

Discounted Cash Flow: Sensitivity Analysis

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Last Time

Discounted Cash Flow (DCF)

- Decision criteria

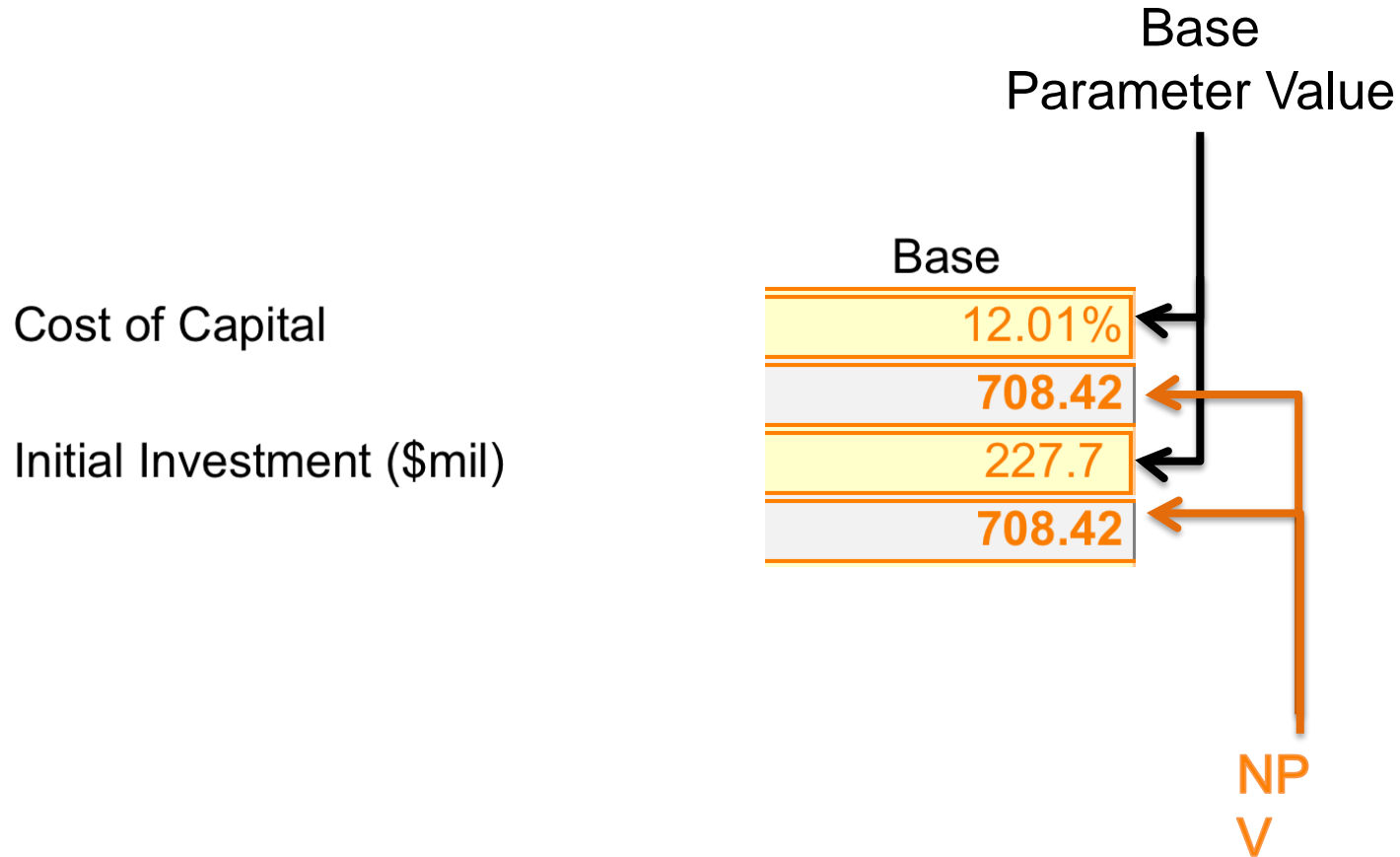
This Time Discounted Cash Flow (DCF)

- 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



Break Even (BE)
Parameter Value

Cost of Capital

Initial Investment (\$mil)

Base	BE
12.01%	43.72%
708.42	0.00
227.7	904.24
708.42	0.00

NP
V

Cost of Capital

Initial Investment (\$mil)

Base	BE
12.01%	43.72%
708.42	0.00
227.7	904.24
708.42	0.00

Excel's Goal Seek

Goal Seek

Set cell: V42

To value:

By changing cell:

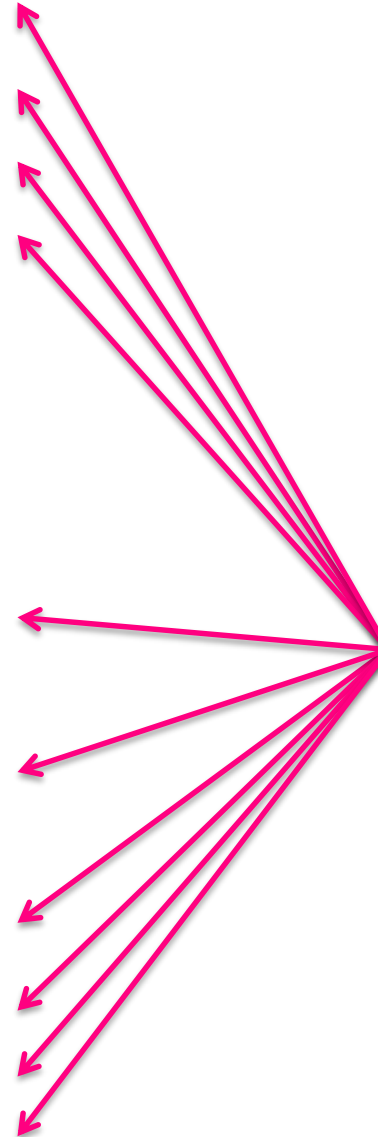
Cancel OK

NP

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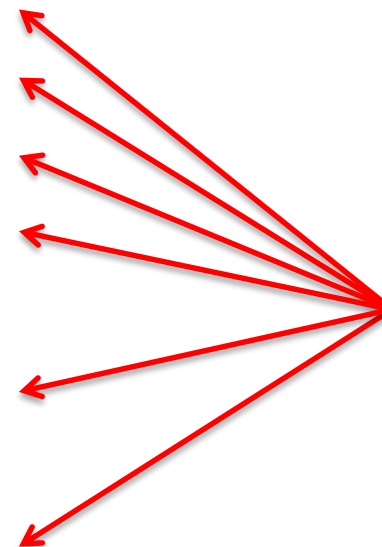
Parameter

	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

	Base	BE
Cost of Capital	12.01%	43.72%
	708.42	0.00
Initial Investment (\$mil)	227.7	904.24
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	708.42	0.00
R&D Versioning (\$mil)	25.00	260.19
	708.42	0.00



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?

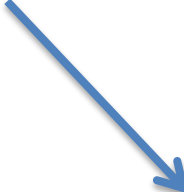
		Worst	Base	Best
Cost of Capital		15.01%	12.01%	9.61%
	708.42	594.19	708.42	812.29
Initial Investment (\$mil)		284.0	227.7	185.0
	708.42	649.47	708.42	753.13

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	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

Does the valuation vary sensibly with variation in the parameters?

Excel: Data Tables

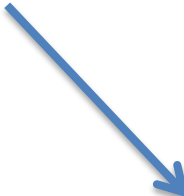
1) Highlight matrix: NPV in bottom left, parameters in top **row**



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Cost of Capital	15.01%	12.01%	9.61%
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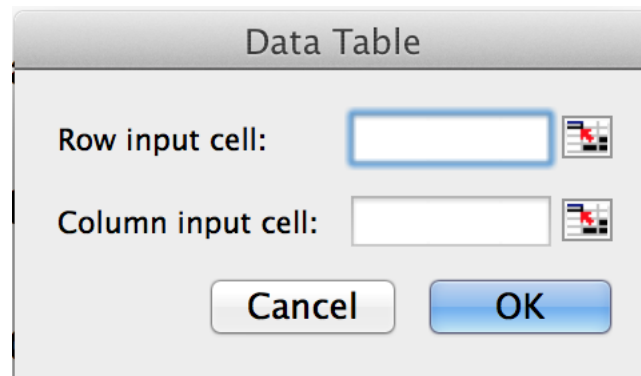
1) Highlight matrix: NPV in bottom left, parameters in top **row**



	Worst	Base	Best
Cost of Capital	15.01%	12.01%	9.61%
Initial Investment (\$mil)	284.0	227.7	185.0

The table shows a 2x3 matrix of values. The first row represents the 'Cost of Capital' with values 15.01%, 12.01%, and 9.61%. The second row represents the 'Initial Investment (\$mil)' with values 284.0, 227.7, and 185.0. The columns are labeled 'Worst', 'Base', and 'Best'. The bottom-left cell (NPV) is highlighted in yellow, and the top row (parameters) is highlighted in blue. The cells for 'Initial Investment' are highlighted in orange.

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



The dialog box is titled 'Data Table'. It contains two input fields: 'Row input cell:' and 'Column input cell:'. Each field has a small icon to its right. At the bottom, there are two buttons: 'Cancel' and 'OK'.

		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
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?

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

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

Cost of Capital

	Base x (1-0.01)	Base	Base x (1+0.01)	Elasticity
	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
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
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

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

Changing cells:

\$A\$6:\$B\$6

Comment:

Created by Author on 2/11/2015

Show

Close

Add...

Delete

Edit...

Merge...

Summary...

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	

		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%
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	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	
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150	225.14	258.77	294.76	333.35	374.85	419.59	467.96	520.43	577.55	639.96	708.42		

NPV will increase from 708.42 to something greater than 776.88

Marketing is concerned about the uncertainty surrounding the market for tablets

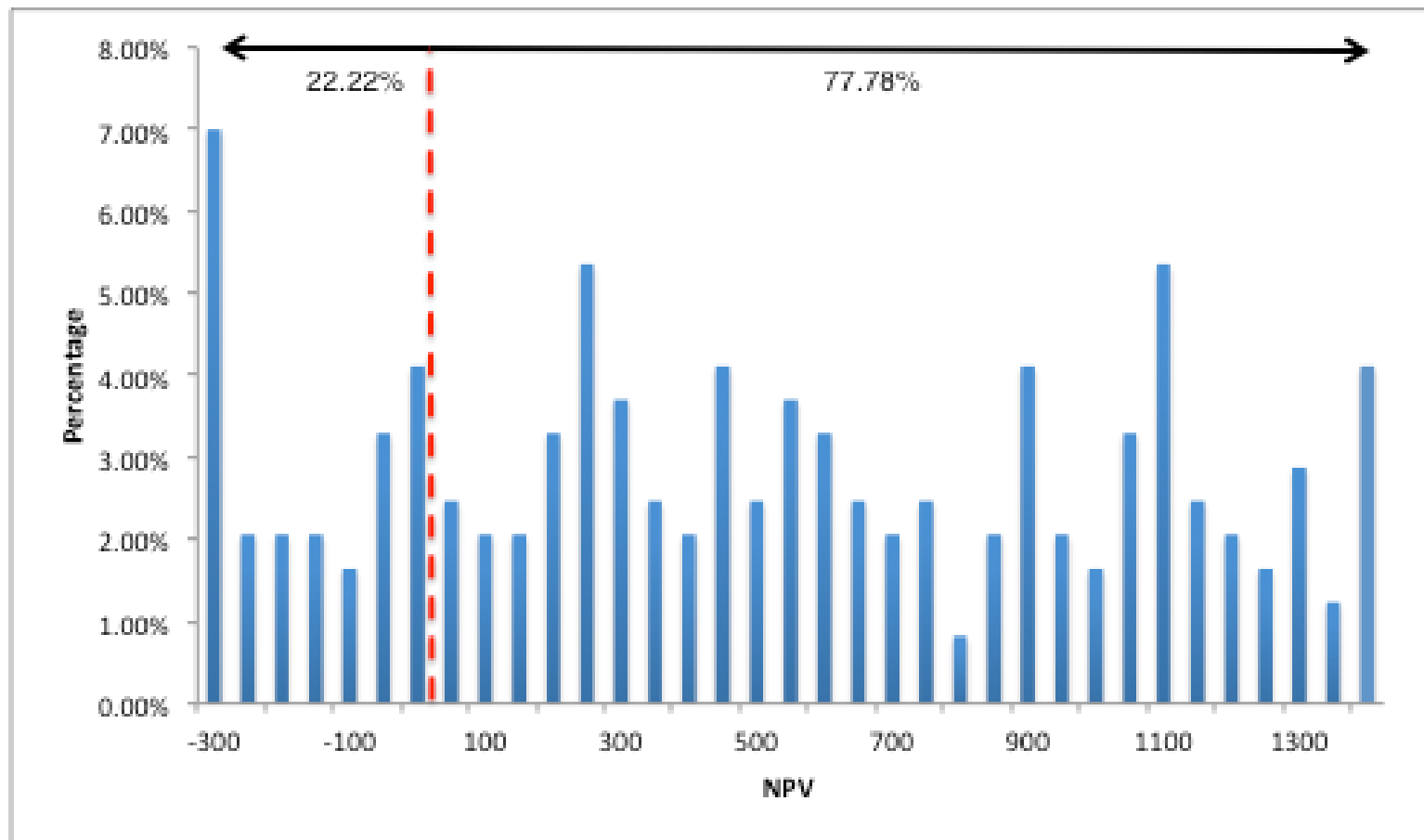
Marketing is concerned about the uncertainty surrounding the market for tablets

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

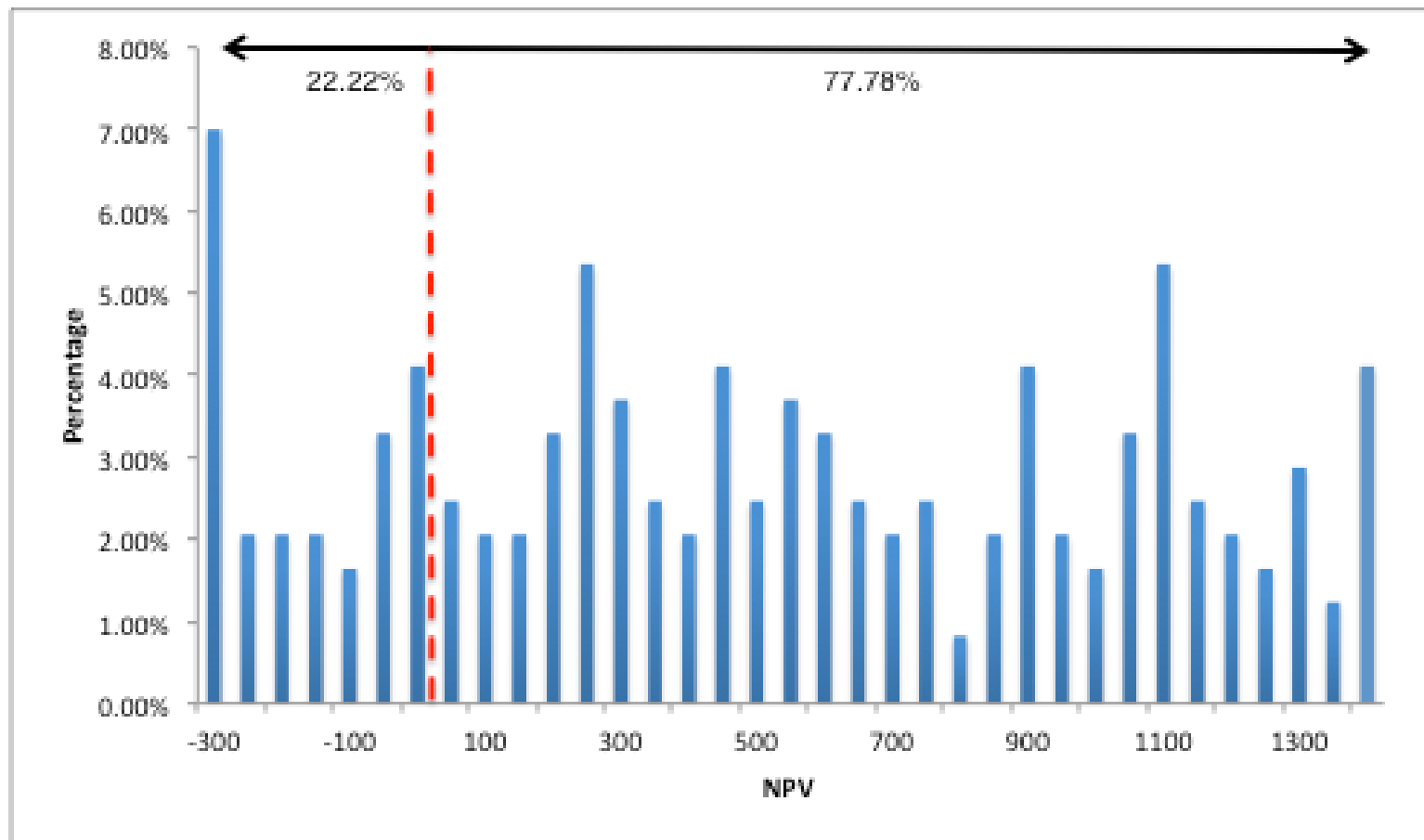
Simulation Analysis performs the valuation for a large number of simulated parameter values (i.e., scenarios)



500 simulated scenarios.

Parameters drawn independently of one another.

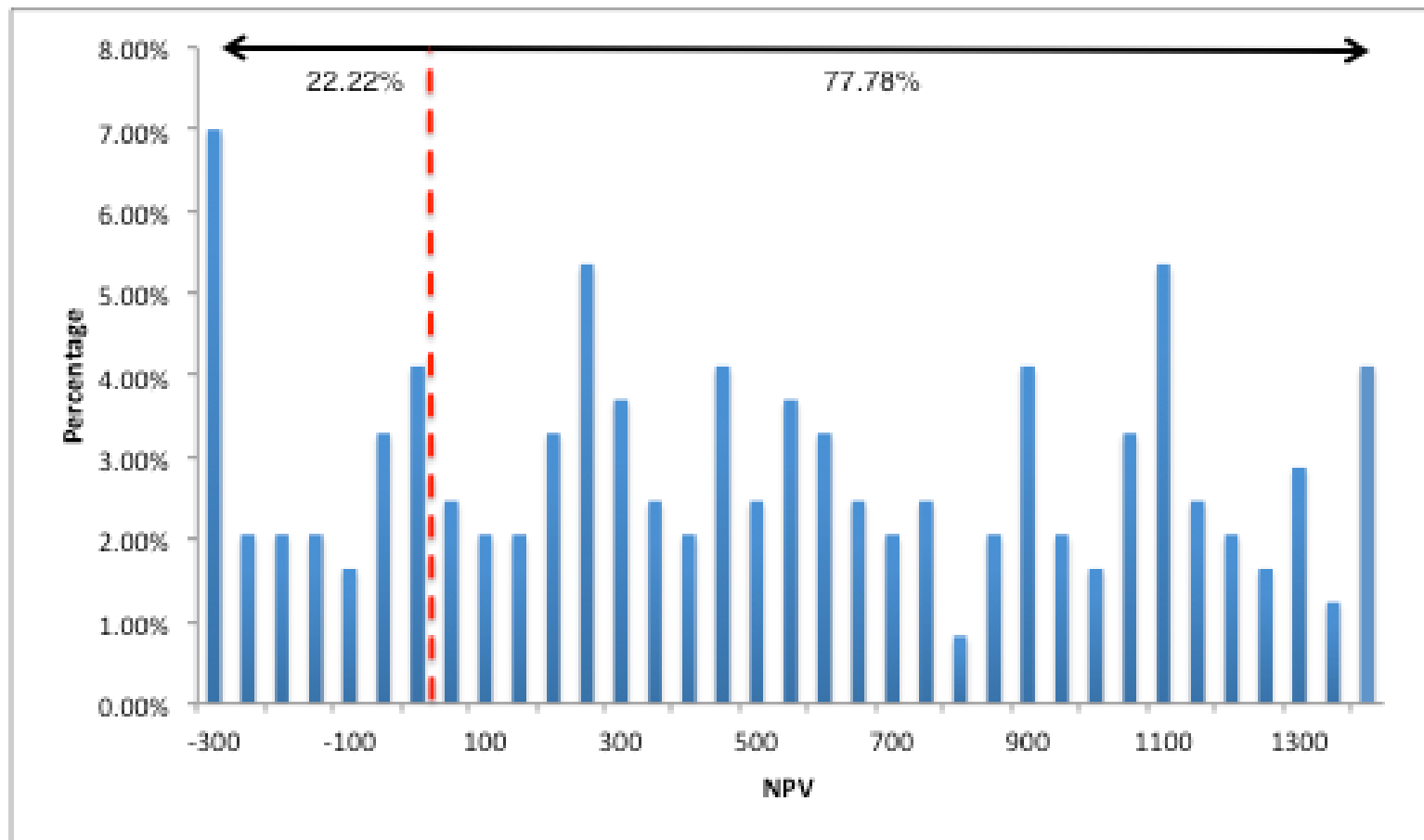
Parameters bounded by Best and Worst case scenario.



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