Uncertainty in Project Analysis: What can we do?

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Based on our expected cash flows and the estimated cost of capital, the proposed theme park looks like a very good investment for Disney. Which of the following may affect your assessment of value?
Revenues may be over estimated (crowds may be smaller and spend less)
Actual costs may be higher than estimated costs
Tax rates may go up
Interest rates may rise
Risk premiums and default spreads may increase
All of the above
How would you respond to this uncertainty?
Will wait for the uncertainty to be resolved
Will not take the investment
Ask someone else (consultant, boss, colleague) to make the decision
Ignore it.
Other

One simplistic solution: See how quickly you can get your money back...

 If your biggest fear is losing the billions that you invested in the project, one simple measure that you can compute is the number of years it will take you to get your money back.

	Year	Cash Flow	Cumulated CF	PV of Cash Flow	Cumulated DCF	
	0	-\$2,000	-\$2,000	-\$2,000	-\$2,000	
	1	-\$1,000	-\$3,000	-\$922	-\$2,922	
	2	-\$859	-\$3,859	-\$730	-\$3,652	
	3	-\$267	-\$4,126	-\$210	-\$3,862	
	4	\$340	-\$3,786	\$246	-\$3,616	
	5	\$466	-\$3,320	\$311	-\$3,305	
	6	\$516	-\$2,803	\$317	-\$2,988	
	7	\$555	-\$2,248	\$314	-\$2,674	
	8	\$615	-\$1,633	\$321	-\$2,353	
Payback = 10.3 years = 10.3 years = 10.3 years = 10.3 years	9	\$681	-\$952	\$328	-\$2,025	
ayback = 10.5 years	10	\$715	-\$237	\$317	-\$1,708	
	11	\$729	\$491	\$298	-\$1,409	
	12	\$743	\$1,235	\$280	-\$1,129	
	13	\$758	\$1,993	\$264	-\$865	
	14	\$773	\$2,766	\$248	-\$617	Discounted Payback
	15	\$789	\$3,555	\$233	-\$384	= 16.8 years
	16	\$805	\$4,360	\$219	-\$165	J
Aswath Damodaran	17	\$821	\$5,181	\$206	\$41	254

A slightly more sophisticated approach: Sensitivity Analysis & What-if Questions...

- The NPV, IRR and accounting returns for an investment will change as we change the values that we use for different variables.
- One way of analyzing uncertainty is to check to see how sensitive the decision measure (NPV, IRR..) is to changes in key assumptions. While this has become easier and easier to do over time, there are caveats that we would offer.
- <u>Caveat 1</u>: When analyzing the effects of changing a variable, we often hold all else constant. In the real world, variables move together.
- <u>Caveat 2</u>: The objective in sensitivity analysis is that we make better decisions, not churn out more tables and numbers.
 - Corollary 1: Less is more. Not everything is worth varying...
 - Corollary 2: A picture is worth a thousand numbers (and tables).

And here is a really good picture...



The final step up: Incorporate probabilistic estimates.. Rather than expected values..

Actual Revenues as % of Forecasted Revenues (Base case = 100%)



Operating Expenses at Parks as % of Revenues (Base Case = 60%)



Country Risk Premium (Base Case = 3% (Brazil))



The resulting simulation...

Average = \$3.40 billion Median = \$3.28 billion



NPV ranges from -\$1 billion to +\$8.5 billion. NPV is negative 12% of the time.

You are the decision maker...

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- Assume that you are the person at Disney who is given the results of the simulation. The average and median NPV are close to your base case values of \$3.29 billion. However, there is a 10% probability that the project could have a negative NPV and that the NPV could be a large negative value? How would you use this information?
 - I would accept the investment and print the results of this simulation and file them away to show that I exercised due diligence.
 - I would reject the investment, because it is too risky (there is a 10% chance that it could be a bad project)
 - Other

Equity Analysis: The Parallels

- The investment analysis can be done entirely in equity terms, as well. The returns, cashflows and hurdle rates will all be defined from the perspective of equity investors.
- If using accounting returns,
 - Return will be Return on Equity (ROE) = Net Income/BV of Equity
 - ROE has to be greater than cost of equity
- □ If using discounted cashflow models,
 - Cashflows will be cashflows after debt payments to equity investors
 - Hurdle rate will be cost of equity

A Vale Iron Ore Mine in Canada Investment Operating Assumptions

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- 1. The mine will require an initial investment of \$1.25 billion and is expected to have a production capacity of 8 million tons of iron ore, once established. The initial investment of \$1.25 billion will be depreciated over ten years, using double declining balance depreciation, down to a salvage value of \$250 million at the end of ten years.
- 2. The mine will start production midway through the next year, producing 4 million tons of iron ore for year 1, with production increasing to 6 million tons in year 2 and leveling off at 8 million tons thereafter (until year 10). The price, in US dollars per ton of iron ore is currently \$100 and is expected to keep pace with inflation for the life of the plant.
- The variable cost of production, including labor, material and operating expenses, is expected to be \$45/ton of iron ore produced and there is a fixed cost of \$125 million in year 1. Both costs, which will grow at the inflation rate of 2% thereafter. The costs will be in Canadian dollars, but the expected values are converted into US dollars, assuming that the current parity between the currencies (1 Canadian \$ = 1 US dollar) will continue, since interest and inflation rates are similar in the two currencies.
- 4. The working capital requirements are estimated to be 20% of total revenues, and the investments have to be made at the beginning of each year. At the end of the tenth year, it is anticipated that the entire working capital will be salvaged.
- 5. Vale's corporate tax rate of 34% will apply to this project as well.

Financing Assumptions

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Vale plans to borrow \$0.5 billion at its current cost of debt of 4.05% (based upon its rating of A-), using a ten-year term loan (where the loan will be paid off in equal annual increments). The breakdown of the payments each year into interest and principal are provided below:

Year	Beginning Debt	Interest expense	Principal Repaid	Total Payment	Ending Debt
1	\$500.00	\$20.25	\$41.55	\$61.80	\$458.45
2	\$458.45	\$18.57	\$43.23	\$61.80	\$415.22
3	\$415.22	\$16.82	\$44.98	\$61.80	\$370.24
4	\$370.24	\$14.99	\$46.80	\$61.80	\$323.43
5	\$323.43	\$13.10	\$48.70	\$61.80	\$274.73
6	\$274.73	\$11.13	\$50.67	\$61.80	\$224.06
7	\$224.06	\$9.07	\$52.72	\$61.80	\$171.34
8	\$171.34	\$6.94	\$54.86	\$61.80	\$116.48
9	\$116.48	\$4.72	\$57.08	\$61.80	\$59.39
10	\$59.39	\$2.41	\$59.39	\$61.80	\$0.00

The Hurdle Rate

- The analysis is done US dollar terms and to equity investors. Thus, the hurdle rate has to be a US \$ cost of equity.
- In the earlier section, we estimated costs of equity, debt and capital in US dollars and \$R for Vale's iron ore business.

	Cost of	After-tax cost of	Debt	Cost of capital (in	Cost of capital (in
Business	equity	debt	ratio	US\$)	\$R)
Metals &					
Mining	11.35%	2.67%	35.48%	8.27%	15.70%
Iron Ore	11.13%	2.67%	35.48%	8.13%	15.55%
Fertilizers	12.70%	2.67%	35.48%	9.14%	16.63%
Logistics	10.29%	2.67%	35.48%	7.59%	14.97%
Vale Operations	11.23%	2.67%	35.48%	8.20%	15.62%

Net Income: Vale Iron Ore Mine

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	1	2	3	4	5	6	7	8	9	10
Production (millions of tons)	4.00	6.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00
* Price per ton	102	104.04	106.12	108.24	110.41	112.62	114.87	117.17	119.51	121.9
= Revenues (millions US\$)	\$408.00	\$624.24	\$848.97	\$865.95	\$883.26	\$900.93	\$918.95	\$937.33	\$956.07	\$975.20
- Variable Costs	\$180.00	\$275.40	\$374.54	\$382.03	\$389.68	\$397.47	\$405.42	\$413.53	\$421.80	\$430.23
- Fixed Costs	\$125.00	\$127.50	\$130.05	\$132.65	\$135.30	\$138.01	\$140.77	\$143.59	\$146.46	\$149.39
- Depreciation	\$200.00	\$160.00	\$128.00	\$102.40	\$81.92	\$65.54	\$65.54	\$65.54	\$65.54	\$65.54
EBIT	-\$97.00	\$61.34	\$216.37	\$248.86	\$276.37	\$299.91	\$307.22	\$314.68	\$322.28	\$330.04
- Interest Expenses	\$20.25	\$18.57	\$16.82	\$14.99	\$13.10	\$11.13	\$9.07	\$6.94	\$4.72	\$2.41
Taxable Income	-\$117.25	\$42.77	\$199.56	\$233.87	\$263.27	\$288.79	\$298.15	\$307.74	\$317.57	\$327.63
- Taxes	(\$39.87)	\$14.54	\$67.85	\$79.51	\$89.51	\$98.19	\$101.37	\$104.63	\$107.97	\$111.40
= Net Income (millions US\$)	-\$77.39	\$28.23	\$131.71	\$154.35	\$173.76	\$190.60	\$196.78	\$203.11	\$209.59	\$216.24
			Book Valu	e and Depr	reciation					
Beg. Book Value	\$1,250.00	\$1,050.00	\$890.00	\$762.00	\$659.60	\$577.68	\$512.14	\$446.61	\$381.07	\$315.54
- Depreciation	\$200.00	\$160.00	\$128.00	\$102.40	\$81.92	\$65.54	\$65.54	\$65.54	\$65.54	\$65.54
+ Capital Exp.	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00
End Book Value	\$1,050.00	\$890.00	\$762.00	\$659.60	\$577.68	\$512.14	\$446.61	\$381.07	\$315.54	\$250.00
- Debt Outstanding	\$458.45	\$415.22	\$370.24	\$323.43	\$274.73	\$224.06	\$171.34	\$116.48	\$59.39	\$0.00
End Book Value of Equity	\$591.55	\$474.78	\$391.76	\$336.17	\$302.95	\$288.08	\$275.27	\$264.60	\$256.14	\$250.00

A ROE Analysis

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Year	Net Income	Beg. BV: Assets	Depreciation	Capital Expense	Ending BV: Assets	BV of Working Capital	Debt	BV: Equity	Average BV: Equity	ROE
0		\$0.00	\$0.00	\$1,250.00	\$1,250.00	\$81.60	\$500.00	\$831.60		
1	(\$77.39)	\$1,250.00	\$200.00	\$0.00	\$1,050.00	\$124.85	\$458.45	\$716.40	\$774.00	-10.00%
2	\$28.23	\$1,050.00	\$160.00	\$0.00	\$890.00	\$169.79	\$415.22	\$644.57	\$680.49	4.15%
3	\$131.71	\$890.00	\$128.00	\$0.00	\$762.00	\$173.19	\$370.24	\$564.95	\$604.76	21.78%
4	\$154.35	\$762.00	\$102.40	\$0.00	\$659.60	\$176.65	\$323.43	\$512.82	\$538.89	28.64%
5	\$173.76	\$659.60	\$81.92	\$0.00	\$577.68	\$180.19	\$274.73	\$483.13	\$497.98	34.89%
6	\$190.60	\$577.68	\$65.54	\$0.00	\$512.14	\$183.79	\$224.06	\$471.87	\$477.50	39.92%
7	\$196.78	\$512.14	\$65.54	\$0.00	\$446.61	\$187.47	\$171.34	\$462.74	\$467.31	42.11%
8	\$203.11	\$446.61	\$65.54	\$0.00	\$381.07	\$191.21	\$116.48	\$455.81	\$459.27	44.22%
9	\$209.59	\$381.07	\$65.54	\$0.00	\$315.54	\$195.04	\$59.39	\$451.18	\$453.50	46.22%
10	\$216.24	\$315.54	\$65.54	\$0.00	\$250.00	\$0.00	\$0.00	\$250.00	\$350.59	61.68%
	Average ROE over the ten-year period = 3								31.36%	

US \$ ROE of 31.36% is greater than

Vale Iron Ore US\$ Cost of Equity of 11.13%

From Project ROE to Firm ROE

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- As with the earlier analysis, where we used return on capital and cost of capital to measure the overall quality of projects at firms, we can compute return on equity and cost of equity to pass judgment on whether firms are creating value to its equity investors.
- Specifically, we can compute the return on equity (net income as a percentage of book equity) and compare to the cost of equity. The return spread is then:
 - Equity Return Spread = Return on Equity Cost of equity
- This measure is particularly useful for financial service firms, where capital, return on capital and cost of capital are difficult measures to nail down.
- For non-financial service firms, it provides a secondary (albeit a more volatile measure of performance). While it usually provides the same general result that the excess return computed from return on capital, there can be cases where the two measures diverge.

An Incremental CF Analysis

	0	1	2	3	4	5	6	7	8	9	10
Net Income		(\$77.39)	\$28.23	\$131.71	\$154.35	\$173.76	\$190.60	\$196.78	\$203.11	\$209.59	\$216.24
+ Depreciation & Amortization		\$200.00	\$160.00	\$128.00	\$102.40	\$81.92	\$65.54	\$65.54	\$65.54	\$65.54	\$65.54
- Capital Expenditures	\$750.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00
- Change in Working Capital	\$81.60	\$43.25	\$44.95	\$3.40	\$3.46	\$3.53	\$3.60	\$3.68	\$3.75	\$3.82	(\$195.04)
- Principal Repayments		\$41.55	\$43.23	\$44.98	\$46.80	\$48.70	\$50.67	\$52.72	\$54.86	\$57.08	\$59.39
+ Salvage Value of mine											\$250.00
Cashflow to Equity	(\$831.60)	\$37.82	\$100.05	\$211.33	\$206.48	\$203.44	\$201.86	\$205.91	\$210.04	\$214.22	\$667.42

An Equity NPV

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Discounted at US\$ cost of equity of 11.13% for Vale's iron ore business

Year	Cash flow to equity	PV @11.13%
0	-\$831.60	-\$831.60
1	\$37.82	\$34.03
2	\$100.05	\$81.02
3	\$211.33	\$153.99
4	\$206.48	\$135.40
5	\$203.44	\$120.04
6	\$201.86	\$107.18
7	\$205.91	\$98.39
8	\$210.04	\$90.31
9	\$214.22	\$82.89
10	\$667.42	\$232.38
NPV		\$304.04

An Equity IRR

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Figure 5.6: NPV Profile on Equity Investment in Paper Plant: Aracruz

Aswath Damodaran

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Real versus Nominal Analysis

In computing the NPV of the plant, we estimated US \$ cash flows and discounted them at the US \$ cost of equity. We could have estimated the cash flows in real terms (with no inflation) and discounted them at a real cost of equity. Would the answer be different?

□Yes

□No

□Explain

Dealing with Macro Uncertainty: The Effect of Iron Ore Price

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- Like the Disney Theme Park, the Vale Iron Ore Mine's actual value will be buffeted as the variables change. The biggest source of variability is an external factor –the price of iron ore.



Vale Paper Plant: Effect of Changing Iron Ore Prices

And Exchange Rates...

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Exchange Rate effects on Iron Ore Plant

Canadian \$ versus US \$

Should you hedge?

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- The value of this mine is very much a function iron ore prices. There are futures, forward and option markets iron ore that Vale can use to hedge against price movements. Should it?
 - Yes
 - No
- Explain.
- The value of the mine is also a function of exchange rates. There are forward, futures and options markets on currency. Should Vale hedge against exchange rate risk?
 - Yes
 - No
- Explain.
- On the last question, would your answer have been different if the mine were in Brazil.
 - Yes
 - No

