaning of sustainable development, whether it should be a single dimension, two dimensions or three dimensions. The most used definition of sustainable development is derived from the Brundtland Commission on Environment and Development (WCED 1987, p. 43): “development that meets the needs of present generations without compromising the ability of future generations to meet their needs and aspirations”. Brundtland’s definition of sustainable development presents a two-pillar model that includes economic growth and social well-being. This model considers both intra- and inter-generational equity in its mention of fulfilling both present and future needs. However, some argue that Brundtland’s definition was the early form of a three-dimensional concept of sustainable development.

Brundtland's definition encapsulates aspects of environmental, economic and social aims in order to achieve the goal of sustainable development (Klöpffer 2008). The definition aims to eliminate poverty and deprivation, conserve and enhance natural resources, encapsulate the concept of economic growth, social and cultural variations into development, and finally, incorporate economic growth and ecology in decision-making. The three-dimensional concept of sustainable development has preconditioned environmental health as crucial for maintaining economic growth and social well-being for present and future generations.

There is no doubt that sustainable development is not a single-dimensional concept, and integrating environmental, economic and social aspects into decision-making in projects and policies has attracted much attention (Jabareen 2008). The three-dimensional concept was later termed the "triple bottom line", a phrase coined by John Elkington in 1995 (Elkington 1997). The initial focus of the triple bottom line was the 3Ps concept: profit, people and planet, and it was initiated to measure performance in corporations. The 3Ps concept of the triple bottom line was later developed into environmental, economic and social sustainability in research studies.

The three dimensions of sustainability have also been conceptualised as three intersecting circles respectively representing environmental, economic and social sustainability. The intersection of the three circles represents sustainability. The three dimensions of sustainability were later further modelled as three concentric circles, with economic sustainability being the innermost circle in the model. The economy is entirely supported by society and both the economy and society are considered as primarily dependent upon the environment. The model shows an interconnected and interdependent relationship on the three pillars of sustainability. Performance in one aspect affects performance in the other areas (Purvis et al. 2019).

It is true that sustainable development is about imposing limitations on the use of scarce natural resources in the production and consumption process in order to ensure the quality of life of present and future generations. In that way, sufficient resources may be reserved to allow future generations to have an acceptable level of welfare and quality of life. As the WCED definition appeals to many, it forms the guiding principle for the design of environmentally sound socio-economic policies. It is also clear from the report that unless decisions are taken now to address the deteriorating situation, future generations will not have the ability to correct them. Therefore, there is an immediate need for action for this crisis situation.

1.6 Conclusion

Today, it may seem natural to consider not only the economics of an investment but also the impact on the environment and the well-being of society. We live in a world where most people are aware of the importance of our environment. The way to get there has, in hindsight, not been as simple as could have been expected. Systematic evaluations of the economic viability of projects using discounting date back to the beginning of the last century (Parker 1968), and have been readily accepted, especially over the last few decades. However, an integrated approach including environmental and social aspects is much more recent, and the methods are not yet as widely accepted. The framework promoted here—the triple bottom line—was coined in the late 90s (Elkington 1997). Even now, methods and methodologies are still being developed.

CHAPTER TWO

DISCOUNTED CASH FLOWS

2.1 Introduction

This section of the book will deal with the economic assessment of investments. We will start by looking at how to use the various techniques in the private sector. This is, as we will discuss later, comparatively straightforward. After mastering the basic techniques, we will look at how they need to be modified to deal with the particular characteristics of the public sector where aims and objectives are much more complex.

Essentially, we will provide you with techniques that can answer questions such as:

Is an investment profitable?
Which alternative investment opportunities should be selected?
Should existing equipment be retained or replaced?
When does a higher potential profit justify a higher risk?

All of these questions concern productivity in the use of resources, and the reason for using these techniques is to ensure the most productive use, and therefore the best return on these resources.

There are several different techniques used for evaluating investments. The simpler ones are based on simple additions or subtractions of expenditures and incomes or expressing ratios as percentages. We will have a look at them soon and see why their answers are not even good approximations of the actual values of investments. The more complex ones incorporate the value of time. They recognise that a dollar today is not the same as a dollar in one or ten years into the future, if for no other reason that I could deposit my dollar in a bank and after a year get it back together with some additional money in interest. This is a payment to me because I have allowed the bank to use my money for a year, or as they say in economic textbooks, my reward for delaying consumption and this, in economic jargon, shows my time preferences.

2.2 The concept of the time value of money

Time here can be really important. When Peter Minuit bought Manhattan Island in 1626 from the Lenape Native Americans (Otto 2015), he apparently paid 60 Dutch Guilders, which is commonly translated as \$24, in what at that time and place was high technology items like cloth, iron kettles and axe heads, hoes and drills. This is generally described as a very good buy. Was it? Well, it depends. If the Lenape people had instead insisted on cash and invested the equivalent sum of money, \$24, at 10 per cent, which is not unreasonable as the Dutch East India Company averaged more than 30 per cent return on capital at that time, they would now have a total of something like \$367,071,898,992,611,584. This is quite a lot of money, enough to give every man, woman and child now living, a lump sum of more than \$50 million each.

Even differences in interest rates are important. When I first used this example, the interest rate was a lot higher than now, so I used 15 per cent instead of 10 per cent. At that interest rate, the total wealth of the Lenape people would have been about 1.3×10^{25} or, more exactly, \$12,973,788,686,229,920,372,752,384 and shared between the population of the world, all 7 billion of us, we would each have about \$1,850 trillion. To put that into perspective, the total Gross World Product is about \$90 trillion. Another way of illustrating the magnitude of the money is that if we wanted to live on the interest only, and not touch the capital, we could each spend about \$10 million every second and still not run out of money.

These calculations may not be, or rather are certainly not, totally realistic. The interest rate has varied over the 393 years since with all sorts of things like wars and famines happening to disrupt the economy. There is also this thing called inflation that has the ability to drastically erode the value of money. Furthermore, it is not likely, for instance, that with that kind of money available for investment, the rate of interest would have stayed as high as that for long, but it does indicate, in an abstract way, the power of interest and time combined. It is certainly enough to make you cross with your ancestors who were too greedy to put a few dollars aside for our benefit.

This kind of evaluation, that considers the time value of money, is referred to as discounting or Discounted Cash Flow Analysis or DCF analysis for short. We will spend most of this section of the book dealing with different aspects of DCF analysis. However, before we get there, we will deal with the most common non-discounting methods, the Investment Yield and the Payback Period. Before we start, we need an explanation, or rather, warning about the terminology and methods. Someone seems to have designed the terminology with the single purpose of confusing everyone. The investment yield, for instance, is known by many names, the two most common alternatives being "Accounting Rate of Return" and "Return on Investment". The terminology used here is the most common and, hopefully, the most easily understood.

2.3 Non-discounting methods of investment evaluations

2.3.1 Investment yield

The investment yield is the annual net income as a percentage of the cost of the investment. The net annual income is the typical annual net income. For a building, the potential income may not be achieved in the first year after construction as there may be some vacancies or lease incentives. Rather it may be in the second or third year when this income is achieved. Investment costs are the sum of all costs associated with the investment. This means money that has been paid out, but it should also include initial shortfalls in income. If, for instance in the first year, tenants have received a discount on their rent, the value of this discount should be added to the cost of investment. Note that refurbishment costs and end-of-life (EOL) expenditures or any other costs occurring during the life of the building are not included. There are other problems with this method. Use of existing resources, such as land, if included, which of course they should be, are mostly included as the cost at the time of purchase—i.e. its historical cost—even if the value has changed significantly since then.

Investment yield is calculated using the following formula:

$$Investment\ yield\ = \frac{Annual\ net\ income}{Total\ cost\ of\ investment}\ \text{x}\ 100 \qquad (2.1)$$

Example 1:
Net annual income = \$200,000
Original investment = \$1,000,000
Investment yield = \$200,000/\$1,000,000 = 20 per cent

The investment yield is just another name for the return on an investment. It is also broadly the same as the accounting rate of return, although this is normally compiled following the rules of the Taxation Office when it calculates investment and income. This would, for instance, include depreciation as a separate entry. While the yield provides a ranking, it is easy to see why it is not a very good one. For a start, it is based on the income in a single year and ignores future costs and incomes. There is nothing about periodic refurbishments or changes in technology that may change the level of income. The lifespan of the building is not included in the calculations. Yet it is simple and therefore popular. It is also conceptually very ambiguous—the yield (minus the cost of money) is frequently mistaken as profit. This kind of analysis is ideal after a good lunch for the anecdotal “back of an envelope” calculations:

> “Assume that it costs $10m and that the annual income is $2m.
> That is a 20 per cent yield.
> Seems clear that we should go ahead?”
> “Any objections???”

2.3.2 Payback period

The payback period is equally simplistic. It is the time it takes to earn the equivalent of the original investment. The concept can be illustrated in the following example:

> Example 2:
> An investment of $10,000 earns $2,000 net per year
> Payback period = $10,000/$2,000 = 5 years

Note that the payback period will not change if the lifespan increases. Projects with the same annual income but with different lifespans will have exactly the same payback period. If the annual income had been $4,000, we assume that the income is evenly distributed over the years so that the payback period is 2.5 years.

If an investment is $1,000 and the annual income is $100, the payback period is 10 years which is when the income adds up to the original investment. This is a simple answer, but there are two problems with that. The first one is that any money coming in after the end of the payback is not considered. The second one has to do with the time value of money. I came across this problem when I lived in a country where the government wanted everyone to invest in a solar water heater.

The government explained in their advertisements that solar water heaters cost about $1,000 and would typically save us $100 every year, so that after 10 years, the hot water would be free. At the time, the interest rate was about 12 per cent which meant that if you had to borrow the money, you had to pay $120 in interest every year on the $1,000, which is $20 more than you saved. If you had money so that you need not borrow, spending it on the solar water heater would mean you would forego the interest it would have earned you, deposited in a bank. That would have been about $100 per year. Nowhere are there any savings that could be used to pay off the initial cost. Depending on your view of politicians, the promotion was either dishonest or fundamentally incompetent.

Both the investment yield and the payback period can rank projects that are very similar, like two warehouses or two photocopiers, but they cannot be used to determine if a project is profitable, nor can they be used to compare alternative investments with different characteristics. The investment yield is normally used for long-term investments such as buildings or infrastructure while the payback period is mostly used for items with a fairly limited lifespan.

The safest way to use these methods is to not use them at all.

2.4 Discounting methods of investment evaluations

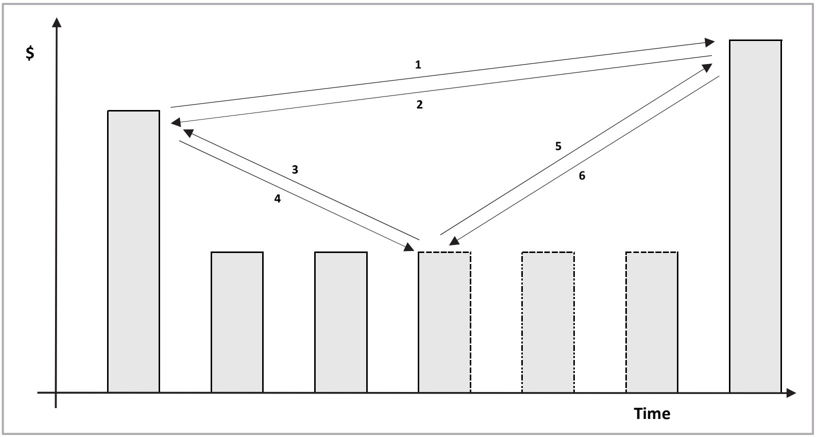
2.4.1 The concept of discounting

DCF analysis is essentially a set of techniques. However, behind these techniques, there is normally a theory. This is mostly neo-classical micro-economics and sometimes welfare economics (Kapp 1972; Cooper 1980). The theories affect the techniques but there is no need to master the theory to use the techniques, although we may refer to the theories when it makes the techniques counter-intuitive or when the terms have different meanings from the meaning we usually infer when we use the words. Utility, for instance, refers to the satisfaction that derives from consuming a good or service; costs are opportunity costs; prices may be shadow prices. It will all be explained later in the book.

Inter-temporal comparisons—comparisons between the utility of money at different periods of time—are theoretically very complex. We ignore these complexities by using a set of rules that bypasses theoretical issues. In particular, we stipulate that all the various factors that affect our utility of consumption at different points in time can be condensed into a single rate of interest (Fredrick et al. 2002)[2]. This is a crucial assumption—without that assumption, there would be no investment evaluation. It is not likely to be true, but we do not know how closely it resembles the truth. We do not really know what goes into the interest rate, what it means or what it measures, but it is convenient to use. For DCF calculations, we refer to this central concept as the discount rate.

Discounting a cash flow means that we convert money at different points in time to its equivalent at one particular point in time. There are six different main ways we can transform money (Figure 2.1) and we can refer to Appendix A for a table showing different conversions:

Figure 2.1 Six different kinds of discounted cash flow conversions



1. From the present to sometime in the future where the interest payments are added to the capital as they accrue (Growth at compound interest; single payment compounded)

$$FV = PV(1 + r)^n \tag{2.2}$$

[2] There are many reviews of the theoretical foundations of time preferences. See for instance Fredrick et al. 2002.