7 Capital Budgeting

Overview

In Chap. 6 we explained decision rules for investment decisions. We discussed financial investment evaluation methods such as NPV (net present value), IRR (internal rate of return), and payback period. The chapter subsequently showed that S (social) and E (environmental) factors can be valued in their own right and can be included in constrained, expanded, or integrated PVs (present values). However, in Chap. 6 the cash flows were presented as given. In this chapter, we dive deeper into the capital budgeting process, which is the process of making a list of investment projects to be done. We make these investment decisions more tangible by presenting more detailed calculation examples—including the calculation and forecasting of cash flows and their drivers.

We start by showing the steps in the capital budgeting process and then show how cash flows and incremental cash flows are calculated and forecasted. Subsequently, we identify behavioural challenges in the capital budgeting process, such as the tendency to continue poor projects for too long, to underestimate risk, and to overestimate cash flows. Even more challenging, people tend to extrapolate business as usual into the future, which is highly unrealistic in dealing with non-linear processes such as climate change.

Next, we integrate S and E in the capital budgeting process—integrated capital budgeting. The constrained, expanded, and integrated PVs (introduced in Chap. 6) are now shown with cash flow projections. It is shown that FV, SV, and EV can have shared, reinforcing, or conflicting underlying value drivers—and that the way and extent to which they are taken into account affect decisions.

The value dimensions FV, SV, and EV can affect each other. We discuss the process of internalisation, by which SV or EV might spill over into FV. Those investment decisions are put in the context of corporate objectives, as put forward in Chap. 3 on corporate governance. See Fig. 7.1 for an overview of the chapter.

D. Schoenmaker, W. Schramade, *Corporate Finance for Long-Term Value*, Springer Texts in Business and Economics, https://doi.org/10.1007/978-3-031-35009-2_7

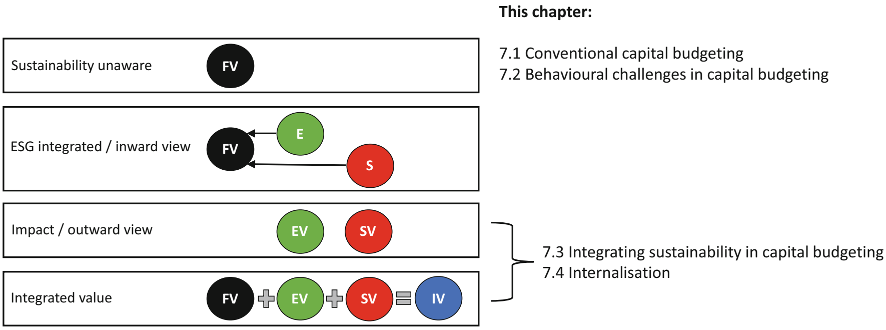


Fig. 7.1 Chapter overview

Learning Objectives
After you have studied this chapter, you should be able to:

- Calculate and compare the value of projects
- Identify behavioural biases in capital budgeting
- Explain how to integrate SV and EV into project evaluation
- Balance the financial, social, and environmental dimensions of projects
- Critically evaluate projects in terms of company valuation profile

7.1 Conventional Capital Budgeting

7.1.1 The Capital Budgeting Process

A *capital budget* is the list of projects the company plans to invest in. The process of determining the list of investment projects to be undertaken is called *capital budgeting*. Capital budgeting happens in several steps, as illustrated in Fig. 7.2.

First, managers and workers from all over the company identify investment opportunities. They can typically choose and execute small investment opportunities on their own authority, but where investment needs are beyond pre-specified and company-specific thresholds (e.g. for every outlay above €500k), they will need to ask for permission. This leads to the second step, where they submit investment proposals, which are collected centrally by a corporate financial planning department.

In the third step, that department will do an initial assessment of the proposed projects: do they meet financial and nonfinancial criteria, such as strategic fit? These nonfinancial criteria might include S and E criteria on, for example, CO_2 emissions, safety, and labour conditions across the value chain. Such criteria will typically inform the behaviour of the proposers as well, meaning that there is a bias towards meeting those criteria. The financial planning department will typically test the

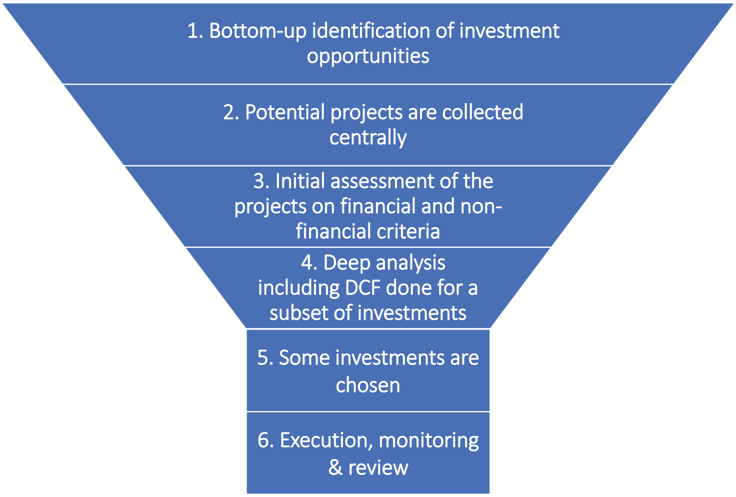


Fig. 7.2 Stages of a typical capital budgeting process

assumptions made in the proposal. See Box 7.1 for an example of the role of strategic objectives in capital budgeting.

A subset of projects makes it to the fourth stage, where their consequences for the company and its value creation are calculated in terms of their DCF (discounted cash flow) value. This gives a list of projects that are ranked on NPV and matched with the available investment budget to decide which projects are finally chosen (Step 5). The final step (#6) is the execution of the chosen projects, which happens over the course of years, and during which they are monitored and reviewed. This chapter will focus on the calculation side of Steps 4 and 5.

Box 7.1: Asahi Group: Strategic Objectives for the Capital Budgeting Process

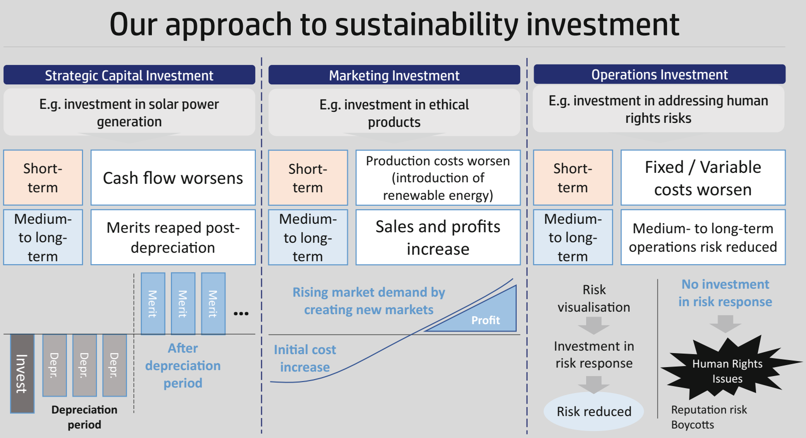
Asahi Group Holdings is a Japanese company that produces alcoholic drinks, soft drinks, and other beverages in the food business. Sustainability concerns are part of Asahi's strategy and the subject of a separate sustainability strategy, which has five components: responsible drinking; health; environment; people; and communities. The goal of promoting responsible drinking indicates that the company is aware of the negative health effects of its alcoholic drinks. Asahi has set several quantified targets on E, such as reducing its waste and carbon emissions. On the S side, the company takes measures to reduce 'inappropriate drinking' and it wants low-alcohol and non-alcohol beverages to account for 20% of its sales by 2025.

To achieve those targets, the company sets management incentives accordingly. In its investor presentations, the company talks about integrating

(continued)

Box 7.1 (continued)

sustainability into management strategy through such initiatives as 'Asahi Group Environmental Vision 2050' and 'Sustainable Communities'. Such strategic choices are set by top management, and they give direction to the goals and actions of middle managers. So, if a strategy includes having more sales from non-alcoholic beverages, or lowering the company's carbon footprint, then managers will be actively looking for projects that further those goals.



Source: Adapted from page 7 of 2021 Investor Relations presentation, Asahi Group

In talking about its sustainability investments, Asahi distinguishes strategic capital investment (e.g. investment in solar power generation); marketing investment (e.g. investment in ethical products); and operations and management investment (e.g. investment in addressing human rights risks). In all three areas, the company expects lower cash flows and/or higher costs in the short term, but better cash flows and lower risk in the medium to long term. As Asahi puts it: 'Sustainability is not about cost—it is investment in the future. By addressing sustainability not from a short-term but rather a medium- to long-term perspective, we aim to secure investment returns, reduce risk, and boost corporate value'.

7.1.2 Calculating Cash Flows

Step 4 of the capital budgeting process involves a DCF analysis, which requires the calculation of expected cash flows. Table 7.1 shows a simplified DCF with a cost of capital of 10%, similar to the ones shown in Chaps. 4 and 6. The PV (present value)

Table 7.1 Simple NPV calculation

Year	2022	2023	2024	2025	2026	2027	2028	2029
Cash flow	–100	25	25	25	25	25	25	25
Discount factor	1.00	0.91	0.83	0.75	0.68	0.62	0.56	0.51
PV(Cash flow)	–100.0	22.7	20.7	18.8	17.1	15.5	14.1	12.8
NPV	**21.7**							

Table 7.2 Calculating cash flows

	2018	2019	2020	2021
Sales	0	320	633	1196
Costs (including depreciation)	–472	–501	–512	–855
EBIT = sales – total costs	**–472**	**–181**	**121**	**341**
Interest paid	–10	–12	–10	–8
× applicable corporate tax rate	25%	25%	25%	25%
Corporate tax	121	48	–28	–83
Net income = EBIT – interest – corporate tax	**–362**	**–145**	**83**	**250**
+ depreciation	48	48	48	48
– CAPEX	–516	–37	–37	–37
– increase in NWC	–12	–14	–24	–37
Project cash flows	**–842**	**–148**	**70**	**224**

for each year is the cash flow multiplied by the discount factor. The NPV (net present value) is the sum of the PVs over the project life.

But how are the cash flows themselves calculated? Where do they come from? How are they generated? Table 7.2 gives a breakdown of cash flows in their components, which can be estimated separately. The following accounting terms are used in the cash flow calculation:

- **EBIT**: earnings before interest and taxes
- **CAPEX**: capital expenditures (i.e. company investments)
- **NWC**: net working capital, which is the difference between the company's current assets (such as cash, inventories, and accounts receivable) and its current liabilities (such as taxes payable, accounts payable, short-term funding). Current assets and liabilities are short term (typically less than 1 year)

Table 7.2 shows the standard set-up. EBIT is sales minus costs. To arrive at net income, interest and corporate taxes are deducted. Please note that corporate tax is positive (i.e. a cash inflow) in 2018 and 2019. This means that the company receives a tax refund, as the negative income (EBIT minus interest paid) can be deducted from corporate taxes. Up till now, we work with accounting terms as represented in a company's management and financial accounts. To get from net income to cash flows, we need to make a few corrections. First, depreciation is a component of costs (as presented in the second line item of Table 7.2) and hence deducted from sales.

However, since depreciation is a non-cash item (i.e. does not affect cash flows), it should be added back. Second, the investment outlays in machinery and buildings are incorporated as capital expenditures (CAPEX) in the cash flow analysis; and investment in inventory is included as an increase in net working capital (NWC). The final result is the project cash flows in Table 7.2. These project cash flows are also labelled 'free cash flows' available to the company's shareholders.

7.1.3 Estimated Cash Flows

However, Table 7.2 shows historical cash flows. For capital budgeting purposes, we need forward-looking cash flows, i.e. estimated cash flows. This requires estimates on individual line items, and importantly, on their underlying value drivers. What's driving sales and costs? To what extent will the company be successful in beating its competitors, in selling its products, and in handling its operating issues to keep costs in check? There is obviously no certainty on any of the above, hence the estimates are no more than expected values, with a large margin of error.

It is important to note that choices can be made as to what line items to estimate, with what detail, and which line items simply follow from others. For example, if one estimates sales and costs, then EBIT and the EBIT margin will result from them. Alternatively, one could estimate sales and the EBIT margin (i.e. EBIT as a percentage of sales), and then EBIT and costs will follow from them. One can also go deeper, for example estimating the volume and price components separately to arrive at sales and cost estimates. We can illustrate this with an example.

Let's suppose a mining company plans to develop an extension to one of its copper mines in Latin America. To obtain a cash flow forecast, the business unit (BU) will forecast the amount of time and money spent on building the extension; the volumes of product to be sold, and at what price; and the costs involved in producing the product. Table 7.3 shows the BU's assumptions for the first 10 years, and how they add up to cash flows. In the first 2 years, there is no production and capital expenditures are high, resulting in negative cash flows of over $500 million. Production starts in year 3 and is expected to reach maximum capacity by year 6. Production costs fall from $7000/tonne (1000 kg) in year 3 to $4200/tonne in year 5. Since the copper price is forecast to be $8000/tonne, this results in an EBIT margin of 48%. Please note that for simplicity, we assume constant prices in our examples. In reality, inflation will lead to increased prices and costs. Moreover, commodity prices are volatile due to fluctuations in demand and supply.

When reading tables with detailed numbers (e.g. Tables 7.3 and 7.4), you will notice that the numbers don't add up exactly, due to rounding. This is the case for internal company overviews and calculations (like in this chapter) as well as external reports (see Chap. 17).

If we suppose that those cash flows run until year 30 (as in year 10) and apply an 11% cost of capital to the cash flows, we can calculate the value of the 20-year annuity from year 11 to year 30. So, the terminal value at year 10 is calculated as a 20-year annuity.

Table 7.3 Copper mine extension FCF calculation (in millions of USD)

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	...	Year 10
Volume (thousands of tonnes)	n/a	n/a	50	120	130	140		140
Price (USD/tonne)	n/a	n/a	8000	8000	8000	8000		8000
Sales (USD million)	**0**	**0**	**400**	**960**	**1040**	**1120**		**1120**
Costs per tonne	n/a	n/a	–7000	–5000	–4200	–4200		–4200
Costs (USD million)	–100	–100	–350	–600	–546	–588		–588
EBIT = sales – total costs	**–100**	**–100**	**50**	**360**	**494**	**532**		**532**
EBIT margin	n/a	n/a	13%	38%	48%	48%		48%
× applicable corporate tax rate	25%	25%	25%	25%	25%	25%		25%
Corporate tax	25	25	–13	–90	–124	–133		–133
Net income = EBIT – corporate tax	**–75**	**–75**	**38**	**270**	**371**	**399**		**399**
+ depreciation	100	100	100	100	100	100		100
– CAPEX	–600	–700	–400	–60	–60	–60		–60
– increase in NWC	–20	–20	–20	–20	–20	–20		–20
Project Cash Flows	**–595**	**–695**	**–283**	**290**	**391**	**419**		**419**

Table 7.4 Copper mine extension DCF (in millions of USD)

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Project cash flows	–595	–695	–283	290	391	419	419	419	419	419
Terminal value										3337
Total cash flows	–595	–695	–283	290	391	419	419	419	419	3756
Discount factor	0.901	0.812	0.731	0.659	0.593	0.535	0.482	0.434	0.391	0.352
Present value	–536	–564	–207	191	232	224	202	182	164	1323
NPV	**1210**									

Using Eq. (4.7) from Chap. 4, we get the following value of the 20-year annuity: $PV = \frac{CF}{r} \cdot \left(1 - \frac{1}{(1+r)^N}\right) = \frac{419}{0.11} \cdot \left(1 - \frac{1}{(1+0.11)^{20}}\right) = 3{,}809.1 \cdot (1 - 0.124) = 3{,}336.8$ (which is rounded to 3337 in Table 7.4). Please note that the annuity from year 11 to year 30 is discounted at the discount factor of the preceding year (year 10) in Table 7.4. Discounting total cash flows (which include project cash flows and the terminal value), one obtains an NPV or DCF value of \$1.2 billion (\$1210 million in Table 7.4).

In the above mining example prices and volumes need to be split, since prices can fluctuate so much. However in many instances, it makes sense to take a shortcut and estimate sales directly, based on estimates of growth rates. For example, a project may be expected to ramp up from 0 to $80 million annual sales in 2 years, with the assumptions in Table 7.5 resulting in the cash flow forecasts of Table 7.6.

In Table 7.5, the white cells in years 0–2 are calculated on given data (as also shown in Table 7.6), whereas the grey cells are assumptions that are inspired by, and extrapolated from, the white cells. Those assumptions in turn drive the results in Table 7.6. It often makes sense to have detailed assumptions (e.g. on the absolute cost level) for the first few years, followed by more high-level assumptions (e.g. on growth rates and percentage margins) in later years.

When discounting the cash flows from Table 7.6 at 9% from the end of year 0, we obtain an NPV of 15.

Table 7.5 Forecasting assumptions

	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7
Sales growth	n/a	n/a	167%	5%	5%	5%	5%	5%
EBIT margin	n/a	-50%	31%	31%	31%	31%	31%	31%
Corporate tax rate	25%	25%	25%	25%	25%	25%	25%	25%
Depreciation/sales	n/a	33%	13%	12%	11%	10%	9%	8%
CAPEX/sales	n/a	17%	6%	8%	8%	8%	8%	8%
Increase in NWC/sales	n/a	3%	1%	1%	1%	1%	1%	1%

Table 7.6 Resulting cash flows (in millions of USD)

	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7
Sales	**0**	**30**	**80**	**84**	**88**	**93**	**97**	**102**
Costs	–10	–45	–55	–58	–61	–64	–67	–70
EBIT	**–10**	**–15**	**25**	**26**	**27**	**29**	**30**	**32**
× applicable tax rate	25%	25%	25%	25%	25%	25%	25%	25%
Corporate tax	3	4	–6	–7	–7	–7	–8	–8
Net income	**–8**	**–11**	**19**	**20**	**21**	**22**	**23**	**24**
+ depreciation	10	10	10	10	9	9	8	8
– CAPEX	–70	–5	–5	–7	–7	–7	–8	–8
– increase in NWC	–1	–1	–1	–1	–1	–1	–1	–1
Project cash flows	**–69**	**–7**	**23**	**21**	**22**	**22**	**22**	**22**
Discount factor	1.000	0.917	0.842	0.772	0.708	0.650	0.596	0.547
Present value	–69	–7	19	17	15	14	13	12
NPV	**15**							

7.1.4 Incremental Cash Flows

It is important to realise that investment assessment is about changes to the current situation. So if a project creates new cash flows—but at the same time reduces the cash flows on on-going projects—the net effect should be calculated, i.e. the *incremental cash flows* of projects. These incremental cash flows reflect the difference in the company's overall cash flows with and without the project under evaluation. It requires estimating incremental sales and incremental costs. One therefore needs to take into account the indirect effects of the project which may increase or decrease the cash flows of other activities of the company.[1] For example, a new product may come at the expense of an existing product's sales. If the new product has superior characteristics compared to the existing product, then clients will switch and buy the new product instead of the existing one. This process is called *cannibalisation*. If the cannibalisation potential relates to a very profitable product, it may hold the company back from introducing the new product.

Table 7.7 shows an example in which the introduction of a new product, B, is expected to result in 15% lower sales of the existing product, A. The change in cash

Table 7.7 Calculating incremental cash flow

	Product A before introduction product B	Product A after introduction product B	Change in product A	Product B	Incremental cash flows of product B
Sales	1000	850	–150	1200	**1050**
Costs	–700	–620	80	–800	**–720**
EBIT	300	230	–70	400	**330**
EBIT margin	30%	27%	–3%	33%	**31%**
× applicable tax rate	25%	25%	0%	25%	**25%**
Corporate tax	–75	–58	18	–100	**–83**
Net income	225	173	–53	300	**248**
+ depreciation	50	50	0	100	**100**
– CAPEX	–50	–40	10	–100	**–90**
– increase in NWC	–20	–20	0	–30	**–30**
Total Cash Flows	205	163	–43	270	**228**

[1] These are also called project externalities. However, we find the name of that concept confusing as it is quite distinct from externalities (or external impacts) as defined in Chaps. 1 and 2, i.e. costs and benefits that fall outside the boundaries of the company.

flow on product A is –43. Since product B gives a cash flow of 270, the incremental cash flow is 270 – 42.5 = 227.5. So, cannibalisation does happen. But since the new product has higher sales and higher profit margins than the existing product, its introduction is still quite value creative for the company.

Another effect that is often missed in calculating incremental cash flows is the *opportunity cost* of the project: the missed value of what could have been done instead. For example, in the above calculation one might have forgotten to include the cost of an idle machine that is used for project B but could have been sold or rented out, with a cash flow of, say, 100. That would have reduced incremental cash flow to 228–100 = 128.

7.1.5 Include the Opportunity Costs of the Desalination Plant in Incremental Cash Flows

Let's return to the copper mine project described in Tables 7.3 and 7.4. Additional information comes in: the water stress of the project is so severe that it puts drinking water quality and availability for the local population at risk. As a result, the company runs the risk of losing the project, and all cash flows associated with it, at the end of year 3—just when cash flows are expected to turn positive. The chance of this happening is estimated at 50%. This means that expected cash flows from year 4 onwards are halved, and the NPV is reduced by $1258 million (see Table 7.8). To address this risk, and reduce the probability of losing the asset to 0%, the company could build a desalination plant, which makes seawater suitable for human consumption.

On a stand-alone basis, i.e. forgetting about the opportunity cost of reducing the risk of losing the asset, the marginal CF from the desalination plant is negative across all years (see Table 7.9). Applying the mining company's 11% discount rate, the marginal cash flows turn into a negative DCF value of $538 million. Note that years 7–9 have marginal project cash flows which are similar to year 6. The respective present value (PV) for these years is –5, –5, and –4, due to the decreasing discount factor over time.

Table 7.8 NPV of 50% chance of losing the asset in year 4 (in millions of USD)

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Total cash flows	0	0	0	–145	–195	–210	–210	–210	–210	–1878
Discount factor	0.901	0.812	0.731	0.659	0.593	0.535	0.482	0.434	0.391	0.352
Present value	0	0	0	–96	–116	–112	–101	–91	–82	–661
NPV	**–1258**									

Note: This table is based on Table 7.4, whereby half of cash flows are lost from year 4 onwards

Table 7.9 The desalination plant's marginal cash flows excluding opportunity costs

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	...	Year 10
Marginal operating costs	0	–10	–10	–10	–10	–10		–10
Marginal depreciation	0	–25	–25	–25	–25	–25		–25
Marginal costs	0	–35	–35	–35	–35	–35		–35
Marginal EBIT	0	–35	–35	–35	–35	–35		–35
Marginal corporate tax	0	9	9	9	9	9		9
Marginal Net Income	0	–26	–26	–26	–26	–26		–26
Marginal depreciation	0	25	25	25	25	25		25
Marginal CAPEX	–500	–10	–10	–10	–10	–10		–10
Marginal project cash flow	**–500**	**–11**	**–11**	**–11**	**–11**	**–11**		**–11**
Terminal value								**–90**
Total marginal project cash flow	**–500**	**–11**	**–11**	**–11**	**–11**	**–11**		**–101**
Discount factor	0.901	0.812	0.731	0.659	0.593	0.535		0.352
Present value	–450	–9	–8	–7	–7	–6		–36
NPV	**–538**							

Table 7.10 The desalination plant's incremental cash flows

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	...	Year 10
Marginal CF of the desalination plant, stand-alone	–500	–11	–11	–11	–11	–11		–11
Opportunity cost: eliminating the expected loss in CF	0	0	0	145	195	210		210
Incremental cash flow	**–500**	**–11**	**–11**	**134**	**184**	**198**		**198**
Terminal value								**1579**
Total incremental cash flow	**–500**	**–11**	**–11**	**134**	**184**	**198**		**1777**
Discount factor	0.901	0.812	0.731	0.659	0.593	0.535		0.352
Present value	–450	–9	–8	88	109	106		626
NPV	**720**							

Based on the calculations in Table 7.9, the desalination plant seems like a poor investment. **However, the analysis should include the benefits of eliminating the probability of losing the asset.** Table 7.10 does exactly that to arrive at the real incremental cash flows of the desalination plant. It does so by calculating the expected cash flows to be missed from the original project (50% of the positive cash flows from year 4 onward—see the bottom line of Table 7.3 for the original cash flows) and adding them to the stand-alone marginal cash flows calculated in Table 7.9.

The cash flows from Table 7.10 result in a $720 million DCF value of building the desalination plant. And the new NPV of the project, including the desalination plant is $672 million. Table 7.11 summarises the DCF results.

To check if the new project value of $672 million is correct, let's calculate the adjusted cash flows of the project and the individual line items. This is done by summing the relevant lines in Tables 7.3 and 7.9, of which the results are shown in Table 7.12.

Table 7.11 DCF value including the desalination plant

Type of value	Value in USD millions
1. Original NPV before the risk of losing the asset (Table 7.4)	1210
2. Loss due to risk of losing the asset (Table 7.8)	–1258
3. New NPV before the desalination plant (3) = (1) + (2)	–48
4. NPV of the desalination plant (Table 7.10)	720
5. New NPV including the desalination plant (5) = (3) + (4)	672

Table 7.12 Project CFs including the desalination plant

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	. . .	Year 10
Volume (thousands of tonnes)	n/a	n/a	50	120	130	140		140
Price (USD/tonne)	n/a	n/a	8000	8000	8000	8000		8000
Sales (USD million)	**0**	**0**	**400**	**960**	**1040**	**1120**		**1120**
Costs per tonne	n/a	n/a	–7000	–5000	–4200	–4200		–4200
Costs (USD million)	–100	–135	–385	–635	–581	–623		–623
EBIT (USD million)	**–100**	**–135**	**15**	**325**	**459**	**497**		**497**
EBIT margin	n/a	n/a	4%	34%	44%	44%		44%
× applicable corporate tax rate	25%	25%	25%	25%	25%	25%		25%
Corporate tax (USD million)	25	34	–4	–81	–115	–124		–124
Net income (USD million)	**–75**	**–101**	**11**	**244**	**344**	**373**		**373**
+ depreciation (USD million)	100	125	125	125	125	125		125
– CAPEX (USD million)[a]	–1100	–710	–410	–70	–70	–70		–70
– increase in NWC (USD million)	–20	–20	–20	–20	–20	–20		–20
Project Cash Flows (USD million)	**–1095**	**–706**	**–294**	**279**	**379**	**408**		**408**

Note: [a]CAPEX is including desalination investment

Table 7.13 Adjusted copper mine extension DCF (in millions of USD)

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Project cash flow	–1095	–706	–294	279	379	408	408	408	408	408
Terminal value										3247
Total cash flow	–1095	–706	–294	279	379	408	408	408	408	3655
Discount factor	0.901	0.812	0.731	0.659	0.593	0.535	0.482	0.434	0.391	0.352
PV	–986	–573	–215	184	225	218	196	177	159	1287
NPV	**672**									

Table 7.13 calculates the present value in the same way as in Table 7.4. We use again a 20-year annuity to calculate the terminal value at year 10. The result is the same as the result in Table 7.11: $672 million.

7.1.6 Sanity Checks in Analysing Projects

When analysing a project, it makes sense to do sanity checks on what is driving the outcomes. A sanity check (or test) is a basic test to quickly evaluate whether a claim, or the result of a calculation, can possibly be true. For example, one could do a sensitivity analysis on (some of) the value drivers of the project: that is an effective way to answer the question of what happens to the NPV when changing key assumptions. Table 7.14 shows what happens when changing the assumptions about sales growth and EBIT margin (from year 3 onward) for the project shown in Tables 7.5 and 7.6. The NPV of $15 million, shown in the middle, is the original outcome with the best estimate of the value drivers, namely 5% sales growth and 31% EBIT margins. When raising the EBIT margin assumption to 33% while holding sales growth constant, the NPV becomes $20 million (one cell to the right of the 15 in the box), i.e. a 2% percentage point higher margin gives a $5 million (=33%) higher value. The sensitivity to sales growth is a bit lower though, since a 7% sales growth assumption (combined with the original 31% EBIT margin) results in an NPV of $19 million (one cell below the 15 in the box). Of course, one could also vary the cost of capital instead of margins or sales growth.

Another sanity check is the break-even analysis, which asks which levels of sales growth and margins (or cost of capital) are needed to have an NPV of 0. In the above example, while holding sales growth at 5% and cost of capital at 9% constant, the 0 NPV is obtained by lowering the EBIT margin assumption to 24%. Similarly, while holding the others constant, a zero NPV is reached by raising the cost of capital to 14%. The project IRR in the base scenario of 5% sales growth and 31% EBIT margin is thus 14%.

Table 7.14 Sensitivity analysis on value drivers: NPV in millions of USD

Sales growth	EBIT margins				
	27%	29%	31%	33%	35%
1%	0	4	8	12	16
3%	3	7	11	16	20
5%	6	11	**15**	20	24
7%	9	14	19	24	29
9%	13	18	23	28	33

Table 7.15 Simple scenario analysis on value drivers

Value driver	Base case	Bear case	Bull case
Product volume growth	3%	0%	5%
Sales price	€40	€30	€50
Cost per unit	€25	€30	€20
Capex needed	€100 million	€200 million	€80 million

One could also do a simple scenario analysis, in which one makes a rough estimate of what a ‘bull’ or ‘bear’ case would look like in terms of value drivers (Table 7.15), which can then be inserted into the more detailed forecasting model. A bull market occurs when prices (and demand) are on the rise, while a bear market occurs when prices fall for a sustained period of time. Of course, analysing a bull or bear case falls well short of a real scenario analysis, in which the qualitative drivers are thoroughly assessed.

7.2 Behavioural Challenges in Capital Budgeting

Chapter 6 described behavioural effects on investment decisions, such as overconfidence (underestimation of risk) and excessive optimism (overestimation of cash flows). In this section, we will focus on forms of the latter. We discuss how such behavioural challenges can affect cash flow projections and how to deal with them.

Excessive optimism at the abovementioned copper mining project might show up in the tendency to overestimate copper demand and copper prices and to underestimate costs. In addition, the project could suffer other behavioural biases, such as the sunk cost fallacy, extrapolation bias, and escalation of commitment.

7.2.1 Sunk Cost Fallacy

The opposite of opportunity costs applies to sunk costs, which are costs that have been made and that are unrecoverable in any case, regardless of the project. Sunk costs have zero incremental impact, are irrelevant for the project, and should not be included in incremental cash flows. For example, if the desalination plant in the above example had already been in place, it should not have been included in the calculations, and the NPV of the copper mining project would simply have been the original $1.2 billion. Still, people are quite often inclined to include sunk costs in their analysis. This is called the 'sunk cost fallacy'. When sunk costs are wrongly included, it can lead to rejecting good projects because of the extra cost burden.

Overhead costs are a typical example of costs that are often, but not always, 'sunk' from a project perspective. The rule here is to include only additional overhead costs, i.e. those incurred specifically for the project, in the calculation of incremental cash flows.

7.2.2 Extrapolation Bias

When forecasting future cash flows, there is a tendency to extrapolate business as usual into the future, a phenomenon called extrapolation bias. This can be highly unrealistic when dealing with non-linear processes such as climate change and transitions, as explained in Chap. 2. For example, ignoring future policy changes such as higher carbon taxes may lock companies into high-emitting projects.

In the copper mining project, projections of copper prices and costs might be based too much on historical copper prices and costs at current operations.

7.2.3 Escalation of Commitment

Once projects are in process, or their preparations are well advanced, the team involved in them might suffer from escalation of commitment: they feel so committed to the project that they ignore signals that it might not be as good as they thought. Instead of seriously evaluating the project, they move forward in its execution. That means that they may continue with projects that should be stopped or start with projects that should not be started.

In the case of the abovementioned copper mining project, escalation of commitment might happen to the managers who propose it, in that they refuse to see (and act on) red flags. The red flags include issues such as rising prices of inputs, poor exploration results at the prospective mine, or difficulties with local stakeholders.

7.2.4 Impact on Discount Rates

In assessing projects, people tend to underestimate the risk of business as usual, while overestimating the risk of new models. Yes, new business models tend to be riskier simply because they are new. But if such new models benefit from internalisation processes, then their risk should fall; the risk of many old business models meanwhile rises with internalisation of social and environmental factors (see Sects. 6.5 and 7.4 on internalisation).

Discount rates should also be adapted over time. For example, a private equity firm might apply a 20% discount rate to an early-stage company, but will let it drop over time as milestones are reached (see Chap. 10).

7.2.5 Dealing with Behavioural Biases

Overcoming behavioural biases starts with awareness of them. In the case of the copper mine, the finance department at HQ (headquarters) might be concerned that the business unit's plan might be too optimistic. To deal with that, HQ might challenge the business unit and ask it to better argue the validity of its assumptions. Alternatively, HQ can do its own calculations and adjust the copper mine forecasts downwards, by using lower copper prices, lower volumes, and/or higher costs, resulting in lower sales, lower margins, and lower valuations. HQ might also choose to reflect overconfidence in a higher discount rate, which also lowers valuation.

However, there is the risk that both sides start to see budgeting as a game: business units submit optimistic plans and/or more projects on purpose, as they know that HQ will downsize the submitted plans and projects. Realistic grounding and testing of the validity of assumptions is therefore important.

7.3 Integrating Sustainability in Capital Budgeting

The preceding sections described the basics of conventional capital budgeting and the behavioural challenges associated with them. However, conventional capital budgeting calculates FV (financial value) only, with S (social) and E (environmental) taking at best a secondary role. Since SV and EV are not calculated, the company effectively remains blind to its integrated value creation. SV and EV need to be incorporated into capital budgeting—and it is possible. Chapter 5 described how to value S and E separately and in present values (PVs). Chapter 6 developed three ways to integrate E and S in investment decision rules, by combining the PV approach with S and E:

1. The **constrained PV** includes S and E in their own units as a budget constraint to the standard NPV on financial value (FV)
2. The **expanded PV** expresses S and E in monetary values (SV and EV) and shows these in addition to the standard NPV on FV
3. The **integrated PV** goes further by explicitly calculating and balancing FV, SV, and EV in a formula

In this section, we show these three types of PVs in more detail for the abovementioned copper mine. A copper mine typically faces several S and E issues. On the E side, these include GHG emissions, water use, and biodiversity effects as negative impacts. However, a copper mine also has a positive impact since it enables the production of renewable energy. This means that the copper mine produces 'avoided emissions' elsewhere. Of course, since these are less certain than the mine's own emissions and can only be partially attributed to the copper mine, they cannot simply be deducted from its emissions. Chapter 5 explained that an attribution factor should be applied for environmental or social externalities in the value chain. On the S side, the copper mine deals with local stakeholders, who might benefit from jobs and schooling due to the mine, but who also suffer from pollution and limited access to water due to the mining activities.

As discussed in Sect. 7.1, capital budgeting should be part of the strategic objectives of the company: new investment projects should be part of implementing the company's strategy. However, some companies still just 'do sustainable projects' to improve their profile (see Box 7.2). That is a missed opportunity to create integrated value.

Box 7.2: Capital Budgeting and Sustainability in Practice

A few years ago, we met a board member from a consumer goods corporation known for its advanced integration of sustainability issues. We asked him how they integrate sustainability into their investment decisions and his answer was sobering: they simply split the list of proposals into sustainability projects and all other projects. For the sustainability projects, they even take projects with a negative Net Present Value (NPV), since not doing them is not an option.

The good thing about that approach is that sustainability is at least prioritised. But this is very imperfect integration, as company management still does not know how valuable these sustainability efforts are, and whether they really should happen. It also means that top management fails in making middle management really change their approach towards taking decisions on the basis of integrated value. And that is what sustainability leadership is about: a multiyear change process throughout the company.

7.3.1 Constrained NPV

In the constrained NPV method, S and E function as a budget constraint to the standard NPV on F. Table 7.16 shows S and E in their own units for the copper mining project that we analysed in Sect. 7.1. Please note that S and E impacts only start to materialise in year 3, when production starts. In Sect. 7.1, we found that the project had a positive NPV of $672 million after inclusion of the desalination project (Tables 7.11 and 7.13). However, it remains to be seen if the project is still value creative when including SV and EV. The constrained PV does not answer that question yet, but takes the first step towards including SV and EV by showing S and E in their own units, as far as that is possible with the current information.

Although the company did not set explicit budgets on S and E items, Table 7.16 does reveal some interesting items. It shows that the mine has significant GHG emissions of about 750 kg per tonne of copper mined. On the other hand, its avoided emissions are much higher than its own emissions (4000 kg per tonne of copper),

Table 7.16 Constrained DCF value calculation including the desalination plant

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	. . .	Year 10
Project cash flows	–1095	–706	–294	279	379	408		408
Volume of copper (thousands of tonnes)			50	120	130	140		140
Emissions 750 kg per tonne copper (thousands of tonnes CO_2e)			38	90	98	105		105
Emissions avoided 4,000 kg per tonne copper (thousands of tonnes CO_2e)			200	480	520	560		560
of which attributable to the copper mining project			20%	20%	20%	20%		20%
Avoided emissions attributable (thousands of tonnes CO_2e)			40	96	104	112		112
Net emissions (thousands of tonnes CO_2e)			–3	–6	–7	–7		–7
Water stress: number of people at risk, thousands			120	120	120	120		120
Probability of risk materialising			1%	1%	1%	1%		1%
Expected number of people affected, thousands			1.2	1.2	1.2	1.2		1.2
Biodiversity damage: fall in MSA (mean species abundance)			?	?	?	?		?
Positive health effects for the local community (quality life years added) due to employment			25	25	25	25		25
Negative health effects for the local community (quality life years lost) due to accidents and pollution			–15	–15	–15	–15		–15
Net health effects (quality life years added)			10	10	10	10		10
Increase in years of schooling of the local population			200	200	200	200		200

since much of the copper is used to build electric vehicles and power lines. However, since those avoided emissions are uncertain and can only be partly attributed to the copper miner, they cannot simply be deducted from the mine's emissions. Rather, we attribute 20% to the copper mine to reflect the aforementioned considerations. As a result, the copper mine turns out to be marginally better than net zero on GHG emissions, i.e. a positive value effect on EV.

Water stress offers an unpleasant surprise: in spite of the desalination plant, there is still an annual 1% risk of 120,000 people being hit by water stress, leading to a negative impact on SV. The planning department at HQ therefore asks the project team to investigate what can be done to eliminate, or at least significantly reduce that risk, and at what cost. They can then determine the trade-off.

In addition, it turns out that the project team did not determine the biodiversity risk of the project. Hence, this is a question mark in Table 7.16. On this item too, HQ demands that the team to get back with further information on biodiversity risk.

The project team did deliver on measuring the health effects (net 10 quality life years) and schooling effects (increase of 200 years of schooling), which are both net positive, i.e. a positive contribution to SV. To determine how much the project contributes to SV, prices are needed, which are added in the expanded PV.

7.3.2 Expanded PV

The expanded PV expresses S and E in monetary values to arrive at SV and EV and shows these in addition to the standard NPV. Table 7.17 does this on the basis of the quantities given in Table 7.16, and then multiplying them by the relevant shadow prices or damages (see Chap. 5).

The company uses a shadow carbon price of $224 per tonne, which rises with 3.5% per year. So, year 3 is $240 (=224*[1.035]^2). Given the low net emissions (which are negative due to saved emissions), the value of emissions will be around $2 million, i.e. about 0.5% of annual cash flows in year 10. Similarly, using $119,000 per quality life year added and $25,300 in annual schooling value per person (see Sect. A.1 in Chap. 5 based on IEF (2022)), the net health effects and schooling effects are positive, but quite low compared to cash flow (combined, they are about 1.5% of cash flow in year 10). And the biodiversity damage cannot be assessed due to problems in measurement. The expected water stress damages are most significant, with expected water stress damages of 20,000 m^3 per person. Using $1.49 per m^3 (see Sect. A.1 in Chap. 5), expected water stress damages amount to about $36 million per year.

In sum, this gives positive annual environmental value flows (EVF) and negative annual social value flows (SVF), as presented in Table 7.18. To discount the EV and SV flows, the company uses a social discount rate of 2%, as suggested in Chap. 4. This means that the value flows during the 10 years of the desalination project's life can be discounted to arrive at the present value (PV). The sum of the PVs provides the EV and SV, respectively. EV amounts to $12.0 million, and SV to –$207.8 million in Table 7.18. These amounts also appear in the first line of Table 7.19.

Table 7.17 Expanded DCF calculation including the desalination plant

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	...	Year 10
Project Cash Flows	–1095	–706	–294	279	379	408		408
Net emissions (thousands of tonnes CO_2e)			–3	–6	–7	–7		–7
Shadow price of emissions, USD/t			240	248	257	266		305
Net value of emissions (USD millions)			0.6	1.5	1.7	1.9		2.1
Expected number of people affected (thousands)			1.2	1.2	1.2	1.2		1.2
Damage per person when affected (USD thousands)			29.8	29.8	29.8	29.8		29.8
Expected water stress damages (USD millions)			–35.8	–35.8	–35.8	–35.8		–35.8
Biodiversity damage			n/a	n/a	n/a	n/a		n/a
Net health effects (quality life years added)			10	10	10	10		10
Value per quality life year added (USD thousands)			119	119	119	119		119
Value of health effects (USD millions)			1.2	1.2	1.2	1.2		1.2
Increase in years of schooling of the local population			200	200	200	200		200
Value per year of schooling added (USD thousands)			25.3	25.3	25.3	25.3		25.3
Value of schooling effects (USD millions)			5.1	5.1	5.1	5.1		5.1

The good news, however, is that the water stress damages can be eliminated by means of an enhancement of the desalination plant, with a financial cost of $64 million (second line of Table 7.19). Combining the two projects, SV then turns positive, amounting to $6 million, an improvement of $214 million (third line of Table 7.19).

7.3.3 Integrated PV (IPV)

In the integrated PV (IPV), SV and EV are not only separately calculated (as in the expanded PV), but also added and weighted, along with the NPV of FV, to arrive at an integrated value creation number. Table 7.19 gives these values for the mining project with the original desalination plant; the desalination plant enhancement; and

Table 7.18 From annual SV and EV flows to SV and EV

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Net external reduction in emissions (USD MM)			0.6	1.5	1.7	1.9	1.9	2.0	2.1	2.1
Value of biodiversity damage			n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Annual environmental value flows (EVF)			**0.6**	**1.5**	**1.7**	**1.9**	**1.9**	**2.0**	**2.1**	**2.1**
Discount factor, 2%			0.942	0.924	0.906	0.888	0.871	0.853	0.837	0.820
PV (EVF)			0.6	1.4	1.5	1.7	1.7	1.7	1.7	1.8
Environmental value (EV) (USD MM)	**12.0**									
Expected water benefits or damages (USD MM)			–35.8	–35.8	–35.8	–35.8	–35.8	–35.8	–35.8	–35.8
Value of health effects (USD MM)			1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
Value of schooling effects (USD MM)			5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1
Annual social value flows (SVF)			**–29.5**	**–29.5**	**–29.5**	**–29.5**	**–29.5**	**–29.5**	**–29.5**	**–29.5**
Discount factor, 2%			0.942	0.924	0.906	0.888	0.871	0.853	0.837	0.820
PV (SVF)			–27.8	–27.3	–26.7	–26.2	–25.7	–25.2	–24.7	–24.2
Social value (SV) (USD MM)	**–207.8**									

Table 7.19 Integrated PV

Project	FV	SV	EV	IPV = SV + EV + FV
Mining project with original desalination plant	672	–208	12	476
Desalination plant enhancement	–64	214	0	150
Mining project with enhanced desalination plant	608	6	12	626

Table 7.20 Integrated PVs under two regimes (in USD millions)

Intermediate regime – $b = 0$, $c = 0.5$	FV	$b \cdot SV$	$c \cdot EV$	$IPV = FV + b \cdot SV + c \cdot EV$
Mining project with original desalination plant	672	0	6	678
Desalination plant enhancement	–64	0	0	–64
Mining project with enhanced desalination plant	608	0	6	614
Responsible regime – $b = 1$, $c = 1$	FV	$b \cdot SV$	$c \cdot EV$	$IPV = FV + b \cdot SV + c \cdot EV$
Mining project with original desalination plant	672	–208	12	476
Desalination plant enhancement	–64	214	0	150
Mining project with enhanced desalination plant	608	6	12	626

the combination of these projects, i.e. the mining project with an enhanced desalination plant.

Table 7.19 calculates integrated value by simply summing FV, SV, and EV. But, as shown in Chap. 6, integrated value can also be calculated by not just adding values, but also balancing them. For example, SV might get a higher weight if the company has a mission focused on S or if its SV value creation profile is negative. As in Chap. 6, we apply different regimes, with b denoting the weighting of SV; and c denoting the weighting of EV. Equation (7.1) for calculating the simple IPV is as follows:

$$IPV = FV + b \cdot SV + c \cdot EV > 0 \qquad with\ b, c > 0 \tag{7.1}$$

In contrast to Chap. 6, the intermediate regime (weights of half) now weights EV at 0.5 ($c = 0.5$) and SV at 0 ($b = 0$) instead of 0.5. Chapters 3 and 6 explained that companies choose the weights in line with their purpose; companies can thus choose to pay more or less attention to social and environmental objectives. The responsible regime (weights of one) applies equal weights: $b = c = 1$. Table 7.20 shows the results.

Under the intermediate regime, the desalination enhancement is seen as a negative value project, since only its FV of –\$64 million is taken into account and the SV improvement of \$214 million is ignored. In contrast, the responsible regime does value the $214 million in SV and arrives at an integrated value of $150 million for the enhancement. The outcome: under the intermediate regime, the mining company would not do the investment for enhancing the desalination plant; but under the responsible regime, it would. In terms of integrated value creation, the mining company is balancing its value dimensions in the long term, optimising value creation and avoiding long-term risks.

In an alternative intermediate regime with $b = 0.5$ and $c = 0$, $b \cdot SV$ would amount to 0.5*$214 million, i.e. $107 million; and integrated value would be positive at $43 million ($107 million – $64 million).

Oil Companies (Not) in Transition

Facing the energy transition, Chap. 2 argued that carbon-intensive companies should consider how to make their company future-proof. A case in point are the oil majors, such as Saudi Aramco, Exxon, Shell, BP, and TotalEnergies. These oil companies have to choose between continuing their investments in fossil fuels (both upstream and downstream) and switching investments to renewables. Example 7.1 allows you to make the calculations. The example illustrates how the outcome can differ when applying the IPV rule instead of the NPV rule.

Example 7.1: Big Oil: Choosing Between Fossil and Renewable Projects

Problem

Consider that the company Big Oil wants to undertake new investment projects to serve society's energy needs. Big Oil can choose between a fossil project and a renewable project. Both projects need an initial investment of $100 million. The fossil project has annual net cash flows of $40 million, while the renewable project has annual net cash flows of $30 million over the next 5 years.

Emissions from the fossil project are 120,000 tonnes per year, of which half are attributed to Big Oil. The renewable project has no emissions. The shadow carbon price is $224 per tonne of carbon emissions and increases with 3.5% per year.

The financial discount rate for Big Oil is 10% and the environmental discount rate is 2%.

Year	2023	2024	2025	2026	2027	2028
Fossil project						
Cash flows, in $ millions	–100	40	40	40	40	40
GHG emissions, in thousands tonnes	0	60	60	60	60	60
Renewable project						
Cash flows, in $ millions	–100	30	30	30	30	30
GHG emissions, in thousands tonnes	0	0	0	0	0	0

Which project should Big Oil choose using the NPV rule? And which project using the IPV rule?

Solution

We can calculate the financial and environmental value of the project by discounting the cash and value flows at their respective discount rates.

Year	2023	2024	2025	2026	2027	2028
Fossil project						
Cash flows, in $ millions	–100	40	40	40	40	40
Discount factor, 10%	1.00	0.91	0.83	0.75	0.68	0.62
PV (Cash flows)	–100.0	36.4	33.1	30.1	27.3	24.8
Financial value, in $ millions	**51.6**					
GHG emissions, in thousands tonnes	0	60	60	60	60	60
Shadow carbon price, in $ per tonne	224	232	240	248	257	266
Environmental value flows, in $ mln	0.0	–13.9	–14.4	–14.9	–15.4	–16.0
Discount factor, 2%	1.00	0.98	0.96	0.94	0.92	0.91
PV (Value flows)	0.0	–13.6	–13.8	–14.0	–14.2	–14.5
Environmental value, in $ millions	**–70.2**					
Integrated value, in $ millions	**–18.6**					
Renewable project						
Cash flows, in $ millions	–100	30	30	30	30	30
Discount factor, 10%	1.00	0.91	0.83	0.75	0.68	0.62
PV (Cash flows)	–100.0	27.3	24.8	22.5	20.5	18.6
Financial value, in $ millions	**13.7**					
GHG emissions, in thousands tonnes	0	0	0	0	0	0
Environmental value, in $ millions	**0**					
Integrated value, in $ millions	**13.7**					

The NPV rule only considers financial value. The fossil project has higher net cash flows leading to an NPV of $51.6 million. The renewable project has an NPV of $13.7 million. Applying the NPV rule, Big Oil chooses the fossil project.

The IPV rule also includes environmental value. We can translate the attributed GHG emissions in environmental value flows using the shadow carbon price, which is $224 in 2023 and increases with 3.5% per year (see Chap. 5). The environmental value is –$70.2 million for the fossil project and $0 million for the renewable project. The IPV of the fossil project is –$18.6 million (= $51.6 –

$70.2 million). The IPV of the renewable project is $13.7 million. Applying the IPV rule, Big Oil chooses the renewable project.

Among the major oil companies mentioned (Saudi Aramco, Exxon, Shell, BP and TotalEnergies), all but one invested about 80–90% of their annual capex in fossil projects and the remaining 10–20% in renewable projects (at the time of writing in early 2023). TotalEnergies was the exception, allocating about 50% of their capex to fossil and 50% to renewables in 2023. While investments in renewables may lead to lower financial profits in the short term, this investment strategy makes TotalEnergies more future-proof. ◄

7.4 Internalisation

The preceding analyses did not assume internalisation. This is the (partial) elimination of external impacts due to changing market conditions, higher taxes, and/or tougher regulations, as discussed in Chap. 2. Such internalisation often involves spillovers from SV or EV to FV. A higher carbon tax on carbon emissions (EV), for example, leads to reduced profits (FV) for carbon-intensive companies.

As explained in Sect. 6.5, the three types of value are created jointly, and in part with the same drivers. The same processes that allow a chemicals company to make money selling plastics also result in GHG emissions, poor (or good) working conditions, and other S and E effects. They are related and have an effect on each other. Improving one of them may have a cost or benefit in the other, now or later, or both now and later, and possibly with different signs. This makes the dynamic perspective very important: do not assume the current conditions are going to last forever, but acknowledge that they can change in various ways. That is the rationale behind integrated value creation, instead of short-term financial value maximisation. The challenge with this is that future outcomes are clouded in uncertainty.

To illustrate the capital budgeting implications of internalisation processes, let's consider a bioplastics project by a commodity chemicals producer. While the company's current business lines have a negative value creation profile on E, the bioplastics project actually produces positive flows on E. At first sight, however, the project looks unattractive from an FV perspective—but that is taking a static view, without internalisation. With internalisation, this changes completely, an illustration of how EV can spill over into FV once shadow prices change (partly or fully) into real prices.

Since the company has already operated a bioplastics pilot plant, its management knows how to do it and at approximately what cost, but the big question is about the price, and hence margins. With an asset life of several decades, this is a big issue. Table 7.21 shows the expanded NPV of the bioplastics project if internalisation does not occur. The absence of internalisation means that fossil fuel-based plastics are not taxed for their negative externalities and continue to be offered at an artificially cheap price. As a result, bioplastics have a competitive disadvantage from their higher costs, and the project's EBIT margin is only 7%. At such margins, the project

Table 7.21 Bioplastics project value without internalisation (in EUR millions)

	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7
Sales	**0**	**0**	**900**	**3200**	**3264**	**3329**	**3396**	**3464**
Sales growth				*256%*	*2%*	*2%*	*2%*	*2%*
Costs	–200	–200	–1100	–2976	–3036	–3096	–3158	–3221
EBIT	**–200**	**–200**	**–200**	**224**	**228**	**233**	**238**	**242**
EBIT margin			*–22%*	*7%*	*7%*	*7%*	*7%*	*7%*
Corporate tax	50	50	50	–56	–57	–58	–59	–61
Net income	**–150**	**–150**	**–150**	**168**	**171**	**175**	**178**	**182**
+ depreciation	200	200	200	200	200	200	200	200
– CAPEX	–2000	–2000	–1000	–10	–10	–10	–10	–10
– increase in NWC	–100	–100	–100	0	0	0	0	0
Project cash flows	**–2050**	**–2050**	**–1050**	**358**	**361**	**365**	**368**	**372**
Terminal value								2778
Total cash flows	**–2050**	**–2050**	**–1050**	**358**	**361**	**365**	**368**	**3149**
Discount factor	1.000	0.893	0.797	0.712	0.636	0.567	0.507	0.452
PV	–2050	–1830	–837	255	230	207	187	1425
NPV FV	**–2415**							
E flows (millions of tonnes CO_2 emissions avoided)			**0.90**	**3.20**	**3.23**	**3.26**	**3.30**	**3.33**
CO_2 price	224	232	240	248	257	266	275	285
EV flows (in EUR millions)			**216**	**795**	**831**	**868**	**908**	**949**
Discount factor	1.000	0.980	0.961	0.942	0.924	0.906	0.888	0.871
PV	0	0	208	749	768	787	806	826
EV	**4143**							

has an FV of –€2.4 billion, based on a standard NPV calculation (with a financial discount rate of 12%). However, the project has positive EV flows that are expected to exceed competitive products for 7 years, after which the alternatives are expected to be of the same quality. Discounting them at 2% gives an EV of €4.1 billion.

Now let's assume internalisation: competing fossil fuel-based products are heavily punished by a carbon tax from year 3 onward. This pushes up plastics prices by 20%, since the tax makes all producers' costs go up. An exception are bioplastics producers, whose costs rise by less than 1%. Table 7.22 shows the higher sales (+20% from 3200 to 3840) in year 3 and higher sales growth from 2 to 5% in later years, as bioplastics gain market share as a more attractive product. As a result, its EBIT margins go from 7 to 22%.

The FV flips from negative (–€2.4 billion) to positive (€1.1 billion). EV increases slightly to €4.3 billion in line with the quantity (Q) component of sales growth, as it is related to production volumes. Note also that the internalisation effect on FV (€1.1 billion + €2.4 billion = €3.5 billion) is large, but smaller than the value of EV which ranges between €4.1 and €4.3 billion.

In the case of internalisation, both FV and EV are positive. But internalisation is not certain, and FV is negative in its absence. So, will the company make the investment? To better understand the decision, it should be put in the context of the company's total value. Table 7.23 shows the company's initial values of FV and EV (these are given) without, and then with, the project (in the top panels for FV and EV). Next, Table 7.23 contrasts the company's $IPV = FV + b \cdot SV + c \cdot EV$ (equal weighted, i.e. $c = 1$) without and with the project, and without and with internalisation (in the bottom panel for IPV).

In terms of EV, the project is a clear improvement for the company, regardless of whether internalisation happens. The same applies to an equal weighted IPV (with $c = 1$), which rises due to the project. The company would therefore undertake the project, when applying the IPV decision model.

For FV though, it is a different story: the project results in a drop in FV in case of no internalisation and a rise in case of internalisation. Hence, for shareholder-driven companies where FV is the main decision criterion with $b = c = 0$, the investment decision depends on the probability of internalisation. Table 7.24 shows that at a 70% probability of internalisation, the expected FV of the company with the project equals the expected value without the project at €13.8 billion.

At lower than 70% probability of internalisation, the project is not expected to be value creative on FV. This is not atypical for such projects and has serious implications for government policy: transitions are very much helped by clarity on transition paths, or at least clear signals that internalisation is highly likely.

7.4.1 Asymmetric and Non-linear Internalisation

In the above example, the shift in FV due to internalisation is similar to the size of EV. But that certainly does not need to be the case in practice. In fact, even the internalisation of small EVs can disrupt business models in such a way that they

Table 7.22 Bioplastics project value with internalisation (in EUR millions)

	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7
Sales	**0**	**0**	**900**	**3840**	**4032**	**4234**	**4445**	**4668**
Sales growth				*327%*	*5%*	*5%*	*5%*	*5%*
Costs	–200	–200	–1100	–2995	–3145	–3302	–3467	–3641
EBIT	**–200**	**–200**	**–200**	**845**	**887**	**931**	**978**	**1027**
EBIT margin			*–22%*	*22%*	*22%*	*22%*	*22%*	*22%*
Corporate tax	50	50	50	–211	–222	–233	–244	–257
Net income	**–150**	**–150**	**–150**	**634**	**665**	**699**	**733**	**770**
+ depreciation	200	200	200	200	200	200	200	200
– CAPEX	–2000	–2000	–1000	–10	–10	–10	–10	–10
– increase in NWC	–100	–100	–100	0	0	0	0	0
Project Cash Flow	**–2050**	**–2050**	**–1050**	**824**	**855**	**889**	**923**	**960**
Annuity value								7172
Total cash flow	**–2050**	**–2050**	**–1050**	**824**	**855**	**889**	**923**	**8132**
Discount factor	1.000	0.893	0.797	0.712	0.636	0.567	0.507	0.452
PV	–2050	–1830	–837	586	544	504	468	3678
NPV FV	**1063**							
E flows (millions of tonnes CO_2 emissions avoided)			**0.90**	**3.20**	**3.28**	**3.36**	**3.45**	**3.53**
CO_2 price	224	232	240	248	257	266	275	285
EV flows (in EUR millions)			**216.0**	**794.7**	**843.1**	**894.4**	**948.9**	**1006.6**
Discount factor	1.000	0.980	0.961	0.942	0.924	0.906	0.888	0.871
PV	0	0	208	749	779	810	843	876
EV	**4264**							

Table 7.23 Value of the company with and without the bioplastics project & with and without internalisation (in EUR billions)

FV	Company value excluding the project	Project value	Company value including the project
Without internalisation	15.4	–2.4	13.0
With internalisation	13.1	1.1	14.2
EV	**Company value excluding the project**	**Project value**	**Company value including the project**
Without internalisation	–13.3	4.1	–9.1
With internalisation	–10.7	4.3	–6.4
IPV = *FV* + *SV* + *EV*	**Company value excluding the project**	**Project value**	**Company value including the project**
Without internalisation	2.1	1.7	3.9
With internalisation	2.4	5.3	7.8

Table 7.24 FV of the company with and without the bioplastics project, while accounting for the probability of internalisation (in EUR billions)

FV	Probability	Company value excluding the project	Company value including the project
Without internalisation	30%	15.4	13.0
With internalisation	70%	13.1	14.2
Expected value		**13.8**	**13.8**

cause shifts in FV that are many times larger. Conversely, internalisation of a large EV can also have small effects on FV if they do not change competitive positions. It is even possible that internalisation of negative impacts actually boosts the FV of negative EV companies, because they have a strong competitive position. In some cases, the entire industry even benefits on FV. A prominent example of an industry that has so far benefited from the internalisation of its SV is the tobacco industry. Because of heavy taxation, its volumes fell. But it also allowed that (heavily concentrated) industry to raise prices continuously and raise its profits. In sum, internalisation is often not linear and not symmetric.

7.4.2 IPV Versus Internalisation

What is the difference between calculating the integrated present value (IPV) and the effects of potential internalisation of negative impacts? The SV and EV calculations show and quantify the company's negative (and positive) impacts. The shadow prices, as derived from welfare theory (see Chap. 5), provide useful discipline in calculating the social and environmental value resulting from negative social and environmental impacts. These calculations are then no longer guesses by management, but can be derived from science-based shadow prices. Using the IPV rule, the company can take the monetised impacts into account when making investment decisions. Using the IPV rule instead of the NPV rule, companies will avoid projects with (large) negative impacts.

Internalisation brings a dynamic aspect to the calculations. When impacts are internalised, shareholder-driven companies using the NPV rule are also forced to move. But there is also a competitive element. Companies that have already reduced impacts because of the application of the IPV rule have a competitive advantage. Laggards in the sector with more negative impacts will be hit harder if and when internalisation happens.

As Chap. 2 explained, a key assumption in this book is that impacts will be internalised during sustainability transitions. But the timing of these transitions (early vs late) is difficult to predict. Companies that are prepared are ahead in these transitions, whereas the laggards may be phased out like Kodak.

7.5 Conclusions

Chapter 6 explained decision rules for investment decisions. It discussed purely financial criteria for investment evaluation such as NPV (net present value), IRR (internal rate of return), and payback period. It subsequently showed that S (social) and E (environmental) factors can be valued in their own right and can be included in constrained, expanded, or integrated PVs (present values). However, in Chap. 6 the cash flows were presented as given. In this chapter, we dived deeper into the capital budgeting process, which is the process used to make a list of investment projects to be done. We made these investment decisions more tangible by presenting more detailed calculation examples—including the calculation and forecasting of cash flows and their drivers.

The chapter started by showing the steps in the capital budgeting process and then how cash flows and incremental cash flows are calculated and forecasted. Subsequently, we identified behavioural challenges in the capital budgeting process, such as the tendency to continue poor projects for too long, to underestimate risk, and to overestimate cash flows. More importantly, people have a tendency to extrapolate business as usual into the future, which is highly unrealistic in dealing with non-linear processes such as climate change or biodiversity loss.

Next, we explained how to integrate S and E in the capital budgeting process—integrated capital budgeting. The constrained, expanded, and integrated PVs (introduced in Chap. 6) were now shown with cash flow projections. It was illustrated that FV, SV, and EV can have shared, reinforcing, or conflicting underlying value drivers. And the way and extent to which they are taken into account affect decisions.

Moreover, the value dimensions FV, SV, and EV can affect each other. We discussed the process of internalisation, by which SV or EV might spill over into FV. These investment decisions were put in the context of corporate objectives, as put forward in Chap. 3 on corporate governance. Interestingly, the IPV (integrated present value) rule leads to different investment decisions, resulting in the creation of integrated value. In the next chapters we will apply the same methods to valuing stocks and bonds.

Key Concepts Used in This Chapter

Break-even analysis is an analysis in which the value drivers are set in such a way that the NPV gives an outcome of zero

Cannibalisation is process whereby new products (partly) replace existing sales

CAPEX (capital expenditures) are investment outlays

Capital budget is the list of projects the company plans to invest in

Capital budgeting is the process to determine the list of investment projects to be undertaken

Incremental cash flows is the net change in cash flows due to the project

Integrated capital budgeting is the process of capital budgeting based on the integrated value of projects; this incorporates the social and environmental value dimensions, alongside the financial dimension

Internalisation is the process by which externalities are borne by the organisation that creates them

Net working capital (*NWC*) is the difference between the company's current assets (such as cash, inventories, and accounts receivable) and its current liabilities (such as taxes payable, accounts payable, short-term funding)

Opportunity costs is the value missed due to not doing alternative projects

Sensitivity analysis is an analysis that involves changing the value driver assumptions to see to what extent that affect the outcome of the NPV

Sunk costs are costs that have been made already and cannot be recouped

Suggested Reading

Impact Economy Foundation (IEF). (2022). *Impact-weighted accounts framework*.

Schramade, W., Schoenmaker, D., & de Adelhart Toorop, R. (2021). *Decision rules for long-term value creation* (CEPR Discussion Paper DP16074).

Serafeim, G., Zochowski, R., & Downing, J. (2019). *Impact-weighted financial accounts: The missing piece for an impact economy* (White Paper). Harvard Business School.

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