Module 2

Decision-making under risk and uncertainty

Introduction

Until now, we have examined managerial decision-making primarily under conditions of certainty. In such cases, the manager knows exactly the outcome of each possible course of action. However, in business the outcome of a decision is usually far from certain (at the time the decision is taken) because the decision maker has incomplete information and the outcome depends on the simultaneous behaviour of rival firms and other factors influencing the managerial cost and demand conditions. When the outcome of a decision is not predictable with certainty, we say that the decision is made under conditions of risk or uncertainty. Most strategic decisions of the firm are of this type. Therefore it is essential to extend the basic model of the firm presented in Module 1 to include risk and uncertainty.

In the first module, we distinguished between risk and uncertainty and introduced some of the concepts essential for risk analysis. Building on that discussion, in this module, we examine methods for measuring risk and for analysing the manager's attitude toward risk.

Upon completion of this module you will be able to:

Outcomes

- *explain* the difference between risk and uncertainty.
- *measure* the expected return and the measure of risk.
- *explain* the concept of cardinal utility as it pertains to risk.
- *identify* attitudes towards risk identified by the behaviour of the marginal utility of income.
- *determine* the risk premium.
- *explain* how decision makers adjust for risk in their estimation of projects' rates of return.
- *explain* the concepts of asymmetric information as reflected by adverse selection and moral hazard.

Terminology

Asymmetric information:	Situations in which one party knows more about its own actions or personal characteristics than another party. When some people in the market have better information than others, the people with the least information may choose not to participate in a market.
Certainty:	Exists if the outcome of a decision is known in advance without a shadow of a doubt.
Marginal utility:	The change in total utility that takes place when one more unit of money is gained or lost.
Risk:	When the probabilities of each outcome can be assigned on an objective basis.
Uncertainty:	The case when there is more than one possible outcome to a decision and where the probability of each specific outcome occurring is not known or even meaningful.

Risk and uncertainty

In simple microeconomics, economists assume full information, or certainty. That is, they assume they know the exact shape and location of demand and cost curves, such that they know exactly how much will be demanded at each price and exactly what the cost of production will be at the chosen output level. In the business world, however, firms typically operate under conditions of incomplete information, or uncertainty, and must estimate the quantity demanded and the costs of production based on the limited information they have at hand or can obtain by conducting information-search activity.

The state of information under which a decision is made has important implications for the predictability of the outcome of that decision. If there is full information, the outcome of a decision will be foreseen clearly and unambiguously. In this situation (of certainty), the firm can accurately predict the outcome of each of its decisions. When there is less than full information, however, the decision maker may foresee several potential outcomes to a decision and, therefore, will be unable to predict consistently which outcome will actually occur. In this case, we say that the individual or firm is operating under conditions of risk and uncertainty.

Certainty exists if the outcome of a decision is known in advance without a shadow of a doubt. Therefore, in this case, there is only *one possible outcome* to a decision and this outcome is known precisely. On other hand, *uncertainty* is the case when there is *more than one possible outcome* to a decision and where the probability of each specific outcome occurring is *not* known or even meaningful.

Risk can be regarded as a subcategory of uncertainty in which the probabilities of each outcome can be assigned on an objective basis. Risk is involved when one flips a coin, or throws dice. The probability of flipping a coin and having it land 'heads' is 1/2, since there are only two possible outcomes, and each is equally likely to occur, given an unbiased coin. Similarly, when one throws two dice, the probability that they will turn up 'double six' or any other pair of numbers, is 1/6 x 1/6 = 1/36.

Measuring risks with probability distributions

As the above examples suggest, the greater the variability – the greater the number and range of possible outcomes – the greater is the risk associated with the decision or action. In the example, the probability of heads or tails is 1/2, whereas the probability of dice landing a pair is 1/36. In more complex business decisions, such as drilling for oil, it is possible that due to insufficient information or instability in the structure of the relevant variables, the investor will not know either the possible oil outputs or their probability of occurrence.

In the previous section, we defined risk as the situation where there is more than one possible outcome to a decision and the probability of each possible outcome is known or can be estimated. In this section we examine the meaning and characteristics of probability distributions, and then we use these concepts to develop a precise measure of risk.

Probability distributions

When faced with outcomes that involve risks, a primary task of managers is to develop techniques that will enable them to calculate and subsequently minimise the risks inherent in a particular problem. One method used to accomplish this is to calculate the probability distribution of possible outcomes from a set of sample observations, and then compute an *expected value*; that is, if several different levels of profit (or loss) are perceived as possible and each of these is assigned a probability of occurring. How does the decision maker summarise all these data so they can be compared with other potential solutions to the same problem?

The probability of an event is the chance or odds that the event will occur. For example, suppose you have just made an investment of $100 value in shares of a car-making (low technology) company believing that one of the three following possibilities might occur to your investment:

1. Its value increases by 10 per cent, to $110.
2. Its value stays the same, ($100).
3. Its value falls by 10 per cent, to $90 (see Table 2-1).

Furthermore, assume that, based on your prior investigation of this company's past performance as well as the current market conditions, you have come to conclude that the probability (likelihood) of outcome (a) is 25 per cent, that is a one out of four chance that this outcome occurs. For outcome (b) and (c) these probabilities are 50 per cent and 25 per cent, respectively.

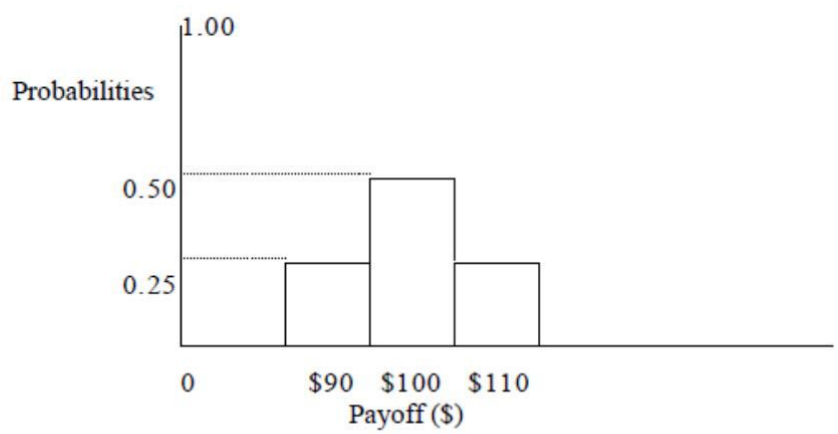
Table 2-1 Probability distribution of states of alternative scenarios of share prices (low-tech company)

State of the affairs	Probability of occurrence
Share price increases	0.25
Share price stays unchanged	0.50
Share price decreases	0.25
Total	**1.00**

Note that the sum of the probabilities is l, or 100 per cent, since one of the three possible scenarios of the share prices must occur with certainty.

The probability distribution depicts all possible payoffs and their associated probabilities. Figure 2-1, below, shows the probability distribution of your car-making company's stock price. Each bar represents a different possible payoff from investing in the company's shares.

Figure 2-1



Expected value

Given the probabilities associated with the possible outcomes of your risky investment, how much can you expect to make? The answer to this question is the *expected value.* The expected value of a lottery is a measure of the average payoff that the lottery will generate. The expected value of an outcome is the value of that outcome multiplied by the probability of that outcome occurring. Since several outcomes are possible under risk and uncertainty, the expected value of a decision is the sum of the expected values of all the possible outcomes that may follow the decision. We can illustrate this with your car-maker stock example:

$$E(X) = P_1 X_1 + P_2 X_2 + \ldots\ldots\ldots\ldots P_n X_n$$

$$E(X) = \sum_{i=1}^{n} P_i X_i \qquad (1)$$

where X_i is the value of the i^{th} payoff, and P_i is the probability of the i^{th} state of nature. Or

Expected value = Probability of (a) x Payoff if (a) occurs
+ Probability of (b) x Payoff if (b) occurs
+ Probability of (c) x Payoff if (c) occurs.

Applying this formula we get:

Expected value = (0.25 x 110) + (0.50 x 100) + (0.25 x 90) =100

Measures of risk (standard deviation)

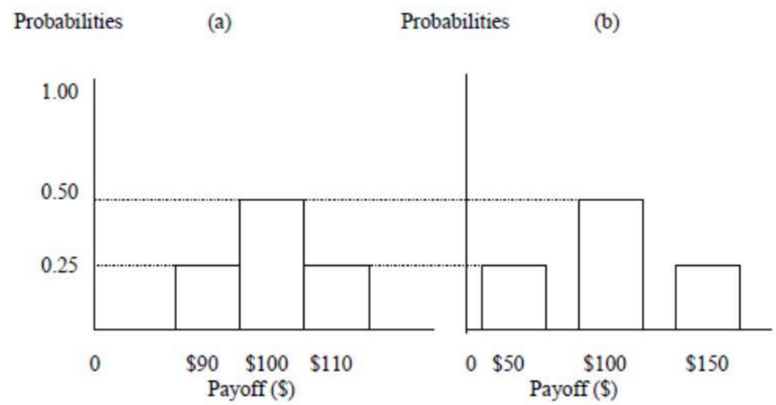
Suppose you had a choice of two investments, Table 2-2 presents the payoffs associated with two investments: L and H. Investment L is the same as the investment in the shares of the (low tech) car-making company in Table 2-1, whereas H represents the outcome of investment in another company's shares, e.g., a (high tech) telecommunication company. The expected value of each project is assumed to be $100, but the range of outcomes for project L (from $90 to $110) is smaller than for project H. The latter is assumed to range from $50 to $150. These are obtained from a greater share price increase or decrease, which is assumed to be 50 per cent, instead of 10 per cent (as in project L). The 50 per cent increase or decrease in share prices translates into the value of your investment increasing or decreasing from $100 to $150 or $50, respectively. The probabilities by which the three outcomes are expected to occur are kept the same in both projects.

Table 2-2 Probability distribution of states of share prices (high and low tech companies)

Project	Sate of share prices	Probability of occurrence	Outcome	Expected value
L	Increase	0.25	$110	$27.50
	Unchanged	0.50	$100	$50.00
	Decrease	0.25	$90	$22.50
	Expected value from Project L			**$100.00**
H	Increase	0.25	$150	$37.50
	Unchanged	0.50	$100	$50.00
	Decrease	0.25	$50	$12.50
	Expected value from Project H			**$100.00**

Figure 2-2 depicts the expected value and the variability in the outcomes of investment L, in panel (a) and H, in panel (b). Note that the expected values of the two investments are the same: $100. However, the telecommunication stock is riskier than the car-maker's stock because while the stock of car-maker will probably remain at its current value of $100, the telecommunication stock has a greater likelihood of going up or down, panel (b).

Figure 2-2



Again, the height of each bar measures the probability that a particular outcome (measured along the horizontal axis) will occur. Since both investments have the same expected outcome ($100) but the relationship between the payoffs (outcomes) is less dispersed in investment L, panel (a), than in investment H, panel (b), investment L is *less risky* than H. In other words, with the telecommunication stock, the investor stands to gain more or lose more than with stock in the car-making company.

Intuitively, we sense that the farther away from the mean the actual payoff can be, the riskier the investment. Hence, one way of measuring risk is to calculate the *range,* which is the difference between the most extreme payoff values. In our example, as noted above, the range of investment L is 20 (from a low 90 to a high 110) while the range of investment H is 100 (from a low 50 to a high 150).

The range, however, is useful in preliminary evaluation, but it considers only the extreme values and gives no weight to values in between. A more common and more accurate measurement of risk is the statistic called *standard deviation,* which is a measurement of variation of payoffs from the expected value. The higher the standard deviation, the greater the deviation of possible payoffs, and therefore, the greater the risk.

The standard deviation is calculated as follows:

$$\sigma = \sqrt{\Sigma[X_i - E(X_i)].P_i} \qquad (3)$$

where σ is the standard deviation. This expression suggests a three-step procedure in calculating the standard deviation: (a) first calculate the expected value, also called the mean, (b) then take the difference between each outcome (payoff) and the mean, and then square the result. And (c) finally multiply each squared deviation in step (b) by the associated probability and add them up.

Demonstration problem

Find the standard deviation of the two investment alternatives L and H, in the example above.

Answer:

Investment L: Expected value = $100

Payoff (X_i)	Prob.(%)	$[X_i - E(X)]^2$	$[X_i - E(X)]^2.P_i$
90	0.25	$[90 - 100]^2 = 100$	100 x 0.25 = 25
100	0.50	$[100 - 100]^2 = 0$	0 x 0.50 = 0
110	0.25	$[110 - 100]^2 = 100$	100 x 0.25 = 25

Standard Deviation = $\sqrt{50} \cong 7$

Investment H: Expected value = $100

50	0.25	$[50 - 100]^2 = 2500$	2500 x 0.25 = 625
100	0.50	$[100 - 100]^2 = 0$	0 x 0.50 = 0
150	0.25	$[150 - 100]^2 = 2500$	2500 x 0.25 = 625

Standard Deviation = $\sqrt{1250} \cong 35$

Based on these calculations, investment H, with a greater standard deviation, is far more risky than investment L.

An alternative measure of the riskiness of a risky investment is the *variance*. Variance is the square of standard deviation.

Utility, risk aversion and risk premium

Suppose a job hunter in the field of management consulting is faced with the following two options. The first is a job offer from a large multinational company that promises to pay $50,000 a year. The second is an offer from a small but growing local company that promises to pay $20,000 a year plus a hefty $60,000 in commission assuming that the job-hunter meets a million dollar sales quota per year. Her assessment, however, shows that there is a 50 per cent chance that she meets this quota and 50 per cent that she does not. The expected value of this lottery is:

$$E(X) = 0.5\ (\$60,000) + 0.5\ (0) = \$30,000 \qquad (4)$$

Based on this calculation, which job would she choose? If she chooses the job with the large multinational company, she is guaranteed $50,000, and if she accepts the job with the small local company, her expected income would be $50,000 ($20,000 salary plus $30,000 in expected commission). On the surface, it appears that both jobs offer the same income. However, it is very likely that she would choose the 100 per cent salary job (certain outcome) with the multinational company over the local company's (risky) commission job. The reason is that the seemingly more exciting job with the local company may in fact end up paying her just $20,000, if our job-hunter is unable to meet her sales quota. This suggests that most people, faced with two alternative projects of equal expected value of profit but different coefficients of variation or risk, will generally prefer the less-risky project (the one with the smaller coefficient of variation). While it is true that some managers may very well choose the more risky project (*risk seekers*) and some may be indifferent to either choice (*risk neutral*), most managers are *risk averters*. The reason is to be found in the principle of diminishing marginal utility of money. The meaning of diminishing, constant, and increasing marginal utility of money will be explained with the aid of a reward structure that helps explain transformation of dollar payoffs into a more meaningful measurement. Utility is such a measurement, and it can be expressed in conceptual units called *utils.* Although difficult to establish a standard util by which one can perform a cardinal measurement of utility, it is nonetheless a useful concept.

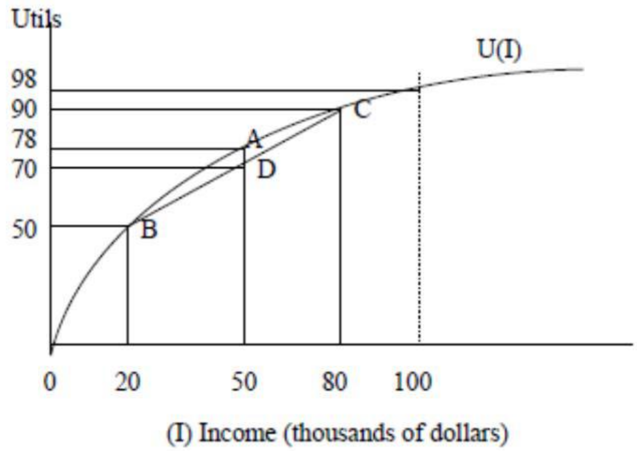
Risk and diminishing marginal utility

At this point, it is necessary to explain the relationship between risk and utility in a formal manner. To do so, profit and loss must be measured in terms of marginal utility rather than absolute dollar values. Marginal utility is defined as the change in total utility that takes place when one more unit of money is gained or lost.

The three ways in which utility may theoretically relate to income are depicted in Figures 2-3, 2-4, and 2-5. These depict behaviour of different types of investors when investment yield or income is increased by equal increments. Money income or wealth is measured along the horizontal axis while the utility or satisfaction of money (measured in utils) is plotted along the vertical axis. Each curve represents utility as a function of income, U = U(I), where U stands for utils and I for income. The slope of each curve represents marginal utility, which is where our interest lies.

The most common behaviour, depicted in Figure 2-3, is a risk avoider (averter). The reason for risk aversion is *diminishing marginal utility*. It shows that with no investment there is no return. A given increment ($20,000) to income when income is low, zero, increases utility by 50 (vertical axis), U($20,000) = 50, whereas the same increment to income when income is, say $80,000, increases utility by a smaller amount, U($100,000) –U($80,000) = (98–90) = 8.

Figure 2-3



If, therefore, the total utility of the money curve is concave (or facing down), doubling money income less than doubles utility. This is the basic explanation of risk and can be used to illustrate the behaviour of our job hunter.

Remember that our job hunter's salary at the established multinational company is $50,000, and as depicted in Figure 2-3, the level utility associated with this income, U($50,000), equals 78, point A. The job hunter's income at the less-established local company, however, is one of the two cases. She either makes $20,000, in case she fails to make any commission income, in which case the corresponding utility would be 50, point B, or she makes $80,000, if she succeeds in meeting her quotas, where the corresponding utility would be 90, point C. Therefore, the job-hunter's *expected utility* at the local company is the expected value of the utility levels she could receive if she worked for the local company:

$$0.50 \times U(\$20{,}000) + 0.50 \times U(\$20{,}000 + \$60{,}000)$$

$$= 0.5 \times 50 + 0.5 \times 90$$

$$= 70. \qquad (5)$$

This is depicted by point D in Figure 2-3.

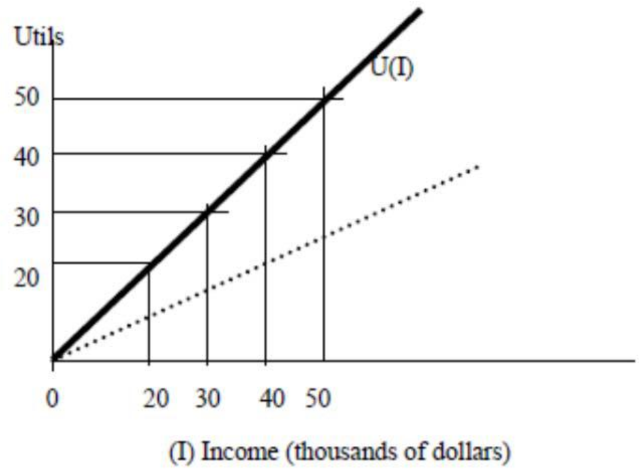
The above analysis shows that although the local company offers the same expected salary as the established multinational company, the job hunter's expected utility at the local company, 70, is lower than the utility she would receive from the job with the multinational company, 78.

Thus we see that the utility from the 100 per cent salary job (risk-free) is greater than the expected utility from a commission-based job (risky) with equal expected value of income. Therefore, if our job-hunter's personality fits that represented by Figure 2-3, she will prefer the risk-free to the risky job. This is the preference of a decision maker who is *risk averse.*

In Figure 2-4, the utility function is a straight line, implying that doubling income doubles utility so that the marginal utility of money is constant.

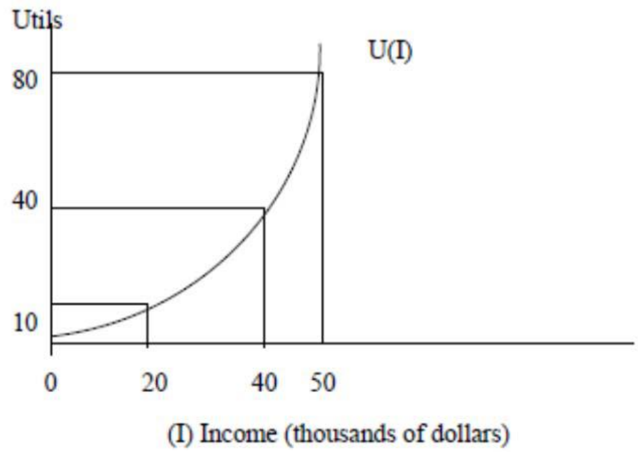
The straight-line utility function characterises a person who is indifferent to risk, for whom marginal utility of a dollar lost is equal to that of a dollar gained.

Figure 2-4



Finally, in Figure 2-5, if the total utility of money curve is convex or faced down, doubling income more than doubles utility, so that the marginal utility of money income increases. This represents the case of compulsive gamblers, who place higher utility on dollars won than dollars lost. The more they win, the more important winning becomes.

Figure 2-5



Most individuals are risk averters because their marginal utility of money diminishes, that is, they face a total utility curve that is concave or faces down. To see why this is so, consider the offer to engage in a bet to win $10,000 if a head turns up in the tossing of a coin or to lose $10,000 if a tail comes up. The expected value of the money won or lost is

Expected value of money income = E(I)

= 0.5($10,000) + 0.5(-$10,000) = 0

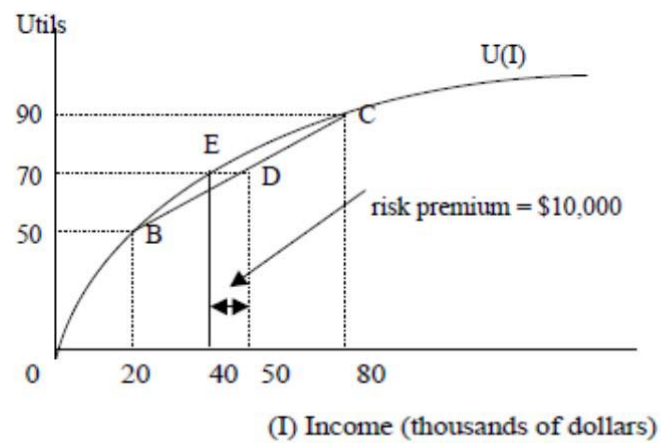
Risk premium

Aversion to risk by managers and investors is manifested in many ways. The following are a few examples of how risk may be averted. Grade AA bonds sell for a higher price than grade B bonds. Investors diversify either by creating individual portfolios or by investing in mutual funds. People deposit their money in government treasury bills at low rates of interest rather than in bonds that may earn substantially more interest. And people buy all kinds of casualty and life insurance.

Why, then, if investors are averse to risk, do they put their money into common stocks, commodities, precious metals, collectibles, and other risky investments? The answer is that they do not do so unless they receive a risk premium. The investor wants to be compensated not only for the use of his or her money, but also for the risk that it may be lost. In other words, the investor demands a higher rate of return when risk is involved.

To illustrate this, we recall the example of our job hunter in Figure 2-6 below. In that example we showed that the job hunter preferred the risk-free job (with the multinational company) to the risky job (with the local company).

Figure 2-6



Accordingly, the *risk premium* is the minimum payment (compensation) to the risk-averse decision maker (our job hunter) to make her indifferent between the risky and risk-free events. In order to find the risk premium for our job seeker, let us ask: at what level of sure (risk-free) income (with the multinational company) would the resulting level of utility be equal to the expected utility of the risky (commission-based) income? In Figure 2-6, the expected utility of the risky job that is expected to pay $50,000 is 70, point D. Therefore, the risk-free income whose corresponding level of utility is also equal to 70 has to be about $40,000, at point E. Note that E and D correspond to the same level of utility. Therefore, our job hunter would be indifferent between a $40,000 (all salary) job with the multinational firm and a $50,000 risky (partly commission-based income) job with the local company. Hence, the risk premium of the risky local company's offer is $10,000.

Demonstration problem

Suppose you have a utility function that is concave (faced down). Also suppose that you bet $100 on the flip of a coin at even odds. The probability of winning is 0.5 and the probability of losing is also 0.5. If you win, you will get $100 and if you lose you will lose $100. Should you take the bet?

Answer:

Note that if you win you get $100 and if you lose you pay $100. We also know that if you win you gain fewer utils of utility than you sacrifice utils if you lose $100. This is because of the shape of the utility function, diminishing marginal utility. Since the probability of winning or losing is the same, the expected value in utils is inevitably negative: 0.5(utils gained) + 0.5(utils sacrificed) <0. This is so because utils gained are fewer than utils sacrificed. Clearly, the investor should not take this bet.

Demonstration problem

Suppose you have a utility function that is concave (faced down). Also suppose that you bet $100 on the flip of a coin at even odds. The probability of winning is 0.5 and the probability of losing is also 0.5. This time if you win, you will get $120 and if you lose you will lose $100. Should you take the bet?

Answer:

It depends on the shape of your utility function. The $20 premium may or may not be sufficient to make you indifferent between the two possibilities. It may take more or less than $20 to take this bet. The curvature of the utility function speaks to this issue. The steeper the utility curve, the smaller the required risk premium, and vice versa.

Risk adjustment in decision-making

In estimating the payoffs for a particular strategy, the decision maker must consider both the present value of future returns and the degree of risk. In this section we examine two of the most commonly used methods: the risk-adjusted discount rate and the certainty-equivalent approach that a risk-averse decision maker employs to compare decision alternatives on a risk-adjusted basis.

The risk-adjusted discount rate

Under conditions of risk and uncertainty the present value of future returns are not known with certainty. Therefore, in estimating the payoffs for a particular strategy, the decision maker needs to maximise the (expected) Net Present Value (NPV), which combines the present value calculation with expected-value analysis.

$$NPV = \sum_{t=1}^{n} \frac{R_t}{(1+i)^t} - I_0 \qquad (6)$$

where R_t represents the expected net return (cash flow) in each of the n years considered, and i, as discussed in Module 1, is the appropriate discount rate, and I_0 is the amount of the initial investment.

One popular method of adjusting the NPV criterion of equation (6) to deal with an investment project subject to risk is using higher discount rates for more risky decision alternatives. We may define the risk-adjusted discount rate as the required rate of return from a proposed investment after due consideration of the risk involved:

$$NPV = \sum_{t=1}^{n} \frac{R_t}{(1+r)^t} - I_0 \qquad (7)$$

where r is the risk-adjusted discount rate, r = *i* + risk premium. As discussed earlier, every firm has a required rate of return reflecting its perception of its normal risk (normal business risk plus financial risk).

Demonstration problem

For example, suppose a firm's normal business and financial risk requires a 20 per cent rate of return. The firm is considering an investment strategy that initially costs $100,000 and is expected to yield $50,000 cash inflow per year for the next three years.

a. Calculate the net present value of the investment at a discount rate of 20 per cent. Should the firm accept this project?

b. Suppose that the risk were such that management feels it should get a 25 per cent return. Calculate the NVP for the adjusted discount rate. Should the firm accept the investment project?

Answer:

a.

$$NVP = \frac{\$50{,}000}{(1.20)} + \frac{\$50{,}000}{(1.2)^2} + \frac{\$50{,}000}{(1.2)^3} - \$100{,}000 = \$5{,}324.$$

Since the net present value is positive, a risk-neutral firm should accept this project. A risk-averse firm may not necessarily accept this project. It depends on the firm's degree of risk-aversion.

b.

$$NVP = \frac{\$50{,}000}{(1.25)} + \frac{\$50{,}000}{(1.25)^2} + \frac{\$50{,}000}{(1.25)^3} - \$100{,}000 = \$-2{,}400.$$

Here the NVP is negative. The project fails to provide a 25 per cent discounted return and should be rejected by both a risk-averse and a risk-neutral firm.

Thus we see that in the risk-adjusted discount-rate approach to evaluation of proposed investments, risk is wholly reflected by the discount rate and discounting process. There are, however, at least three limitations to this approach to incorporation of risk:

1. How do we determine the appropriate discount rate? Clearly, the introduction of a new product is riskier than buying government bonds, but how much riskier? It is very difficult to resolve this question consistently and objectively, particularly when there is no historical evidence on which to base an estimate.
2. This method does not consider the probability distribution of future cash flows information that could be of great value.
3. The risk-adjusted discount rate does not offer any consistent method for evaluation of risk, an evaluation that may be quite subjective. This limitation may be overcome by the certainty-equivalent approach.

The certainty-equivalent approach

The risk-adjusted discount-rate approach discussed in the preceding section accounts for risk by simply modifying the discount rate appearing in the denominator of the valuation model. In contrast, the certainty-equivalent approach accounts for risk in the numerator of the valuation model and uses a risk-free discount rate, i (such as the rate of return on government bonds) in the denominator to account for the time value of money. The degree of risk is reflected in the numerator by multiplying the expected risky return by a certainty-equivalent coefficient.

$$NPV = \sum_{t=1}^{n} \frac{\alpha_t R_t}{(1+r)^t} - I_0 \qquad (8)$$

where α is the certainty equivalent coefficient, a number between 0 and 1. 1 means the project is risk free, and 0 means too risky to be considered.

Certainty equivalent of a decision alternative is the sum of money available with certainty that would make the manager indifferent between taking that decision and accepting the certain sum of money:

$$\alpha R = R^* \qquad (9)$$

where R^* is the risk-free equivalent cash flow.

Demonstration problem

The manager of a company regards the sum of $80,000 with certainty as equivalent to the expected (risky) net cash flow or return of $100,000 per year for the next three years, what is the value of α?

Answer:

$$\alpha = \frac{80,000}{100,000} = 0.8$$

Asymmetric information

Asymmetric information refers to situations in which one party knows more about its own actions or personal characteristics than another party. When some people in the market have better information than others, the people with the least information may choose not to participate in a market. For example, the market for used cars is characterised by information asymmetry. The seller always knows better than the buyer about the quality of the car, including whether the car has been regularly serviced and inspected or whether it has been involved in an accident. That is why some people tend to shy away from used cars, unless some form of warranty is tacked on.

Adverse selection

In the above example, while warranties may reduce the financial cost of owning a lemon, they do not eliminate the bother, such as the time it takes to bring the car into the shop. Of course, the owners know they have a lemon and would like to pass it along to someone else. Those with the worst lemons are going to be the most willing to sell their car, whatever the price. But at a high used-car price, they will be joined by owners of better-quality cars. As the price drops, more of the good cars will be withdrawn from the market as the owners decide to keep them. And the average quality of the used cars for sale will drop. We say there is an *adverse selection* effect. The mix of those who elect to sell changes adversely as price falls.

Asymmetric information affects many other managerial decisions, including car insurance, employing workers, and issuing credit to customers. Private car insurers do not have complete information about the risk level of their clients, but they know that, as a group, young single males demonstrate the highest claim frequency. The problem of adverse selection arises because the insurers cannot identify the individuals who are high risk. One way to rectify this matter, at least partially, is to segment the market by age or gender charging higher premiums to high-risk individuals.

This type of discriminating policy, however, is bound to be an imperfect way to overcome the adverse selection problem. There will undoubtedly be some drivers from certain categories, say, young males, who are cautious drivers but who have to pay high premiums because of the accident record of others of their gender and age group. On the other hand, a non-discriminatory policy, charging the same premium to all drivers will also discriminate between good and bad drivers by not rewarding the good drivers. The end result is that some drivers are less insured than they would like to be, because of high prices.

Another area where asymmetric information affects managerial decisions is the job market. Job applicants have much better information about their own capabilities than does the person in charge of hiring new workers. A job applicant who claims to have excellent skills may be lying or not telling the whole truth; the personnel manager has less information than the applicant. This is why firms spend considerable amounts of time and money setting up several interviews, designing tests to evaluate job applicants, doing background checks, and the like. The basic reason for these types of expenditures is to provide the firm with better information about the capabilities and tendencies of job applicants.

Moral hazard

A second problem faced by insurance companies is an incentive problem. Insurance reduces people's incentives to attempt to avoid a loss and encourages them to take excessive risk. If there existed some form of business bankruptcy insurance, entrepreneurs would take riskier steps than necessary or warranted. However, people buy insurance for their house, cars and valuable belongings. For example, a person who has no fire insurance on a house may choose to limit the risk by buying smoke alarms and home fire extinguishers, and by being especially cautious. However, if he has fire insurance, he might not be so as careful. Therefore, *moral hazard* generally occurs when one takes *hidden* actions that one knows another party cannot observe.

When moral hazard problems are strong, insurance firms will offer limited or even no insurance. The limitations often take one of two forms: deductibility provisions and co-insurance. Insurance policies may pay damages only above some initial amount, referred to as a deductible. For example, your car insurance policy may require you to pay the first $500 of damages before insurance benefits kick in. This reduces the moral hazard problem associated with small claims; drivers might be much more vigilant about avoiding minor accidents than major ones. Alternatively, insurance policies may pay only some specified proportion of damages. This is referred to as co-insurance. It forces those who are insured to bear some cost of any accident and so to behave with greater care.

Module summary

Summary

This module has dealt with methods and approaches to decision-making under conditions of risk and uncertainty. Under the condition of risk, the primary decision criterion for selecting the optimum strategy is expected value. The degree of risk is indicated by the *standard deviation*.

How decision makers choose to deal with risk depends upon their attitudes. Some may try to seek risk, some may be indifferent toward it, but most business people try to avoid risk. Their attitudes are based upon utility functions in which increasing increments of income (profits) bring decreasing increments of satisfaction (utility).

Risk aversion is based on the principle of diminishing marginal utility of money, which is reflected in a total utility of money curve that is concave or face down. A risk-averse decision maker will accept risk only if there is a commensurate risk premium. Every business firm and individual investor has in mind some required rate of return that reflects the perceived risk. As the degree of risk increases, the required rate of return also increases along a market-indifference curve that depicts the investor's risk-return trade-off function.

The profit-maximisation model can be simultaneously adjusted for both risk and the true value of money by several techniques. Two of the most common are the risk-adjusted discount rate and the certainty-equivalent approach. The former involves adding a risk premium to the risk-free rate of interest, or discount, used to find the present value of the net cash flow or the return of the investment. A better method is the latter, which uses a risk-free discount rate in the denominator and incorporates risk by multiplying the net cash flow or return in the numerator of the valuation by the certainty-equivalent coefficient.

Assignment

Assignment

1. Suppose the required rate of return by a firm is 20 per cent while the risk on government Treasury bills is 8 per cent. The firm is considering an investment of $500,000 in a venture that promises to yield $150,000 per year for the next five years.

    a. Calculate the NPV of the proposed venture by the risk adjusted discount method.

    b. Calculate coefficient of a. that will cause the certainty-equivalent approach to yield the same result.

2. Suppose a firm is considering an investment of $100,000 that is expected to yield a cash flow of $50,000 per year for three years. Suppose that management's perception of risk is such that it considers risk-free returns of $45,000 in the first year, $40,000 in the second year, and $35,000 in the third year to be equivalent to the risky return of $50,000 for each year. Calculate NPV for each of the three years.

Assessment

Assessment

1. Why is the certainty-equivalent approach to risk adjustment considered to be superior to the risk-adjusted approach?
2. Explain the concept of risk premium. What causes the magnitude of risk premium change?
3. ‘For a risk-averse consumer the expected utility of a gamble is greater than the utility of the expected value of that gamble.’ True or False? Explain.
4. ‘For a risk-lover consumer the expected utility of a gamble is greater than the utility of the expected value of that gamble.’ True or False? Explain.
5. Explain why a used car that is only six months old and has been driven only 5,000 km typically sells for 20 per cent less than a new car with the same options.

Assessment answers

1. If there are any time periods in which perceived risk is more or less than what is represented by the risk-adjusted discount rate, then the certainty-equivalent approach can provide a better estimate of the net present value of a proposed investment. For example, the return from an investment for the introduction of a new product might be more uncertain in its earlier years, while the firm is struggling for product recognition and market share, than in later years when the product's market has become established. The certainty equivalent approach can easily handle this situation during the process of establishing α for each separate time period. The certainty-equivalent approach enables managers to specify directly the degree of risk for and then discount the cash flow.

2. The risk premium is the minimum payment (compensation) to the risk averse decision maker (our job hunter) to make her indifferent between the risky and risk-free events. The magnitude of risk premium changes with changes in attitude towards risk. The higher the degree of risk aversion the greater the risk premium required by the decision maker.

3. FALSE: If two events (one risky and one safe) have the same outcome, due to diminishing marginal utility of income, the expected utility of the risky event will always be smaller than the utility of the safe asset (concave utility function). You can show this by drawing the marginal utility of income curve under alternative risk attitudes.

4. TRUE. See answer to question 3.

5. This is due to asymmetric information. The buyer of the used car is not aware of the behaviour and driving habits of the first owner – adverse selection (hidden characteristics). The first owner knows how the car has been kept up, while the buyer does not.

References

References

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