Investment risk

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Introduction

A fair return on investment is defined as one that compensates the investor for the risk incurred in making the investment – neither more nor less. Conversely, an excess return is one that over-compensates the investor for the risk incurred. Investors want to avoid investments that pay **less** than a fair return, while borrowers want to avoid paying an excess return. In this course we shall:

- define more precisely what we mean by 'risk' in a financial context;
- consider how investors react to the presence or threat of risk;
- develop a method of quantifying risk mathematically; and
- look at the main factors contributing to investment risk in the real world.

Finally, we shall see how the use of the net present value rule enables investors to calculate whether the risks they incur are adequately rewarded.

This OpenLearn course provides a sample of postgraduate study in Business

Learning Outcomes

After studying this course, you should be able to:

- explain the concept of risk in an investment context
- comment critically on the impact of the principal risk factors in a given investment context.

1 Risk aversion

1.1 A note about terminology

We begin with a ‘health warning’ about terminology, this time about the use of the word ‘risk’ in finance.

The difference between the everyday and the specialised meanings of ‘risk’ is less technical and more radical than in the case of ‘return’. In everyday usage, ‘risk’ is negative – the risk of having a car accident or the risk of losing one's job. If we use ‘risk’ in a positive sense at all, it is only as a result of adopting a consciously ironic tone: ‘There's not much risk of my winning the lottery this week.’ But in the language of finance, ‘risk’ is **neutral** and refers purely to the possibility that a particular outcome will be different from (that is, either worse **or better** than) either a single expected outcome or the probability-weighted mean of many possible outcomes. In other words, in financial language ‘risk’ is the same as ‘uncertainty’.

1.2 Are investors risk-averse?

We will define ‘risk premium’ as an extra reward required by investors to compensate for perceived uncertainty in the amount or timing of an expected return.

But do investors in fact require an extra premium for uncertainty, or is this perhaps just a convenient assumption?

The following activity is designed to give you an opportunity to test your own reactions.

Activity 1

Consider two alternative and mutually exclusive investments. Investment A is guaranteed to produce a constant annual real rate of return of x%. Investment B is guaranteed to produce an **average** annual real rate of return of x% over a period of many years, but the actual annual returns will be scattered widely around this average value. Which investment would you choose, and why? You may wish to use the Comments section below to ask other students whether they reach the same conclusion as you do – and for the same reasons.

Answer

You probably found that most people preferred Investment A, but what sort of reasons did you and they give? One answer is something like this. The benefit conferred by the unexpected extra income of, say, £a in a good year is somehow less than the corresponding pain inflicted by the unexpected shortfall of £a in a bad year. This could be because, as our income increases, we spend each marginal pound on less essential goods and services. On average, for every good year when Investment B produces a return of (x + a)%, there will be a correspondingly bad year when it produces a return of only (x – a)%. In the terminology of economics, the extra a% earned in the good year gives the investor less utility than is lost by the shortfall of a% in the bad year. So the total utility of the fluctuating returns on B will be less than the total utility of the constant return on A. Most investors will therefore prefer Investment A.

So much for the theoretical argument. Is it supported by empirical observation? The answer is a clear 'yes'. The detailed mathematics of this risk/return trade-off is dealt with by more advanced topics such as the benefits of diversification and portfolio theory. What is important at this early stage of the debate is that you accept that there is a risk/return trade-off, and understand how risk is quantified. We can express this trade-off by saying that investors are **risk-averse**. By this we do not mean that they avoid risk at all costs, or that they routinely seek to insure away all risks. We mean rather that for a given level of return, investors prefer less risk to more risk, and that for a given level of risk, they prefer more return to less return.

2 Quantifying risk

2.1 Looking at each of the possible alternative outcomes

Investment risk is synonymous with uncertainty of outcome, so it is logical to try to quantify risk by looking at the relative uncertainty, or probability, of each of the possible alternative outcomes.

Suppose that we are interested in investing in the shares of Company X, and want to know:

- What is the mean or average expected total return for the next year?
- What is the degree of risk or uncertainty in this mean figure?

We might begin by collecting and tabulating data about total returns on the same company's shares for each of the past 50 years. In order to make this example easy to follow, we shall keep the data very simple, but the same principles apply to the more complex patterns of data derived from real-life studies. The simplified table might look like Table 1.

Table 1 Frequency distribution of the actual total returns on a one-year investment in shares of Company X in each of the last 50 years

Total return (% per annum)	Frequency of occurrence	Probability
4%	10	0.2
6%	15	0.3
8%	15	0.3
10%	10	0.2
Totals	**50**	**1.0**

What can we say about next year's total return on an investment in shares of Company X? If the fundamental factors determining the share's performance are unchanged – and that is a very big 'if' indeed – we can convert these long-run frequencies of past returns into probabilities concerning the future. The big question – whether the future is an extension of the past – is one to which we shall return later.

2.2 Calculating returns

Our first question was: what is the mean expected total return for next year? We calculate this by taking each of the possible returns and weighting it by its relative probability. As our table is so simple and symmetrical, it is not difficult to see that the weighted mean return is 7% per annum.

Our second question was: what is the degree of risk or uncertainty in this mean figure? In other words, how widely dispersed are the possible outcomes around the mean expected outcome? The most commonly used statistical measure of dispersion is the standard deviation. We need to be aware of some limitations in its use, but first here is how the calculation would look in the case of returns on Company X's shares. We shall use the notation *E (R)* to denote the mean expected return, which is *7%* per annum in this case.

Table 2 Calculation of standard deviation of actual total returns on a one-year investment in shares of Company X in each of the last 50 years

Annual return R_I	Dispersion $E(R) - R_i$	Square of dispersion $[E(R) - R_I]^2$	Probability P_I	$P_i[E(R) - R_i]^2$
4	+3	9	0.2	1.8
6	+1	1	0.3	0.3
8	−1	1	0.3	0.3
10	−3	9	0.2	1.8

Sum of the squares of the probability-weighted dispersions (= variance) *V* = 4.2

Square root of variance *(V)* = standard deviation $(S) = \sqrt{4.2} = 2.05$

The standard deviation is normally expressed in the same units as the expected return (in this case, per cent per annum) and is intuitively easier to understand than the variance, especially with a normal distribution where the possible outcomes are symmetrically dispersed around the mean.

The particular usefulness of the standard deviation of normally distributed data is the way it divides up the data so that:

- 68.3% of the data points lie within one standard deviation on either side of the mean;
- 95.4% of the data points lie within two standard deviations on either side of the mean.

In the case of an investment in shares of Company X, the calculation in Table 2 tells us that there is:

- a 68.3% probability that the return will lie between 4.95% (i.e. 7 – 2.05) and 9.05% (i.e. 7 + 2.05), and
- a 95.4% probability that it will lie between 2.9% (i.e. 7 – 2 x 2.05) and 11.1% (i.e. 7 + 2 x 2.05).

The principal limitation on the use of standard deviation as a measure of dispersion in investment returns is that in the real world actual returns are not as neatly or symmetrically dispersed as they were in our Company X example. However, the shape of many long-run statistical series for investment returns is in fact quite close to the familiar bell-curve of the normal distribution. So for most practical purposes the standard deviation is as useful a measure as we are likely to find.

Try these techniques for yourself in the following self-assessment.

Self-assessment question 1

1. Calculate the mean expected annual return on shares in The Lead Balloon Co. Ltd from the following historical data.

Total return (% per annum)	Frequency of occurrence	Probability	Probability-weighted return
−7%	4		
3%	15		
10%	18		
15%	24		
21%	19		
26%	12		
29%	8		
Total/Mean	**100**		

2. What assumptions did you make in your calculation?

3. Now take your results from the first part of the self-assessment and use the following table to calculate the standard deviation of the same set of returns.

Annual return R_i	Dispersion $E(R) - R_i$	Square of dispersion $[E(R) - R_i]^2$	Probability P_i	$P_i[E(R) - R_i]^2$
−7%				
3%				
10%				
15%				
21%				
26%				
29%				

Sum of the squares of the probability-weighted dispersions (= variance) =

Square root of variance *(V)* = standard deviation (S) =

4. Does the table show a normal distribution?

5. What do you think is the probability that the actual rate of return in any year might lie between 6% and 24%?

Answer

1.

Total return (% per annum)	Frequency of occurrence	Probability	Probability-weighted return (% per annum)
−7	4	0.04	−0.28

3	15	0.15	0.45
10	18	0.18	1.80
15	24	0.24	3.60
21	19	0.19	3.99
26	12	0.12	3.12
29	8	0.08	2.32
Total/Mean	**100**		**15.00%**

2. The main assumption that you made was that the future can be extrapolated from the past. You may well take the view that demand for this particular company's product is unlikely to fluctuate substantially over time!

3.

Annual return R_I	**Dispersion $E(R) - R_i$**	**Square of dispersion $[E(R) - R_I]^2$**	**Probability P_I**	**$P_i[E(R) - R_i]^2$**
−7%	22	484	0.04	19.36
3%	12	144	0.15	21.60
10%	5	25	0.18	4.50
15%	0	0	0.24	0
21%	−6	36	0.19	6.84
26%	−11	121	0.12	14.52
29%	−14	196	0.08	15.68
				82.50

Sum of the squares of the probability-weighted dispersions (= variance)

Square root of variance *(V)* = standard deviation (S) = 82.50 = 9.083

4. The table shows a pattern quite close to a normal distribution. The mean and mode do coincide at 15.00%. There is a slight asymmetry in the shape of the ‘shoulders’ of the bell. The ‘tails’ at opposite ends of the distribution differ from each other slightly, but not so much as to skew the data significantly in one direction or the other. Overall, we can say that standard deviation is still a useful measure of dispersion for a table of this type.

5. The standard deviation of 9.083% means that there is a 68.3% probability that the actual return will lie between (15.00 – 9.083)% and (15 + 9.083)%, i.e. between approximately 5.9% and 24.1%. The probability of an outcome between 6.00% and 24.00% is therefore slightly less than this – say, about two-thirds.

3 Risk factors

3.1 Background

In practice, there is almost always some element of risk (in the technical sense of 'uncertainty') in any investment return. There is in finance the theoretical concept of a truly risk-free asset, but at the moment it is sufficient just to be aware of the main factors causing risk or uncertainty in practice. These are:

- maturity
- liquidity
- variability of income
- default or credit risk
- event risk
- interest rate risk.

We shall consider each of these in more detail in a moment, but first we need to remind ourselves of the principal features of each of the main forms of financial investment. The most important distinction to keep in mind is that between equity and debt.

The commonest form of equity investment is the ownership of ordinary shares (in US parlance, 'common stock') of a company. Ordinary shares issued by a company are not contractual obligations and have no repayment or maturity date. Unlike lenders and other creditors, investors in the shares of a company cannot legally demand their money back from the company. They are entitled only to a proportional share in:

1. any dividend that the company might pay out of its income; and
2. the capital surplus (if any) after the claims of all creditors have been paid off in a final liquidation of the company.

Shares may or may not be tradable on a stock exchange.

Debt is a contractual obligation of the company to make fixed (or at least determinable) payments of interest and principal to a creditor or group of creditors. Failure to meet these contractual commitments exposes the company to the threat of legal action for recovery of the amounts owed, as well as the possible loss of any assets pledged as security for the debt and – in extreme cases – compulsory liquidation. Debt comes in many shapes and forms, all of which rank ahead of equity in terms of their claims on the assets of a company. How they rank *vis-à-vis* each other depends on the contractual arrangements between each creditor or creditor group and the company. Some creditors – such as the tax authorities – enjoy a degree of statutory preference that cannot be overturned by contract. Important forms of debt are:

- **bank debt**, which can take many forms. The simplest is the overdraft, repayable on demand. At the other end of the spectrum, syndicates of banks may make long-term loans to large companies, with complicated security provisions and covenants limiting management's freedom of action while the loan is outstanding.
- **bonds**, which are batches of identical IOUs issued simultaneously to a number of investors by a government or by a large and creditworthy company. They typically

have fixed repayment dates and require the issuer to pay fixed amounts of interest annually or semi-annually. Like shares, bonds may be tradable on a stock exchange, and this is an important factor in the investor's assessment of their relative riskiness as investments.

Note that bank debt and bonds are just examples (though important ones) of debt as a generalised idea – you are likely to meet other forms as well. This is the general background against which we now consider each of the types of investment risk.

3.2 Maturity

The maturity of an investment is the date when the investor is contractually entitled to demand repayment of the investment and the associated return. Some investments (such as company shares, as discussed in Section 3.1) actually have no contractual maturity. Others – such as demand deposits at banks – are subject to contractual repayment at any time if the investor demands it. If any of the other risk factors discussed below apply to an investment, those risks will tend to increase with length of time to maturity.

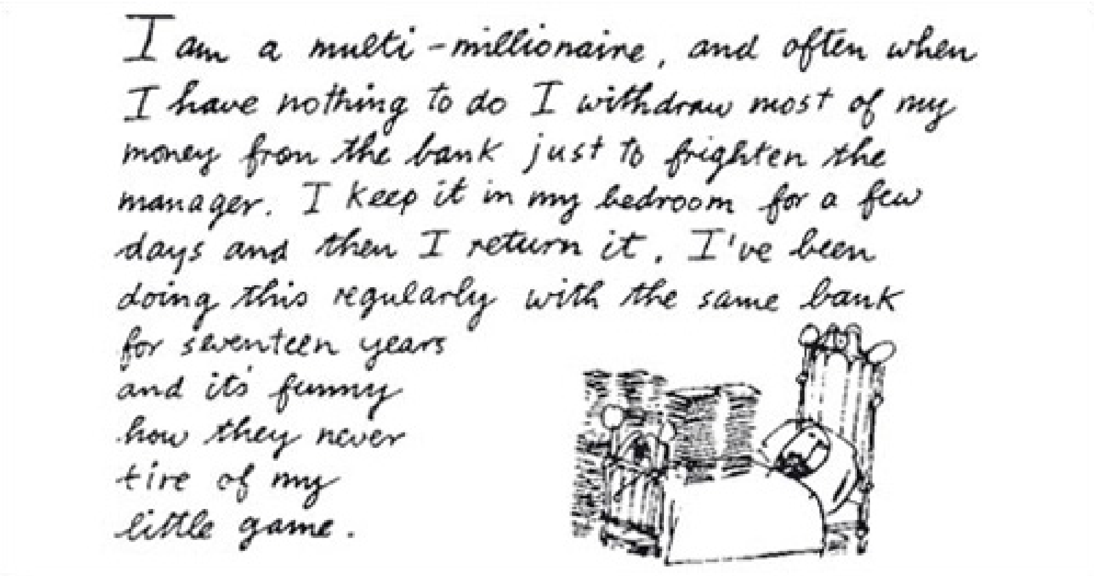

Figure 1

3.3 Liquidity

Borrowers prefer to have the use of funds for as long as possible, while investors generally prefer to be able to get their money back as soon as possible. A major function of the financial markets, and of the stock market in particular, is to reconcile these conflicting requirements. The stock market enables shareholders and bondholders to realise their investment independently of the company by selling their holdings to other investors. This is called the secondary capital market, to distinguish it from the primary capital market in which companies issue new securities directly to investors to raise new funds for their activities. The secondary market is **liquid** if there are large numbers of potential buyers and sellers of already issued securities. If there is a liquid secondary market, investors will accept a lower return from their shares and bonds than they would if they had no hope of being able to realise their investment except in the very long term. The liquidity of an investment is a measure of how easily the investor can get his money back, either from the issuer or from a secondary market. The less liquid the investment, the higher the risk and the higher the return required by investors. The most illiquid securities of all are those issued by private companies and not listed on a recognised stock exchange. A properly functioning secondary market reduces the overall cost of capital to users of finance and thus plays a critical role in the healthy functioning of a complex modern economy.

Liquidity and the lobsterpot: a cautionary tale

Julian Baring, who died in 2000, was for many years a well-known and much respected figure among UK stockbrokers. He was also mildly eccentric. He kept a lobsterpot suspended from the ceiling above his desk as a salutary reminder – to his clients, to his colleagues and to himself – of the dangers of investing in illiquid securities. Unlisted securities, he liked to say, were just like a lobsterpot – very easy to get into, and exceedingly difficult to get out of!

3.4 Variability of income

This applies to investments where the return is defined in generic terms but the actual amount of the return may fluctuate in an unpredictable manner. As we have seen, the most obvious example is the company share, but there are others, such as debt instruments (such as many bank deposits) where there is a contractual right to interest but the interest rate fluctuates according to some formula – or even simply at the whim of the bank! An important example of this type of security is the Floating Rate Note, a type of bond with a variable interest rate that is periodically readjusted to short-term (three- or six-month) money-market deposit rates.

3.5 Default or credit risk

This is the risk that contractual returns will not be paid because the borrower's financial situation has deteriorated to the point that it is no longer able to service the debt. It is possibly the commonest type of risk in commerce generally, and you are probably familiar with it in some shape or form. It affects many areas of business decision-making over and beyond the specialised world of investment risk and return. Most large companies devote significant resources to the identification, control or elimination of credit risks incurred in the normal course of their trading activities. What gives it a special dimension in the investment context is the issue of maturity, noted in Section 3.2. Making a long-term loan to a company clearly poses a greater credit risk than granting the company normal 30-day credit terms for the supply of goods and services. Not surprisingly, the analysis of borrowers' long-term creditworthiness is a big business in itself.

3.6 Event risk

This is not unlike default risk but it is a special case meriting its own category. The shareholders or management of a company might consciously and voluntarily enter into a major transaction that radically changes either the company's nature or its capital structure (that is, the balance and mix of shares and various types of debt in its overall sources of finance). Such a restructuring might cause some or all investors to suffer a significant increase in the uncertainty of their investment returns. One common example of such an event is a management buyout (MBO), which frequently results in the replacement of a portion of the equity capital with debt and causes a corresponding increase in the financial risks to investors. In practice, more sophisticated investors seek to protect themselves in advance against event risk by incorporating suitable covenants into their original contracts with the company.

3.7 Interest rate risk

This has to be seen in conjunction with the previous comments about the secondary market in shares and debt instruments. An efficient secondary market can ensure that there is always a ready buyer for an investment, but the price at which the investment can actually be sold will depend entirely on market conditions at the time of sale. The secondary market price will not necessarily bear any relation to the price originally paid by the investor. The following example illustrates the general principle.

The Treasury Bill (‘T-bill’ for short) is a short-term IOU issued by the government and is the nearest approximation to a risk-free investment in the real world. It does not pay a separate contractual rate of interest, but is sold to the investor at a discount to its face value so that the investor achieves the agreed rate of return – if he holds the T-bill to maturity.

Investor A buys a 3-month T-bill with a face value of £1,000 at a discount to yield 8% p.a. (roughly equivalent to 2% for 3 months, i.e. ignoring the effect of quarterly compounding [1.02^4 = 1.0824, or 8.24%]). The amount she actually pays for the T-bill will therefore be £980.39, because 2% of **that** amount is £19.61, and £980.39 plus £19.61 is £1,000 exactly – the amount she will receive from the Treasury when it repays the face value on maturity. One advantage of T-bills as investments is that because they are so short-term and of such high quality, they can be traded at any time on the secondary market. After just a month – one-third of the way through the three months – investor A wants to realise her investment. Unfortunately, short-term interest rates have shot up in response to some unforeseen economic crisis, and investors now require a return of 12% p.a. from short-term loans to the government. How much will Investor A get for her T-bill on the secondary market? A new investor (Investor B) will pay only an amount which gives him a return of 12% per annum. Unfortunately, 12% per annum for a T-bill is equivalent to 2% for two months, so Investor B's arithmetic is exactly the same as Investor A's original calculation. He will be prepared to pay only £980.39 – precisely the same amount as Investor A paid a month earlier – because he needs an extra £19.61 on maturity to give him the required return of 12% per annum over the remaining two months.

So Investor A has paid a heavy price for the benefit of secondary market liquidity. She invested £980.39, and received just £980.39 on liquidation of her investment a month later. Effective rate of return for one month – zero % p.a.!

Self-assessment question 2

An investor purchases a newly issued 3-month T-bill with a face value of £5,000 at a price calculated to yield 6% p.a. to maturity of the bill. Interest rates subsequently fall sharply, and after exactly two months the investor sells the T-bill at a price that will yield 4% p.a. for the remaining period to maturity.

1. How much did the investor pay for the T-bill, and how much did the investor receive on selling it? As in the example above, ignore compounding effects.
2. What annual percentage rate of return did the investor achieve over the two-month holding period?

Answer

1. The original price paid is the amount on which the sum of £5,000 received after three months will represent repayment of principal plus interest at 6% p.a., which is (for T-bills) 1.5% for three months.

If we let P_0 = the price paid, then:

£5,000 = P_0 × (1 + 0.015)

Rearranging the equation with P_0 on the left, we get:

P_0 = £5,000 / (1 + 0.015)

= £4,926.11

If we let P_1 = the price received on sale of the T-bill at a yield of 4% p.a. with only one month to run to maturity (approximately 4/12 = 0.3333% for 1 month), then:

P_1 = £5,000 / (1 + 0.003333)

= £4,983.39

2. The investor's annual percentage return on holding the T-bill for two months is:

$(P_1 - P_0) / P_0 \times 12/2 \times 100$ = 6.98% p.a.

i.e. {[4,983,39 − 4.926.11) / 4926.11] × 6} × 100

(For a T-bill the annual rate is 6 times the return over 2 months.)

By holding the T-bill during a period when interest rates fell, the investor has significantly enhanced the originally expected yield of 6% p.a. (to around 7%).

4 Discounted cash flow and the net present value rule

4.1 Introduction

This section looks at how discounted cash flow (DCF) and the net present value (NPV) rule help investors to choose between possible alternative investments and decide whether the return offered on an investment is worth it, given the risk.

- DCF allows us to compare two alternative investments with different expected cash flows, different maturities and different risks.
- NPV allows us to decide whether or not to go ahead in either case.

4.2 Discounted cash flow

Any investment gives rise to a stream of future expected cash flows. DCF converts all of these to an equivalent amount of present-day money (or present value) by discounting each future cash flow for the appropriate number of periods (for example, years) by the periodic discount rate. The periodic discount rate is the investor's **required rate of return** including the time preference rate, a premium for risk and an adjustment for inflation.

Having established the **present values** of each of our possible alternative investments, we now need to compare each present value with the cost of acquiring that investment today. This cost can be expressed as a negative cash flow and included in the DCF calculation at its face value (it is already expressed in present-day money terms, so it does not need to be discounted) by subtracting it from the present value of all the future expected returns. The difference between the positive present value of all the future returns and the negative present value of the initial investment gives us the net present value (NPV) of the overall investment.

4.3 Net present value

If the NPV is positive, then the aggregate present value of the future cash flows is greater than the price to be paid for the investment today, so the investment is cheap and offers an excess return. If the NPV is negative, then the price to be paid today is greater than the present value of the future cash flows; the investment is therefore overpriced and does not offer an adequate return. If the NPV is zero, we can say the investment is fairly priced by the market.

All significant financial decisions can be reduced to just two major questions:

1. Which projects should an organisation invest in?
2. How should an organisation procure the funds to pay for them?

We now have an answer to those questions. The NPV rule states simply that you should select investments with positive NPVs and reject those with negative NPVs, because the returns from the former exceed what is required to compensate you for the risks involved, whereas the latter do not.

Financing decisions, as well as investment decisions, have NPVs. If you pay investors in your organisation a higher return than is warranted by the risks they run, then the financing obtained from those investors has a negative NPV for you, just as it has a positive NPV for the lucky investors.

Positive and negative NPVs are less common in the markets for purely financial investments (or ‘paper assets’) than they are in the market for physical investments (or ‘real assets’). This is because the financial markets are generally more liquid and transparent than the markets for real projects: financial investments with positive NPVs are very quickly spotted by investors whose excess demand for them soon pushes up the price to the point where the NPV is again zero. This is summed up in the old adage: ‘There is no such thing as a free lunch.’ An investment seemingly offering an excess return – something for nothing – is likely to be a mirage.

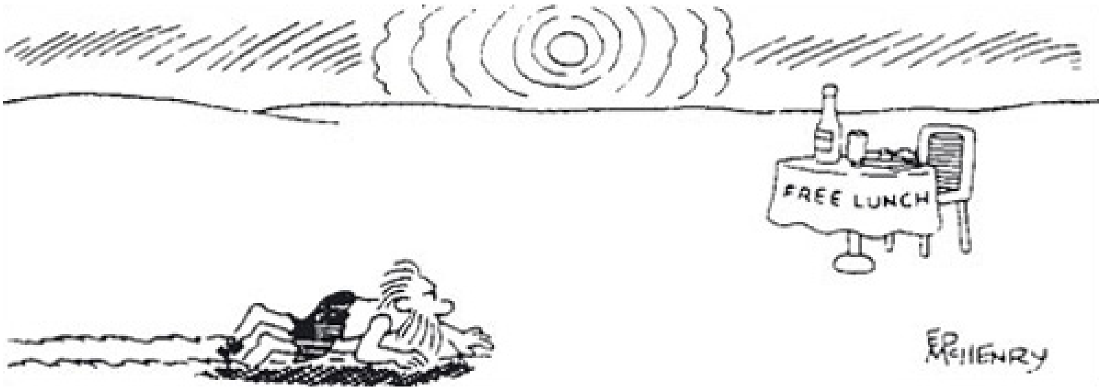

Figure 2

Ed McHenry, Private Eye, No. 899 May 1996

It is considerably more difficult to identify, exploit and subsequently fine-tune investments in real assets with positive NPVs. It takes months or even years for an industrial company to exploit a market opportunity by building a new factory. If the factory turns out to be 20% larger than is justified by eventual demand, there is no easy or economical way for the company to adapt the scale of its investment to the changed conditions. A fund manager handling a large and diversified portfolio of shares, by contrast, enjoys continuous and almost infinite flexibility to adjust and fine-tune his or her investments.

5 Conclusion

In a financial context, risk is a synonym for uncertainty – the possibility that the actual outcome will differ from the mean expected outcome. It is therefore a neutral rather than a negative concept. Investors are risk-averse in the sense that they require more return for taking on more risk. Risk itself is measured by the standard deviation of actual returns around the mean expectation. In the real world, investment risk is created by a number of different factors that affect the certainty of returns in different ways and to different extents. The financial markets, and in particular the stock market, play a crucial role in the control and diversification of risk. They provide a means whereby investors can get their money back by selling on their interests to other investors. This resolves a conflict of interest between firms (which want to keep the use of resources for as long as possible) and investors (who accept a lower return if they can see the opportunity for an early exit).

Having established a fair return for a particular investment (in terms of time preference rate, allowance for inflation and risk premium), we can use this as a discount rate for establishing the present value of expected cash flows. If this exceeds the price demanded by the market, the investment offers a positive net present value and should be acquired. If the present value is less than the price demanded, the investment is relatively expensive and should be passed over. This rule of positive net present value is the dominant rule in financial decision-making.

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Figure 1 ‘I am a multi-millionaire…’ © John Glashan

Figure 2 Ed McHenry, Private Eye, No. 899, 31 May 1996

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