PERFORMANCE OPERATIONS

Grahame Steven offers his guide to the development of four key investment appraisal methods – and their strengths and weaknesses.

Research suggests that companies in the late 19th century didn't do comprehensive investment appraisals, although some used the payback technique – along with gut feeling – to decide which projects to pursue. Payback, the simplest appraisal method, works out how long it will take a project to recoup the investment, but doesn't account for cash flows occurring after that time. As a result, its users may still choose unprofitable projects or those yielding low returns.

Table 1 concerns an oil production project with a cash outflow at the end of its life. The cash flow in year five is negative, since it includes the cost of decommissioning the oil rig. To estimate the payback period, we divide the last cumulative cash outflow, which occurs at the end of year two (£55m), by the cash inflow expected in year three (£60m). We then add this figure (0.92) to the number of years (two) associated with the last negative cumulative cash flow to obtain

the project's payback period: 2.92 years. This approach assumes that cash flows occur equally throughout a year. In practice, of course, they may vary according to the seasonal nature of the business.

Payback cannot evaluate mutually exclusive projects because it doesn't consider the whole project period – would it be better to accept a project with a longer payback period that provides higher returns after that point than to accept a project with a shorter payback period but lower returns?

Table 2 considers two mutually exclusive projects with different cash flow profiles. If we were to use payback to choose between them, we'd pick project A for its shorter payback period. But would this be the right decision? While payback does not calculate a return for a project, it does provide a simple

measure of risk. Most people intuitively feel that the longer the payback period, the greater the risk. But the use of payback for investment appraisal was to be challenged by the emergence of new business models that required different management practices.

The DuPont chemical company was created when two cousins bought their family's interests in a number of firms at the turn of the 20th century. The new organisation was more complex than most of its contemporaries, as it sold many different products to different markets. Its managers realised that they needed mechanisms to evaluate the company's diverse interests and allocate money for investment. The breakthrough came when they developed return on investment (ROI) to evaluate the performance of its various businesses, plus accounting rate of return (ARR), which is based on ROI, for investment appraisal. The latter's development was a big advance for investment appraisal since, unlike payback, ARR calculates a project's return.

Table 3 shows the ARR calculation for the original oil project. The first step here is to determine the profit flows for the project. While this can be hard in practice, a simple adjustment that gives an acceptable ARR figure is to charge depreciation on the initial investment. This example, which assumes that the asset has no residual value, charges £125m of depreciation to the project. The total profit flow (£30m) is then divided by the life of the project (five years) to calculate the

1 Oil project payback calculation

Year	Annual cash flow	Cumulative cash flow
0	-£125m	-£125m
1	£20m	-£105m
2	£50m	-£55m
3	£60m	£5m
4	£40m	£45m
5	-£15m	£30m
Payback: 2.92 years		

2 Comparing two mutually exclusive projects using payback

Project A Year	Annual cash flow	Cumulative cash flow
0	-£25m	-£25m
1	£16m	-£9m
2	£12m	£3m
3	£10m	£13m
4	£8m	£21m
5	£6m	£27m
Payback: 1.75 years		

Project B Year	Annual cash flow	Cumulative cash flow
0	-£35m	-£35m
1	£10m	-£25m
2	£15m	-£10m
3	£20m	£10m
4	£15m	£25m
5	£10m	£35m
Payback: 2.50 years		

3 Oil project ARR calculation

Year	Cash flow	Depreciation	Profit flow
0	-£125m		
1	£20m	-£25m	-£5m
2	£50m	-£25m	£25m
3	£60m	-£25m	£35m
4	£40m	-£25m	£15m
5	-£15m	-£25m	-£40m
Total profit flow			**£30m**

average annual profit: £6m. The next step is to calculate the average value of the investment, which is the total of the opening and closing value of the investment divided by two: (£125m + £0) ÷ 2 = £62.5m. The ARR is calculated by dividing the average annual profit flow by the average value of the investment: £6m ÷ £62.5m = 9.6 per cent. Is this an acceptable rate of return?

We can apply the same principles to the two mutually exclusive projects to calculate an ARR for each. For project A it's 43.2 per cent and for project B it's 40 per cent. Using ARR to choose between them, we would pick project A because it offers a higher return. But is this the right decision?

Many firms adopted ARR, since DuPont was highly regarded by its peers. But by the forties an increasing number of businesses were questioning its application to investment appraisals. This led to the wider adoption of discounted cash flow (DCF) techniques. These have their origins in the 16th century, but their first recorded use didn't occur until the late 19th century, when a railway engineer called Arthur Wellington advocated the use of present value. Unfortunately, his work attracted little interest and more than half a century passed before DCF techniques were used for investment appraisals.

DCF methods are based on a simple idea: today's money is worth more than the same amount received in future, because today's money can be invested – eg, put in a deposit account at a fixed interest rate. Future cash flows from an alternative investment are discounted at the opportunity cost of capital – eg, the interest lost by taking money out of the deposit account to fund a project – in order to determine whether it provides a better return. Another way of looking at this concept, if the investor needs to borrow money, is to consider what future money would be worth now after taking account of the cost of borrowing. ARR cannot take account of the time value of money, since it uses profit flows rather than cash flows.

Discount factors are calculated as follows: $1 ÷ (1 + r)^n$, where r is the rate of interest and n is the year for which the factor is being calculated. The discount factor for an interest rate of 10 per cent for year one, for example, would be: $1 ÷ (1 + 0.1)^1 = 0.909$. The factor

4 Oil project IRR calculation

Year	Cash flow	Discount factor: 5%	Present value
0	-£125m	1.000	-£125.00m
1	£20m	0.952	£19.04m
2	£50m	0.907	£45.35m
3	£60m	0.864	£51.84m
4	£40m	0.823	£32.92m
5	-£15m	0.784	-£11.76m
Total NPV			**£12.39m**

Year	Cash flow	Discount factor: 15%	Present value
0	-£125m	1.000	-£125.00m
1	£20m	0.870	£17.40m
2	£50m	0.756	£37.80m
3	£60m	0.658	£39.48m
4	£40m	0.572	£22.88m
5	-£15m	0.497	-£7.46m
Total NPV			**-£14.90m**

for year two would be $1 ÷ (1 + 0.1)^2 = 0.826$. Most textbooks provide these factors and CIMA supplies them in the exams.

The first recorded use of a DCF-based investment appraisal technique occurred when US firm Atlantic Refining applied a method known as the internal rate of return (IRR) in 1946. Influential commentators were soon championing its use. The IRR is the discount rate that produces a net present value (NPV) of zero for a project's cash flows. The simple decision rule is to accept projects with an IRR that's greater than the cost of capital and reject those with an IRR that's less than the cost of capital.

To obtain the IRR by interpolation, two sets of calculations must be performed for a project's cash flows. Ideally, one set will calculate a positive NPV and the other a negative NPV, as in table 4 for the oil project (it is possible to use figures that produce two positive or two negative values). We first apply discount factors to future cash flows to determine their present value. Then we add up the present values of the cash flows for each year to calculate the NPVs.

The first set of calculations, which uses a discount factor of 5 per cent, produces a NPV of £12.39m. The second set, which

uses a discount factor of 15 per cent, produces a NPV of -£14.90m. These figures show that the IRR must lie between 5 per cent and 15 per cent. To obtain a better estimate, we first need to find the difference between the two NPV figures: £12.39m – -£14.90m = £27.29m. This difference is covered by a range of 10 percentage points (ie, 15 per cent – 5 per cent).

We can estimate the IRR by dividing the NPV at the 5 per cent discount factor by the monetary range, multiplying that figure by the percentage range and adding the result to the original 5 per cent discount factor: (£12.39m ÷ £27.29m x 0.1) + 0.05 = 0.0954.

While the resulting IRR of 9.54 per cent is not as accurate as the figure that can be obtained by using a spreadsheet calculation (9.13 per cent), we could have got closer to it by using a tighter spread of discount factors – for example, 8 per cent and 10 per cent.

If the oil company's cost of capital were, say, 7 per cent, we would support the project, since it has a higher projected rate of return. But if the company's cost of capital were 12 per cent, we'd reject the project.

The IRRs for our mutually exclusive projects A and B are 38.3 per cent and 28.0 per cent respectively. Based on these figures, we'd pick A, since it promises a higher return. But is this the right decision?

While many companies adopted IRR and still use it today, the technique does have a number of weaknesses:
- It assumes that money earned from a potential investment will be reinvested at the project's IRR. But is this a realistic assumption, particularly if a project has a high potential return?
- It is possible to calculate multiple rates of return for a project if it has irregular or unusual cash flows. Which one is right?
- IRR may produce a different recommendation from that of other DCF techniques. Which should be accepted?
- IRR does not always evaluate mutually exclusive projects correctly, as it calculates a relative return, not an absolute return. For example, it's better to have 9 per cent of £1,000 than 10 per cent of £800.

In recent years experts have advocated using the modified internal rate of return (MIRR) for investment appraisal, because it

5 Comparing two mutually exclusive projects using NPV

Project A Year	Cash flow	Discount factor: 10%	Present value
0	-£25m	1.000	-£25.00m
1	£16m	0.909	£14.54m
2	£12m	0.826	£9.91m
3	£10m	0.751	£7.51m
4	£8m	0.683	£5.46m
5	£6m	0.621	£3.73m
Total NPV			**£16.15m**

Project B Year	Cash flow	Discount factor: 10%	Present value
0	-£35m	1.000	-£35.00m
1	£10m	0.909	£9.09m
2	£15m	0.826	£12.39m
3	£20m	0.751	£15.02m
4	£15m	0.683	£10.25m
5	£10m	0.621	£6.21m
Total NPV			**£17.96m**

6 Discounted payback calculation for A

Project A Year	Discounted cash flow (DCF)	Cumulative DCF
0	-£25.00m	-£25.00m
1	£14.54m	-£10.46m
2	£9.91m	-£0.55m
3	£7.51m	£6.96m
4	£5.46m	£12.42m
5	£3.73m	£16.15m
Payback: 2.07 years		

reinvests a project's cash flows at the project's cost of capital. But, although MIRR addresses many of IRR's weaknesses, it still doesn't calculate an absolute return. (Note that MIRR isn't examined in paper P1.)

The final method, NPV, does give an absolute return rather than a percentage. Using this approach we apply discount factors to future cash flows to determine their present value. We then add up the present values of the cash flows for each year of the project to find its NPV. The simple decision rule is to accept projects with a positive NPV and reject those with a negative NPV.

Table 5 applies NPV, based on a 10 per cent cost of capital, to our mutually exclusive projects. The calculations show that we should pick project B, as it has a higher NPV than A. This is the right choice, although the situation would change if the company's cost of capital were to exceed 14 per cent.

Discounted cash flows can be used to calculate the discounted payback period of a project. From table 6 we can see that the discounted payback period is 2.07 years for project A and 2.90 years for project B. While this technique provides a better measure than the original payback method, it still has the same deficiencies.

This article has focused on investment appraisal techniques, but this is not the full story when it comes to evaluating projects, of course. You must take great care in identifying relevant cash flows and you'll also need to consider other factors – for example, tax, inflation, risk and qualitative issues – to assess a proposal. Getting it right isn't easy.

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Exam practice

Try the following question to test your understanding. The answer will be published in a future issue of *Velocity*, CIMA's student e-magazine (www.cimaglobal.com/velocity).

A company called Expansion has an empty department in one of its factories that could be used to expand the production of current products or manufacture new goods. Four proposals relating to the use of this space have been submitted. Only one of them can be accepted, since each project would fully utilise the department.

The following information was obtained for the proposals:

Year	Proposal 1 cash flows	Proposal 2 cash flows	Proposal 3 cash flows	Proposal 4 cash flows
0	-£120	-£95	-£80	-£160
1	£80	£10	£30	£30
2	£60	£40	£40	£50
3	£40	£40	£30	£90
4	£20	£60	£30	£80
5	-£40	£50	£20	£60
Residual value	£0	£5	£0	£40

The cash flows for year five include, where applicable, the sale of the fixed assets purchased (in year zero) at residual value. The company's cost of capital is 10 per cent.
You are required to:
A Calculate the payback, accounting rate of return, internal rate of return and net present value for each of the four projects.
B Identify which project should be approved by the company and, with reference to the figures calculated for part B, explain why.

P1 further reading

S Dulman, "The development of discounted cash flow techniques in US industry", *Business History Review*, autumn 1989.
G Steven, "Management Accounting – Decision Management", *Financial Management*, March 2008.
B Scarlett, *The Official CIMA Learning System – Performance Operations*, CIMA Publishing, 2009.