Decision making made easy

(Relevant to AAT Examination Paper 4: Business Economics and Financial Mathematics)

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In the competitive world of business, we need to make varied important decisions every day, so that effective decision making is crucial. Some decisions are very easy to make but others are quite complex. Simple decisions usually require simple decision-making skills such as yes / no, either / or decision: for example, should I take the AAT paper 4 examination in June? However, most people face more complex decisions in today's business world. To make a decision means that you need to decide between alternative choices and you would like to choose the one that (1) has the highest returns, (2) has the highest chances of success and (3) best meets your criteria, goals, preferences, values and so on. In this article, the net present value method (NPV) and expected net present value (ENPV) methods for evaluating business projects are discussed.

Net present value method

The net present value (NPV) is a discounted cash flow technique and it can be used as a capital expenditure appraisal method. The NPV method starts by calculating the present values of all cash outflows and inflows related to an investment at a given rate of return, arriving at a NPV. If the NPV is positive, we can conclude that the investment is acceptable. If it is negative, the investment is unacceptable. If it is zero, we are indifferent about the investment.

Example 1

Adam is considering whether to buy an annuity at $1,000,000. The annuity pays cash of $110,000 at the end of year forever. Adam will not invest in any annuity unless it offers a return in excess of 10% per annum. Is the annuity worthwhile?

In this example, an outlay of $1,000,000 now guarantees a return of $110,000 at the end of each year forever. The cash flows of the annuity are as follows:

		$
Year 0	(now)	(1,000,000)
Year 1	At the end of the year	110,000
Year 2	At the end of the year	110,000
.		
.		
Year n = ∞	At the end of the year	110,000

The NPV method takes the following approach

1. The annuity offers $110,000 at the end of each year forever, for an initial cash outflow of $1,000,000 now.
2. Adam has an another choice to invest elsewhere to earn a return of 10% per annum
3. If Adam did invest at 10% per annum, how much would he need to invest now, at 10%, to obtain $110,000 at the end of each year forever?
4. Is it worth investing $1,000,000 in the annuity, or should he invest elsewhere at 10%, in order to earn these future cash flows?

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If Adam invested elsewhere at 10% per annum, the amount required to earn $110,000 at the end of each year forever would be as follows.

Year	Cash flow	Discount factor	Present value
	$	10%	$
1	110,000	0.909	99,990
2	110,000	0.826	90,860
.	.	.	.
.	.	.	.
n = ∞	110,000	.	.

Adam's case is a perpetuity, or an annuity whose payments are paid forever, i.e. the term of the annuity is not finite.

The present value of a perpetuity $\frac{annual\ payments}{i}$ =

The present value of an annuity = $1,100,000

The alternative is to invest $1,000,000 in the annuity, or $1,100,000 elsewhere at 10%, in order to earn the future cash flows. We then obtain the following conclusion.

- It is worth investing in the annuity, by $100,000 ($1,100,000 - $1,000,000)
- The annuity gives a return of more than 10% per annum.

The net present value is the difference between the present value of cash inflows from the annuity ($1,100,000) and the present value of cash outflows (in this example, $1,000,000): since net present value is positive, the annuity is acceptable.

The NPV method can also be used in comparing two or more investment projects and the decision rule is to choose the project with the highest NPV.

Expected value

It is important to realize that there are a lot of uncertainties in the future such as over cash flows, interest rates and so on. Consider the following examples of decision-making problems.

Amy must decide whether to purchase an apartment to live in as an investment, or whether to rent it. If sales of apartments continue to increase, it will be more profitable to purchase the

apartment. If sales levels decline, it will be more profitable to rent the apartment. Which decision should she make?

AA Company is considering three options regarding the prices of shoes for next year. AA Company could (option 1) increase the prices by 4 percent, (option 2) increase the prices by 2 percent, or (option 3) keep the prices as they are. The final decision will be determined by estimated demand.

In the above cases, the decisions are characterized by several options and factors not controlled by the decision maker. For example, AA Company has no control over the sales volume. These cases tell us a lot about the nature of decision making. We can list the decision options, determine the possible future events and even assign probabilities, but we still face uncertainty in our decision making.

The three components in any decision process are as follows:

> The options or alternatives are the choices available to the decision maker and which are under the control of the decision maker. AA company can decide to increase its prices by 4 percent, or by 2 percent.
> The economic environment determines the outcome of the decision that actually happens. This is not under the control of the decision maker. AA Company does not know whether demand for its shoes will be high after it has increased prices. By the same token, Amy cannot know whether the real estate market will be either good or poor over the next year
> A payoff is required to compare each combination of decision options and the economic environment. Amy thinks that if the economic climate is good and she decides to buy an apartment, the payoff will be an estimated $100,000. On the other hand, if Amy decides to buy the apartment and the economic climate is poor, the payoff is estimated to be -$90,000.

The expected value approach is used to take this uncertainty into account. We now introduce the application of probability to business decision making under conditions of uncertainty. We first introduce expected value as an appropriate criterion for decision making and extend its usage to investment appraisal. The expected value is the weighted average of each value multiplied by their corresponding probabilities.

Expected value $\sum_{i=1}^{n} xipi$ =

Where

x_i = the value of the payoffs.

p_i = the probability of the state of nature.

Over the past decade, in six years the economic climate has been good and in four years it has been poor. We can therefore project that the probability of a good economic climate is 0.6 and the probability of a poor economic climate 0.4.

The expected value of Amy's decision to buy an apartment is:

EV (purchase apartment) = \$100,000 × 0.6 + (\$90,000) × 0.4

= \$60,000 – \$36,000

= \$24,000

Expected net present value method

Here we extend the expected value idea in evaluating an investment project. The expected net present value (ENPV) method uses the idea of expected value through uncertain cash flows, an unknown future economic environment, and so on.

Example 2

Becky Company is considering whether to invest \$340,000 in a project which has only a 20% chance of being successful and receiving cash inflows of \$210,000 at the end of year one and year two. However, there is 80% chance that the project will fail, in which case the cash inflows will only be \$150,000, received at the end of each of year one and year two.

Is it worth Becky Company investing in the project if the cost of capital is 5%?

The solution for the Becky Company 's problem is summarized as follows:

1. Construct a table to lay down the outcomes for each event and each year.
2. Assign probabilities to the events.

	Discount factor	Success (0.2)		Failure (0.8)	
Year	5%	Cash flows, \$	PV	Cash flow, \$	PV
0	1.000	(340,000)	(340,000)	(340,000)	(340,000)
1	0.952	210,000	199,920	150,000	142,800
2	0.907	210,000	190,470	150,000	136,050
		NPV =	50,390	NPV =	(61,150)

1. Calculate the ENPV by weighting the net present values by the assigned probabilities and summing the weighted values.

ENPV = (0.2 × \$50,390) + (0.8 × - \$61,150) = \$-38,842

2. If the ENPV is positive, the investment is acceptable. If it is negative, the investment is unacceptable. If it is zero, the company should be indifferent to the investment.

Since the ENPV is \$-38,842, Becky Company should not invest in the project.

Limitations of using expected net present value method in decision making

Although the ENPV method is a good way of considering an investment appraisal, it may not always be applicable. The probabilities, future discount factors and cash flows are also estimated, i.e. they are not known with certainty. Here we consider the limitations of the NPV method.

Suppose Mr. Chan has the chance to invest a new product. Assume that if the new product is invested in and is successful, there will be an estimated net profit of $2,000,000. However, if the product is not successful, there will be an estimated cost of $100,000. The payoff figures for this decision, including probabilities, are given in table 1.

Table 1: Project payoffs

	State	
	Success	Failure
Options	0.9	0.1
Invest	$2,000,000	-$100,000
Do not invest	0	0

When Mr. Chan assigns a subjective probability of 0.9 to success, the investment makes a profit of $1,790,000 ($2,000,000 × 0.9 - $100,000 × 0.1 = $1,790,000). Because the expected value is $1,790,000, Mr. Chan should invest the new product.

Now consider another situation. If the probability of failure now is 0.4 and the estimated loss is $500,000 if the product is not successful, then the expected profit for the investment now is $1,000,000 ($2,000,000 × 0.6 - $500,000 × 0.4 = $1,000,000), as compared with an expected value of $0 for the option.

Mr. Chan may still chose to invest in the new product based on the positive expected value. However, Mr. Chan may be unwilling to accept a 0.4 probability of losing $500,000 regardless of the higher expected profit, since a loss of $500,000 would result in his bankruptcy.

Why would some decision makers reject the higher expected profit in this type of situation? They may do so because the probability assessment is subjective and difficult to estimate. If the decision exposes the investor to a high risk, the expected value method may not be a good guide to use.