Capital Budgeting and Sensitivity Analysis

The NPV model has a simple decision rule: accept any project that has an NPV > 0.

Considering the length of time involved in most capital investment decisions there tends to be a lot of uncertainty about annual cash flows and the economic life of the project itself. There are two basic approaches to the issue of cash flow uncertainty.

1. We can do a few scenarios using high/medium/low estimates of revenues or savings.

2. We can do a break-even calculation on how much annual cash flows have to be in order to have NPV = 0.

The first approach is simple enough; just do three or more NPV calculations using different annual cash flow estimates.

The second approach is much less time-consuming. In the following example assume a machine is purchased for $300,000 that will produce annual savings of $70,000 each year for 10 years. Salvage is $3,000, and there will be a working capital investment of $10,000 that will be fully recovered at the end of the project. The tax rate is 40%, CCA is 30%, and the required rate of return (discount rate) is 10%.

Now:	$300,000 equipment outflow $10,000 working capital outflow
Years 1-10:	$70,000 annual savings
Year 10:	$30,000 salvage value inflow $10,000 working capital inflow

Putting that into the NPV chart format ……..

Item	Time	Cash Flows	10% PV Factor	Tax	PVAT
Equipment	Now	(300,000)	1	See CCA	(300,000)
Working Capital Outflow	Now	(10,000)	1	None	(10,000)
Operating Savings	1-10	70,000	6.145	.60	258,090
Salvage Value	10	30,000	.386	See CCA	11,580
Working Capital Inflow	10	10,000	.386	None	3.860
CCA (Tax Savings)					82,435
Total Positive NPV > 0					45,965

CCA calculated as: (((300,000*.40*.30)/.40)*(1.05/1.1))-(((30,000*.40*.30)/.40)*.386)

Conclusions: The NPV of $45,965 says that we will achieve greater than 10% return on this investment; we will have an additional $45,965 above a 10% return.

Uncertainty about Cash Flows

BUT: What sort of "margin of safety" do we have before NPV reaches 0, assuming our estimates of operational savings (annual cash inflows) are too high?

1. We can forego $45,965 over 10 years in PV terms, and still have a 10% return on investment, since that would bring NPV to 0.

2. Divide $45,965 by the PV factor for an annuity for 10 years at 10% to put this in nominal after-tax dollars: $45,965/6.145 = $7,480

3. But this is after tax. How much is it BEFORE tax? Divide by 1-tax rate: $7,480/.60 = $12,467

   Our original estimate of $70,000 (pre-tax) savings per year could be "off" by $12,467 each year and we would still earn 10% return on the investment.

4. How much "margin of safety" does this represent? Divide the margin by the original estimate: $12,467/$70,000 = 17.81% margin of safety.

Implications for Pricing

Assume we are bidding on a project where we know all of the costs and we need to submit a quote that will give a specific return on investment. We can use a similar approach.

1. First determine the net cash outflows without any annual inflows or savings. In this case it would be:

Item	Time	Cash Flows	10% PV Factor	Tax	PVAT
Equipment	Now	(300,000)	1	See CCA	(300,000)
Working Capital Outflow	Now	(10,000)	1	None	(10,000)
Salvage Value	10	30,000	.386	See CCA	11,580
Working Capital Inflow	10	10,000	.386	None	3.860
CCA (Tax Savings)					82,435
Total Positive NPV > 0					(212,125)
REQUIRED BID PRICE	1-10	57,533.22	6.145	.60	212,125

2. Divide 212,125 by the PV factor for 10% for 10 Years: 212,125/6.145 = 34,520.

3. Divide 34,520 by 1-tax rate: 34.520/.6 = 57,533.22. This would be the bid price to earn exactly 10% over 10 years.

Uncertainty Regarding Expenses

Sometimes there is uncertainty about costs. There may be multiple probabilities, depending on uncontrollable factors, such as gas prices. If we are dealing with a situation like this, we try to determine a weighted average costs. For example, if there is a 50% probability that gas prices will be $ 1.30 per litre and a 50% probability that gas prices will be $1.50 per litre, we can determine an average:

$1.30 x 50% = .65
$1.50 x 50% = .75
1.40 – We can use $1.40 as a reasonable estimate.

Uncertainty of a Project's Life Span

There are two basic approaches to the issue of uncertainty regarding a project's life:

1. We can do a few scenarios using shorter lives to identify how long it takes before our NPV = 0.

2. We can do a "Discounted Payback" calculation which will determine how long it takes for the project to pay for itself.

The first approach is straightforward. We assume 7 years instead of 10, as in the previous example. However, the discounted payback approach is more direct.

We will use all of the same variables as in the previous example, except that we will assume that we will not get any salvage value or recover the working capital, if the project's life is at risk. We will still get the CCA tax savings on the purchase of the equipment. The discounted payback calculation follows.

Time	In/Out flow	Amount	PVF	After Tax	Annuity PVAT	Cum PVAT
Now	Net outflow**				(224,091)	(224,091)
1	Inflow	70,000	0.909	0.6	38,178	(185,913)
2	Inflow	70,000	0.826	0.6	34,692	(151,221)
3	Inflow	70,000	0.751	0.6	31,542	(119,679)
4	Inflow	70,000	0.683	0.6	28,666	(90,993)
5	Inflow	70,000	0.621	0.6	26,082	(64,911)
6	Inflow	70,000	0.564	0.6	23,686	(41,223)
7	Inflow	70,000	0.513	0.6	21,546	(19,677)
8	Inflow	70,000	0.467	0.6	19,614	(63)
9	Inflow	70,000	0.424	0.6	17,808	17,745
10	Inflow	70,000	0.386	0.6	16,212	33,957

**** (-$300,000 - $10,000 + $85,909).** **(CCA is: (($300,000*.40*.30)/.40)*(1.05/1.1) = $85,909**
The equipment is an outflow, the working capital is an outflow, and the CCA is an inflow. Note that we exclude the CCA on the salvage, because there is uncertainty about the life-expectancy. We are not certain that we will be able to sell the equipment for any salvage value.

Conclusions:

Based on the above chart, the project pays for itself (breaks-even) in approximately 8 years. How good or bad this is will depend on the risk specific to this particular project.

Other Indicators of a Capital Project's Benefits

A manager might also consider the project's impact on year 1 financial statements. Perhaps the company wants to issue shares, or maybe someone is worried about a bonus based on accounting net income. We can calculate the Accounting Rate of Return:

$$\frac{\text{Impact on Income Statement}}{\text{Impact on Balance Sheet}} = \frac{\text{Savings – Depreciation + Gain/Loss}}{\text{Change in PP\&E – Depreciation + Working Capital}}$$

In our example above:

$$\frac{\text{Numerator:}}{\text{Denominator:}} = \frac{\underbrace{\$70{,}000}_{\text{savings}} - \underbrace{\$27{,}000}_{\text{depreciation}}}{\underbrace{\$300{,}000}_{\text{new equip}} - \underbrace{\$27{,}000}_{\text{depreciation}} + \underbrace{10{,}000}_{\text{working capital}}} = \mathbf{15\%\ ARR}$$

$$\text{Depreciation} = (\underbrace{\$300{,}000}_{\text{new equip}} - \underbrace{\$30{,}000)/10 \text{ years}}_{\text{residual value / \# of years}} = \$27{,}000$$

Note that we depreciate “down to” the salvage value. If old equipment is being sold, we may have a gain or loss on disposal. This is in the calculation for the numerator, as it impacts the income statement. On the balance sheet, the net book value (if any) of the old equipment has to be removed, and any cash received is added to assets. This impacts ARR.

Assume old equipment with zero net book value is sold as scrap for $20,000.

$$\text{New ARR} = \frac{\underbrace{\$70{,}000}_{\text{savings}} - \underbrace{\$27{,}000}_{\text{depreciation}} + \underbrace{\$20{,}000}_{\text{gain on disposal}}}{\underbrace{\$300{,}000}_{\text{new equip}} - \underbrace{\$27{,}000}_{\text{depreciation}} + \underbrace{\$10{,}000}_{\text{working capital}} + \underbrace{\$20{,}000}_{\text{cash rec'd on disposal}}} = \mathbf{21\%\ ARR}$$

Now assume that old equipment with a net book value of $80,000 is disposed, but can only be sold for $20,000. Now we have cash received of $20,000 but have a loss on disposal of $60,000. The old equipment has to be removed from the balance sheet.

$$\text{New ARR} = \frac{\underbrace{\$70{,}000}_{\text{savings}} - \underbrace{\$27{,}000}_{\text{depreciation}} - \underbrace{60{,}000}_{\text{loss on disposal}}}{\underbrace{\$300{,}000}_{\text{new equip}} - \underbrace{\$27{,}000}_{\text{depreciation}} + \underbrace{\$10{,}000}_{\text{working capital}} - \underbrace{80{,}000}_{\text{old equip}} + \underbrace{\$20{,}000}_{\text{cash received}}} = \mathbf{(6\%)\ ARR}$$

If a manager’s bonus is based on ARR, the manager will want to carefully manage the disposal of equipment. There may be a bias to keep old, ineffective equipment rather than replace it if it will have to be sold at a loss. On the other hand, a manager may be motivated to see equipment if it can be sold at a gain, since it has a positive impact on the year of disposal. This would be a short-sighted decision, as it disregards the profit over the lifetime of the equipment.