Uncertainty in forecasts, Exploring

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1 Uncertainty in valuations - explorations

No matter what type of valuation one is doing, have to deal with the fact that we are forecasting *uncertain* future cash flows.

Valuation: Forecast *expected* future cash flows.

NPV of those a *point estimate* of the value.

Because the interest rate that is used in discounting is a risk-adjusted one, this *does* take into account risk.

However, in most settings one want to look closer at the uncertainty involved in the cash flows.

→ It may help in understanding what is going on.

Particularly, something often missed when constructing cash flow expections: Look for interactions.

Summarize this as a sequence of useful questions to ask, and ways to formally proceed.

- How bad can it get?
  - Breakeven analysis
  - Scenario Analysis
- How likely is it?
  - Scenario analysis with probabilities
  - Simulation
- What circumstances should force a rethink?
  - Decision Trees
  - Real option analysis

2 Breakeven analysis

Given a NPV calculation, ask:

How much does each input need to change (fall/increase) before the NPV falls to zero.

Examples:

- How much can the discount rate increase before the NPV turns negative?
- Suppose the cash flows are estimated using a growth rate in sales assumption.

  How much lower is the growth in sales when the NPV goes negative?

This method useful to

- Identify critical factors

- one at a time

However problematic for:

- Interactions between inputs

Implementation: Typically done using either of

- *Goal Seek*
- *Solve*

Spreadsheet functions.

Techically, involves solution a (nonlinear) equation.) May be problematic if there are more than one solution, but most of the time gets reasonable solution.

Alternative: "Solve by hand" by varying the input parameter in a systematic way to get NPV$\approx$ 0.

3 Scenario analysis

Example: When doing estimation of expected value, come up with:

- Pessimistic
- Expected
- Optimistic

forecasts. Calculate the NPV of each scenario

More generally:

Scenario: Different sets of assumptions about the realized value of each of the value drivers.

Sceniario analysis

- the sky is the limit in scenarios on can think of
- however, there is no *systematic* way to define scenarios

If associate probabilities with each scenario, can use to calculate a different estimate of the expected NPV. (It will typically be different from the NPV of the expected cash flows.)

Exercise 1.

The Titmar Motor Company is considering the production of a new personal transportation vehicle (PTV). The PTV would compete directly with the innovative new Segway. The PTV will utilize a three-wheel platform capable of carrying one rider for up to six hours per battery charge, thanks to a new battery system developed by TitMar. TitMar's PTV will sell for substantially less than the Segway but offer equivalent features. The pro forma financials for the proposed PTV project, including the underlying forecasts and assumptions, are given below.

Assumptions and Predictions	Estimates
Price per unit	$4,895
Market share (%)	15.00%
Market size (Year 1)	$200,000 units
Growth rate in market size beginning in Year 2	5.00%
Unit variable cost	$4,250
Fixed cost	$9,000,000
Tax rate	50.00%
Cost of capital	18.00%
Investment in NWC	5.00% of the predicted change in firm revenues.
Initial investment in PP&E	$7,000,000
Depreciation (5 year life w/no salvage)	$1,400,000

	Year 0	1	2	3	4	5
Investment	$(7,000,000)					
Revenue		146,850,000	154,192,500	161,902,125	169,997,231	178,497,093
Variable Cost		(127,500,000)	(133,875,000)	(140,568,750)	(147,597,188)	(154,977,047)
Fixed cost		(9,000,000)	(9,000,000)	(9,000,000)	(9,000,000)	(9,000,000)
Depreciation		(1,400,000)	(1,400,000)	(1,400,000)	(1,400,000)	(1,400,000)
EBT(Net Operating Income)		$8,950,000	$9,917,500	$10,933,375	$12,000,044	$13,120,046
Tax		(4,475,000)	(4,958,750)	(5,466,688)	(6,000,022)	(6,560,023)
Net Operating Profit after Tax (NOPAT)		$4,475,000	$4,958,750	$5,466,688	$6,000,022	$6,560,023
Plus: Depreciation expense		1,400,000	1,400,000	1,400,000	1,400,000	1,400,000
Less: Capex	(7,000,000)	-	-	-	-	-
Less: Change in NWC	(7,342,500)	(367,125)	(385,481)	(404,755)	(424,993)	8,924,855
Free Cash Flow	$(14,342,500)	$5,507,875	$5,973,269	$6,461,932	$6,975,029	$16,884,878
Net Present Value	$9,526,209					
Internal Rate of Return	39.82%					
Units Sold		30,000	31,500	33,075	34,729	36,465

Note that revenue is calculated as follows: price per unix × market share × market size and units sold = revenues/price per unit. The project offers an expected NPV of $9,526,209 and an IRR of 39.82%. Given TitMars stated Hurdle rate of 18%, the project looks like a winner.

Even though the project looks very good based on management's estimates, it is risky and can turn from a positive NPV investment to a negative one with relatively modest changes in key value drivers. Develop a spreadsheet model of the project valuation, and answer the following questions:

1. If the market share turns out to be only 5%, what happens to the project's NPV?

2. If market share remains at 15% and the price of the PTV falls to $4,500, what is the resulting NPV?

Solution to Exercise 1.

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Part a. If the market share is only 5% then the project's NPV = $(9,413,430)

Part b. If market share = 15% and the price of the PTV falls to \$4,500 the NPV = \$(10,261,801)

Breakeven Sensitivity Analysis

	Critical % Change	Critical Value
Price per unit	-3.88%	\$4,705
Market share (%)	-33.53%	9.97%
Market size (Year 1)	-33.53%	\$132,936
Growth rate in market size (start year 2)	-496.00%	-19.80%
Unit variable cost	4.40%	\$4,437
Fixed cost	67.69%	\$ 15,092,541
Tax rate	57.20%	78.60%
Cost of capital	121.22%	39.82%
Investment in NWC	212.00%	15.60%

The analysis suggests that the two key value drivers are price per unit and unit variable cost!

4 Monte Carlo Simulation

The next logical step, when one desires more insight in how cash flow uncertainty maps into uncertainty about the NPV of a project.

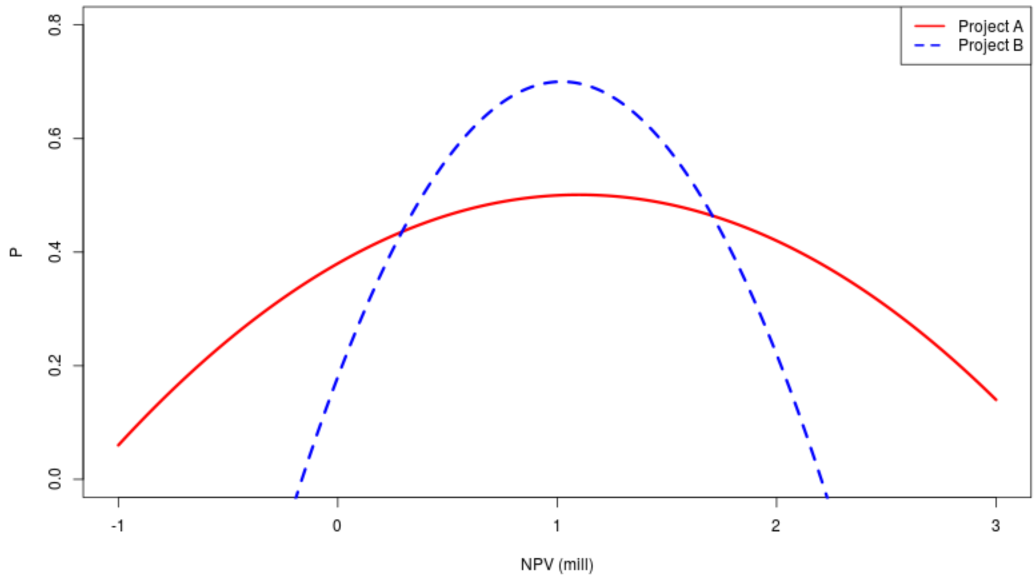
Simply:

- Construct the NPV calculation
- Choose one or more inputs to the NPV calculation which is uncertain.
  - e.g. Sales increase can vary from -10% to $+20\%$
- For each input, choose a probability distribution
  - e.g Sales can vary uniformly between -10% and $+20\%$.
  - or sales has a symmetric triangular distribution betwen -10% and $+20\%$.
- Simulate
  - Draw randomly each parameter
  - Using the drawn parameters, evaluate NPV
  - Remember NPV, iterate
  - Summarize distribution of estimated NPV's

End result of a simulation: Distribution of NPV's.

Evaluate distribution, e.g. a plot

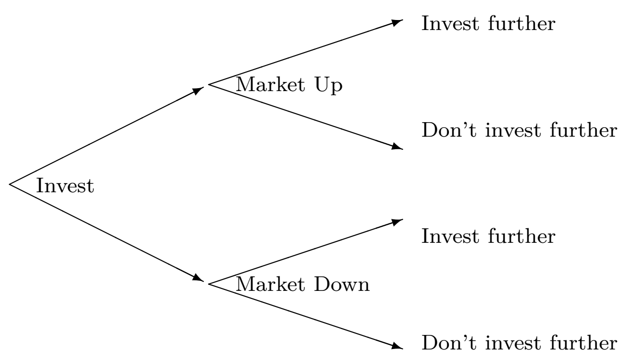
Example: Two different projects, probability distributions.



Discuss: Implications for cost of capital for the two projects?

5 Decision Trees

Old idea in decision analysis: Sequence of contingent decisions.



At each node where there is a decision, calculate the NPV "going forward" from that node.
Build in sequential decisions into the analysis.
Note similarity to option pricing.

6 Real Options

In many investment projects, there are "hidden options."

Example

Value of waiting

Consider the decision problem of *ExOff Oil*, which is deciding the particiption in a joint venture with a Russian firm, to purchase an oil field in the remoter regions of Siberia.

We are given the following data about ExOff's share:

- Initial purchase payment for a share in the joint venture: $10,000.
- Drilling costs: $500,000.
- Number of barrels per year 10,000 (in perpetuity).
- Oil prices (per barrel) $20.
- Extraction and transportation costs (per barrel) $16.
- Discount rate $r = 10\%$.

Let us use traditional NPV analysis to value this investment.

- Initial investment: $510,000.
- Profit per barrel: $\$20 - \$16 = \$4$.
- Total profit each year: $\$4 \cdot 10,000 = \$40,000$.

$$NPV = -C_0 + \frac{C_1}{r}$$

$$NPV = -510,000 + \frac{40,000}{0.10} = -110,000$$

This is the traditional NPV analysis of this investment project. But let us assume we have some more information about this particular project.

There is big uncertainty about the oil price next year. You have heard ominous rumours from your industrial spies in Utah, that the "cold fusion" crazies actually have found a way of running a car using this source of energy.

If this happen to be true, it will immediately reduce the demand for oil by 80%, thus reducing the price of oil to (your guesstimate) $5 a barrel.

However, if they are not successful, you believe that OPEC will get together, and the oil price will rise, to about $35 a barrel.

What about your drilling in Siberia?

The two choices analyzed (using NPV) above were

- Not invest.
- Invest:
  - Purchase (at $10,000).
  - Drill immediately (at $500,000).
  - Start pumping oil next year.

You found that investing were a negative NPV project.

However, you should realize that in addition to the choice of drilling now or not drilling at all, you have a third choice.[1]

- Purchase (at $10,0000).
- Wait one year with drilling.

[1] Actually an infinite number of choices. Can you figure out which? But let's forget about the rest of them for now, and concentrate on one.

- If the oil price is \$5, forget it.
- If the oil price is \$35, start drilling.

$$
\begin{aligned}
NPV &= -500,000 + \frac{35-16}{0.10} \\
&= 1,390,000
\end{aligned}
$$

By investing \$10,000, you get a project that *may* be worth either \$ 1,390,000 or \$0 next year.

Clearly, you should make the purchase, and wait with drilling for one year, unless the probability of an oil price of \$5 is *extremely* high.

What the example shows, is that the investment project had a "hidden option". By waiting one year, and making your investment decision contingent on the outcome of the oil price, you could make a much better investment analysis than the go/no go decision considered first.

This example illustrates the **Value of Waiting**. By waiting one year to get more information, you gave yourself an option.

You can view this investment as a call option: For \$10,000 you buy a call option on a oil field producing 10,000 barrels/year. The exercise price of this option is the \$500,000 cost of drilling.

By making appropriate assumptions about the oil price, we could analyze this using the binomial option pricing approach.

This approach to investment analysis is called *Real Options Analysis*.

7 Readings

(Titman and Martin, 2016, Ch 3)

References

Sheridan Titman and John D Martin. *Valuation. The art and science of corporate investment decisions*. Pearson, third edition, 2016.