

Project Analysis

Marko Hartmann, 2010-10-15

Introduction

Most companies prepare each year a list of investment projects planned for the next coming year: The annual capital budget. However, being in the list of investments proposals not mean automatic go ahead with this project. Managers have to ask themselves what makes a project tick, what are the main uncertainties and how can you recognize these at an early stage. Therefore, we learn to use different kinds of analysis –methods like *sensitive analysis*, *break-even analysis* and *Monte Carlo simulation*.

Options concerning which to expand when a project has a rising yield or which to abandon when things seem to be going wrong, called *real options*. We look at the real options, mostly constituting in *desicion trees* at the end of this documentation.

The Capital Investment Process

Investment proposals for the annual capital budget are mostly made “bottom-up”. They are sometimes inconsistent and have to be embedded in the company’s strategic planning which takes a “top-down” view of the company.

Therefore, you need to establish consensus forecasts of economic indicators to build a consistent basis for the capital budget.

Project Authorizations

After the capital budget has been admitted, the next step is to authorize each project. Therefore you need to submit an appropriation request which includes:

- Detailed forecasts
- Discounted cash-flow analysis (DCF)
- Back-up information

The final desicion is made by senior management, but it is the nature of the beast that forecasts are often biased and tend to be over optimistic while project risks are understated. Even if senior managers cannot wipe out bias completely they should learn to challenge the forecast critically.

Post audits

Appropriation requests approve the investment, the project has begun to run. But it is not advisable to lay back and let things take its course, you have to keep a check on the progress if you do not want to be caught by surprise.

Post audits help managers to identify uncertainties and improve the processes when it comes to the next round of investments.

Sensitivity Analysis

To reduce the risks of future uncertainties (*Murphy's law: "if anything can go wrong, it will".*) you have to ask yourself, what could happen in the future? You have to analyze the projects sensitivity.

To do this, first figure out the underlying variables like

- Market size
- Share of market
- Variable costs
- Fixed costs

Example 1: A Japanese company wants to launch an electrically powered motor scooter and prepared this cash-flow forecast based on:

Market size = 1,000,000 scooters

Market share = 10%

→ Unit sales/year = 100,000 scooters

Price/unit = ¥375,000

→ Revenue = 100,000 x 375,000 = ¥37.5 bill.

Variable costs/unit = ¥300,000

→ Total variable costs = 100,000 x 300,000 = ¥30 bill.

Table 11.1

	Year 0	Years 1-10
Investment	15	
Revenue		37,5
Variable cost		30
Fixed cost		3
Depreciation		1,5
Pretax Profit		3
Tax		1,5
Net profit		1,5
Operating cash flow		3
Net cash flow	-15	3
NPV	3,43	
Notes:		
Market size (million)	1,00	
Market share %	0,10	
Price per unit (yen)	375.000	
Variable costs (yen)	300.000	
Tax rate %	50	

Cost of capital %	10
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$$NPV = -15 + \sum_{t=1}^{10} \frac{3}{(1.10)^t} = +¥3.43 \text{ bill.}$$

Then they give optimistic and pessimistic values in turn to each variable and regard the resulting NPV's. If the resulting range of NPV is wide and decrease distinctly on the negative side, take care of this variable.

Table 11.2

Variable	Range			NPV (billions of yen)		
	Pess.	Expected	Opt.	Pess.	Expected	Opt.
Market size, million	0,9	1	1,1	1,13	3,43	5,74
Market share	0,04	0,10	0,16	-10,39	3,43	17,26
Unit price ¥	350.000	375.000	380.000	-4,25	3,43	4,97
Unit variable cost¥	360.000	300.000	275.000	-15,00	3,43	11,11
Fixed cost, bns ¥	4	3	2	0,36	3,43	6,51

As you can see, the project is sensitive to the variables *Market share* and *Unit variable costs*.

Value of Information

The result of the pessimistic estimate for unit variable costs is a high negativ NPV because of the production department's fear, some machines will not work as planned and cause additional costs. An assumption is that the extra costs per unit is 20 €it will reduce your after-tax cash flow by:

$$100,000 \text{ units} \times 20,000 \times 50\% = ¥1 \text{ bill.}$$

The NPV would reduce:

$$\sum_{t=1}^{10} \frac{1}{(1.10)^t} = ¥6.14 \text{ bill.}$$

The result is a negativ NPV (+ 3.34 – 6.14) = - ¥2.71 bill.

Limits of Sensitivity Analysis

Sensitive analysis recovers the interrelationship between cash-flow and the prime variables of the project. As a result managers are able to recognize the *sensitive* variables of the project and allow them to take step against useless or confused forecasts.

One the other side, most of the underlying variables are interrelated. The effect of examining variables one by one is

rather questionable. For example an increasing market size will entail rising demand and market prices will be pushed. Another problem is the equivocal result of sensitive analysis because of the different view of optimistic and pessimistic values.

Scenario Analysis

As we learned that the variables are mostly interrelated, it make sense to regard the effect of changing several but consistent variables at a time → you have to consider alternative scenarios.

Example 2: An estimate rise in oil price of 20% would cause a larger market size of electric scooters of 3%. Otherwise, the oil price is interrelated with the world inflation, market size will reduce to 0.8 million scooters and costs and prices are increasing by about 15%. By replacing the cash flow forecast of example 1, with the new estimates, the NPV would increase to ¥6.4 bill.

Table 11.3

Cash Flows, Years 1- 10, billions of yen		
	Base Case	High Oil Prices and Recession Case
Revenue	37,5	44,9
Variable cost	30	35,9
Fixed cost	3	3,5
Depreciation	1,5	1,5
Pretax Profit	3	4,0
Tax	1,5	2,0
Net profit	1,5	2,0
Net cash flow	3	3,5
PV of cash flows	18,4	21,4
NPV	3,4	6,4
Assumptions		
	Base Case	High Oil Prices and Recession Case
Market size (million)	1	0,8
Market share	0,10	0,13
Unit price (yen)	375.000	431.300
Unit variable cost (yen)	300.000	345.000
Fixed cost (bns of yen)	3	3,5

Break-Even Analysis

In terms of scenario- and sensitive analysis we look at the effect on NPV by changing variables one by one or several variables at a time.

But, to determine the point when the project begins to lose money, we have to do a *Break-Even Analysis*.

Example 3: To identify the break-even value of key variables we set out the revenues and costs under different assumptions of annual sales. Then we discount these costs

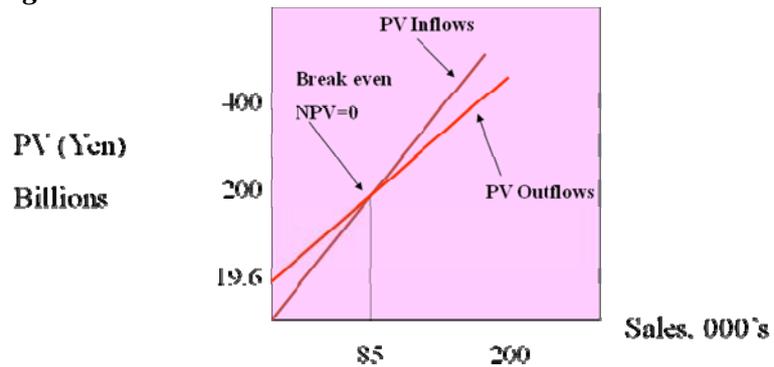
to give the present value of the inflows and the outflows.

Unit Sales, Thousands	Inflows		Outflows			PV Inflows	PV Outflows	NPV
	Revenues Years 1-10	Year 0		Years 1-10				
		Investment	Variable Costs	Fixed Costs	Taxes			
0	0	15	0	3	-2,25	0,0	19,6	-19,6
100	37,5	15	30	3	1,5	230,4	227,0	3,4
200	75,0	15	60	3	5,25	460,8	434,4	26,5

The difference of these numbers is the NPV.

Table 11.4

Figure 11.1



In figure 11.1 we see the lines of the present value of the inflows and the present value of the outflows, the break-even point is where the lines are crossed (NPV = 0) this is about 85,000 units. To get a positive NPV, sales have to be greater as the value of the crossing point.

You can also calculate break-even points in terms of accounting profits, but be aware a project breaks even in terms of accounting profits will have a negative NPV. Revenues will be adequate to recover operating costs and initial outlay but it will not be enough to refund the *opportunity costs of capital* of the invest.

Break-even charts allows managers to estimate *operating leverage*, to recover the effect of project fixe costs and NPV.

Monte Carlo Simulation

Sensitive Analysis = the effect of changing one variable at a time.

Alternative scenario = changing a limited number of variables

Monte Carlo Simulation = consider all possible combinations of variables.

Step 1 – Modeling the Project:

Firstly we build a financial model of the project, based on the same assumptions of cash flow, revenues or costs like in the

sensitive analysis of the Electric Scooter Project. Have special attention on the interrelationship between the variables, for example we look at the interdependence between different *periods* and *variables*:

Market size Y1=expected market size Y1x (1+forecast error Y1)
Market size Y2=Market size Y1 (incl. FE Y1) x (1+FE Y2)

Assumption: The price will increase in time with market size by 3%:

Price Y1 = expected price Y1 x (1+.3 x FE market size Y1)
Price Y2 = Price Y1 (incl. FE Y1) x (1+.3 x FE market size Y2)

→ Forecast errors accumulate from one year to the other and in this way uncertainty increases over time.

In this manner you have to build the complete model of your project which includes many equations for each interrelated variable till you would become a complex list of equations.

Step 2 – Specifying Probabilities:

In the next step we have to specify the probabilities of forecast errors for each variable in the model, for example market size:

Expect market size = 1 Million
Pessimistic estimate = .85 Million
Optimistic estimate = 1.15 Million
Range = +/- 15%

Step 3 – Simulate the cash flow:

In step 3 the computer simulates the cash flow based on the distribution of forecast errors. The result after much iterations is an accurate estimate of the probability distribution of the project cash flow.

Step 4 – Calculate Present Value:

Finally, calculate the expected cash flows, based on the distribution of cash flows. Then discount these expected cash flows to obtain the present value.

| To set up a simulation model allows you to find the sources of uncertainties, and to counteract by improving the forecasts. However, it is far from being easy to assume the interrelationships between the variables and the probability distribution of forecast errors.

Real Options and Decision Trees

If an investment decision is made, you cannot sit back and take things easy. You always have to challenge the projects cash flow. Perhaps cash flow is better than anticipated and there is a chance of expanding and increasing the revenues? Or to abandon it if things go wrong and you have to cut the losses. An important issue is the flexibility of modifying the project. These options of expanding or abandoning are called *real options*.

(Sensitive analysis and Monte Carlo Simulation do not allow the option of modifying a project).

Decision Trees display the real options in an easy way.

The Option to Expand

The option to expand gives the flexibility of expanding at a later point of time, when business is well on track. Note, you are not obliged to expand!

The more valuable the options of expanding are, the more market value of a company will rise and finally it will be higher than the value of its physical assets.

The Option to Abandon

The option to abandon allows the management to cut its losses if the project is no longer profitable. To estimate the value of bail out, you have to be aware that tangible assets are easier to sell than intangible ones. That means, if you take the decision to invest in new plants you also have to consider the *abandonment value*.

Tangible assets = real estate, airplanes, trucks etc.

Intangible assets = accumulated knowledge etc.

Production Options

The flexibility of producing different variants of a product or to vary the inputs (electricity, burning oil or burning gas)

Timing option

To find out the best point of time to start an investment, you have to calculate the *net future value* of different dates and to discount these net future value back to present:

$$\text{NPV at date } t = \frac{\text{NFV at date } t}{(1+r)^t}$$

You get the NPV if you deduct the appropriate discount rate from the NFV.

The optimal date, for example to sell an asset, is the last date when the gain in value is greater than the cost of capital tied up.

→ Suppose the discount rate is 10% than you have to sell if the gain of value at date t will be narrow over 10%.

Example 4: To harvest inaccessible timber, you have to invest \$75,000. As long as you wait to harvest, investment will increase but lumber prices increase to and the trees will keep growing.

Year of Harvest					
	1	2	3	4	5
Net <i>future</i> value	64.4 T\$	77.5 T\$	89.4 T\$	100 T\$	109.4 T\$
Change in value	+28.8%	+20.3%	+15.4%	+11.9%	+9.4%

$$\text{NPV in year 1} = \frac{64.4}{1.10} = \$58,800$$

Year of Harvest					
	1	2	3	4	5
Net <i>present</i> value	58,8 T\$	64,0 T\$	67,2 T\$	68,3 T\$	67,9 T\$

as you can see, NPV maximize in year 4, that is the optimal point of time to harvest. After year 4, the gain of value would not cover the costs of the capital (discount rate = 10%; gain of value < 10%)

Timing options have to be made when there are no uncertainties about future cash flow, but mostly there is an uncertainty about future cash flow; therefore, you have to come to a decision about whether to wait and get more information to avoid a mistake or “to strike while the iron is hot”.

Decision Trees

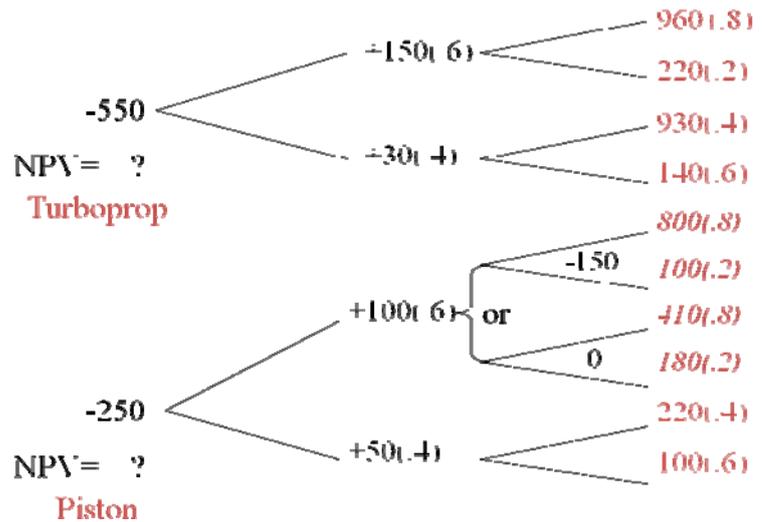
Now we know the different kinds of real options. We use decision trees to constitute these real options and to show project risks and cash flow consequences of future decisions. Then, working back from future to the present, we calculate the *NPV* of each branch of the decision tree.

Example 5: Magna Charter is a corporation which provides a flying service. The venture to buy a plane is not sure, there is a 40% probability that demand in first year will be low and 60% that it will remain low in the following years. The probability of a high demand is 60/80%.

They have to choose between two kinds of planes: A turboprop for \$550,000 and a piston-engine for \$250,000. The idea is to buy a piston-engine plane and if demand is high next year, to buy another, second-hand plane for only \$150.000. → *Option to Expand*

Figure 11.7 shows these choice and the probabilities of demand and the cash flow consequences.

Figure 11.7



To get the NPV of the *Option to Expand*, we consider first the right side of the decision tree and work backward to the beginning of the investment:

$$(80\% \times 800) + (20\% \times 100) = +660 \text{ (\$660,000)}$$

Discount rate = 10%

$$\text{NPV Y1} = -150 + \frac{660}{1.10} = +450 \text{ (\$450,000)}$$

→ \$450,000 + \$100,000 cash flow = \$550,000

We do the same with the fork of low demand and receive a NPV = \$135,000 + \$50,000 cash flow = \$185,000
 Then we go to the beginning left-hand-side and calculate the NPV of the investment in the piston engine plane:

$$\text{NPV} = -250 + \frac{60\% (550) + 40\% (185)}{1.10} = \$117,000$$

In terms of buying a turboprop (no decision to expand) we can calculate directly the expected cash flows and discount:

$$\text{NPV} = -550 + \frac{60\% (150) + 40\% (30)}{1.10}$$

$$\frac{60\%[80\%(960) + 20\%(220)] + 40\%[40\%(930) + 60\%(140)]}{(1.10)^2} = \$96,000$$

Result: Assumed we take the option to expand, the piston-engine plane has a higher NPV and would be the better choice. But in this example we do not consider other real options, for example the *option to abandon*. Imagine, we insert the option to sell the Turboprop if demand is low in the first year. The decision tree and the equivalents will become more and more complex.

Pro Decision Trees

- Help to find the strategy with the highest *NPV*.
- Display the links between today's and tomorrow's decisions
- Give a clearer view of cash flow and risks of a project
- Allows managers to analysis possible future events.

Contra Decision Trees

- With every possible future decision they become more and more complex and seem to be more and more confusing.