

Discounted Cash Flow: Sensitivity Analysis

Michael R. Roberts

William H. Lawrence Professor of Finance

The Wharton School, University of Pennsylvania

Last Time

Discounted Cash Flow (DCF)

- Decision criteria

This Time Discounted Cash Flow (DCF)

- Sensitivity analysis

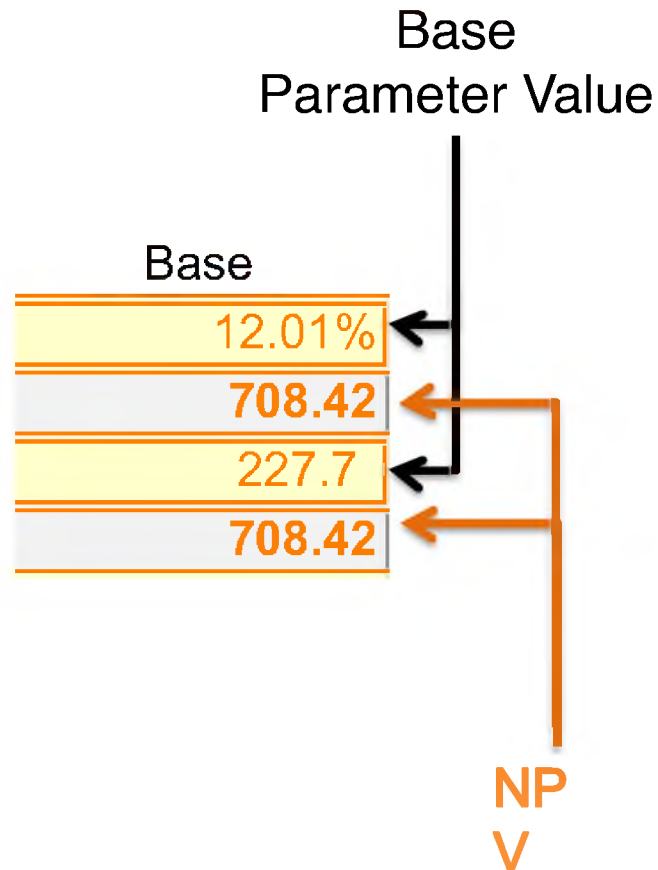
Sensitivity Analysis

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

Cost of Capital

Initial Investment (\$mil)



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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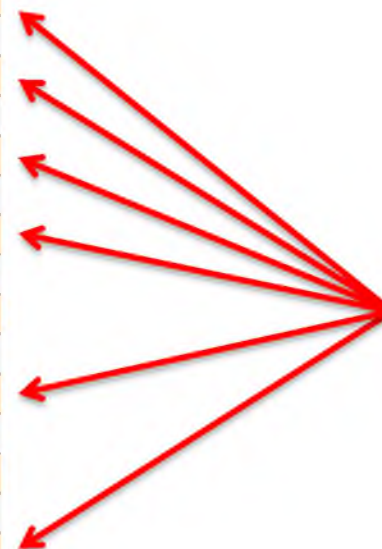
Parameter

	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
	708.42	0.00
PP&E Liquidation Value	50%	-2253%
	708.42	0.00
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Tax Rate	25.45%	88%
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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



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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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

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

Data Table

Row input cell:

Column input cell:

Cancel 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?

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

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	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:

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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%

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

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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NPV will increase from 708.42 to something greater than 776.88

Marketing is concerned about the uncertainty surrounding the market for tablets

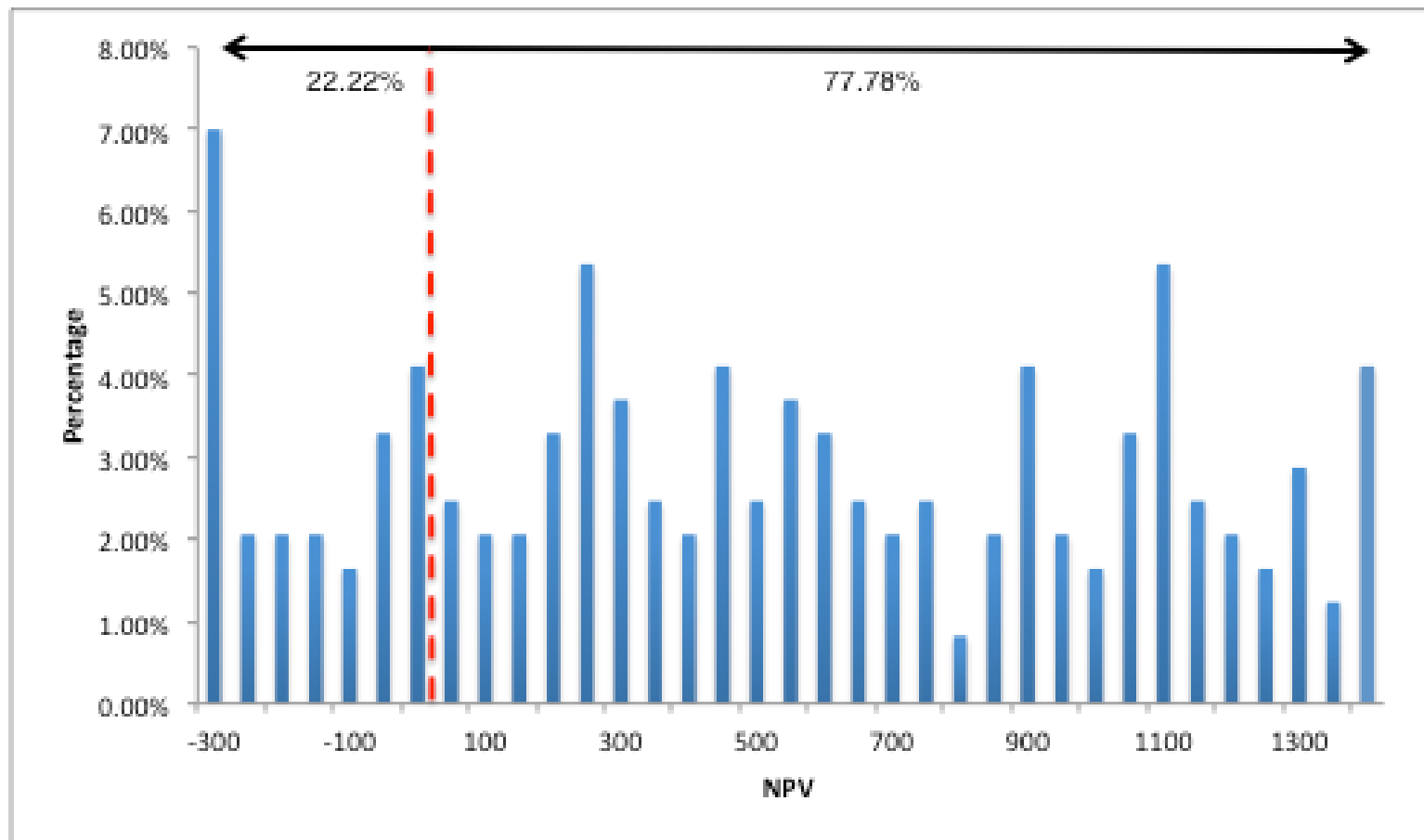
Marketing is concerned about the uncertainty surrounding the market for tablets

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

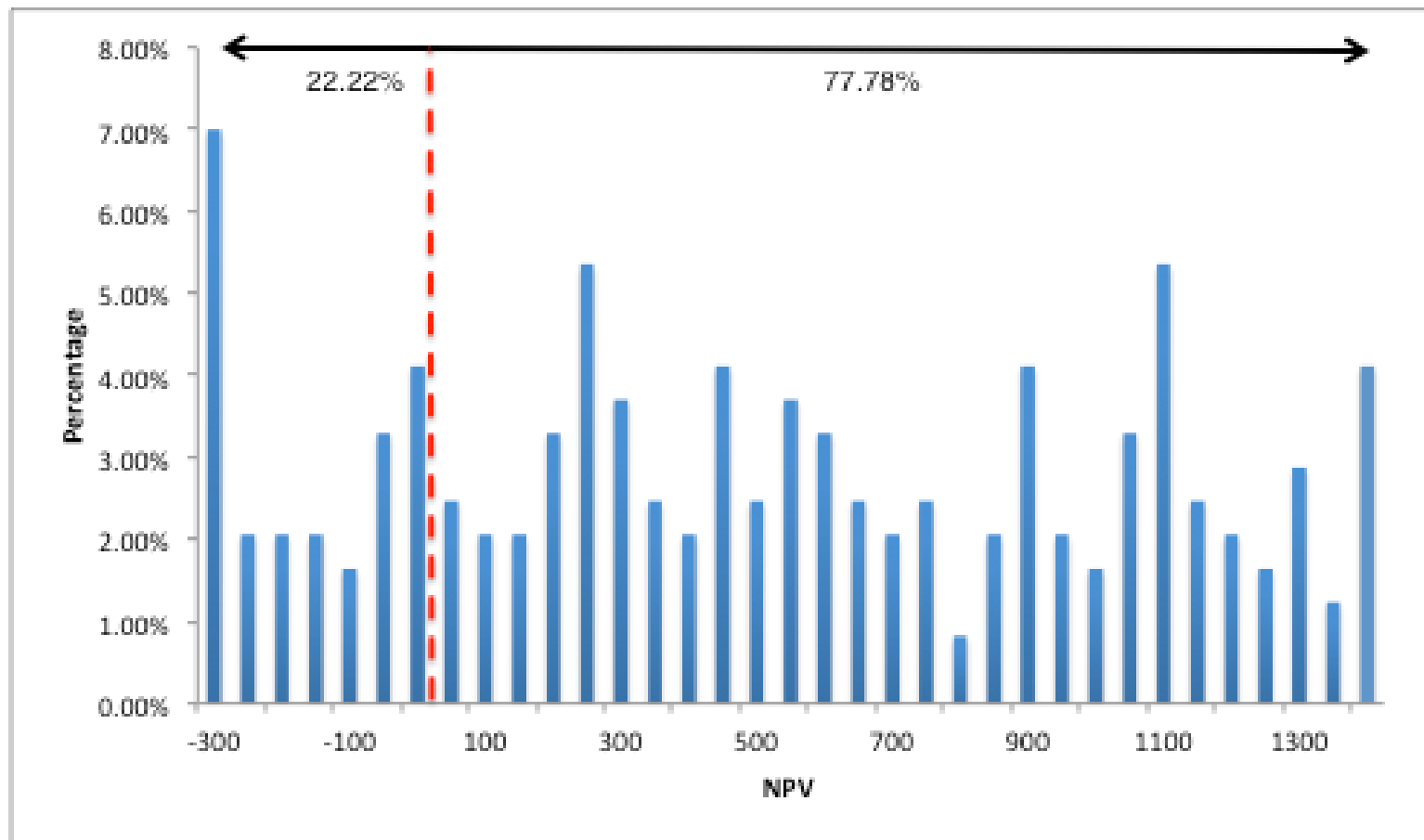
Simulation Analysis performs the valuation for a large number of simulated parameter values (i.e., scenarios)



500 simulated scenarios.

Parameters drawn independently of one another.

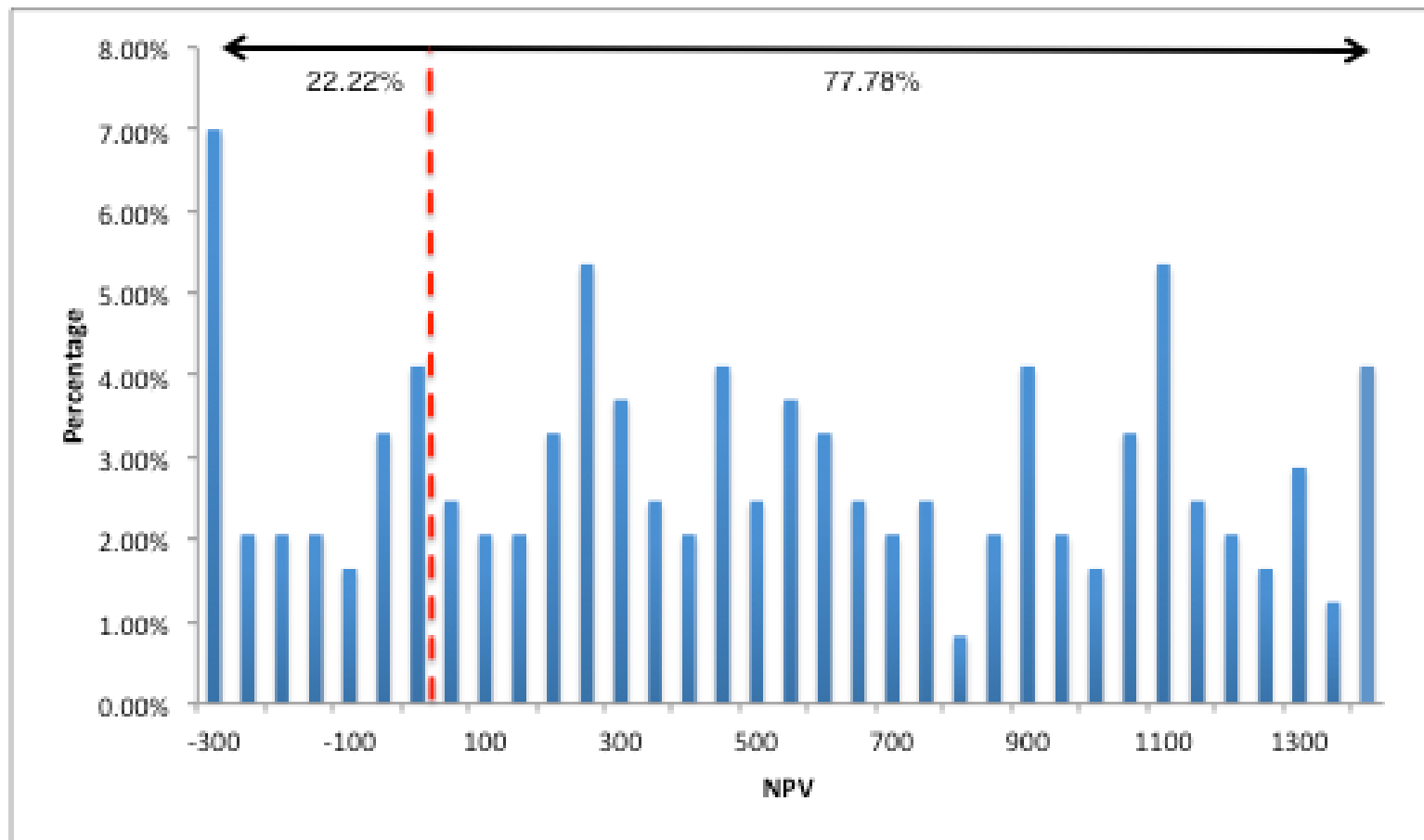
Parameters bounded by Best and Worst case scenario.



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