Discounted Cash Flow: Sensitivity Analysis

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Last Time
Discounted Cash Flow (DCF)

- Decision criteria

This Time
## Discounted Cash Flow (DCF)
- Sensitivity analysis

Sensitivity Analysis

BREAK EVEN ANALYSIS

Break Even Analysis finds the parameter value that sets the NPV of the project equal to zero holding fixed all other parameters

Base
Parameter Value

Base

Cost of Capital

12.01%

708.42

Initial Investment ($mil)

227.7

708.42

NPV

Break Even (BE)
Parameter Value

	Base	BE
Cost of Capital	12.01%	43.72%
	708.42	0.00
Initial Investment ($mil)	227.7	904.24
	708.42	0.00

NPV
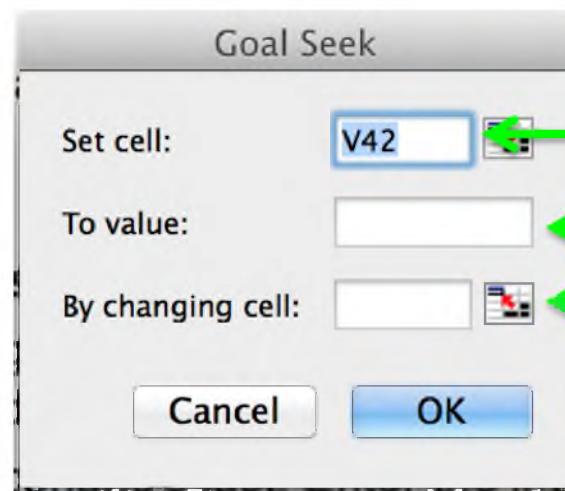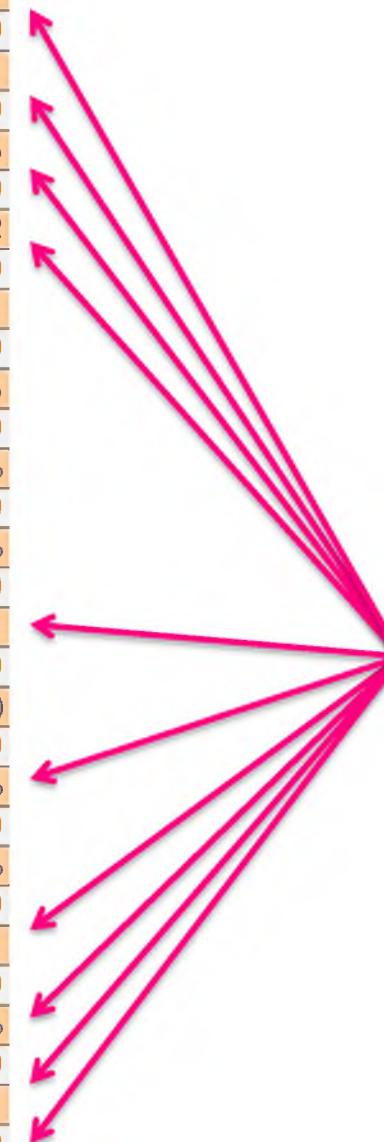
	Base	BE
Cost of Capital	12.01%	43.72%
	708.42	**0.00**
Initial Investment ($mil)	227.7	904.24
	708.42	**0.00**

Excel's Goal Seek

Goal Seek

Set cell: `V42`   ⟵ **NP**

To value: ⟵ **0**

By changing cell: ⟵ **Parameter**

Cancel   OK

	Base	BE
Cost of Capital	12.01%	43.72%
	708.42	0.00
Initial Investment ($mil)	227.7	904.24
	708.42	0.00
PP&E Liquidation Value	50%	-2253%
	708.42	0.00
PP&E Life for Depreciation	5.00	0.32
	708.42	0.00
Initial Market Size (Units Mil)	1.00	0.52
	708.42	0.00
Market Growth Rate	2500%	1571%
	708.42	0.00
Initial Market Share	25.00%	13%
	708.42	0.00
Market Share Growth Rate	5.00%	-18%
	708.42	0.00
Initial Unit Price ($/unit)	200.00	77.36
	708.42	0.00
Bi-Annual Price Increases ($/unit)	49.99	(59.44)
	708.42	0.00
Tax Rate	25.45%	88%
	708.42	0.00
COGS / Sales (% Sales)	80.66%	90%
	708.42	0.00
SG&A First-Year ($mil)	69.59	229.81
	708.42	0.00
SG&A Expense Growth Rate	25%	98%
	708.42	0.00
R&D Upfront ($mil)	200.00	1,150.26
	708.42	0.00
R&D Versioning ($mil)	25.00	260.19
	708.42	0.00

Large Margin for Error

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Cost of Capital	12.01%	43.72%
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Potentially Important

Lesson: Break Even Analysis is a partial equilibrium analyses that assume parameters are independent of one another.

COMPARATIVE STATICS

Comparative statics quantifies the sensitivity of the valuation to variation in a parameter holding fixed all other parameters

How does valuation change parameter variation from worst to best case?
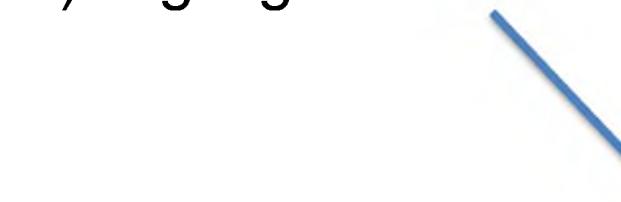
	Worst	Base	Best
Cost of Capital	15.01%	12.01%	9.61%
708.42	**594.19**	**708.42**	**812.29**
Initial Investment ($mil)	284.0	227.7	185.0
708.42	**649.47**	**708.42**	**753.13**

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Does the valuation vary sensibly with variation in the parameters?

Excel: Data Tables
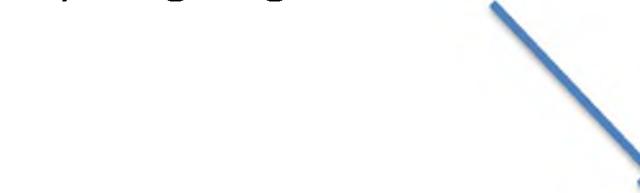
1) Highlight matrix: NPV in bottom left, parameters in top *row*

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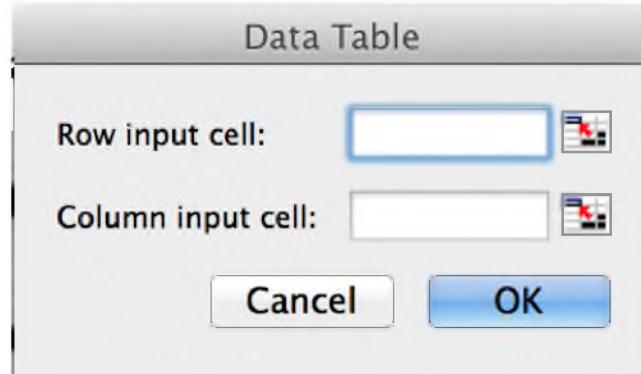
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2) Data Table: Choose Row Input Cell and enter parameter cell

Data Table

Row input cell: [   ]

Column input cell: [   ]

Cancel   OK

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708.42	594.19	708.42	812.29
Initial Investment ($mil)	284.0	227.7	185.0
708.42	649.47	708.42	753.13
PP&E Liquidation Value	30%	50%	75%
708.42	702.27	708.42	716.11
PP&E Life for Depreciation	3.00	5.00	7.00
708.42	676.20	708.42	722.23
Initial Market Size (Units Mil)	0.50	1.00	2.00
708.42	-31.05	708.42	2187.36
Market Growth Rate	1000%	2500%	5000%
708.42	-332.83	708.42	3696.24
Initial Market Share	15.00%	25.00%	35.00%
708.42	116.84	708.42	1300.00
Market Share Growth Rate	1.00%	5.00%	8.00%
708.42	557.30	708.42	830.22
Initial Unit Price ($/unit)	175.00	200.00	250.00
708.42	564.00	708.42	997.25
Bi-Annual Price Increases ($/unit)	24.99	49.99	99.99
708.42	546.58	708.42	1032.10
Tax Rate	35%	25.45%	12.50%
708.42	600.32	708.42	855.01
COGS / Sales (% Sales)	84.30%	80.66%	74.25%
708.42	425.90	708.42	1205.93
SG&A First-Year ($mil)	45.00	69.59	85.00
708.4	817.14	708.42	640.28
SG&A Expense Growth Rate	30%	25%	15%
708.4	680.34	708.42	757.99
R&D Upfront ($mil)	250.00	200.00	150.00
708.4	671.14	708.42	745.69
R&D Versioning ($mil)	30.00	25.00	15.00
708.4	693.36	708.42	738.54

What is the elasticity of the valuation with respect to each parameter?

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$$\text{Elasticity} = \frac{\%\ \text{Change in NPV}}{\%\ \text{Change in Parameter}} = \frac{\Delta NPV}{\Delta P}\frac{P}{NPV}$$

	Base x (1-0.01)	Base	Base x (1+0.01)	Elasticity
Cost of Capital	11.89%	12.01%	12.13%	
708.42	713.34	708.42	703.53	-0.69

$$\text{Elasticity} = \frac{(703.53 - 713.34)}{(0.1213 - 0.1189)} \times \frac{\frac{1}{2}(0.1189 + 0.1213)}{\frac{1}{2}(703.53 + 713.34)}$$

	Base x (1-0.01)	Base	Base x (1+0.01)	Elasticity
Cost of Capital	11.89%	12.01%	12.13%	
708.42	713.34	708.42	703.53	-0.69
Initial Investment ($mil)	225.4	227.7	230.0	
708.42	710.80	708.42	706.03	-0.34
PP&E Liquidation Value	50%	50%	51%	
708.42	708.26	708.42	708.57	0.02
PP&E Life for Depreciation	4.95	5.00	5.05	
708.42	707.93	708.42	708.90	0.07
Initial Market Size (Units Mil)	0.99	1.00	1.01	
708.42	693.63	708.42	723.21	2.09
Market Growth Rate	2475%	2500%	2525%	
708.42	686.61	708.42	730.38	3.09
Initial Market Share	24.75%	25.00%	25.25%	
708.42	693.63	708.42	723.21	2.09
Market Share Growth Rate	4.95%	5.00%	5.05%	
708.42	706.45	708.42	710.39	0.28
Initial Unit Price ($/unit)	198.00	200.00	202.00	
708.42	696.87	708.42	719.97	1.63
Bi-Annual Price Increases ($/unit)	49.49	49.99	50.49	
708.42	705.18	708.42	711.65	0.46
Tax Rate	25%	25.45%	25.70%	
708.42	711.30	708.42	705.54	-0.41
COGS / Sales (% Sales)	79.85%	80.66%	81.47%	
708.42	771.02	708.42	645.81	-8.84

Lesson: Comparative statics implicitly assumes parameters are independent of one another.

SCENARIO ANALYSIS

Scenario Analysis quantifies the sensitivity of the valuation to variation in multiple parameters

	Worst	Base	Best
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708.42	594.19	708.42	812.29
Initial Investment ($mil)	284.0	227.7	185.0
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Initial Market Share	15.00%	25.00%	35.00%
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708.42	557.30	708.42	830.22
Initial Unit Price ($/unit)	175.00	200.00	250.00
708.42	564.00	708.42	997.25
Bi-Annual Price Increases ($/unit)	24.99	49.99	99.99
708.42	546.58	708.42	1032.10
Tax Rate	35%	25.45%	12.50%
708.42	600.32	708.42	855.01
COGS / Sales (% Sales)	84.30%	80.66%	74.25%
708.42	425.90	708.42	1205.93
SG&A First-Year ($mil)	45.00	69.59	85.00
708.4	817.14	708.42	640.28
SG&A Expense Growth Rate	30%	25%	15%
708.4	680.34	708.42	757.99
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Scenario Analysis

	Worst	Base	Best
	(654.16)	708.42	33,112.71

Scenario Analysis

Worst	Base	Best
(654.16)	708.42	33,112.71

Excel: Scenarios

Scenario Manager

Scenarios:

Base
Worst
Best

Show
Close
Add...
Delete
Edit...
Merge...
Summary...

Changing cells:

$AL$6:$BG$6

Comment:

Created by Author on 2/11/2015

Scenario Analysis

	Worst	Base	Best
	(654.16)	708.42	33,112.71

Excel: Lookup tables + a toggle are more efficient

Strategy wants to reduce the price by $30 in order to increase the initial market penetration from 25% to 30%

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Does this make sense?

Quantity (Initial Market Share)

708	20.92%	21.62%	22.38%	23.19%	24.06%	25.00%	26.02%	27.12%	28.32%	29.63%	31.07%
Price											
250	708.42	758.38	811.83	869.16	930.80	997.25	1069.10	1147.05	1231.89	1324.58	1426.27
240	660.09	708.42	760.13	815.58	875.20	939.48	1008.99	1084.39	1166.45	1256.12	1354.49
230	611.76	658.46	708.42	762.00	819.61	881.72	948.88	1021.72	1101.02	1187.66	1282.70
220	563.43	608.50	656.71	708.42	764.01	823.95	888.76	959.06	1035.59	1119.19	1210.92
210	515.11	558.54	605.00	654.84	708.42	766.18	828.65	896.40	970.15	1050.73	1139.13
200	466.78	508.58	553.30	601.26	652.82	708.42	768.53	833.74	904.72	982.27	1067.35
190	418.45	458.62	501.59	547.68	597.23	650.65	708.42	771.08	839.29	913.81	995.56
180	370.12	408.66	449.88	494.10	541.63	592.89	648.30	708.42	773.85	845.34	923.78
170	321.79	358.69	398.17	440.52	486.04	535.12	588.19	645.76	708.42	776.88	851.99
160	273.47	308.73	346.47	386.94	430.44	477.35	528.08	583.10	642.98	708.42	780.20
150	225.14	258.77	294.76	333.35	374.85	419.59	467.96	520.43	577.55	639.96	708.42

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NPV will increase from 708.42 to something greater than 776.88

Marketing is concerned about the uncertainty surrounding the market for tablets
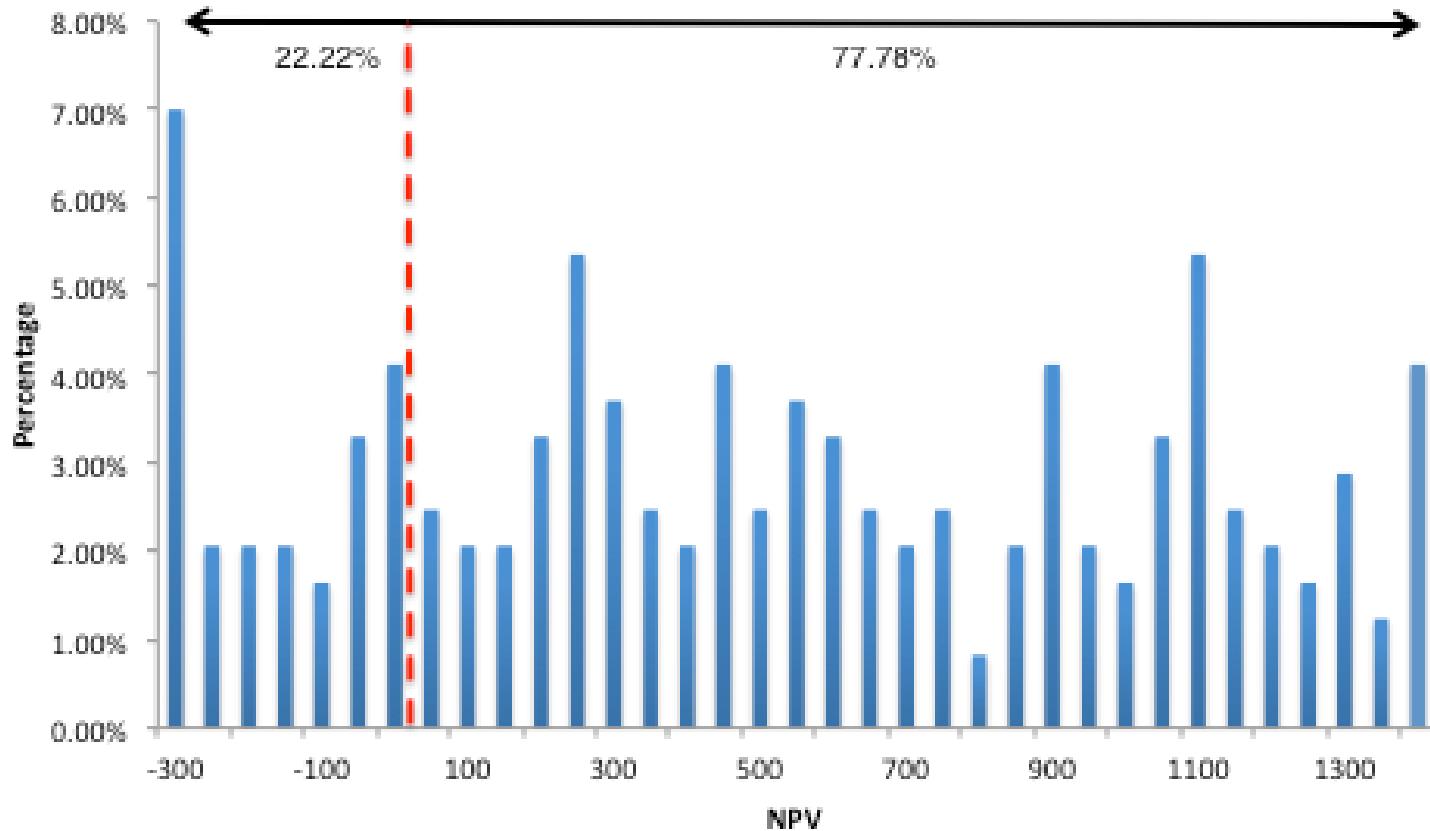
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Can you provide some information?
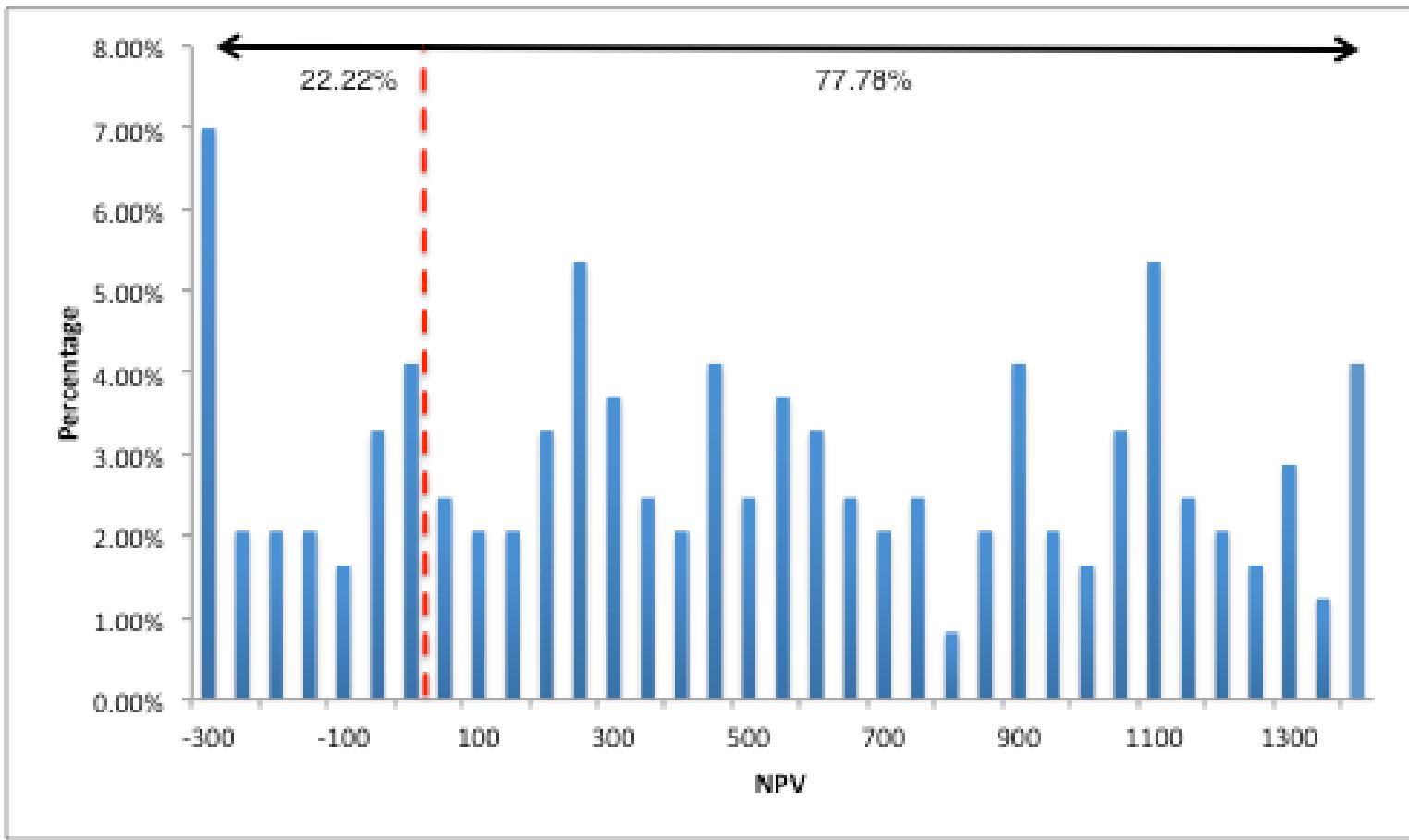
Market Growth Rate

| 708	1390.55%	1522.34%	1682.86%	1883.75%	2144.35%	2500.00%	3024.12%	3905.32%	5879.44%	9680.69%	13770.16%
Market Size											
2.25	708.42	893.29	1130.97	1447.89	1891.57	2557.10	3666.30	5884.72	12539.97	32505.73	65781.97
2.00	544.09	708.42	919.70	1201.40	1595.78	2187.36	3173.32	5145.25	11061.03	28808.37	58387.24
1.75	379.76	523.55	708.42	954.91	1300.00	1817.63	2680.34	4405.78	9582.08	25111.01	50992.52
1.50	215.44	338.68	497.14	708.42	1004.21	1447.89	2187.36	3666.31	8103.14	21413.65	43597.80
1.25	51.11	153.81	285.86	461.93	708.42	1078.15	1694.38	2926.83	6624.20	17716.29	36203.08
1.00	-113.22	-31.05	74.59	215.44	412.63	708.42	1201.40	2187.36	5145.25	14018.92	28808.36
0.75	-277.54	-215.92	-136.69	-31.05	116.84	338.68	708.42	1447.89	3666.31	10321.56	21413.64
0.50	-441.87	-400.79	-347.97	-277.54	-178.95	-31.05	215.44	708.42	2187.36	6624.20	14018.92
0.25	-606.20	-585.66	-559.25	-524.04	-474.74	-400.79	-277.54	-31.05	708.42	2926.84	6624.20
0.10	-704.79	-696.58	-686.01	-671.93	-652.21	-622.63	-573.33	-474.74	-178.95	708.42	2187.36
0.05	-737.66	-733.55	-728.27	-721.23	-711.37	-696.58	-671.93	-622.63	-474.74	-31.05	708.42

SIMULATION ANALYSIS

Simulation Analysis performs the valuation for a large number of simulated parameter values (i.e., scenarios)
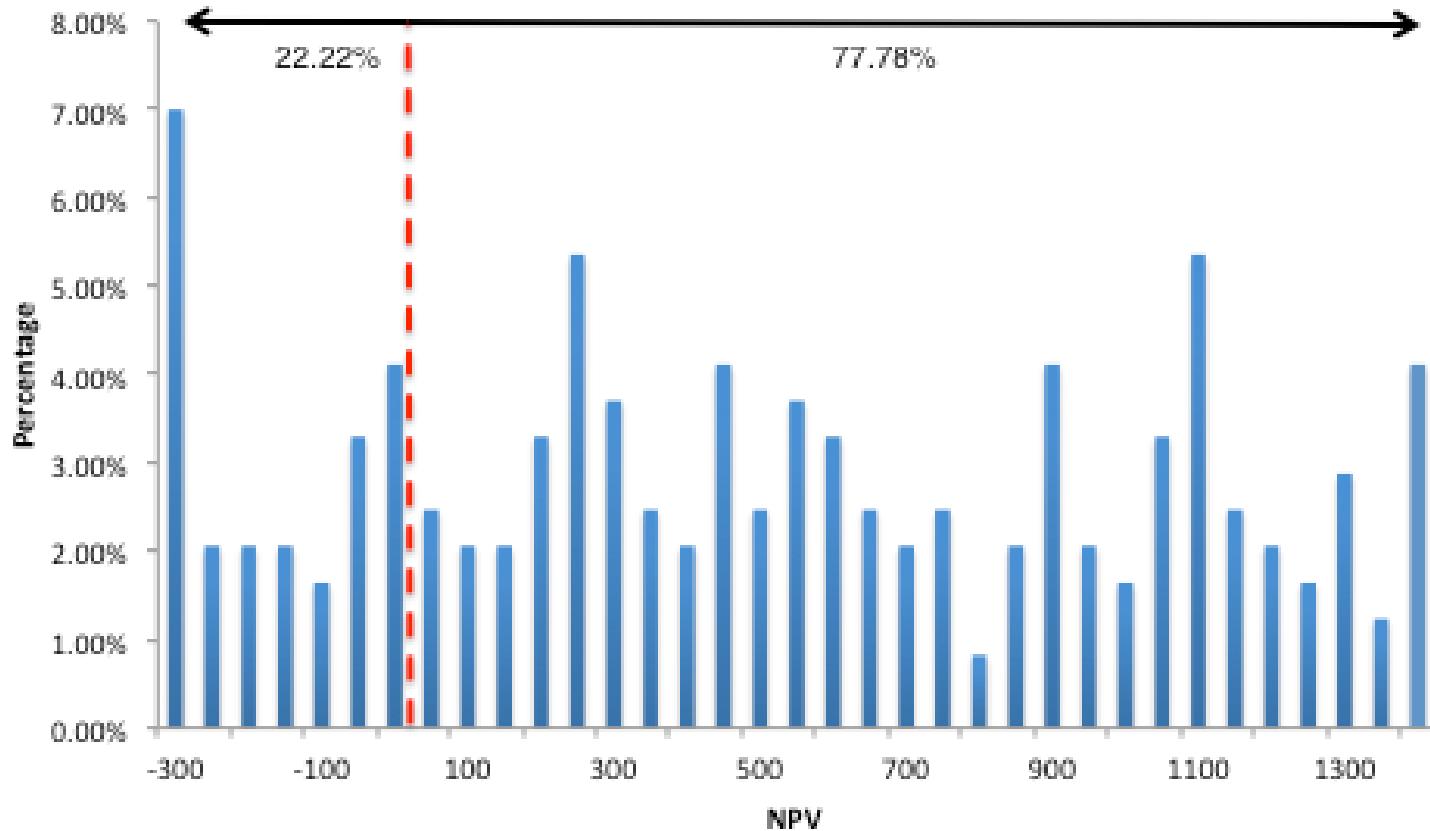
500 simulated scenarios.
Parameters drawn independently of one another.
Parameters bounded by Best and Worst case scenario.

500 simulated scenarios.
Parameters drawn independently of one another.
Parameters bounded by Best and Worst case scenario.

500 simulated scenarios.
Parameters drawn independently of one another.
Unreasonable assumption (e.g., price & quantity)
    → Can lead to implausible outcomes

Summary

Lessons

- Sensitivity analysis is an integral part of any valuation
  - Where value is created and destroyed?
  - What are the key value drivers?
  - What is the risk exposure?
  - How robust is the profitability of the project?

Coming up next

- Return on investment