

in the procurement analysis of Chapter 8. The estimation of development costs is particularly subject to uncertainty and to optimistic bias against which the analyst must be on his guard. We will postpone the complication that the development may take any of several routes with different costs and different probabilities of success, assuming here that one route has been (or will be) selected.

If there is only one development under consideration (the question being, say, should we develop or not develop the HC-500), the criterion is, in principle, simple — as long as we are satisfied with expected values. If the expected value (discounted and adjusted somehow for uncertainties, biases, and chance of failure) exceeds the expected cost, the development should proceed.¹⁹ In realistic cases, however, the criterion problem is more complex. Should we, for example, develop both the HC-500 and the HC-600? The analysis of Chapter 8 tells us that *if* both developments are successful, they will be worth only \$100 million more than if HC-600 alone is successfully undertaken. But this does not necessarily mean that we should refrain from developing HC-500 if we expect its development to cost a little more than \$100 million. For the development of the HC-500 is worth \$300 million.

Table 22. Cost and payoff of developing the HC-500 and HC-600 (millions of dollars)

	<i>Estimated payoff if successful^a</i>	<i>Expected payoff if probability of success = 50%</i>	<i>Expected cost of development</i>	<i>Net worth of development</i>
HC-500	300	150	50	100
HC-600	500	250	100	150
HC-500 and -600	600	350 ^b	150	200

^a It is assumed for simplicity that this payoff "if successful" has already been appropriately discounted.

^b $\frac{1}{4} \times 600$ (both successful) + $\frac{1}{4} \times 0$ (neither successful) + $\frac{1}{4} \times 500$ (HC-600 succeeds, HC-500 fails) + $\frac{1}{4} \times 300$ (HC-500 succeeds, HC-600 fails). Note that we assume here, again for the sake of simplicity, that the probability of success in one development is independent of efforts on the other one.

Table 22 indicates how — in principle — we should set about determining whether to proceed with two (or more) developments rather than with one. Still assuming that we are satisfied with "expected" values, we calculate the expected net worth (expected payoff minus expected cost) of each alternative course of action. In this particular problem the three possibilities are to develop the HC-500 only, the HC-600 only, and both. The estimated payoffs if all developments are successful are 300, 500,

¹⁹ If there is an arbitrary ceiling on the total amount that can be spent on R and D, projects that qualify by this rule may more than exhaust the budget. If transfers from other sources (the preferred alternative) are not permitted, R and D projects should be chosen to maximize the excess of payoff over cost.