

Packet 3: Real Options, Acquisition Valuation and Value Enhancement

Equity Instruments and Markets

Aswath Damodaran

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Real Options: Fact and Fantasy

Aswath Damodaran

Underlying Theme: Searching for an Elusive Premium

- Traditional discounted cashflow models under estimate the value of investments, where there are options embedded in the investments to
 - Delay or defer making the investment (delay)
 - Adjust or alter production schedules as price changes (flexibility)
 - Expand into new markets or products at later stages in the process, based upon observing favorable outcomes at the early stages (expansion)
 - Stop production or abandon investments if the outcomes are unfavorable at early stages (abandonment)
- Put another way, real option advocates believe that you should be paying a premium on discounted cashflow value estimates.

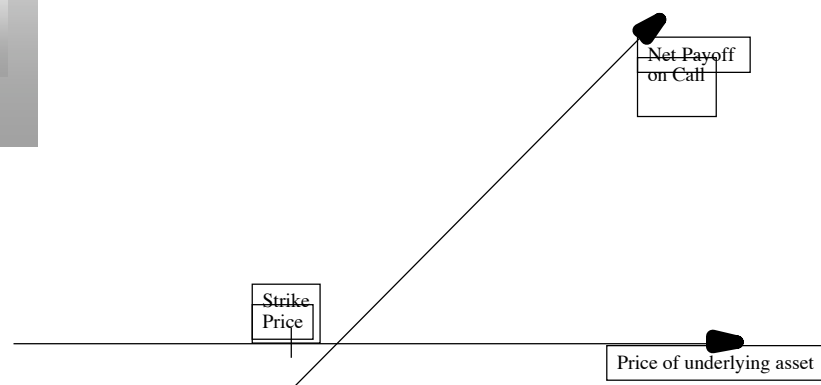
Three Basic Questions

- When is there a real option embedded in a decision or an asset?
- When does that real option have significant economic value?
- Can that value be estimated using an option pricing model?

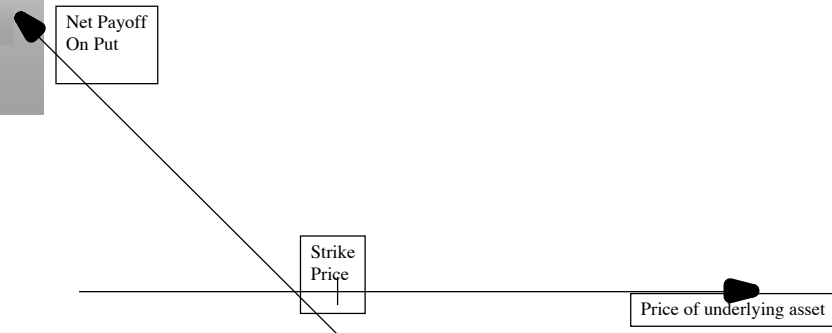
When is there an option embedded in an action?

- An option provides the holder with the **right** to buy or sell a specified quantity of an underlying asset at a fixed price (called a strike price or an exercise price) at or before the expiration date of the option.
- There has to be a clearly defined underlying asset whose value changes over time in unpredictable ways.
- The payoffs on this asset (real option) have to be contingent on an specified event occurring within a finite period.

Payoff Diagram on a Call



Payoff Diagram on Put Option



When does the option have significant economic value?

- For an option to have significant economic value, there has to be a restriction on competition in the event of the contingency. In a perfectly competitive product market, no contingency, no matter how positive, will generate positive net present value.
- At the limit, real options are most valuable when you have exclusivity - you and only you can take advantage of the contingency. They become less valuable as the barriers to competition become less steep.

Determinants of option value

- Variables Relating to Underlying Asset
 - Value of Underlying Asset: as this value increases, the right to buy at a fixed price (calls) will become more valuable and the right to sell at a fixed price (puts) will become less valuable.
 - Variance in that value: as the variance increases, both calls and puts will become more valuable because all options have limited downside and depend upon price volatility for upside.
 - Expected dividends on the asset, which are likely to reduce the price appreciation component of the asset, reducing the value of calls and increasing the value of puts.
- Variables Relating to Option
 - Strike Price of Options: the right to buy (sell) at a fixed price becomes more (less) valuable at a lower price.
 - Life of the Option: both calls and puts benefit from a longer life.
- Level of Interest Rates; as rates increase, the right to buy (sell) at a fixed price in the future becomes more (less) valuable.

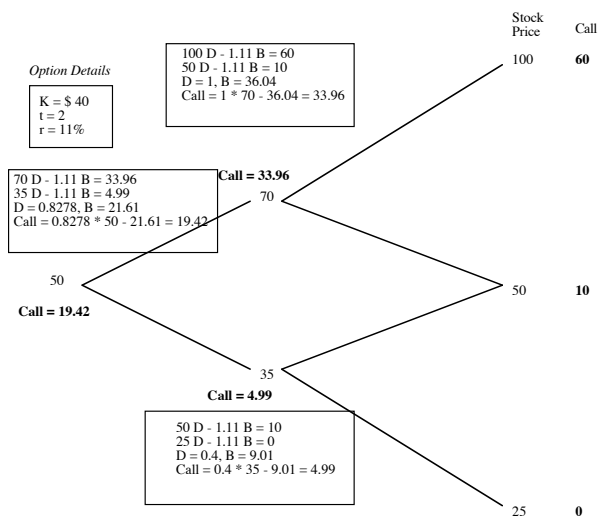
When can you use option pricing models to value real options?

- The notion of a replicating portfolio that drives option pricing models makes them most suited for valuing real options where
 - The underlying asset is traded - this yields not only observable prices and volatility as inputs to option pricing models but allows for the possibility of creating replicating portfolios
 - An active marketplace exists for the option itself.
 - The cost of exercising the option is known with some degree of certainty.
- When option pricing models are used to value real assets, we have to accept the fact that
 - The value estimates that emerge will be far more imprecise.
 - The value can deviate much more dramatically from market price because of the difficulty of arbitrage.

Creating a replicating portfolio

- The objective in creating a replicating portfolio is to use a combination of riskfree borrowing/lending and the underlying asset to create the same cashflows as the option being valued.
 - Call = Borrowing + Buying Δ of the Underlying Stock
 - Put = Selling Short Δ on Underlying Asset + Lending
 - The number of shares bought or sold is called the **option delta**.
- The principles of arbitrage then apply, and the value of the option has to be equal to the value of the replicating portfolio.

The Binomial Option Pricing Model



The Limiting Distributions....

- As the time interval is shortened, the limiting distribution, as $t \rightarrow 0$, can take one of two forms.
 - If as $t \rightarrow 0$, **price changes become smaller**, the limiting distribution is the normal distribution and the **price process is a continuous one**.
 - If as $t \rightarrow 0$, **price changes remain large**, the limiting distribution is the poisson distribution, i.e., a **distribution that allows for price jumps**.
- **The Black-Scholes model** applies when the **limiting distribution is the normal distribution**, and explicitly assumes that the price process is continuous and that there are no jumps in asset prices.

The Black-Scholes Model

- The version of the model presented by Black and Scholes was designed to value European options, which were dividend-protected.
- The value of a call option in the Black-Scholes model can be written as a function of the following variables:
 - S = Current value of the underlying asset
 - K = Strike price of the option
 - t = Life to expiration of the option
 - r = Riskless interest rate corresponding to the life of the option
 - σ^2 = Variance in the $\ln(\text{value})$ of the underlying asset

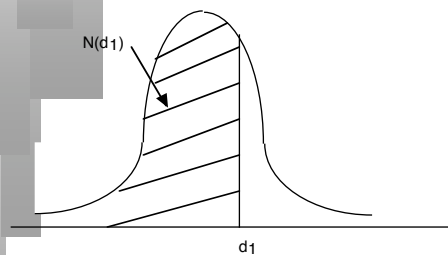
The Black Scholes Model

Value of call = $S N(d_1) - K e^{-rt} N(d_2)$
 where,

$$d_1 = \frac{\ln\left(\frac{S}{K}\right) + \left(r + \frac{\sigma^2}{2}\right)t}{\sigma \sqrt{t}}$$

- $d_2 = d_1 - \sigma \sqrt{t}$
- The replicating portfolio is embedded in the Black-Scholes model. To replicate this call, you would need to
 - Buy $N(d_1)$ shares of stock; $N(d_1)$ is called the option delta
 - Borrow $K e^{-rt} N(d_2)$

The Normal Distribution



d	N(d)	d	N(d)	d	N(d)
-3.00	0.0013	-1.00	0.1587	1.05	0.8531
-2.95	0.0016	-0.95	0.1711	1.10	0.8643
-2.90	0.0019	-0.90	0.1841	1.15	0.8749
-2.85	0.0022	-0.85	0.1977	1.20	0.8849
-2.80	0.0026	-0.80	0.2119	1.25	0.8944
-2.75	0.0030	-0.75	0.2266	1.30	0.9032
-2.70	0.0035	-0.70	0.2420	1.35	0.9115
-2.65	0.0040	-0.65	0.2578	1.40	0.9192
-2.60	0.0047	-0.60	0.2743	1.45	0.9265
-2.55	0.0054	-0.55	0.2912	1.50	0.9332
-2.50	0.0062	-0.50	0.3085	1.55	0.9394
-2.45	0.0071	-0.45	0.3264	1.60	0.9452
-2.40	0.0082	-0.40	0.3446	1.65	0.9505
-2.35	0.0094	-0.35	0.3632	1.70	0.9554
-2.30	0.0107	-0.30	0.3821	1.75	0.9599
-2.25	0.0122	-0.25	0.4013	1.80	0.9641
-2.20	0.0139	-0.20	0.4207	1.85	0.9678
-2.15	0.0158	-0.15	0.4404	1.90	0.9713
-2.10	0.0179	-0.10	0.4602	1.95	0.9744
-2.05	0.0202	-0.05	0.4801	2.00	0.9772
-2.00	0.0228	0.00	0.5000	2.05	0.9798
-1.95	0.0256	0.05	0.5199	2.10	0.9821
-1.90	0.0287	0.10	0.5398	2.15	0.9842
-1.85	0.0322	0.15	0.5596	2.20	0.9861
-1.80	0.0359	0.20	0.5793	2.25	0.9878
-1.75	0.0401	0.25	0.5987	2.30	0.9893
-1.70	0.0446	0.30	0.6179	2.35	0.9906
-1.65	0.0495	0.35	0.6368	2.40	0.9918
-1.60	0.0548	0.40	0.6554	2.45	0.9929
-1.55	0.0606	0.45	0.6736	2.50	0.9938
-1.50	0.0668	0.50	0.6915	2.55	0.9946
-1.45	0.0735	0.55	0.7089	2.60	0.9953
-1.40	0.0808	0.60	0.7257	2.65	0.9960
-1.35	0.0885	0.65	0.7422	2.70	0.9965
-1.30	0.0968	0.70	0.7580	2.75	0.9970
-1.25	0.1056	0.75	0.7734	2.80	0.9974
-1.20	0.1151	0.80	0.7881	2.85	0.9978
-1.15	0.1251	0.85	0.8023	2.90	0.9981
-1.10	0.1357	0.90	0.8159	2.95	0.9984
-1.05	0.1469	0.95	0.8289	3.00	0.9987
-1.00	0.1587	1.00	0.8413		

Adjusting for Dividends

- If the dividend yield ($y = \text{dividends} / \text{Current value of the asset}$) of the underlying asset is expected to remain unchanged during the life of the option, the Black-Scholes model can be modified to take dividends into account.

$$C = S e^{-yt} N(d_1) - K e^{-rt} N(d_2)$$

$$\text{where, } d_1 = \frac{\ln\left(\frac{S}{K}\right) + (r - y + \frac{\sigma^2}{2}) t}{\sigma \sqrt{t}}$$

$$d_2 = d_1 - \sigma \sqrt{t}$$

- The value of a put can also be derived:

$$P = K e^{-rt} (1 - N(d_2)) - S e^{-yt} (1 - N(d_1))$$

Choice of Option Pricing Models

- Most practitioners who use option pricing models to value real options argue for the binomial model over the Black-Scholes and justify this choice by noting that
 - Early exercise is the rule rather than the exception with real options
 - Underlying asset values are generally discontinuous.
- If you can develop a binomial tree with outcomes at each node, it looks a great deal like a decision tree from capital budgeting. The question then becomes when and why the two approaches yield different estimates of value.

The Decision Tree Alternative

- Traditional decision tree analysis tends to use
 - One cost of capital to discount cashflows in each branch to the present
 - Probabilities to compute an expected value
 - **These values will generally be different from option pricing model values**
- If you modified decision tree analysis to
 - Use different discount rates at each node to reflect where you are in the decision tree (This is the Copeland solution) (or)
 - Use the riskfree rate to discount cashflows in each branch, estimate the probabilities to estimate an expected value and adjust the expected value for the market risk in the investment

Decision Trees could yield the same values as option pricing models

Key Tests for Real Options

- Is there an option embedded in this asset/ decision?
 - Can you identify the underlying asset?
 - Can you specify the contingency under which you will get payoff?
- Is there exclusivity?
 - If yes, there is option value.
 - If no, there is none.
 - If in between, you have to scale value.
- Can you use an option pricing model to value the real option?
 - Is the underlying asset traded?
 - Can the option be bought and sold?
 - Is the cost of exercising the option known and clear?

Option Pricing Applications in Investment/Strategic Analysis

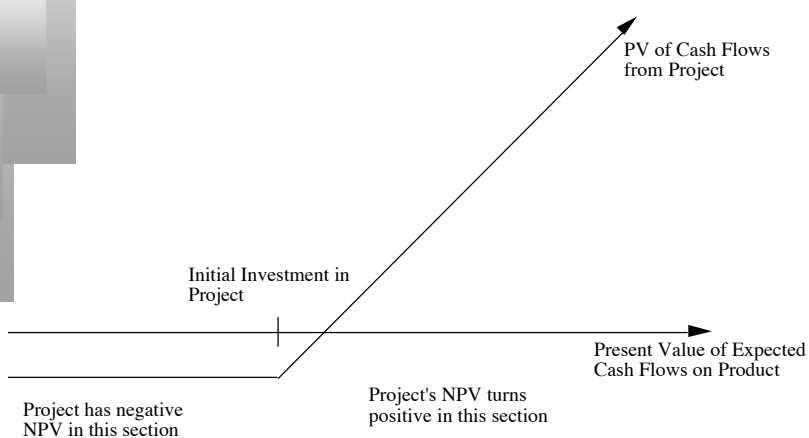
Options in Projects/Investments/Acquisitions

- One of the limitations of traditional investment analysis is that it is static and does not do a good job of capturing the options embedded in investment.
 - The first of these options is the option to delay taking a investment, when a firm has exclusive rights to it, until a later date.
 - The second of these options is taking one investment may allow us to take advantage of other opportunities (investments) in the future
 - The last option that is embedded in projects is the option to abandon a investment, if the cash flows do not measure up.
- These options all add value to projects and may make a “bad” investment (from traditional analysis) into a good one.

The Option to Delay

- When a firm has exclusive rights to a project or product for a specific period, it can delay taking this project or product until a later date.
- A traditional investment analysis just answers the question of whether the project is a “good” one if taken today.
- Thus, the fact that a project does not pass muster today (because its NPV is negative, or its IRR is less than its hurdle rate) does not mean that the rights to this project are not valuable.

Valuing the Option to Delay a Project



Insights for Investment Analyses

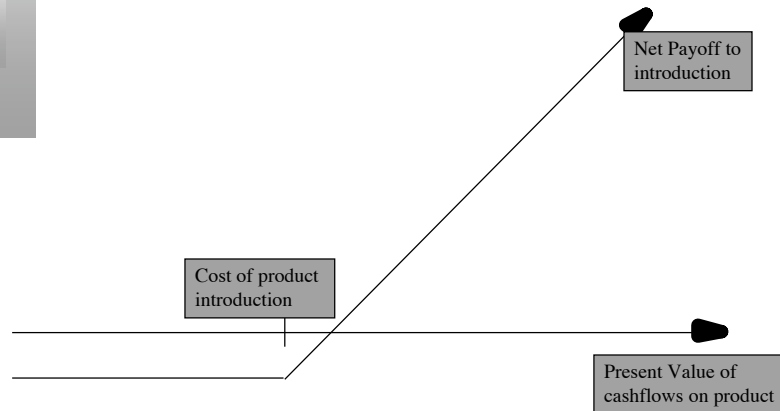
- Having the exclusive rights to a product or project is valuable, even if the product or project is not viable today.
- The value of these rights increases with the volatility of the underlying business.
- The cost of acquiring these rights (by buying them or spending money on development, for instance) has to be weighed off against these benefits.

Example 1: Valuing product patents as options

- A product patent provides the firm with the right to develop the product and market it.
- It will do so only if the present value of the expected cash flows from the product sales exceed the cost of development.
- If this does not occur, the firm can shelve the patent and not incur any further costs.
- If I is the present value of the costs of developing the product, and V is the present value of the expected cashflows from development, the payoffs from owning a product patent can be written as:

$$\begin{array}{lll} \text{Payoff from owning a product patent} & = V - I & \text{if } V > I \\ & = 0 & \text{if } V \leq I \end{array}$$

Payoff on Product Option



Obtaining Inputs for Patent Valuation

Input	Estimation Process
1. Value of the Underlying Asset	- Present Value of Cash Inflows from taking project now - This will be noisy, but that adds value.
2. Variance in value of underlying asset	- Variance in cash flows of similar assets or firms - Variance in present value from capital budgeting simulation.
3. Exercise Price on Option	- Option is exercised when investment is made. - Cost of making investment on the project ; assumed to be constant in present value dollars.
4. Expiration of the Option	Life of the patent
5. Dividend Yield	- Cost of delay - Each year of delay translates into one less year of value-creating cashflows $\text{Annual cost of delay} = \frac{1}{n}$

Valuing a Product Patent: Avonex

- Biogen, a bio-technology firm, has a patent on Avonex, a drug to treat multiple sclerosis, for the next 17 years, and it plans to produce and sell the drug by itself. The key inputs on the drug are as follows:

PV of Cash Flows from Introducing the Drug Now = $S = \$3.422$ billion

PV of Cost of Developing Drug for Commercial Use = $K = \$2.875$ billion

Patent Life = $t = 17$ years Riskless Rate = $r = 6.7\%$ (17-year T.Bond rate)

Variance in Expected Present Values = $\sigma^2 = 0.224$ (Industry average firm variance for bio-tech firms)

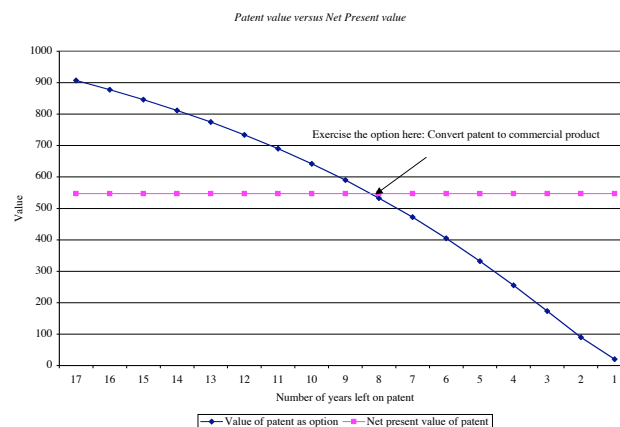
Expected Cost of Delay = $y = 1/17 = 5.89\%$

$d1 = 1.1362$ $N(d1) = 0.8720$

$d2 = -0.8512$ $N(d2) = 0.2076$

Call Value = $3,422 \exp^{(-0.0589)(17)} (0.8720) - 2,875 (\exp^{(-0.067)(17)} (0.2076)) = \$907$ million

The Optimal Time to Exercise



Valuing a firm with patents

- The value of a firm with a substantial number of patents can be derived using the option pricing model.

Value of Firm = Value of commercial products (using DCF value
+ Value of existing patents (using option pricing)
+ (Value of New patents that will be obtained in the future – Cost of obtaining these patents)

- The last input measures the efficiency of the firm in converting its R&D into commercial products. If we assume that a firm earns its cost of capital from research, this term will become zero.
- If we use this approach, we should be careful not to double count and allow for a high growth rate in cash flows (in the DCF valuation).

Value of Biogen's existing products

- Biogen had two commercial products (a drug to treat Hepatitis B and Intron) at the time of this valuation that it had licensed to other pharmaceutical firms.
- The license fees on these products were expected to generate \$ 50 million in after-tax cash flows each year for the next 12 years. To value these cash flows, which were guaranteed contractually, the pre-tax cost of debt of the guarantors was used:

$$\begin{aligned}\text{Present Value of License Fees} &= \$ 50 \text{ million } (1 - (1.07)^{-12}) / .07 \\ &= \$ 397.13 \text{ million}\end{aligned}$$

Value of Biogen's Future R&D

- Biogen continued to fund research into new products, spending about \$ 100 million on R&D in the most recent year. These R&D expenses were expected to grow 20% a year for the next 10 years, and 5% thereafter.
- It was assumed that every dollar invested in research would create \$ 1.25 in value in patents (valued using the option pricing model described above) for the next 10 years, and break even after that (i.e., generate \$ 1 in patent value for every \$ 1 invested in R&D).
- There was a significant amount of risk associated with this component and the cost of capital was estimated to be 15%.

Value of Future R&D

<i>Yr</i>	<i>Value of Patents</i>	<i>R&D Cost</i>	<i>Excess Value</i>	<i>Present Value (at 15%)</i>
1	\$ 150.00	\$ 120.00	\$ 30.00	\$ 26.09
2	\$ 180.00	\$ 144.00	\$ 36.00	\$ 27.22
3	\$ 216.00	\$ 172.80	\$ 43.20	\$ 28.40
4	\$ 259.20	\$ 207.36	\$ 51.84	\$ 29.64
5	\$ 311.04	\$ 248.83	\$ 62.21	\$ 30.93
6	\$ 373.25	\$ 298.60	\$ 74.65	\$ 32.27
7	\$ 447.90	\$ 358.32	\$ 89.58	\$ 33.68
8	\$ 537.48	\$ 429.98	\$ 107.50	\$ 35.14
9	\$ 644.97	\$ 515.98	\$ 128.99	\$ 36.67
10	\$ 773.97	\$ 619.17	\$ 154.79	\$ 38.26
				\$ 318.30

Value of Biogen

- The value of Biogen as a firm is the sum of all three components – the present value of cash flows from existing products, the value of Avonex (as an option) and the value created by new research:

$$\begin{aligned}\text{Value} &= \text{Existing products} + \text{Existing Patents} + \text{Value: Future R\&D} \\ &= \$ 397.13 \text{ million} + \$ 907 \text{ million} + \$ 318.30 \text{ million} \\ &= \$1622.43 \text{ million}\end{aligned}$$

- Since Biogen had no debt outstanding, this value was divided by the number of shares outstanding (35.50 million) to arrive at a value per share:

$$\text{Value per share} = \$ 1,622.43 \text{ million} / 35.5 = \$ 45.70$$

The Real Options Test: Patents and Technology

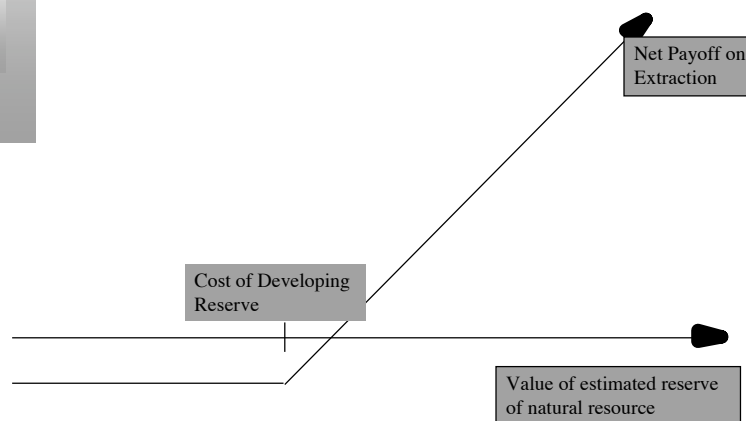
- The Option Test:
 - Underlying Asset: Product that would be generated by the patent
 - Contingency:
 - If PV of CFs from development > Cost of development: PV - Cost
 - If PV of CFs from development < Cost of development: 0
- The Exclusivity Test:
 - Patents restrict competitors from developing similar products
 - Patents do not restrict competitors from developing other products to treat the same disease.
- The Pricing Test
 - Underlying Asset: Patents are not traded. Not only do you therefore have to estimate the present values and volatilities yourself, you cannot construct replicating positions or do arbitrage.
 - Option: Patents are bought and sold, though not as frequently as oil reserves or mines.
 - Cost of Exercising the Option: This is the cost of converting the patent for commercial production. Here, experience does help and drug firms can make fairly precise estimates of the cost.
- Conclusion: You can estimate the value of the real option but the quality of your estimate will be a direct function of the quality of your capital budgeting. It works best if you are valuing a publicly traded firm that generates most of its value from one or a few patents - you can use the market value of the firm and the variance in that value then in your option pricing model.

Example 2: Valuing Natural Resource Options

- In a natural resource investment, the underlying asset is the resource and the value of the asset is based upon two variables - the quantity of the resource that is available in the investment and the price of the resource.
- In most such investments, there is a cost associated with developing the resource, and the difference between the value of the asset extracted and the cost of the development is the profit to the owner of the resource.
- Defining the cost of development as X , and the estimated value of the resource as V , the potential payoffs on a natural resource option can be written as follows:

$$\begin{aligned}\text{Payoff on natural resource investment} &= V - X && \text{if } V > X \\ &= 0 && \text{if } V \leq X\end{aligned}$$

Payoff Diagram on Natural Resource Firms



Estimating Inputs for Natural Resource Options

Input	Estimation Process
1. Value of Available Reserves of the Resource	Expert estimates (Geologists for oil...); The present value of the after-tax cash flows from the resource are then estimated.
2. Cost of Developing Reserve (Strike Price)	Past costs and the specifics of the investment
3. Time to Expiration	- Relinquishment Period: if asset has to be relinquished at a point in time. - Time to exhaust inventory - based upon inventory and capacity output.
4. Variance in value of underlying asset	based upon variability of the price of the resources and variability of available reserves.
5. Net Production Revenue (Dividend Yield)	Net production revenue every year as percent of market value.
6. Development Lag	Calculate present value of reserve based upon the lag.

Valuing an Oil Reserve

- Consider an offshore oil property with an estimated oil reserve of 50 million barrels of oil, where the present value of the development cost is \$12 per barrel and the development lag is two years.
- The firm has the rights to exploit this reserve for the next twenty years and the marginal value per barrel of oil is \$12 per barrel currently (Price per barrel - marginal cost per barrel).
- Once developed, the net production revenue each year will be 5% of the value of the reserves.
- The riskless rate is 8% and the variance in $\ln(\text{oil prices})$ is 0.03.

Inputs to Option Pricing Model

- Current Value of the asset = S = Value of the developed reserve discounted back the length of the development lag at the dividend yield = $\$12 * 50 / (1.05)^2 = \$ 544.22$
- (If development is started today, the oil will not be available for sale until two years from now. The estimated opportunity cost of this delay is the lost production revenue over the delay period. Hence, the discounting of the reserve back at the dividend yield)
- Exercise Price = Present Value of development cost = $\$12 * 50 = \$600$ million
- Time to expiration on the option = 20 years
- Variance in the value of the underlying asset = 0.03
- Riskless rate = 8%
- Dividend Yield = Net production revenue / Value of reserve = 5%

Valuing the Option

- Based upon these inputs, the Black-Scholes model provides the following value for the call:
 $d1 = 1.0359$ $N(d1) = 0.8498$
 $d2 = 0.2613$ $N(d2) = 0.6030$
- Call Value = $544.22 \exp^{(-0.05)(20)} (0.8498) - 600 (\exp^{(-0.08)(20)} (0.6030)) = \$ 97.08$ million
- This oil reserve, though not viable at current prices, still is a valuable property because of its potential to create value if oil prices go up.

Extending the option pricing approach to value natural resource firms

- Since the assets owned by a natural resource firm can be viewed primarily as options, **the firm itself can be valued using option pricing** models.
- The preferred approach would be to **consider each option separately**, value it and cumulate the values of the options to get the firm value.
- Since this information is likely to be **difficult to obtain** for large natural resource firms, such as oil companies, which own hundreds of such assets, a variant is to value the entire firm as one option.
- A purist would probably disagree, arguing that **valuing an option on a portfolio of assets (as in this approach) will provide a lower value than valuing a portfolio of options** (which is what the natural resource firm really own). Nevertheless, the value obtained from the model still provides an interesting perspective on the determinants of the value of natural resource firms.

Inputs to the Model

<i>Input to model</i>	<i>Corresponding input for valuing firm</i>
Value of underlying asset	Value of cumulated estimated reserves of the resource owned by the firm, discounted back at the dividend yield for the development lag.
Exercise Price	Estimated cumulated cost of developing estimated reserves
Time to expiration on option	Average relinquishment period across all reserves owned by firm (if known) or estimate of when reserves will be exhausted, given current production rates.
Riskless rate	Riskless rate corresponding to life of the option
Variance in value of asset	Variance in the price of the natural resource
Dividend yield	Estimated annual net production revenue as percentage of value of the reserve.

Valuing Gulf Oil

- Gulf Oil was the target of a takeover in early 1984 at \$70 per share (It had 165.30 million shares outstanding, and total debt of \$9.9 billion).
 - It had estimated reserves of 3038 million barrels of oil and the average cost of developing these reserves was estimated to be \$10 a barrel in present value dollars (The development lag is approximately two years).
 - The average relinquishment life of the reserves is 12 years.
 - The price of oil was \$22.38 per barrel, and the production cost, taxes and royalties were estimated at \$7 per barrel.
 - The bond rate at the time of the analysis was 9.00%.
 - Gulf was expected to have net production revenues each year of approximately 5% of the value of the developed reserves. The variance in oil prices is 0.03.

Valuing Undeveloped Reserves

- Inputs for valuing undeveloped reserves
 - Value of underlying asset = Value of estimated reserves discounted back for period of development lag = $3038 * (\$22.38 - \$7) / 1.05^2 = \$42,380.44$
 - Exercise price = Estimated development cost of reserves = $3038 * \$10 = \$30,380$ million
 - Time to expiration = Average length of relinquishment option = **12 years**
 - Variance in value of asset = Variance in oil prices = **0.03**
 - Riskless interest rate = **9%**
 - Dividend yield = Net production revenue/ Value of developed reserves = **5%**
- Based upon these inputs, the Black-Scholes model provides the following value for the call:
 - $d1 = 1.6548$ $N(d1) = 0.9510$
 - $d2 = 1.0548$ $N(d2) = 0.8542$
- Call Value = $42,380.44 \exp^{(-0.05)(12)} (0.9510) - 30,380 (\exp^{(-0.09)(12)} (0.8542))$
 = **\$ 13,306 million**

Valuing Gulf Oil

- In addition, Gulf Oil had free cashflows to the firm from its oil and gas production of \$915 million from already developed reserves and these cashflows are likely to continue for ten years (the remaining lifetime of developed reserves).
- The present value of these developed reserves, discounted at the weighted average cost of capital of 12.5%, yields:
 - Value of already developed reserves = $915 (1 - 1.125^{-10}) / .125 = \$5065.83$
- Adding the value of the developed and undeveloped reserves

Value of undeveloped reserves	= \$ 13,306 million
Value of production in place	= \$ 5,066 million
Total value of firm	= \$ 18,372 million
Less Outstanding Debt	= \$ 9,900 million
Value of Equity	= \$ 8,472 million
Value per share	= \$ 8,472 / 165.3 = \$51.25

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Putting Natural Resource Options to the Test

- The Option Test:
 - Underlying Asset: Oil or gold in reserve
 - Contingency: If value > Cost of development: Value - Dev Cost
If value < Cost of development: 0
- The Exclusivity Test:
 - Natural resource reserves are limited (at least for the short term)
 - It takes time and resources to develop new reserves
- The Option Pricing Test
 - Underlying Asset: While the reserve or mine may not be traded, the commodity is. If we assume that we know the quantity with a fair degree of certainty, you can trade the underlying asset
 - Option: Oil companies buy and sell reserves from each other regularly.
 - Cost of Exercising the Option: This is the cost of developing a reserve. Given the experience that commodity companies have with this, they can estimate this cost with a fair degree of precision.
- Real option pricing models work well with natural resource options.

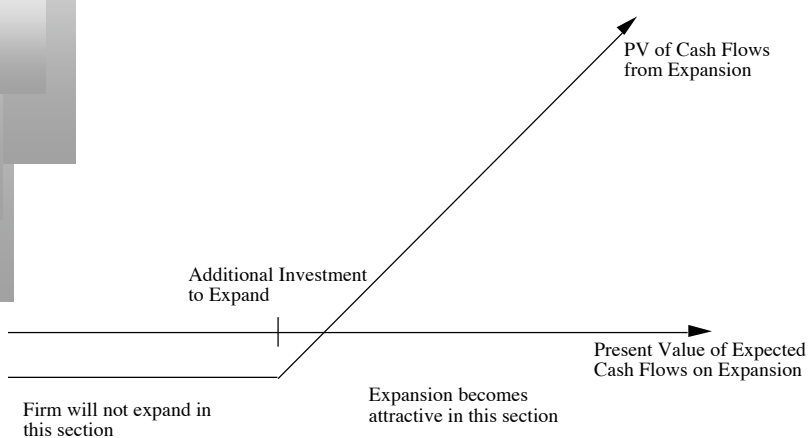
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The Option to Expand/Take Other Projects

- Taking a project today may allow a firm to consider and take other valuable projects in the future.
- Thus, even though a project may have a negative NPV, it may be a project worth taking if the option it provides the firm (to take other projects in the future) provides a more-than-compensating value.
- These are the options that firms often call “strategic options” and use as a rationale for taking on “negative NPV” or even “negative return” projects.

The Option to Expand



An Example of an Expansion Option

- Ambev is considering introducing a soft drink to the U.S. market. The drink will initially be introduced only in the metropolitan areas of the U.S. and the cost of this “limited introduction” is \$ 500 million.
- A financial analysis of the cash flows from this investment suggests that the present value of the cash flows from this investment to Ambev will be only \$ 400 million. Thus, by itself, the new investment has a **negative NPV of \$ 100 million.**
- If the initial introduction works out well, Ambev **could go ahead with a full-scale introduction to the entire market with an additional investment of \$ 1 billion** any time over the next 5 years. While the current expectation is that the cash flows from having this investment is only \$ 750 million, there is considerable uncertainty about both the potential for the drink, leading to significant variance in this estimate.

Valuing the Expansion Option

- Value of the Underlying Asset (S) = PV of Cash Flows from Expansion to entire U.S. market, if done now = \$ 750 Million
- Strike Price (K) = Cost of Expansion into entire U.S market = \$ 1000 Million
- We estimate the standard deviation in the estimate of the project value by using the annualized standard deviation in firm value of publicly traded firms in the beverage markets, which is approximately 34.25%.
 - Standard Deviation in Underlying Asset's Value = 34.25%
- Time to expiration = Period for which expansion option applies = 5 years

Call Value= \$ 234 Million

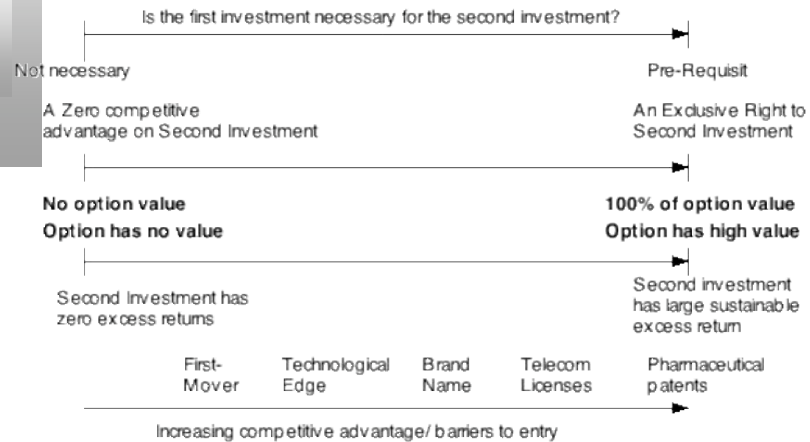
Considering the Project with Expansion Option

- NPV of Limited Introduction = \$ 400 Million - \$ 500 Million
= - \$ 100 Million
- Value of Option to Expand to full market= \$ 234 Million
- NPV of Project with option to expand
= - \$ 100 million + \$ 234 million
= \$ 134 million
- **Invest in the project**

The Real Options Test for Expansion Options

- The Options Test
 - Underlying Asset: Expansion Project
 - ContingencyIf PV of CF from expansion > Expansion Cost: PV - Expansion Cost
If PV of CF from expansion < Expansion Cost: 0
- The Exclusivity Test
 - Barriers may range from strong (exclusive licenses granted by the government) to weaker (brand name, knowledge of the market) to weakest (first mover).
- The Pricing Test
 - Underlying Asset: As with patents, there is no trading in the underlying asset and you have to estimate value and volatility.
 - Option: Licenses are sometimes bought and sold, but more diffuse expansion options are not.
 - Cost of Exercising the Option: Not known with any precision and may itself evolve over time as the market evolves.
- Using option pricing models to value expansion options will not only yield extremely noisy estimates, but may attach inappropriate premiums to discounted cashflow estimates.

Opportunities are not Options...

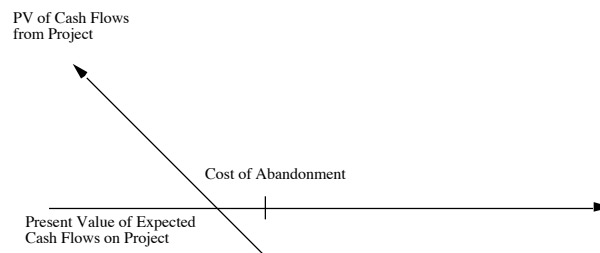


Internet Firms as Options

- Some analysts have justified the valuation of internet firms on the basis that you are buying the option to expand into a very large market. What do you think of this argument?
 - Is there an option to expand embedded in these firms?
 - Is it a valuable option?

The Option to Abandon

- A firm may sometimes have the option to abandon a project, if the cash flows do not measure up to expectations.
- If abandoning the project allows the firm to save itself from further losses, this option can make a project more valuable.



Valuing the Option to Abandon

- Airbus is considering a joint venture with Lear Aircraft to produce a small commercial airplane (capable of carrying 40-50 passengers on short haul flights)
 - Airbus will have to invest \$ 500 million for a 50% share of the venture
 - Its share of the present value of expected cash flows is 480 million.
- Lear Aircraft, which is eager to enter into the deal, offers to buy Airbus's 50% share of the investment anytime over the next five years for \$ 400 million, if Airbus decides to get out of the venture.
- A simulation of the cash flows on this time share investment yields a variance in the present value of the cash flows from being in the partnership is 0.16.
- The project has a life of 30 years.

Project with Option to Abandon

- Value of the Underlying Asset (S) = PV of Cash Flows from Project
= \$ 480 million
- Strike Price (K) = Salvage Value from Abandonment = \$ 400 million
- Variance in Underlying Asset's Value = 0.16
- Time to expiration = Life of the Project = 5 years
- Dividend Yield = 1/Life of the Project = $1/30 = 0.033$ (We are assuming that the project's present value will drop by roughly $1/n$ each year into the project)
- Assume that the five-year riskless rate is 6%. The value of the put option can be estimated as follows:

Should Airbus enter into the joint venture?

- Value of Put = $Ke^{-rt} (1-N(d2)) - Se^{-yt} (1-N(d1))$
 $= 400 (\exp^{(-0.06)(5)} (1-0.4624) - 480 \exp^{(-0.033)(5)} (1-0.7882))$
= \$ 73.23 million
- The value of this abandonment option has to be added on to the net present value of the project of -\$ 20 million, yielding a total net present value with the abandonment option of \$ 53.23 million.

Implications for Investment Analysis

- Having a option to abandon a project can make otherwise unacceptable projects acceptable.
- Actions that increase the value of the abandonment option include
 - More cost flexibility, that is, making more of the costs of the projects into variable costs as opposed to fixed costs.
 - Fewer long-term contracts/obligations with employees and customers, since these add to the cost of abandoning a project
 - Finding partners in the investment, who are willing to acquire your investment in the future
- These actions will undoubtedly cost the firm some value, but this has to be weighed off against the increase in the value of the abandonment option.

Option Pricing Applications in the Capital Structure Decision

Options in Capital Structure

- The most direct applications of option pricing in capital structure decisions is in the design of securities. In fact, most complex financial instruments can be broken down into some combination of a simple bond/common stock and a variety of options.
 - If these securities are to be issued to the public, and traded, the options have to be priced.
 - If these are non-traded instruments (bank loans, for instance), they still have to be priced into the interest rate on the instrument.
- The other application of option pricing is in valuing flexibility. Often, firms preserve debt capacity or hold back on issuing debt because they want to maintain flexibility.

The Value of Flexibility

- Firms maintain excess debt capacity or larger cash balances than are warranted by current needs, to meet unexpected future requirements.
- While maintaining this financing flexibility has value to firms, it also has a cost; the excess debt capacity implies that the firm is giving up some value and has a higher cost of capital.
- The value of flexibility can be analyzed using the option pricing framework; a firm maintains large cash balances and excess debt capacity in order to have the option to take projects that might arise in the future.

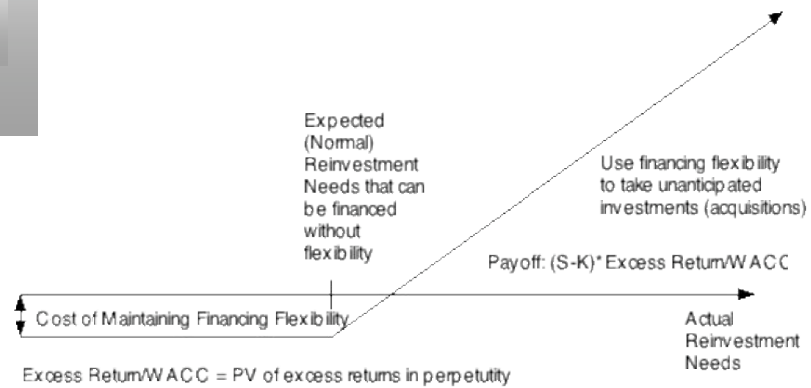
Value of Flexibility as an Option

- Consider a firm that has expected reinvestment needs of X each year, with a standard deviation in that value of σ_X . These external reinvestments include both internal projects and acquisitions.
- Assume that the firm can raise L from internal cash flows and its normal access to capital markets. (Normal access refers to the external financing that is used by a firm each year)
- Excess debt capacity becomes useful if external reinvestment needs exceed the firm's internal funds.
If $X > L$: Excess debt capacity can be used to cover the difference and invest in projects
If $X < L$: Excess debt capacity remains unused (with an associated cost)

What happens when you make the investment?

- If the investment earns excess returns, the firm's value will increase by the present value of these excess returns over time. If we assume that the excess return each year is constant and perpetual, the present value of the excess returns that would be earned can be written as:
Value of investment = $(\text{ROC} - \text{Cost of capital}) / \text{Cost of capital}$
- The value of the investments that you can take because you have excess debt capacity becomes the payoff to maintaining excess debt capacity.
If $X > L$: $[(\text{ROC} - \text{Cost of capital}) / \text{Cost of capital}] \text{ New investments}$
If $X < L$: 0

The Value of Flexibility



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Disney's Optimal Debt Ratio

Debt Ratio	Cost of Equity	Cost of Debt	Cost of Capital
0.00%	13.00%	4.61%	13.00%
10.00%	13.43%	4.61%	12.55%
Current: 18%	13.85%	4.80%	12.22%
20.00%	13.96%	4.99%	12.17%
30.00%	14.65%	5.28%	11.84%
<u>40.00%</u>	<u>15.56%</u>	<u>5.76%</u>	<u>11.64%</u>
50.00%	16.85%	6.56%	11.70%
60.00%	18.77%	7.68%	12.11%
70.00%	21.97%	7.68%	11.97%
80.00%	28.95%	7.97%	12.17%
90.00%	52.14%	9.42%	13.69%

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Inputs to Option Valuation Model

- One way to think about firms that preserve debt capacity because they want flexibility is that they are foregoing use this debt to invest in existing projects at existing excess returns because they think that they might have an increase in either investment needs or excess returns.
- To value flexibility as a percent of firm value (as an annual cost), these would be the inputs to the model:
 - S = Expected Reinvestment needs as percent of Firm Value
 - K = Expected Reinvestment needs that can be financed without financing flexibility
 - $t = 1$ year
 - σ^2 = Variance in $\ln(\text{Net Capital Expenditures})$
- Once this option has been valued, estimate the present value of the excess returns that will be gained by taking the additional investments by multiplying by $(\text{ROC} - \text{WACC})/\text{WACC}$

The Inputs for Disney

- Expected reinvestment needs as a percent of firm value:
 - Over the last 5 years, reinvestment (net cap ex, acquisitions and changes in working capital) has been approximately 5.3% of firm value
 - I am assuming that this is the expected reinvestment need; the variance in $\ln(\text{reinvestment})$ over the last 5 years is 0.375
- Reinvestment needs that can be financed without flexibility.
 - We looked at *internal funds*, after debt payments but before reinvestment needs, as a percent of firm value over the last 5 years. (Internal funds = $(\text{Net Income} + \text{Depreciation})/\text{Market Value of the Firm}$)
 - We looked at *net debt financing* each period, as a percent of firm value (as a measure of access to external financing each year). (New Debt - Debt Repaid)/Market Value of Firm)
 - Reinvestment needs that can be financed without flexibility = $(\text{Net Income} + \text{Depreciation} + \text{Net Debt Issued})/\text{Market Value of Firm}$
 - This number has averaged 4.8%, over the last 5 years

Valuing Flexibility at Disney

The value of flexibility as a percentage of firm value can be estimated as follows:

- $S = 5.3\%$
- $K = 4.8\%$
- $t = 1$ year
- $\sigma^2 = 0.375$ (Variance in $\ln(\text{Reinvestment Needs}/\text{Firm Value})$)

The value of an option with these characteristics is 1.6092%

- Disney earns 18.69% on its projects has a cost of capital of 12.22%.
The excess return (annually) is 6.47%.

Value of Flexibility (annual) = $1.6092\% (.0647 / .1222) = 0.85\%$ of value

- Disney's cost of capital at its optimal debt ratio is 11.64%. The cost it incurs to maintain flexibility is therefore 0.58% annually (12.22% - 11.64%). It therefore pays to maintain flexibility.

Determinants of the Value of Flexibility

- Capacity to raise funds to meet financing needs: The greater the capacity to raise funds, either internally or externally, the less the value of flexibility.
 - 1.1: Firms with significant internal operating cash flows should value flexibility less than firms with small or negative operating cash flows.
 - 1.2: Firms with easy access to financial markets should have a lower value for flexibility than firms without that access.
- Unpredictability of reinvestment needs: The more unpredictable the reinvestment needs of a firm, the greater the value of flexibility.
- Capacity to earn excess returns: The greater the capacity to earn excess returns, the greater the value of flexibility.
 - 1.3: Firms that do not have the capacity to earn or sustain excess returns get no value from flexibility.

Option Pricing Applications in Valuation

Equity Value in Deeply Troubled Firms
Value of Undeveloped Reserves for Natural Resource Firm
Value of Patent/License

Option Pricing Applications in Equity Valuation

- Equity in a troubled firm (i.e. a firm with high leverage, negative earnings and a significant chance of bankruptcy) can be viewed as a call option, which is the option to liquidate the firm.
- Natural resource companies, where the undeveloped reserves can be viewed as options on the natural resource.
- Start-up firms or high growth firms which derive the bulk of their value from the rights to a product or a service (eg. a patent)

Valuing Equity as an option

- The equity in a firm is a **residual claim**, i.e., equity holders lay claim to all cashflows left over after other financial claim-holders (debt, preferred stock etc.) have been satisfied.
- If a firm is liquidated, the same principle applies, with equity investors **receiving whatever is left over in the firm** after all outstanding debts and other financial claims are paid off.
- The **principle of limited liability**, however, protects equity investors in publicly traded firms if the value of the firm is less than the value of the outstanding debt, and they cannot lose more than their investment in the firm.

Equity as a call option

- The payoff to equity investors, on liquidation, can therefore be written as:

$$\begin{array}{ll} \text{Payoff to equity on liquidation} = V - D & \text{if } V > D \\ = 0 & \text{if } V \leq D \end{array}$$

where,

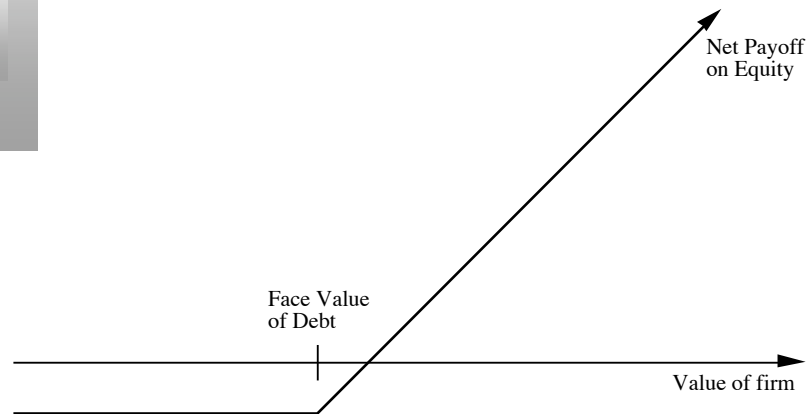
V = Value of the firm

D = Face Value of the outstanding debt and other external claims

- A call option, with a strike price of K, on an asset with a current value of S, has the following payoffs:

$$\begin{array}{ll} \text{Payoff on exercise} = S - K & \text{if } S > K \\ = 0 & \text{if } S \leq K \end{array}$$

Payoff Diagram for Liquidation Option



Application to valuation: A simple example

- Assume that you have a firm whose assets are currently valued at \$100 million and that the standard deviation in this asset value is 40%.
- Further, assume that the face value of debt is \$80 million (It is zero coupon debt with 10 years left to maturity).
- If the ten-year treasury bond rate is 10%,
 - how much is the equity worth?
 - What should the interest rate on debt be?

Model Parameters

- Value of the underlying asset = S = Value of the firm = \$ 100 million
- Exercise price = K = Face Value of outstanding debt = \$ 80 million
- Life of the option = t = Life of zero-coupon debt = 10 years
- Variance in the value of the underlying asset = σ^2 = Variance in firm value = 0.16
- Riskless rate = r = Treasury bond rate corresponding to option life = 10%

Valuing Equity as a Call Option

- Based upon these inputs, the Black-Scholes model provides the following value for the call:
 - $d1 = 1.5994$ $N(d1) = 0.9451$
 - $d2 = 0.3345$ $N(d2) = 0.6310$
- Value of the call = $100 (0.9451) - 80 \exp^{(-0.10)(10)} (0.6310) = \$75.94$ million
- Value of the outstanding debt = $\$100 - \$75.94 = \$24.06$ million
- Interest rate on debt = $(\$80 / \$24.06)^{1/10} - 1 = 12.77\%$

The Effect of Catastrophic Drops in Value

- Assume now that a catastrophe wipes out half the value of this firm (the value drops to \$ 50 million), while the face value of the debt remains at \$ 80 million. What will happen to the equity value of this firm?
- It will drop in value to \$ 25.94 million [\$ 50 million - market value of debt from previous page]
- It will be worth nothing since debt outstanding > Firm Value
- It will be worth more than \$ 25.94 million

Illustration : Value of a troubled firm

- Assume now that, in the previous example, the value of the firm were reduced to \$ 50 million while keeping the face value of the debt at \$80 million.
- This firm could be viewed as troubled, since it owes (at least in face value terms) more than it owns.
- The equity in the firm will still have value, however.

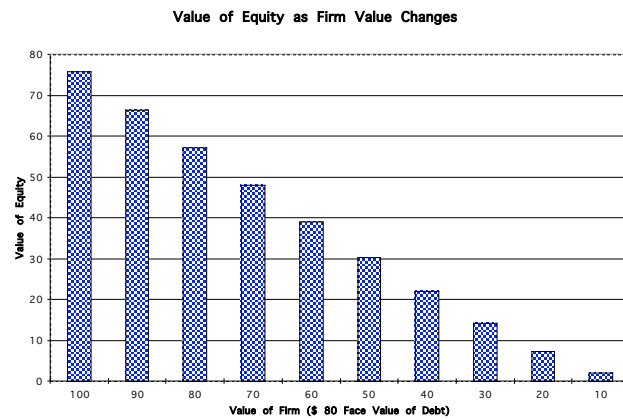
Valuing Equity in the Troubled Firm

- Value of the underlying asset = S = Value of the firm = \$ 50 million
- Exercise price = K = Face Value of outstanding debt = \$ 80 million
- Life of the option = t = Life of zero-coupon debt = 10 years
- Variance in the value of the underlying asset = σ^2 = Variance in firm value = 0.16
- Riskless rate = r = Treasury bond rate corresponding to option life = 10%

The Value of Equity as an Option

- Based upon these inputs, the Black-Scholes model provides the following value for the call:
 - $d1 = 1.0515$ $N(d1) = 0.8534$
 - $d2 = -0.2135$ $N(d2) = 0.4155$
- Value of the call = $50 (0.8534) - 80 \exp^{(-0.10)(10)} (0.4155) = \$30.44$ million
- Value of the bond = $\$50 - \$30.44 = \$19.56$ million
- The equity in this firm drops by, because of the option characteristics of equity.
- This might explain why stock in firms, which are in Chapter 11 and essentially bankrupt, still has value.

Equity value persists ..



Option Pricing Theory and Real Option Applications

Aswath Damodaran

The Conflict between bondholders and stockholders

- Stockholders and bondholders have different objective functions, and this can lead to conflicts between the two.
- For instance, stockholders have an incentive to take riskier projects than bondholders do, and to pay more out in dividends than bondholders would like them to.
- This conflict between bondholders and stockholders can be illustrated dramatically using the option pricing model.
 - Since equity is a call option on the value of the firm, **an increase in the variance in the firm value, other things remaining equal, will lead to an increase in the value of equity.**
 - It is therefore conceivable that stockholders can take risky projects with **negative net present values**, which while making them better off, may make the bondholders and the firm less valuable. This is illustrated in the following example.

Illustration: Effect on value of the conflict between stockholders and bondholders

- Consider again the firm described in the earlier example, with a value of assets of \$100 million, a face value of zero-coupon ten-year debt of \$80 million, a standard deviation in the value of the firm of 40%. The equity and debt in this firm were valued as follows:
 - Value of Equity = \$75.94 million
 - Value of Debt = \$24.06 million
 - Value of Firm == \$100 million
- Now assume that the stockholders have the opportunity to take a project with a negative net present value of -\$2 million, but assume that this project is a very risky project that will push up the standard deviation in firm value to 50%.

Valuing Equity after the Project

- Value of the underlying asset = S = Value of the firm = \$ 100 million - \$2 million = \$ 98 million (The value of the firm is lowered because of the negative net present value project)
- Exercise price = K = Face Value of outstanding debt = \$ 80 million
- Life of the option = t = Life of zero-coupon debt = 10 years
- Variance in the value of the underlying asset = σ^2 = Variance in firm value = 0.25
- Riskless rate = r = Treasury bond rate corresponding to option life = 10%

Option Valuation

- Option Pricing Results for Equity and Debt Value
 - Value of Equity = \$77.71
 - Value of Debt = \$20.29
 - Value of Firm = \$98.00
- The value of equity rises from \$75.94 million to \$ 77.71 million , even though the firm value declines by \$2 million. The increase in equity value comes at the expense of bondholders, who find their wealth decline from \$24.06 million to \$20.19 million.

Effects of an Acquisition

- Assume that you are the manager of a firm and that you buy another firm, with a fair market value of \$ 150 million, for exactly \$ 150 million. In an efficient market, the stock price of your firm will
 - ☐ Increase
 - ☐ Decrease
 - ☐ Remain Unchanged

II. Effects on equity of a conglomerate merger

- You are provided information on two firms, which operate in unrelated businesses and hope to merge.

	Firm A	Firm B
Value of the firm	\$100 million	\$ 150 million
Face Value of Debt (10 yr zeros)	\$ 80 million	\$ 50 million
Maturity of debt 10 years	10 years	
Std. Dev. in value	40 %	50 %
Correlation between cashflows	0.4	

The ten-year bond rate is 10%.

- The variance in the value of the firm after the acquisition can be calculated as follows:

$$\begin{aligned}
 \text{Variance in combined firm value} &= w_1^2 \sigma_1^2 + w_2^2 \sigma_2^2 + 2 w_1 w_2 \rho_{12} \sigma_1 \sigma_2 \\
 &= (0.4)^2 (0.16) + (0.6)^2 (0.25) + 2 (0.4) (0.6) (0.4) (0.4) (0.5) \\
 &= 0.154
 \end{aligned}$$

Valuing the Combined Firm

- The values of equity and debt in the individual firms and the combined firm can then be estimated using the option pricing model:

	Firm A	Firm B	Combined firm
Value of equity in the firm	\$75.94	\$134.47	\$ 207.43
Value of debt in the firm	\$24.06	\$ 15.53	\$ 42.57
Value of the firm	\$100.00	\$150.00	\$ 250.00

- The combined value of the equity prior to the merger is \$ 210.41 million and it declines to \$207.43 million after.
- The wealth of the bondholders increases by an equal amount.
- There is a **transfer of wealth from stockholders to bondholders**, as a consequence of the merger. Thus, conglomerate mergers that are not followed by increases in leverage are likely to see this redistribution of wealth occur across claim holders in the firm.

Obtaining option pricing inputs - Some real world problems

- The examples that have been used to illustrate the use of option pricing theory to value equity have made some simplifying assumptions. Among them are the following:
 - (1) There were only two claim holders in the firm - debt and equity.
 - (2) There is only one issue of debt outstanding and it can be retired at face value.
 - (3) The debt has a zero coupon and no special features (convertibility, put clauses etc.)
 - (4) The value of the firm and the variance in that value can be estimated.

Real World Approaches to Getting inputs

Input	Estimation Process
Value of the Firm	- Cumulate market values of equity and debt (or) - Value the <u>assets in place</u> using FCFF and WACC (or) - Use cumulated market value of assets, if traded.
Variance in Firm Value	- If stocks and bonds are traded, $\sigma^2_{\text{firm}} = w_e^2 \sigma_e^2 + w_d^2 \sigma_d^2 + 2 w_e w_d \rho_{ed} \sigma_e \sigma_d$ where σ_e^2 = variance in the stock price w_e = MV weight of Equity σ_d^2 = the variance in the bond price w_d = MV weight of debt - If not traded, use variances of similarly rated bonds. - Use average firm value variance from the industry in which company operates.
Value of the Debt	- If the debt is short term, you can use only the face or book value of the debt. - If the debt is long term and coupon bearing, add the cumulated nominal value of these coupons to the face value of the debt.
Maturity of the Debt	- Face value weighted duration of bonds outstanding (or) - If not available, use weighted maturity

Valuing Equity as an option - Eurotunnel in early 1998

- Eurotunnel has been a financial disaster since its opening
 - In 1997, Eurotunnel had earnings before interest and taxes of -£56 million and net income of -£685 million
 - At the end of 1997, its book value of equity was -£117 million
 - It had £8,865 million in face value of debt outstanding
 - The weighted average duration of this debt was 10.93 years
- | Debt Type | Face Value | Duration |
|--------------|-------------------|--------------------|
| Short term | 935 | 0.50 |
| 10 year | 2435 | 6.7 |
| 20 year | 3555 | 12.6 |
| Longer | 1940 | 18.2 |
| <i>Total</i> | <i>£8,865 mil</i> | <i>10.93 years</i> |

The Basic DCF Valuation

- The value of the firm estimated using projected cashflows to the firm, discounted at the weighted average cost of capital was £2,312 million.
- This was based upon the following assumptions –
 - Revenues will grow 5% a year in perpetuity.
 - The COGS which is currently 85% of revenues will drop to 65% of revenues in yr 5 and stay at that level.
 - Capital spending and depreciation will grow 5% a year in perpetuity.
 - There are no working capital requirements.
 - The debt ratio, which is currently 95.35%, will drop to 70% after year 5. The cost of debt is 10% in high growth period and 8% after that.
 - The beta for the stock will be 1.10 for the next five years, and drop to 0.8 after the next 5 years.
 - The long term bond rate is 6%.

Other Inputs

- The stock has been traded on the London Exchange, and the annualized std deviation based upon $\ln(\text{prices})$ is 41%.
- There are Eurotunnel bonds, that have been traded; the annualized std deviation in $\ln(\text{price})$ for the bonds is 17%.
 - The correlation between stock price and bond price changes has been 0.5. The proportion of debt in the capital structure during the period (1992-1996) was 85%.
 - Annualized variance in firm value
$$= (0.15)^2 (0.41)^2 + (0.85)^2 (0.17)^2 + 2 (0.15) (0.85)(0.5)(0.41)(0.17) = 0.0335$$
- The 15-year bond rate is 6%. (I used a bond with a duration of roughly 11 years to match the life of my option)

Valuing Eurotunnel Equity and Debt

- Inputs to Model
 - Value of the underlying asset = S = Value of the firm = £2,312 million
 - Exercise price = K = Face Value of outstanding debt = £8,865 million
 - Life of the option = t = Weighted average duration of debt = 10.93 years
 - Variance in the value of the underlying asset = σ^2 = Variance in firm value = 0.0335
 - Riskless rate = r = Treasury bond rate corresponding to option life = 6%
- Based upon these inputs, the Black-Scholes model provides the following value for the call:
 - $d1 = -0.8337$ $N(d1) = 0.2023$
 - $d2 = -1.4392$ $N(d2) = 0.0751$
- Value of the call = $2312 (0.2023) - 8,865 \exp^{(-0.06)(10.93)} (0.0751) = \text{£}122$ million
- Appropriate interest rate on debt = $(8865/2190)^{(1/10.93)} - 1 = 13.65\%$

In Closing...

- There are real options everywhere.
- Most of them have no significant economic value because there is no exclusivity associated with using them.
- When options have significant economic value, the inputs needed to value them in a binomial model can be used in more traditional approaches (decision trees) to yield equivalent value.
- The real value from real options lies in
 - Recognizing that building in flexibility and escape hatches into large decisions has value
 - Insights we get on understanding how and why companies behave the way they do in investment analysis and capital structure choices.

Industry Name	Std Dev(Equity)	Std Dev(Firm)	Industry Name	Std Dev(Equity)	Std Dev(Firm)
Advertising	35.48%	27.11%	Household Products	29.40%	24.91%
Aerospace/Defense	37.40%	33.13%	Industrial Services	43.95%	39.62%
Air Transport	44.52%	33.80%	Insurance (Diversified)	28.46%	26.99%
Aluminum	29.20%	22.03%	Insurance (Life)	30.61%	29.15%
Apparel	45.25%	37.34%	Insurance (Prop/Casualty)	26.98%	25.68%
Auto & Truck	31.01%	23.90%	Investment Co. (Domestic)	23.40%	22.28%
Auto Parts (OEM)	31.21%	26.63%	Investment Co. (Foreign)	28.01%	27.91%
Auto Parts (Replacement)	33.28%	25.71%	Investment Co. (Income)	10.95%	10.95%
Bank	24.44%	22.44%	Machinery	35.25%	30.34%
Bank (Canadian)	21.18%	19.12%	Manuf. Housing/Rec Veh	41.09%	36.00%
Bank (Foreign)	23.12%	22.39%	Maritime	33.85%	24.38%
Bank (Midwest)	20.13%	19.15%	Medical Services	63.58%	55.77%
Beverage (Alcoholic)	22.21%	20.24%	Medical Supplies	54.33%	50.44%
Beverage (Soft Drink)	37.59%	32.50%	Metal Fabricating	35.61%	32.85%
Building Materials	35.68%	31.08%	Metals & Mining (Div.)	55.48%	50.20%
Cable TV	41.41%	21.67%	Natural Gas (Distrib.)	19.35%	15.23%
Canadian Energy	25.24%	21.41%	Natural Gas (Diversified)	33.69%	28.21%
Cement & Aggregates	32.83%	29.86%	Newspaper	23.54%	19.99%
Chemical (Basic)	29.43%	25.16%	Office Equip & Supplies	34.40%	29.32%
Chemical (Diversified)	30.87%	27.01%	Oilfield Services Equip.	43.25%	39.70%
Chemical (Specialty)	33.74%	29.34%	Packaging & Container	37.44%	30.32%
Coal/Alternate Energy	40.48%	34.85%	Paper & Forest Products	28.41%	17.50%
Computer & Peripherals	64.64%	59.54%	Petroleum (Integrated)	25.66%	20.98%
Computer Software & Svcs	52.88%	50.35%	Petroleum (Producing)	49.32%	42.47%
Copper	30.41%	12.62%	Precision Instrument	47.36%	44.21%
Diversified Co.	42.82%	35.20%	Publishing	35.89%	30.75%
Drug	59.77%	58.50%	R.E.I.T.	25.06%	24.52%
Drugstore	47.64%	36.63%	Railroad	23.73%	19.37%
Electric Util. (Central)	14.93%	11.38%	Recreation	30.25%	39.58%
Electric Utility (East)	16.56%	11.67%	Restaurant	40.12%	35.55%
Electric Utility (West)	18.18%	13.80%	Retail (Special Lines)	51.20%	39.98%
Electrical Equipment	43.70%	39.49%	Retail Building Supply	40.55%	33.95%
Electronics	53.39%	48.39%	Retail Store	40.14%	29.46%
Entertainment	36.01%	28.95%	Securities Brokerage	33.42%	22.74%
Environmental	53.98%	43.74%	Semiconductor	54.64%	52.72%
Financial Services	36.16%	27.68%	Semiconductor Cap Equip	53.41%	52.50%
Food Processing	33.13%	26.83%	Shoe	44.63%	40.08%
Food Wholesalers	27.60%	22.11%	Steel (General)	33.73%	28.96%
Foreign Diversified	91.01%	44.08%	Steel (Integrated)	40.34%	27.69%
Foreign Electron/Entertn	34.03%	29.17%	Telecom. Equipment	61.61%	56.72%
Foreign Telecom.	36.18%	32.99%	Telecom. Services	42.29%	35.05%
Furn./Home Furnishings	34.62%	30.90%	Textile	31.60%	24.12%
Gold/Silver Mining	49.57%	46.46%	Thrift	28.94%	26.42%
Grocery	31.64%	21.84%	Tire & Rubber	26.39%	23.60%
Healthcare Info Systems	57.80%	54.69%	Tobacco	33.85%	25.31%
Home Appliance	34.82%	29.48%	Toiletries/Cosmetics	42.97%	36.82%
Homebuilding	43.66%	27.13%	Trucking/Transp. Leasing	38.09%	29.21%
Hotel/Gaming	45.01%	29.76%	Utility (Foreign)	23.17%	18.34%
			Water Utility	18.53%	14.16%

Aswath Damodaran

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Acquisition Valuation

It is not what you buy but what you pay for it....

Aswath Damodaran

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Issues in Acquisition Valuation

- Acquisition valuations are complex, because the valuation often involved issues like synergy and control, which go beyond just valuing a target firm. It is important on the right sequence, including
 - When should you consider synergy?
 - Where does the method of payment enter the process.
- Can synergy be valued, and if so, how?
- What is the value of control? How can you estimate the value?

Steps involved in an Acquisition Valuation

- *Step 1:* Establish a **motive** for the acquisition
- *Step 2:* Choose a **target**
- *Step 3:* **Value** the target with the **acquisition motive** built in.
- *Step 4:* Decide on the **mode of payment** - cash or stock, and if cash, arrange for financing - debt or equity.
- *Step 5:* Choose the **accounting method** for the merger/acquisition - purchase or pooling.

Step 1: Motives behind acquisitions

- (1) Simplest rationale is **undervaluation**, i.e., that firms that are undervalued by financial markets, relative to true value, will be targeted for acquisition by those who recognize this anomaly.
- (2) A more controversial reason is **diversification**, with the intent of stabilizing earnings and reducing risk.
- (3) **Synergy** refers to the potential additional value from combining two firms, either from operational or financial sources.
 - Operating Synergy can come from *higher growth* or *lower costs*
 - Financial Synergy can come from *tax savings*, *increased debt capacity* or *cash slack*.
- (4) **Poorly managed firms are taken over and restructured** by the new owners, who lay claim to the additional value.
- (5) **Managerial self-interest** and hubris are the primary, though unstated, reasons for many takeovers.

Step 2: Choose a target firm for the acquisition

<i>If motive is</i>	<i>Target firm</i>
Undervaluation	trades at a price below the estimated value
Diversification business	is in a business which is different from the acquiring firm's
Operating Synergy	have the characteristics that create the operating synergy <i>Cost Savings</i> : in same business to create economies of scale. <i>Higher growth</i> : should have potential for higher growth.
Financial Synergy	<i>Tax Savings</i> : provides a tax benefit to acquirer <i>Debt Capacity</i> : is unable to borrow money or pay high rates <i>Cash slack</i> : has great projects/ no funds
Control	badly managed firm whose stock has underperformed the market.
Manager's Interests	has characteristics that best meet CEO's ego and power needs.

Step 3: Value Target Firm with motive built in

<i>If motive is</i>	<i>Target firm</i>
Undervaluation	Value target firm as stand-alone entity: No extra premium
Diversification	Value target firm as stand-alone entity: No extra premium
Operating Synergy	Value the firms independently. Value the combined firm with the operating synergy Synergy is the difference between the latter and former Target Firm Value = Independent Value + Synergy
Financial Synergy	Tax Benefits: Value of Target Firm + PV of Tax Benefits Debt Capacity: Value of Target Firm + Increase in Value from Debt Cash Slack: Value of Target Firm + NPV of Projects/ Target
Control	Value of Target Firm run optimally
Manager's Interest	Value of Target Firm: No additional premium

The Valuation Process

VALUING AN ACQUISITION		
Component	Valuation Guidelines	Should you pay?
Synergy	Value the combined firm with synergy built in. This may include a. a higher growth rate in revenues: <i>growth synergy</i> b. higher margins, because of <i>economies of scale</i> c. lower taxes, because of tax benefits: <i>tax synergy</i> d. lower cost of debt: <i>financing synergy</i> e. higher debt ratio because of lower risk: <i>debt capacity</i> Subtract the value of the target firm (with control premium) + value of the bidding firm (pre-acquisition). This is the value of the synergy.	Which firm is indispensable for the synergy? If it is the target, you should be willing to pay up to the synergy. If it is the bidder, you should not.
Control Premium	Value the company as if optimally managed. This will usually mean that investment, financing and dividend policy will be altered: Investment Policy: Higher returns on projects and divesting unproductive projects. Financing Policy: Move to a better financing structure, eg. optimal capital structure Dividend Policy: Return unused cash Practically, 1. Look at industry averages for optimal (if lazy) 2. Do a full-fledged corporate financial analysis	If motive is control or in a stand-alone valuation, this is the maximum you should pay.
Status Quo Valuation	Value the company as is, with existing inputs for investment, financing and dividend policy.	If motive is undervaluation, this is the maximum you should pay.

Valuing NCR for AT & T: 1991

VALUING NCR for AT & T		
Component	Valuation Guidelines	Value
Synergy	Value the combined firm with synergy built in. This may include: a. a higher growth rate in revenues: <i>growth synergy</i> b. higher margins, because of <i>economies of scale</i> c. lower taxes, because of tax benefits: <i>tax synergy</i> d. lower cost of debt: <i>financing synergy</i> e. higher debt ratio because of lower risk: <i>debt capacity</i> Subtract the value of the target firm (with control premium) + value of the bidding firm (pre-acquisition). This is the value of the synergy.	\$ 11,278 million - \$ 6,723 million = \$ 4,552 million
Control Premium	Value the company as if optimally managed. This will usually mean that investment, financing and dividend policy will be altered: Investment Policy: Higher returns on projects and divesting unproductive projects. Financing Policy: Move to a better financing structure; eg. optimal capital structure Dividend Policy: Return unused cash Practically: 1. Look at industry averages for optimal (if lazy) 2. Do a full-fledged corporate financial analysis	\$ 6,723 million - \$ 5,949 million = \$ 774 million
Status Quo Valuation	Value the company as is, with existing inputs for investment, financing and dividend policy.	\$ 5,949 million

Step 4: Decide on payment mechanism: Cash versus Stock

- Generally speaking, firms which **believe that their stock is under valued** will not use stock to do acquisitions.
- Conversely, firms which believe that their stock is **over or correctly valued will use stock** to do acquisitions.
- Not surprisingly, the **premium paid is larger** when an acquisition is **financed with stock** rather than cash.
- There might be an **accounting rationale** for using **stock** as opposed to cash. You are allowed to use pooling instead of purchase.
- There might also be a **tax rationale** for using stock. Cash acquisitions create tax liabilities to the selling firm's stockholders.

The Exchange Ratio in a Stock for Stock Exchange

- **Correct Exchange Ratio** to use in a Valuation = Value per Share of Target Firm (with control premium and target-controlled synergies) / Value per Share of Bidding Firm
- If the exchange ratio is set **too high**, there will be a **transfer of wealth from the bidding firm's stockholders** to the target firm's stockholders.
- If the exchange ratio is set **too low**, there will be **transfer of wealth from the target firm** to the bidding firm's stockholders.

Step 5: Choose an accounting method for the merger

■ **Purchase Method:**

- The acquiring firm records the assets and liabilities of the acquired firm at market value, with *goodwill* capturing the difference between market value and the value of the assets acquired.
- This goodwill will then be amortized, though the amortization is generally not tax deductible (though a portion that can be attributed to assets can be deducted). If a firm pays cash on an acquisition, it has to use the purchase method to record the transaction.

■ **Pooling of Interests:**

- The book values of the assets and liabilities of the merging firms are added to arrive at values for the combined firm. Since the market value of the transaction is not recognized, no goodwill is created or amortized.
- This approach is allowed only if the acquiring firm exchanges its common stock for common stock of the acquired firm.
- Since earnings are not affected by the amortization of goodwill, the reported earnings per share under this approach will be greater than the reported earnings per share in the purchase approach.

The Value of Control

- The value of control should be **inversely proportional to the perceived quality** of that management and its capacity to maximize firm value.
- **Value of control will be much greater for a poorly managed firm** that operates at below optimum capacity than it is for a well managed firm.
- Value of Control = Value of firm, with restructuring - Value of firm, without restructuring
- Negligible for firms which are operating at or close to their optimal value

Stand Alone Valuation: Digital - Status Quo

- Digital had earning before interest and taxes of \$391.38 million in 1997, which translated into a
 - A pre-tax operating margin of 3% on its revenues of \$13,046 million
 - An after-tax return on capital of 8.51%
- Based upon its beta of 1.15, an after-tax cost of borrowing of 5% and a debt ratio of approximately 10%, the cost of capital for Digital in 1997 was
 - Cost of Equity = $6\% + 1.15 (5.5\%) = 12.33\%$
 - Cost of Capital = $12.33\% (.9) + 5\% (.1) = 11.59\%$
- Digital had capital expenditures of \$475 million, depreciation of \$ 461 million and working capital was 15% of revenues.
- Operating income, net cap ex and revenues are expected to grow 6% a year for the next 5 years, and 5% thereafter.

Digital: Status Quo Valuation

Year	FCFF	Terminal Value	PV
1	\$133.26		\$119.42
2	\$141.25		\$113.43
3	\$149.73		\$107.75
4	\$158.71		\$102.35
5	\$168.24	\$2,717.35	\$1,667.47
Terminal Year	\$156.25		

Firm Value = **\$2,110.41**

- The capital expenditures are assumed to be 110% of revenues in stable growth; working capital remains 15%;
- Debt ratio remains at 10%, but after-tax cost of debt drops to 4%. Beta declines to 1.

Digital: Change in Control

- Digital will raise its debt ratio to 20%. The beta will increase, but the cost of capital will decrease.
 - New Beta = 1.25 (Unlevered Beta = 1.07; Debt/Equity Ratio = 25%)
 - Cost of Equity = 6% + 1.25 (5.5%) = 12.88%
 - New After-tax Cost of Debt = 5.25%
 - Cost of Capital = 12.88% (0.8) + 5.25% (0.2) = 11.35%
- Digital will raise its return on capital to 11.35%, which is its cost of capital. (Pre-tax Operating margin will go up to 4%)
- The reinvestment rate remains unchanged, but the increase in the return on capital will increase the expected growth rate in the next 5 years to 10%.
- After year 5, the beta will drop to 1, and the after-tax cost of debt will decline to 4%.

Digital Valuation: Change in Control

Year	FCFF	Terminal Value	PV
1	\$156.29		\$140.36
2	\$171.91		\$138.65
3	\$189.11		\$136.97
4	\$208.02		\$135.31
5	\$228.82	\$6,584.62	\$3,980.29
Terminal Year	\$329.23		
Value of the Firm: with Control Change			= \$ 4,531 million
Value of the Firm: Status Quo			= \$ 2,110 million
Value of Control			= \$2,421 million

Valuing operating synergy

- (a) What **form** is the synergy expected to take? Will it **reduce costs** as a percentage of sales and increase profit margins (as is the case when there are economies of scale)? Will it **increase future growth** (as is the case when there is increased market power)?)
- (b) **When can the synergy be reasonably expected to start** affecting cashflows? (Will the gains from synergy show up instantaneously after the takeover? If it will take time, when can the gains be expected to start showing up?)

A procedure for valuing synergy

- (1) the firms involved in the merger are **valued independently**, by discounting expected cash flows to each firm at the weighted average cost of capital for that firm.
- (2) the **value of the combined firm, with no synergy**, is obtained by adding the values obtained for each firm in the first step.
- (3) The **effects of synergy are built into expected growth rates and cashflows**, and the combined firm is re-valued with synergy.

Value of Synergy = Value of the combined firm, with synergy - Value of the combined firm, without synergy

Synergy Effects in Valuation Inputs

<i>If synergy is</i>	<i>Valuation Inputs that will be affected are</i>
Economies of Scale	<i>Operating Margin</i> of combined firm will be greater than the revenue-weighted operating margin of individual firms.
Growth Synergy	More projects: <i>Higher Reinvestment Rate</i> (Retention) Better projects: <i>Higher Return on Capital</i> (ROE) <i>Longer Growth Period</i> Again, these inputs will be estimated for the combined firm.

Valuing Synergy: Compaq and Digital

- In 1997, Compaq acquired Digital for \$ 30 per share + 0.945 Compaq shares for every Digital share. (\$ 53-60 per share) The acquisition was motivated by the belief that the combined firm would be able to find investment opportunities and compete better than the firms individually could.

Background Data

	<i>Compaq</i>	<i>Digital: Opt Mgd</i>
Current EBIT	\$ 2,987 million	\$ 522 million
Current Revenues	\$25,484 mil	\$13,046 mil
Capital Expenditures - Depreciation	\$ 184 million	\$ 14
Expected growth rate -next 5 years	10%	10%
Expected growth rate after year 5	5%	5%
Debt /(Debt + Equity)	10%	20%
After-tax cost of debt	5%	5.25%
Beta for equity - next 5 years	1.25	1.25
Beta for equity - after year 5	1.00	1.0
Working Capital/Revenues	15%	15%
Tax rate is 36% for both companies		

Valuing Compaq

Year	FCFF	Terminal Value	PV
1	\$1,518.19		\$1,354.47
2	\$1,670.01		\$1,329.24
3	\$1,837.01		\$1,304.49
4	\$2,020.71		\$1,280.19
5	\$2,222.78	\$56,654.81	\$33,278.53
Terminal Year	\$2,832.74		\$38,546.91

- Value of Compaq = \$ 38,547 million
- After year 5, capital expenditures will be 110% of depreciation.

Combined Firm Valuation

- The Combined firm will have some economies of scale, allowing it to increase its current after-tax operating margin slightly. The dollar savings will be approximately \$ 100 million.
 - Current Operating Margin = $(2987+522)/(25484+13046) = 9.11\%$
 - New Operating Margin = $(2987+522+100)/(25484+13046) = 9.36\%$
- The combined firm will also have a slightly higher growth rate of 10.50% over the next 5 years, because of operating synergies.
- The beta of the combined firm is computed in two steps:
 - Digital's Unlevered Beta = 1.07; Compaq's Unlevered Beta=1.17
 - Digital's Firm Value = 4.5; Compaq's Firm Value = 38.6
 - Unlevered Beta = $1.07 * (4.5/43.1) + 1.17 (38.6/43.1) = 1.16$
 - Combined Firm's Debt/Equity Ratio = 13.64%
 - New Levered Beta = $1.16 (1+(1-0.36)(.1364)) = 1.26$
 - Cost of Capital = $12.93\% (.88) + 5\% (.12) = 11.98\%$

Combined Firm Valuation

Year	FCFF	Terminal Value	PV
1	\$1,726.65		\$1,541.95
2	\$1,907.95		\$1,521.59
3	\$2,108.28		\$1,501.50
4	\$2,329.65		\$1,481.68
5	\$2,574.26	\$66,907.52	\$39,463.87
Terminal Year	\$3,345.38		
Value of Combined Firm			= \$ 45,511

The Value of Synergy

■ Value of Combined Firm wit Synergy	= \$45,511 million
■ Value of Compaq + Value of Digital = 38,547 + 4532	= \$ 43,079 million
■ Total Value of Synergy	= \$ 2,432 million

Digital: Valuation Blocks

Value of Firm - Status Quo	= \$ 2,110 million
+ Value of Control	= \$ 2,421 million
Value of Firm - Change of Control	= \$ 4,531 million
+ Value of Synergy	= \$ 2,432 million
Total Value of Digital with Synergy	= \$ 6,963 million

Estimating Offer Prices and Exchange Ratios

- There are 146.789 million Digital shares outstanding, and Digital had \$1,006 million in debt outstanding. Estimate that maximum price you would be willing to offer on this deal.
- Assume that Compaq wanted to do an exchange offer, where it would exchange its shares for Digital shares. Assuming that Compaq stock is valued at \$27 per share, what would be the exchange ratio?

Evaluating Compaq's Offer

Value of Digital with Synergy	=	\$6,963 mil
- Value of Cash paid in deal = \$ 30 * 146.789 mil shrs =		\$4,403 mil
- Digital's Outstanding Debt (assumed by Compaq)		\$1,006 mil
Remaining Value		\$ 1,554 mil
/ number of Shares outstanding		146.789
= Remaining Value per Share		\$ 10.59
Compaq's value per share at time of Exchange Offer		\$ 27
Appropriate Exchange Ratio = $10.59/27 = 0.39$ Compaq shares for every Digital share		
Actual Exchange Ratio = 0.945 Compaq shares/Digital Share		

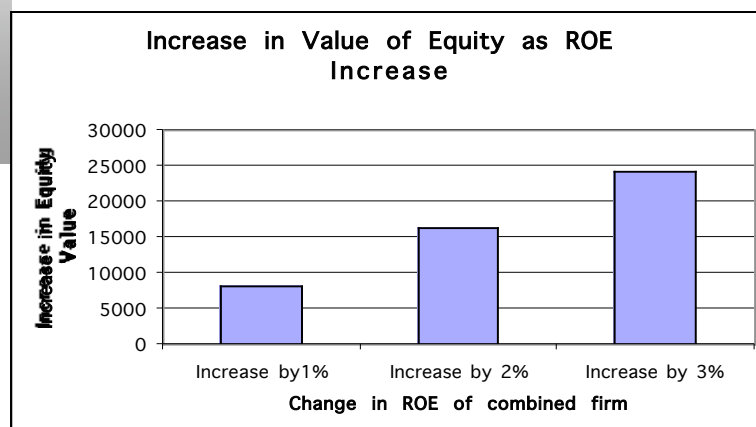
Citicorp + Travelers = ?

	Citicorp	Travelers	Citigroup
Net Income	\$ 3,591	\$ 3,104	\$ 6,695
BV of Equity	\$ 20,722	\$ 20,736	\$ 41,458
ROE	17.33%	14.97%	16.15%
Dividends	\$ 1,104	\$ 587	\$ 1,691
Payout Ratio	30.74%	18.91%	25.27%
Retention Ratio	69.26%	81.09%	74.73%
Expected growth	12.00%	12.14%	12.07%
Growth Period	5	5	5
Beta	1.25	1.40	1.33
Risk Premium	4.00%	4.00%	4.00%
MV of Equity (bil)	81	84	165.00
Cost of Equity	11.00%	11.60%	11.31%
Beta - stable	1.00	1.00	1.00
Growth-stable	6.00%	6.00%	6.00%
Payout-stable	65.38%	59.92%	62.85%
DDM	\$ 70,743	\$ 53,464	\$ 124,009
DDM/share	155.84	46.38	

The Right Exchange Ratio

- Based upon these numbers, what exchange ratio would you agree to as a Citicorp stockholder?
- The actual exchange ratio was 2.5 shares of Travelers for every share of Citicorp. As a Citicorp stockholder, do you think that this is a reasonable exchange ratio?

The Value of Synergy



Financial Synergy

■ Sources of Financial Synergy

- *Diversification*: Acquiring another firm as a way of reducing risk cannot create wealth for two publicly traded firms, with diversified stockholders, but it could create wealth for private firms or closely held publicly traded firms.
- *Cash Slack*: When a firm with significant excess cash acquires a firm, with great projects but insufficient capital, the combination can create value.
- *Tax Benefits*: The tax paid by two firms combined together may be lower than the taxes paid by them as individual firms.
- *Debt Capacity*: By combining two firms, each of which has little or no capacity to carry debt, it is possible to create a firm that may have the capacity to borrow money and create value.

I. Diversification: No Value Creation?

- A takeover, motivated only by diversification considerations, has no effect on the combined value of the two firms involved in the takeover. The value of the combined firms will always be the sum of the values of the independent firms.
- In the case of private firms or closely held firms, where the owners may not be diversified personally, there might be a potential value gain from diversification.

II. Cash Slack

- Managers **may reject profitable investment opportunities** if they have to raise new capital to finance them.
- It may therefore make sense for a company with **excess cash and no investment opportunities** to take over a cash-poor firm with good investment opportunities, or vice versa.
- The **additional value** of combining these two firms lies in the **present value of the projects** that would not have been taken if they had stayed apart, but can now be taken because of the availability of cash.

Valuing Cash Slack

- Assume that Netscape has a severe capital rationing problem, that results in approximately \$500 million of investments, with a cumulative net present value of \$100 million, being rejected.
- IBM has far more cash than promising projects, and has accumulated \$4 billion in cash that it is trying to invest. It is under pressure to return the cash to the owners.
- If IBM takes over Netscape Inc, it can be argued that the value of the combined firm will increase by the synergy benefit of \$100 million, which is the net present value of the projects possessed by the latter that can now be taken with the excess cash from the former.

III. Tax Benefits

- (1) If one of the firms has tax deductions that it cannot use because it is losing money, while the other firm has income on which it pays significant taxes, the combining of the two firms can lead to tax benefits that can be shared by the two firms. The value of this synergy is the present value of the tax savings that accrue because of this merger.
- (2) The assets of the firm being taken over can be written up to reflect new market value, in some forms of mergers, leading to higher tax savings from depreciation in future years.

Valuing Tax Benefits: Tax Losses

- Assume that you are Best Buys, the electronics retailer, and that you would like to enter the hardware component of the market. You have been approached by investment bankers for Zenith, which while still a recognized brand name, is on its last legs financially. The firm has net operating losses of \$ 2 billion. If your tax rate is 36%, estimate the tax benefits from this acquisition.
- If Best Buys had only \$500 million in taxable income, how would you compute the tax benefits?
- If the market value of Zenith is \$800 million, would you pay this tax benefit as a premium on the market value?

Valuing Tax Benefits: Asset Write Up

- One of the earliest leveraged buyouts was done on Congoleum Inc., a diversified firm in ship building, flooring and automotive accessories, in 1979 by the firm's own management.
 - After the takeover, estimated to cost \$400 million, the firm would be allowed to write up its assets to reflect their new market values, and claim depreciation on the new values.
 - The estimated change in depreciation and the present value effect of this depreciation, discounted at the firm's cost of capital of 14.5% is shown below:

Congoleum's Tax Benefits

<i>Year</i>	<i>Deprec'n before</i>	<i>Deprec'n after</i>	<i>Change in Deprec'n</i>	<i>Tax Savings</i>	<i>PV</i>
1980	\$8.00	\$35.51	\$27.51	\$13.20	\$11.53
1981	\$8.80	\$36.26	\$27.46	\$13.18	\$10.05
1982	\$9.68	\$37.07	\$27.39	\$13.15	\$8.76
1983	\$10.65	\$37.95	\$27.30	\$13.10	\$7.62
1984	\$11.71	\$21.23	\$9.52	\$4.57	\$2.32
1985	\$12.65	\$17.50	\$4.85	\$2.33	\$1.03
1986	\$13.66	\$16.00	\$2.34	\$1.12	\$0.43
1987	\$14.75	\$14.75	\$0.00	\$0.00	\$0.00
1988	\$15.94	\$15.94	\$0.00	\$0.00	\$0.00
1989	\$17.21	\$17.21	\$0.00	\$0.00	\$0.00
1980-89	\$123.05	\$249.42	\$126.37	\$60.66	\$41.76

IV. Debt Capacity

- Diversification will lead to an **increase in debt capacity** and an **increase in the value of the firm**.
- Has to be weighed against the immediate transfer of wealth that occurs to existing bondholders in both firms from the stockholders.

Valuing Debt Capacity

- When two firms in different businesses merge, the combined firm will have less variable earnings, and may be able to borrow more (have a higher debt ratio) than the individual firms.
- In the following example, we will combine two firms, with optimal debt ratios of 30% each, and end up with a firm with an optimal debt ratio of 40%.

Effect on Costs of Capital of Added debt

	Firm A	Firm B New Debt	AB -No Debt	AB - Added
Debt (%)	30%	30%	30%	40%
Cost of debt	6.00%	5.40%	5.65%	5.65%
Equity(%)	70%	70%	70%	60%
Cost of equity	13.60%	12.50%	12.95%	13.65%
WACC - Year 1	11.32%	10.37%	10.76%	10.45%
WACC- Year 2	11.32%	10.37%	10.76%	10.45%
WACC- Year 3	11.32%	10.37%	10.77%	10.45%
WACC- Year 4	11.32%	10.37%	10.77%	10.45%
WACC- Year 5	11.32%	10.37%	10.77%	10.45%
WACC-after year 5	10.55%	10.37%	10.45%	9.76%

Effect on Value of Added Debt

	Firm A	Firm B Debt	AB -No new Debt	AB - Added
FCFF in year 1	\$120.00	\$220.00	\$340.00	\$340.00
FCFF in year 2	\$144.00	\$242.00	\$386.00	\$386.00
FCFF in year 3	\$172.80	\$266.20	\$439.00	\$439.00
FCFF in year 4	\$207.36	\$292.82	\$500.18	\$500.18
FCFF in year 5	\$248.83	\$322.10	\$570.93	\$570.93
Terminal Value	\$5,796.97	\$7,813.00	\$13,609.97	\$16,101.22
Present Value	\$4,020.91	\$5,760.47	\$9,781.38	\$11,429.35

- The value of the firm, as a consequence of the added debt, will increase from \$9,781.38 million to \$11,429.35 million.

Empirical Evidence on Synergy

- If synergy is perceived to exist in a takeover, the value of the combined firm should be greater than the sum of the values of the bidding and target firms, operating independently.

$$V(AB) > V(A) + V(B)$$

- Bradley, Desai and Kim (1988) use a sample of 236 inter-firm tender offers between 1963 and 1984 and report that the **combined value of the target and bidder firms increases 7.48%** (\$117 million in 1984 dollars), on average, on the announcement of the merger.
- **Operating synergy** was the primary motive in **one-third of hostile takeovers**. (Bhide)

Operational Evidence on Synergy

- A stronger test of synergy is to **evaluate whether merged firms improve their performance (profitability and growth)**, relative to their competitors, after takeovers.
 - McKinsey and Co. examined 58 acquisition programs between 1972 and 1983 for evidence on two questions -
 - Did the return on the amount invested in the acquisitions exceed the cost of capital?
 - Did the acquisitions help the parent companies outperform the competition?
 - They concluded that **28 of the 58 programs failed both tests**, and 6 failed at least one test.
- KPMG in a more recent study of global acquisitions concludes that most mergers (>80%) fail - the merged companies do worse than their peer group.
- **Large number of acquisitions that are reversed within fairly short time periods.** About 20.2% of the acquisitions made between 1982 and 1986 were divested by 1988. In studies that have tracked acquisitions for longer time periods (ten years or more) the **divestiture rate of acquisitions rises to almost 50%**.

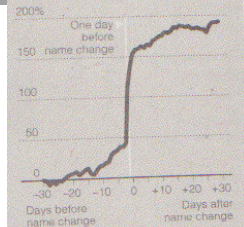
Who gets the benefits of synergy?

- The sharing of the benefits of synergy among the two players will depend in large part on whether the bidding firm's contribution to the **creation of the synergy is unique or easily replaced**. If it can be easily replaced, the bulk of the synergy benefits will accrue to the target firm. If it is unique, the sharing of benefits will be much more equitable.
- Bradley, Desai and Kim (1988) conclude that the benefits of synergy accrue primarily to the target firms when there are **multiple** bidders involved in the takeover. They estimate that the market-adjusted stock returns around the announcement of the takeover for the successful bidder to be 2%, in single bidder takeovers, and -1.33%, in contested takeovers.

Value Enhancement: Back to Basics

Price Enhancement versus Value Enhancement

Stock price performance of companies that changed their names to include Web-oriented designations like ".com," from 30 trading days before the name change announcement to 30 days after. The study looked at stocks of companies that changed their names from January 1998 through March 26, 1999.



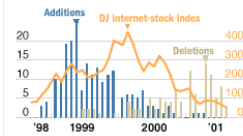
Source: "A Rise Com by Any Other Name" by Michael J. Cooper, P. Raghavendra Rau and Orlin Demerutis of Purdue University

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NAME THAT STOCK

New Markets, New Names

In the bull market, adding dot-com to a company name made a stock soar. Lately those zippy new monikers are disappearing.



New Name, Higher Price

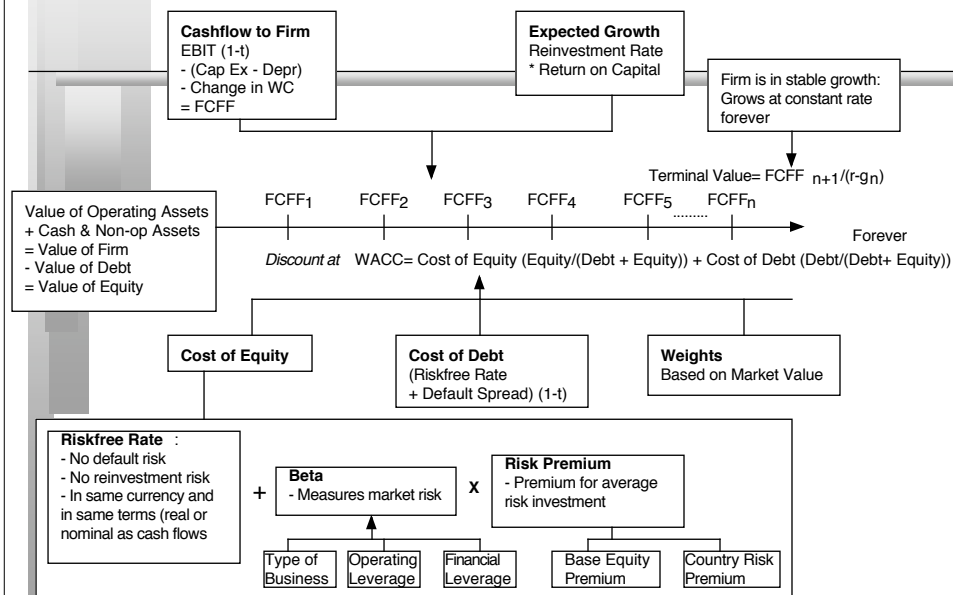
But the stocks still get a bounce when dot-com goes away. Chart shows returns in the days before and after the name change.



Sources: Thomson Datastream; P. Raghavendra Rau, Michael J. Cooper, Igor Osobov, Purdue Univ.; Ajay Khosla, Virginia Univ.; Ajay Patel, Wake Forest Univ.

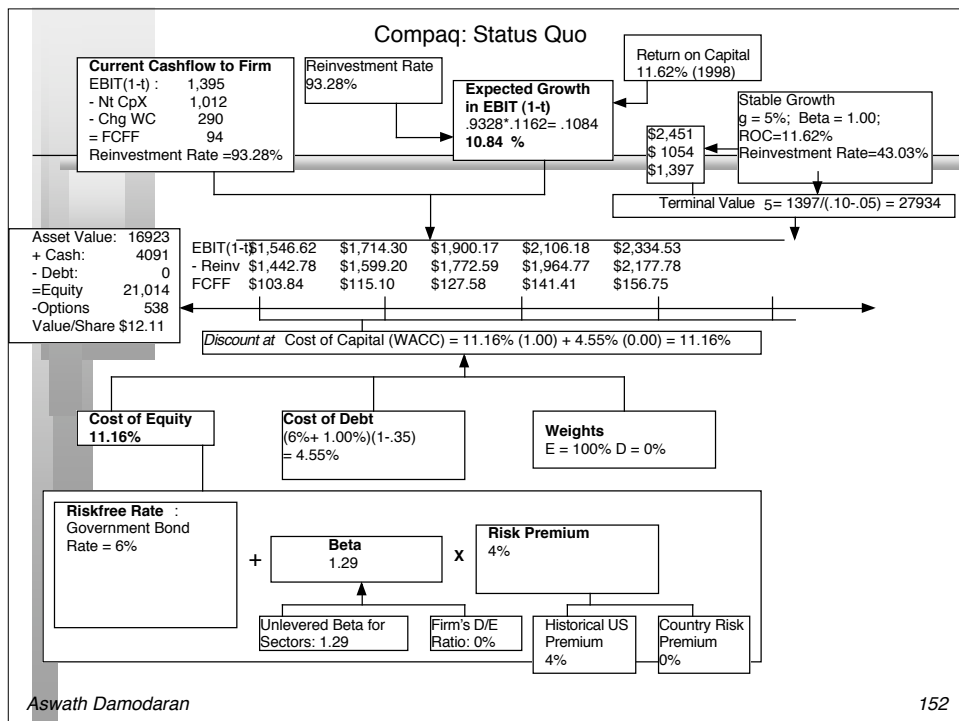
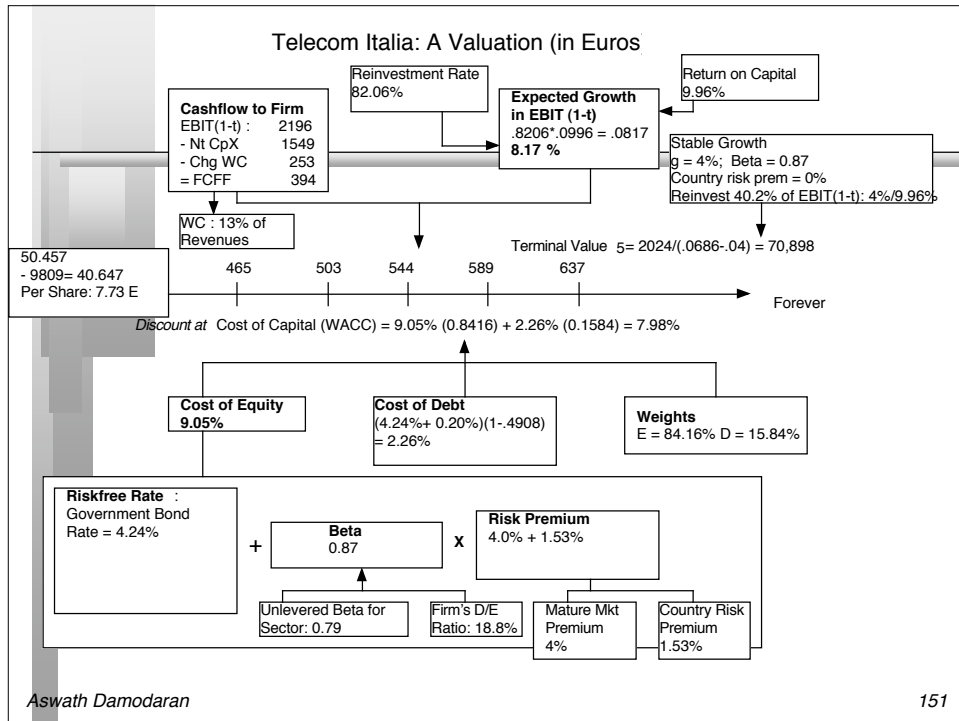
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DISCOUNTED CASHFLOW VALUATION



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The Paths to Value Creation

- Using the DCF framework, there are four basic ways in which the value of a firm can be enhanced:
 - The cash flows from existing assets to the firm can be increased, by either
 - increasing after-tax earnings from assets in place or
 - reducing reinvestment needs (net capital expenditures or working capital)
 - The expected growth rate in these cash flows can be increased by either
 - Increasing the rate of reinvestment in the firm
 - Improving the return on capital on those reinvestments
 - The length of the high growth period can be extended to allow for more years of high growth.
 - The cost of capital can be reduced by
 - Reducing the operating risk in investments/assets
 - Changing the financial mix
 - Changing the financing composition

A Basic Proposition

- For an action to affect the value of the firm, it has to
 - Affect current cash flows (or)
 - Affect future growth (or)
 - Affect the length of the high growth period (or)
 - Affect the discount rate (cost of capital)
- **Proposition 1: Actions that do not affect current cash flows, future growth, the length of the high growth period or the discount rate cannot affect value.**

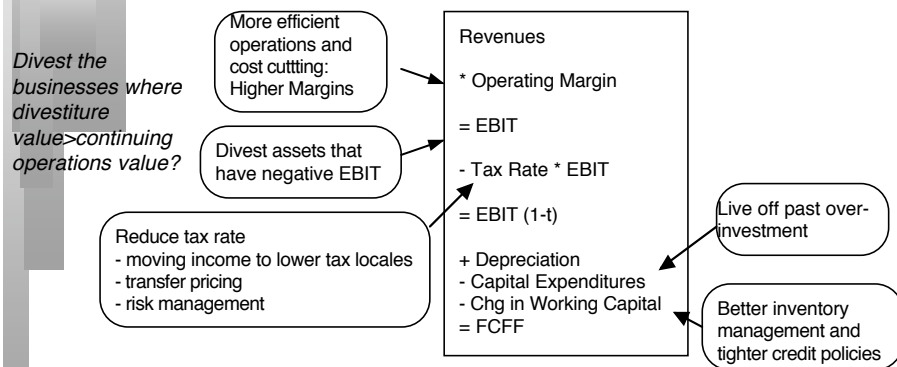
Value-Neutral Actions

- Stock splits and stock dividends change the number of units of equity in a firm, but cannot affect firm value since they do not affect cash flows, growth or risk.
- Accounting decisions that affect reported earnings but not cash flows should have no effect on value.
 - Changing inventory valuation methods from FIFO to LIFO or vice versa in financial reports but not for tax purposes
 - Changing the depreciation method used in financial reports (but not the tax books) from accelerated to straight line depreciation
 - Major non-cash restructuring charges that reduce reported earnings but are not tax deductible
 - Using pooling instead of purchase in acquisitions cannot change the value of a target firm.
- Decisions that create new securities on the existing assets of the firm (without altering the financial mix) such as tracking stock.

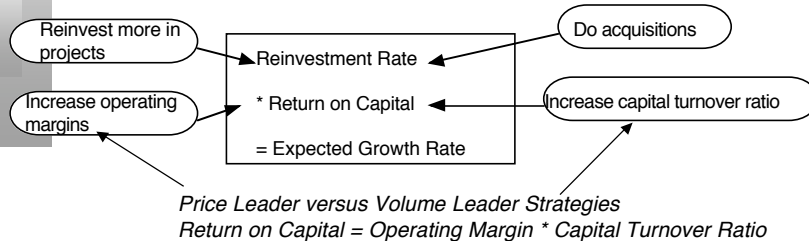
Value Creation 1: Increase Cash Flows from Assets in Place

- The assets in place for a firm reflect investments that have been made historically by the firm. To the extent that these investments were poorly made and/or poorly managed, it is possible that value can be increased by increasing the after-tax cash flows generated by these assets.
- The cash flows discounted in valuation are after taxes and reinvestment needs have been met:
$$\begin{aligned} & \text{EBIT} (1-t) \\ & - (\text{Capital Expenditures} - \text{Depreciation}) \\ & - \text{Change in Non-cash Working Capital} \\ & = \text{Free Cash Flow to Firm} \end{aligned}$$
- Proposition 2: A firm that can increase its current cash flows, without significantly impacting future growth or risk, will increase its value.

Ways of Increasing Cash Flows from Assets in Place



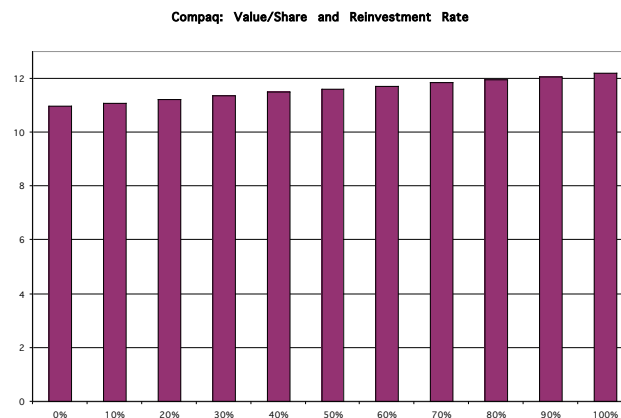
Value Creation 2: Increase Expected Growth



2.1: Increase the Reinvestment Rate

- Holding all else constant, increasing the reinvestment rate will increase the expected growth in earnings of a firm. Increasing the reinvestment rate will, however, reduce the cash flows of the firms. The net effect will determine whether value increases or decreases.
- As a general rule,
 - Increasing the reinvestment rate when the ROC is less than the cost of capital will reduce the value of the firm
 - Increasing the reinvestment rate when the ROC is greater than the cost of capital will increase the value of the firm

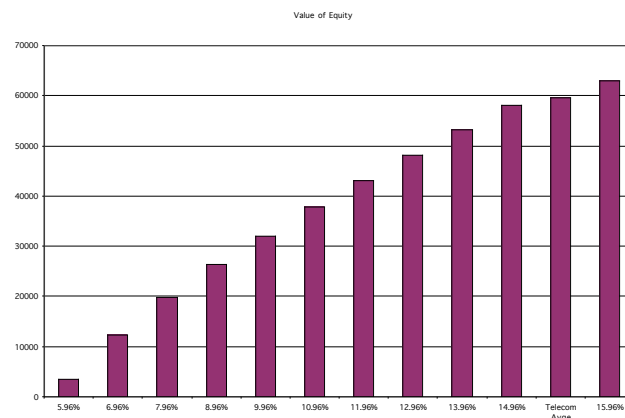
The Return Effect: Reinvestment Rate



2.2: Improve Quality of Investments

- If a firm can increase its return on capital on new projects, while holding the reinvestment rate constant, it will increase its firm value.
 - The firm's cost of capital still acts as a floor on the return on capital. If the return on capital is lower than the cost of capital, increasing the return on capital will reduce the amount of value destroyed but will not create value. The firm would be better off under those circumstances returning the cash to the owners of the business.
 - It is only when the return on capital exceeds the cost of capital, that the increase in value generated by the higher growth will more than offset the decrease in cash flows caused by reinvesting.
- This rule applies just as much to acquisitions as it does to internal investments. A good acquisition is one where you earn a return on invested capital that exceeds the cost of capital of the business that you are acquiring.
- This proposition might not hold, however, if the investments are in riskier projects, because the cost of capital will then increase.

Telecom Italia: Quality of Investments



Value Creation 3: Increase Length of High Growth Period

- Every firm, at some point in the future, will become a stable growth firm, growing at a rate equal to or less than the economy in which it operates.
- The high growth period refers to the period over which a firm is able to sustain a growth rate greater than this “stable” growth rate. If a firm is able to increase the length of its high growth period, other things remaining equal, it will increase value.
- For firms to maintain high growth over a period, they have to earn excess returns. In a competitive market place, these excess returns should attract competitors who will erase these excess returns over time.
- Thus, for a firm to maintain high growth and excess returns over time, it has to create barriers to entry that allow it to maintain these excess returns.

3.1: The Brand Name Advantage

- Some firms are able to sustain above-normal returns and growth because they have well-recognized brand names that allow them to charge higher prices than their competitors and/or sell more than their competitors.
- Firms that are able to improve their brand name value over time can increase both their growth rate and the period over which they can expect to grow at rates above the stable growth rate, thus increasing value.

3.2: Patents and Legal Protection

- The most complete protection that a firm can have from competitive pressure is to own a patent, copyright or some other kind of legal protection allowing it to be the sole producer for an extended period.
- Note that patents only provide partial protection, since they cannot protect a firm against a competitive product that meets the same need but is not covered by the patent protection.
- Licenses and government-sanctioned monopolies also provide protection against competition. They may, however, come with restrictions on excess returns; utilities in the United States, for instance, are monopolies but are regulated when it comes to price increases and returns.

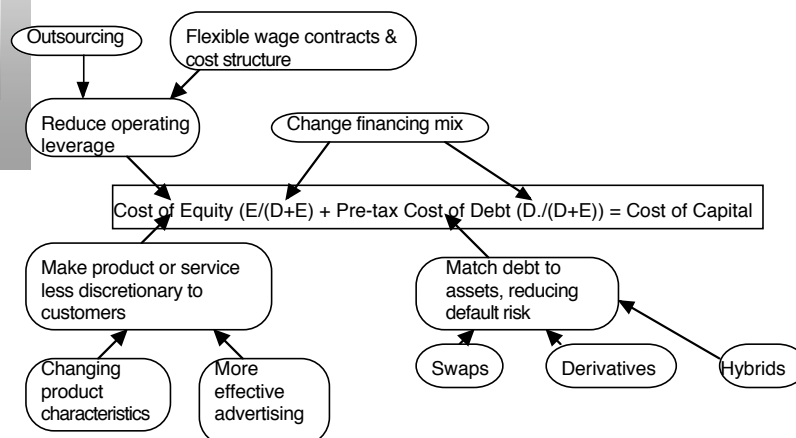
3.3: Switching Costs

- Another potential barrier to entry is the cost associated with switching from one firm's products to another.
- The greater the switching costs, the more difficult it is for competitors to come in and compete away excess returns.
- Firms that devise ways to increase the cost of switching from their products to competitors' products, while reducing the costs of switching from competitor products to their own will be able to increase their expected length of growth.

3.4: Cost Advantages

- There are a number of ways in which firms can establish a cost advantage over their competitors, and use this cost advantage as a barrier to entry:
 - In businesses, where scale can be used to reduce costs, economies of scale can give bigger firms advantages over smaller firms
 - Owning or having exclusive rights to a distribution system can provide firms with a cost advantage over its competitors.
 - Owning or having the rights to extract a natural resource which is in restricted supply (The undeveloped reserves of an oil or mining company, for instance)
- These cost advantages will show up in valuation in one of two ways:
 - The firm may charge the same price as its competitors, but have a much higher operating margin.
 - The firm may charge lower prices than its competitors and have a much higher capital turnover ratio.

Value Creation 4: Reduce Cost of Capital



Estimating Cost of Capital: Telecom Italia

■ Equity

- Cost of Equity = $4.24\% + 0.87 (5.53\%) = 9.05\%$
- Market Value of Equity = $9.92 \text{ E/share} \times 5255.13 = 52,110 \text{ Mil} (84.16\%)$

■ Debt

- Cost of debt = $4.24\% + 0.2\% (\text{default spread}) = 4.44\%$
- Market Value of Debt = $9,809 \text{ Mil} (15.84\%)$

■ Cost of Capital

$$\begin{aligned}\text{Cost of Capital} &= 10.36\% (.8416) + 4.44\% (1 - .8416) \\ &= 9.05\% (.8416) + 2.26\% (.1584) = 7.98\%\end{aligned}$$

Estimating Cost of Capital: Compaq

■ Equity

- Cost of Equity = $6\% + 1.29 (4\%) = 11.16\%$
- Market Value of Equity = $23.38 \times 1691 = \$ 39.5 \text{ billion}$

■ Debt

- Cost of debt = $6\% + 1\% (\text{default spread}) = 7\%$
- Market Value of Debt = 0

■ Cost of Capital

$$\text{Cost of Capital} = 11.16\% (1.00) + 7\% (1 - 1.00) = 11.16\%$$

Telecom Italia: Optimal Debt Ratio and Debt design

Debt Ratio	Beta	Cost of Equity	Bond Rating	Interest rate on debt	Tax Rate	Cost of Debt (after-tax)	WACC	Firm Value (G)
0%	0.79	8.63%	AAA	4.54%	49.08%	2.31%	8.63%	\$45,598
10%	0.84	8.88%	AAA	4.54%	49.08%	2.31%	8.22%	\$54,659
20%	0.89	9.19%	A+	5.24%	49.08%	2.67%	7.89%	\$65,095
30%	0.97	9.59%	A-	5.74%	49.08%	2.92%	7.59%	\$77,927
40%	1.06	10.12%	BB	6.74%	49.08%	3.43%	7.45%	\$86,035
50%	1.20	10.87%	B-	9.24%	49.08%	4.71%	7.79%	\$68,933
60%	1.40	11.98%	CCC	10.24%	49.08%	5.21%	7.92%	\$63,772
70%	1.87	14.60%	CC	11.74%	41.76%	6.84%	9.17%	\$37,267
80%	2.94	20.50%	C	13.24%	32.40%	8.95%	11.26%	\$20,942
90%	5.88	36.76%	C	13.24%	28.80%	9.43%	12.16%	\$17,340

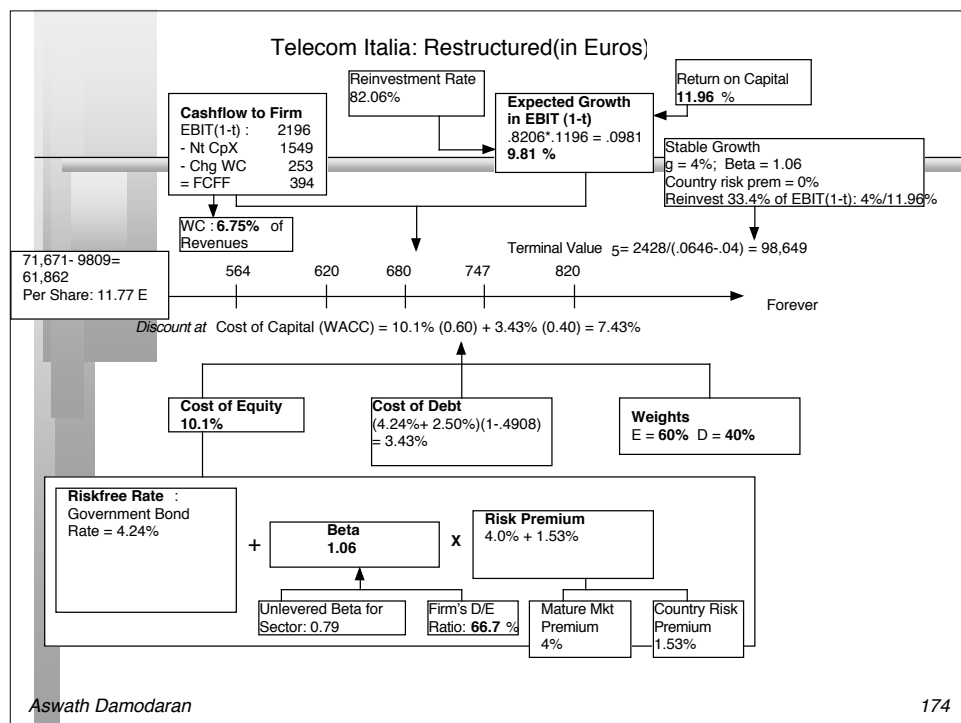
Compaq: Optimal Capital Structure

Debt Ratio	Beta	Cost of Equity	Bond Rating	Interest rate on debt	Tax Rate	Cost of Debt (after-tax)	WACC	Firm Value (G)
0%	1.29	11.16%	AAA	6.30%	35.00%	4.10%	11.16%	\$38,893
10%	1.38	11.53%	AA	6.70%	35.00%	4.36%	10.81%	\$41,848
20%	1.50	12.00%	BBB	8.00%	35.00%	5.20%	10.64%	\$43,525
30%	1.65	12.60%	B-	11.00%	35.00%	7.15%	10.96%	\$40,528
40%	1.85	13.40%	CCC	12.00%	35.00%	7.80%	11.16%	\$38,912
50%	2.28	15.12%	C	15.00%	23.18%	11.52%	13.32%	\$26,715
60%	2.85	17.40%	C	15.00%	19.32%	12.10%	14.22%	\$23,535
70%	3.80	21.21%	C	15.00%	16.56%	12.52%	15.12%	\$20,984
80%	5.70	28.81%	C	15.00%	14.49%	12.83%	16.02%	\$18,890
90%	11.40	51.62%	C	15.00%	12.88%	13.07%	16.92%	\$17,141

The Value Enhancement Chain			
	<i>Gimme'</i>	<i>Odds on.</i>	<i>Could work if..</i>
Assets in Place	1. Divest assets/projects with Divestiture Value > Continuing Value 2. Terminate projects with Liquidation Value > Continuing Value 3. Eliminate operating expenses that generate no current revenues and no growth.	1. Reduce net working capital requirements, by reducing inventory and accounts receivable, or by increasing accounts payable. 2. Reduce capital maintenance expenditures on assets in place.	1. Change pricing strategy to maximize the product of profit margins and turnover ratio.
Expected Growth	Eliminate new capital expenditures that are expected to earn less than the cost of capital	Increase reinvestment rate or marginal return on capital or both in firm's existing businesses.	Increase reinvestment rate or marginal return on capital or both in new businesses.
Length of High Growth Period	If any of the firm's products or services can be patented and protected, do so	Use economies of scale or cost advantages to create higher return on capital.	1. Build up brand name 2. Increase the cost of switching from product and reduce cost of switching to it.
Cost of Financing	1. Use swaps and derivatives to match debt more closely to firm's assets 2. Recapitalize to move the firm towards its optimal debt ratio.	1. Change financing type and use innovative securities to reflect the types of assets being financed 2. Use the optimal financing mix to finance new investments. 3. Make cost structure more flexible to reduce operating leverage.	Reduce the operating risk of the firm, by making products less discretionary to customers.

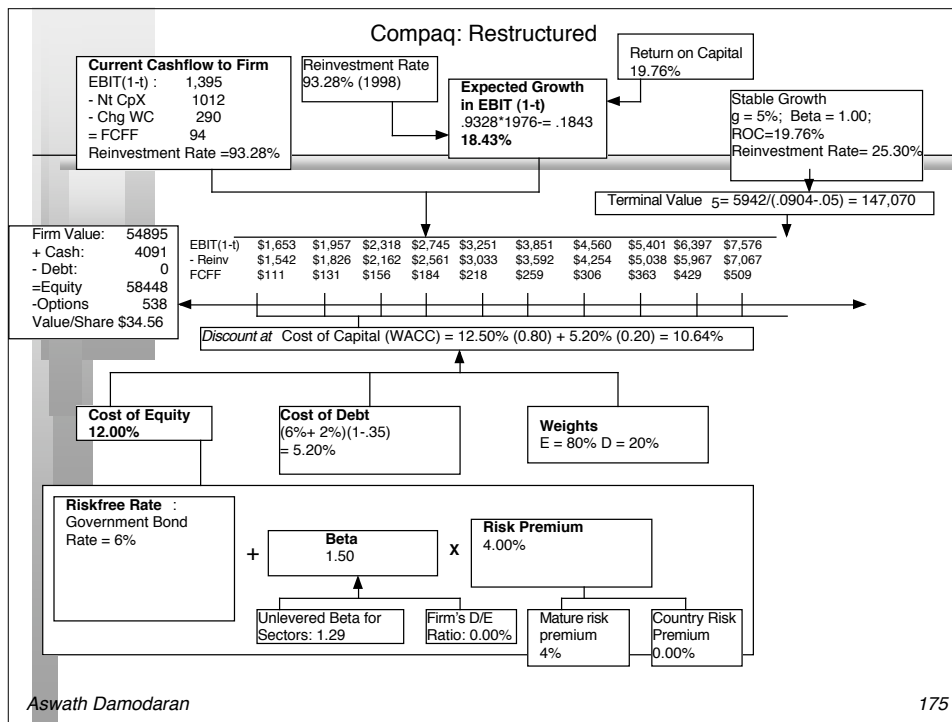
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Alternative Approaches to Value Enhancement

- *Maximize a variable that is correlated with the value of the firm. There are several choices for such a variable. It could be*
 - an accounting variable, such as **earnings or return on investment**
 - a marketing variable, such as **market share**
 - a cash flow variable, such as cash flow return on investment (CFROI)
 - a risk-adjusted cash flow variable, such as Economic Value Added (EVA)
- **The advantages of using these variables are that they**
 - Are often simpler and easier to use than DCF value.
- **The disadvantage is that the**
 - Simplicity comes at a cost; these variables are not perfectly correlated with DCF value.

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Economic Value Added (EVA) and CFROI

- The Economic Value Added (EVA) is a measure of surplus value created on an investment.
 - Define the return on capital (ROC) to be the “true” cash flow return on capital earned on an investment.
 - Define the cost of capital as the weighted average of the costs of the different financing instruments used to finance the investment.

$$\text{EVA} = (\text{Return on Capital} - \text{Cost of Capital}) (\text{Capital Invested in Project})$$

- The CFROI is a measure of the cash flow return made on capital
$$\text{CFROI} = (\text{Adjusted EBIT} (1-t) + \text{Depreciation \& Other Non-cash Charges}) / \text{Capital Invested}$$

In Practice: Measuring EVA

- *Capital Invested:* Many firms use the book value of capital invested as their measure of capital invested. To the degree that book value reflects accounting choices made over time, this may not be true. In addition, the book capital may not reflect the value of intangible assets such as research and development.
- *Operating Income:* Operating income has to be cleansed of any expenses which are really capital expenses or financing expenses.
- *Cost of capital:* The cost of capital for EVA purposes should be computed based on market values.
- *Bottom line:* If you estimate return on capital and cost of capital correctly in DCF valuation, you can use those numbers to compute EVA.

Estimating Nestle's EVA in 1995

- Return on Capital
 - After-tax Operating Income = 5665 Million Sfr (1 - .3351)
= 3767 Million Sfr
 - Capital in Assets in Place 1994 = BV of Equity + BV of Debt
= 17774 + (4180 + 7546) = 29,500 Million Sfr
 - Return on Capital = 3767 / 29,500 = 12.77%
- Cost of Capital
 - Cost of Equity = 4.5% + 0.99 (5.5%) = 10%
 - Cost of Debt = 4.75% (1 - .3351) = 3.16%
 - Debt to Capital Ratio (market value) = 11726 / 68376
 - Cost of Capital = 10% (56650 / 68376) + 3.16% (11726 / 68376) = 8.85%
- Economic Value Added in 1995 = (.1277 - .0885) (29,500 Million Sfr)
= 1154.50 Million Sfr

EVA for Growth Companies

- For companies, divisions or projects which make significant infrastructure investments, with long gestation periods, the current EVA may not be a good indicator of the quality of investments.

Estimating Tsingtao's EVA in 1996

- Tsingtao Brewery, a Chinese Beer manufacturer, has made significant capital investments in the last two years, and plans to increase its exports over time. Using 1996 numbers, Tsingtao had the following fundamentals:
 - Return on Capital = 1.28%
 - Cost of Capital = 15.51%
 - Capital Invested = 3,015 million CC
- Economic Value Added in 1996 = – 429 million CC

Discussion Issue: Reading the EVA

- Tsingtao had a negative EVA of – 429 million in 1996. Assuming that the book value of capital, operating income and cost of capital are correctly measured, which of the following are implied by this EVA?
 - The firm has invested in poor projects
 - The firm has inferior management
 - The firm is currently earning less on its projects than it should be earning, given its cost of capital.
- What does this tell you about the current EVA of young, start-up firms early in the life cycle?
 - The measured EVA will generally be very positive
 - The measured EVA will generally be very negative

An Equity EVA

- When capital is difficult to measure, and leverage is not a choice variable (because of regulations or standard practice), the economic value added can be stated in equity terms
- $\text{Equity EVA} = (\text{ROE} - \text{Cost of Equity}) (\text{Equity Invested})$
 - **Equity Invested** : This is supposed to measure the equity invested in projects in place. It is usually measured using the book value of equity, with adjustments made.
 - **Return on Equity**: This is supposed to measure the return made on the equity invested in projects in place. It is usually measured by dividing the net income by the book value of equity
 - **Cost of Equity**: This is supposed to measure the cost of equity for the project, division or firm, for which the EVA is being measured.

J.P. Morgan's Equity EVA: 1996

- Equity Invested at the end of 1995 = \$ 10,451 Million
- Net Income Earned in 1996 = \$ 1,574 Million
- Cost of Equity for 1996 = $7\% + 0.94 (5.5\%) = 12.17\%$
 - I used the riskfree rate from the start of 1996
- Equity EVA for J.P. Morgan = \$ 1,574 Million - $(\$10,451 \text{ Million})(.1217) = \$ 303 \text{ Million}$

Increasing Equity EVA at J.P. Morgan

- Assume now that you are the CEO of J.P. Morgan and that your compensation next year will depend upon whether you increase the EVA or not. What are the three ways in which you can increase your EVA?

Divisional EVA

- When EVA is computed at the division level, the computation requires that
 - book value be estimated at the divisional level. Since firms do not maintain balance sheets at divisional levels, this will involve allocation mechanisms
 - income be estimated at the divisional level. Again, allocation of fixed headquarters expenses becomes an issue
 - cost of equity and capital be estimated at the divisional level
- The initial estimates of EVA are likely to reflect the allocation mechanisms used and the mistakes made in those allocations
- Changes in EVA over time are more useful measures than the initial EVA estimates themselves

Things to Note about EVA

- EVA is a measure of dollar surplus value, not the percentage difference in returns.
- It is closest in both theory and construct to the net present value of a project in capital budgeting, as opposed to the IRR.
- The value of a firm, in DCF terms, can be written in terms of the EVA of projects in place and the present value of the EVA of future projects.

DCF Value and NPV

Value of Firm

= Value of Assets in Place + Value of Future Growth

= (Investment in Existing Assets + $NPV_{\text{Assets in Place}}$) + NPV of all future projects

= (I + $NPV_{\text{Assets in Place}}$) + $\sum_{j=1}^{j=N} NPV_j$

where there are expected to be N projects yielding surplus value (or excess returns) in the future and I is the capital invested in assets in place (which might or might not be equal to the book value of these assets).

DCF Valuation, NPV and EVA

$$\begin{aligned}
 \text{Value of Firm} &= (I + \text{NPV}_{\text{Assets in Place}}) + \sum_{j=1}^{j=N} \text{NPV}_j \\
 &= \left(I_A + \sum_{t=1}^{t=n} \frac{(\text{ROC} - \text{WACC}) I_A}{(1 + \text{WACC})^t} \right) + \left[\sum_{j=1}^{j=N} \left(\sum_{t=1}^{t=n} \frac{(\text{ROC} - \text{WACC}) I_j}{(1 + \text{WACC})^t} \right) \right] \\
 &= \left(I_A + \sum_{t=1}^{t=n} \frac{(\text{ROC} - \text{WACC}) I_A}{(1 + \text{WACC})^t} \right) + \left[\sum_{j=1}^{j=N} \left(\sum_{t=1}^{t=jn} \frac{(\text{ROC} - \text{WACC}) I_j}{(1 + \text{WACC})^t} \right) \right] \\
 &= \left(I_A + \sum_{t=1}^{t=n} \frac{\text{EVA}_A}{(1 + \text{WACC})^t} \right) + \left[\sum_{j=1}^{j=N} \left(\sum_{t=1}^{t=jn} \frac{\text{EVA}_j}{(1 + \text{WACC})^t} \right) \right]
 \end{aligned}$$

Firm Value = Capital Invested in Assets in Place + PV of EVA from Assets in Place + Sum of PV of EVA from new projects

A Simple Illustration

- Assume that you have a firm with
 - $I_A = 100$ In each year 1-5, assume that
 - $\text{ROC}_A = 15\%$ $\Delta I = 10$ (Investments are at beginning of each year)
 - $\text{WACC}_A = 10\%$ $\text{ROC}_{\text{New Projects}} = 15\%$
 - $\text{WACC}_{\text{New Projects}} = 10\%$
- Assume that all of these projects will have infinite lives.
- After year 5, assume that
 - Investments will grow at 5% a year forever
 - ROC on projects will be equal to the cost of capital (10%)

Firm Value using EVA Approach

Capital Invested in Assets in Place	= \$ 100
EVA from Assets in Place = $(.15 - .10)(100)/.10$	= \$ 50
+ PV of EVA from New Investments in Year 1 = $[(.15 - .10)(10)/.10]$	= \$ 5
+ PV of EVA from New Investments in Year 2 = $[(.15 - .10)(10)/.10]/1.1$	= \$ 4.55
+ PV of EVA from New Investments in Year 3 = $[(.15 - .10)(10)/.10]/1.1^2$	= \$ 4.13
+ PV of EVA from New Investments in Year 4 = $[(.15 - .10)(10)/.10]/1.1^3$	= \$ 3.76
+ PV of EVA from New Investments in Year 5 = $[(.15 - .10)(10)/.10]/1.1^4$	= \$ 3.42
Value of Firm	= \$ 170.85

Firm Value using DCF Valuation: Estimating FCFF

	Base Year	1	2	3	4	5	Term. Year
EBIT (1-t) : Assets in Place	\$ 15.00	\$ 15.00	\$ 15.00	\$ 15.00	\$ 15.00	\$ 15.00	
EBIT(1-t) :Investments- Yr 1		\$ 1.50	\$ 1.50	\$ 1.50	\$ 1.50	\$ 1.50	
EBIT(1-t) :Investments- Yr 2			\$ 1.50	\$ 1.50	\$ 1.50	\$ 1.50	
EBIT(1-t): Investments -Yr 3				\$ 1.50	\$ 1.50	\$ 1.50	
EBIT(1-t): Investments -Yr 4					\$ 1.50	\$ 1.50	
EBIT(1-t): Investments- Yr 5						\$ 1.50	
Total EBIT(1-t)		\$ 16.50	\$ 18.00	\$ 19.50	\$ 21.00	\$ 22.50	\$ 23.63
- Net Capital Expenditures	\$10.00	\$ 10.00	\$ 10.00	\$ 10.00	\$ 10.00	\$ 11.25	\$ 11.81
FCFF		\$ 6.50	\$ 8.00	\$ 9.50	\$ 11.00	\$ 11.25	\$ 11.81

Firm Value: Present Value of FCFF

Year	0	1	2	3	4	5	Term Year
FCFF		\$ 6.50	\$ 8.00	\$ 9.50	\$ 11.00	\$ 11.25	\$ 11.81
PV of FCFF	(\$10)	\$ 5.91	\$ 6.61	\$ 7.14	\$ 7.51	\$ 6.99	
Terminal Value						\$ 236.25	
PV of Terminal Value						\$ 146.69	
Value of Firm	\$170.85						

Implications

- Growth, by itself, does not create value. It is growth, with investment in excess return projects, that creates value.
 - The growth of 5% a year after year 5 creates no additional value.
- The “market value added” (MVA), which is defined to be the excess of market value over capital invested is a function of the excess value created.
 - In the example above, the market value of \$ 170.85 million exceeds the book value of \$ 100 million, because the return on capital is 5% higher than the cost of capital.

EVA Valuation of Nestle

	0	1	2	3	4	5	Term. Year
Return on Capital	12.77%	12.77%	12.77%	12.77%	12.77%	12.77%	12.77%
Cost of Capital	8.85%	8.85%	8.85%	8.85%	8.85%	8.85%	8.85%
EBIT(1-t)	3,766.66Fr	4,066.46Fr	4,390.06Fr	4,739.37Fr	5,116.40Fr	5,523.38Fr	5,689.08Fr
WACC(Capital)	2,612.06Fr	2,819.97Fr	3,044.38Fr	3,286.61Fr	3,548.07Fr	3,830.29Fr	3,945.20Fr
EVA	1,154.60Fr	1,246.49Fr	1,345.69Fr	1,452.76Fr	1,568.33Fr	1,693.08Fr	1,743.88Fr
PV of EVA		1,145.10Fr	1,135.67Fr	1,126.30Fr	1,117.00Fr	1,107.76Fr	
						29,787.18Fr	
PV of EVA =	25,121.24Fr					PV of 1693.08 Fr growing at 3% a year	
Value of Assets in Place =	29,500.00Fr						
Value of Firm =	54,621.24Fr						
Value of Debt =	11,726.00Fr						
Value of Equity =	42,895.24Fr						
Value Per Share =	1,088.16Fr						

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DCF Valuation of Nestle

	0	1	2	3	4	5	Terminal Year
EBIT (1-t)	0.00Fr	4,066.46Fr	4,390.06Fr	4,739.37Fr	5,116.40Fr	5,523.38Fr	5,689.08Fr
+ Deprec'n	2,305.00Fr	2,488.02Fr	2,685.58Fr	2,898.83Fr	3,129.00Fr	1,273.99Fr	1,350.42Fr
- Cap Ex	3,898.00Fr	4,207.51Fr	4,541.60Fr	4,902.22Fr	5,291.48Fr	2,154.45Fr	2,283.71Fr
- Change in WC	755.00Fr	814.95Fr	879.66Fr	949.51Fr	1,024.90Fr	417.29Fr	442.33Fr
FCFF	-2,348.00Fr	1,532.02Fr	1,654.38Fr	1,786.46Fr	1,929.03Fr	4,225.62Fr	4,313.46Fr
Terminal Value						151,113.54Fr	
WACC	8.85%	8.85%	8.85%	8.85%	8.85%	8.85%	8.85%
PV of FCFF	-2,348.00Fr	1,407.40Fr	1,396.19Fr	1,385.02Fr	1,373.90Fr	51,406.74Fr	
Value of Firm=	54,621.24Fr						
Value of Debt =	11,726.00Fr						
Value of Equity =	42,895.24Fr						
Value Per Share =	1,088.16Fr						

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In summary ...

- Both EVA and Discounted Cash Flow Valuation should provide us with the same estimate for the value of a firm.
- In their full forms, the information that is required for both approaches is exactly the same - expected cash flows over time and costs of capital over time.
- A policy of maximizing the present value of economic value added over time should be the equivalent of a policy of maximizing firm value.

Year-by-year EVA Changes

- Firms are often evaluated based upon year-to-year changes in EVA rather than the present value of EVA over time.
- The advantage of this comparison is that it is simple and does not require the making of forecasts about future earnings potential.
- Another advantage is that it can be broken down by any unit - person, division etc., as long as one is willing to assign capital and allocate earnings across these same units.
- While it is simpler than DCF valuation, using year-by-year EVA changes comes at a cost. In particular, it is entirely possible that a firm which focuses on increasing EVA on a year-to-year basis may end up being less valuable.

Year-to-Year EVA Changes: Nestle

	0	1	2	3	4	5	Term, Year
Return on Capital	12.77%	12.77%	12.77%	12.77%	12.77%	12.77%	12.77%
Cost of Capital	8.85%	8.85%	8.85%	8.85%	8.85%	8.85%	8.85%
EBIT(1-t)	3,766.66Fr	4,066.46Fr	4,390.06Fr	4,739.37Fr	5,116.40Fr	5,523.38Fr	5,689.08Fr
WACC(Capital)	2,612.06Fr	2,819.97Fr	3,044.38Fr	3,286.61Fr	3,548.07Fr	3,830.29Fr	3,945.20Fr
EVA	1,154.60Fr	1,246.49Fr	1,345.69Fr	1,452.76Fr	1,568.33Fr	1,693.08Fr	1,743.88Fr
PV of EVA		1,145.10Fr	1,135.67Fr	1,126.30Fr	1,117.00Fr	1,107.76Fr	
						29,787.18Fr	
PV of EVA =	25,121.24Fr					PV of 590.67 Fr growing at 3% a year	
Value of Assets in Place =	29,500.00Fr						
Value of Firm =	54,621.24Fr						
Value of Debt =	11,726.00Fr						
Value of Equity	42,895.24Fr						
Value per Share =	1088.16Fr						

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Discussion Issues

- In the above example, Nestle is expected to increase its EVA from 1154.50 Million Sfr in 1995 to 1246 Million Sfr in 1996.
- Assume that you are the CEO of Nestle and that you are offered a deal. If you deliver an EVA greater than 1246 million Sfr, you will receive a very substantial bonus. Can you think of ways in which you can deliver a higher EVA than expected while making the firm less valuable?

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When Increasing EVA on year-to-year basis may result in lower Firm Value

If the increase in EVA on a year-to-year basis has been accomplished at the expense of the EVA of future projects. In this case, the gain from the EVA in the current year may be more than offset by the present value of the loss of EVA from the future periods.

- For example, in the Nestle example above assume that the return on capital on year 1 projects increases to 13.27% (from the existing 12.77%), while the cost of capital on these projects stays at 8.85%. If this increase in value does not affect the EVA on future projects, the value of the firm will increase.
- If, however, this increase in EVA in year 1 is accomplished by reducing the return on capital on future projects to 12.27%, the firm value will actually decrease.

Firm Value and EVA tradeoffs over time

	0	1	2	3	4	5	Term. Year
Return on Capital	12.77%	13.27%	12.27%	12.27%	12.27%	12.27%	12.27%
Cost of Capital	8.85%	8.85%	8.85%	8.85%	8.85%	8.85%	8.85%
EBIT(1-t)	3,766.66Fr	4,078.24Fr	4,389.21Fr	4,724.88Fr	5,087.20Fr	5,478.29Fr	5,642.64Fr
WACC(Capital)	2,612.06Fr	2,819.97Fr	3,044.38Fr	3,286.61Fr	3,548.07Fr	3,830.29Fr	3,948.89Fr
EVA	1,154.60Fr	1,258.27Fr	1,344.84Fr	1,438.28Fr	1,539.13Fr	1,648.00Fr	1,693.75Fr
PV of EVA		1,155.92Fr	1,134.95Fr	1,115.07Fr	1,096.20Fr	1,078.27Fr	
						28,930.98Fr	
PV of EVA =	24,509.62Fr	PV of 590.67 Fr growing at 3% a year					
Value of Assets in Place =	29,500.00Fr						
Value of Firm =	54,009.62Fr						
Value of Debt =	11,726.00Fr						
Value of Equity =	42,283.62Fr						
Value Per Share =	1,072.64Fr						

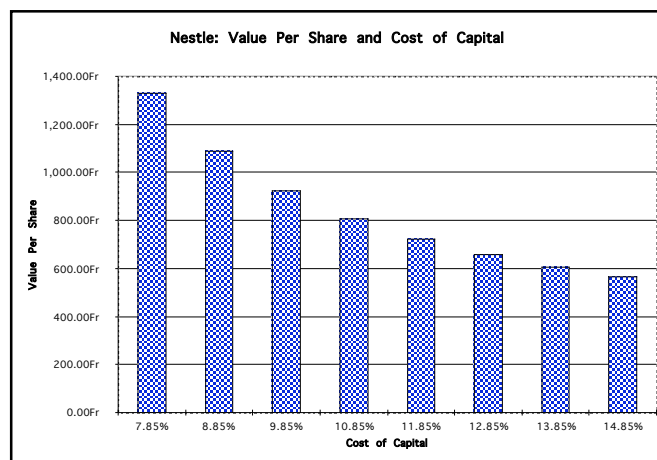
EVA and Risk

- When the increase in EVA is accompanied by an increase in the cost of capital, either because of higher operational risk or changes in financial leverage, the firm value may decrease even as EVA increases.
 - For instance, in the example above, assume that the spread stays at 3.91% on all future projects but the cost of capital increases to 9.85% for these projects (from 8.85%). The value of the firm will drop.

Nestle's Value at a 9.95 % Cost of Capital

	0	1	2	3	4	5	Term. Year
Return on Capital	12.77%	13.77%	13.77%	13.77%	13.77%	13.77%	13.77%
Cost of Capital	8.85%	9.85%	9.85%	9.85%	9.85%	9.85%	9.85%
EBIT(1-t)	3,766.66Fr	4,089.94Fr	4,438.89Fr	4,815.55Fr	5,222.11Fr	5,660.96Fr	5,830.79Fr
WACC(Capital)	2,612.06Fr	2,843.45Fr	3,093.20Fr	3,362.79Fr	3,653.78Fr	3,967.88Fr	4,384.43Fr
EVA	1,154.60Fr	1,246.49Fr	1,345.69Fr	1,452.76Fr	1,568.33Fr	1,693.08Fr	1,446.36Fr
PV of EVA		1,134.68Fr	1,115.09Fr	1,095.82Fr	1,076.88Fr	1,058.25Fr	
						21,101.04Fr	
PV of EVA =	18,669.84Fr	PV of 590.67 Fr growing at 3% a year					
Value of Assets in Place =	29,500.00Fr						
Value of Firm =	48,169.84Fr						
Value of Debt =	11,726.00Fr						
Value of Equity =	36,443.84Fr						
Value Per Share =	924.50Fr						

EVA: The Risk Effect



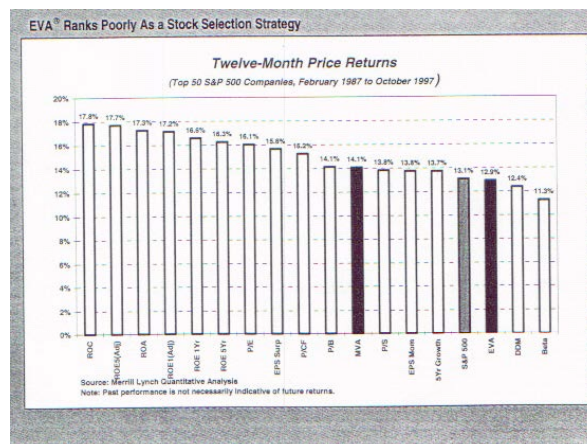
Advantages of EVA

1. EVA is closely related to NPV. It is closest in spirit to corporate finance theory that argues that the value of the firm will increase if you take positive NPV projects.
2. It avoids the problems associated with approaches that focus on percentage spreads - between ROE and Cost of Equity and ROC and Cost of Capital. These approaches may lead firms with high ROE to turn away good projects to avoid lowering their percentage spreads.
3. It makes top managers responsible for a measure that they have more control over - the return on capital and the cost of capital are affected by their decisions - rather than one that they feel they cannot control as well - the market price per share.
4. It is influenced by all of the decisions that managers have to make within a firm - the investment decisions and dividend decisions affect the return on capital and the financing decision affects the WACC.

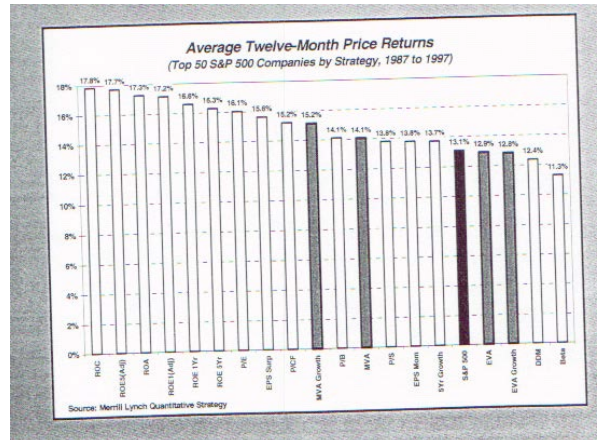
EVA and Changes in Market Value

- The relationship between EVA and Market Value Changes is more complicated than the one between EVA and Firm Value.
- The market value of a firm reflects not only the Expected EVA of Assets in Place but also the Expected EVA from Future Projects
- To the extent that the actual economic value added is smaller than the expected EVA the market value can decrease even though the EVA is higher.

High EVA companies do not earn excess returns



Increases in EVA do not create excess returns



Implications of Findings

- This does not imply that increasing EVA is bad from a corporate finance standpoint. In fact, given a choice between delivering a “below-expectation” EVA and no EVA at all, the firm should deliver the “below-expectation” EVA.
- It does suggest that the correlation between increasing year-to-year EVA and market value will be weaker for firms with high anticipated growth (and excess returns) than for firms with low or no anticipated growth.
- It does suggest also that “investment strategies” based upon EVA have to be carefully constructed, especially for firms where there is an expectation built into prices of “high” surplus returns.

When focusing on year-to-year EVA changes has least side effects

1. Most or all of the assets of the firm are already in place; i.e., very little or none of the value of the firm is expected to come from future growth.
 - [This minimizes the risk that increases in current EVA come at the expense of future EVA]
2. The leverage is stable and the cost of capital cannot be altered easily by the investment decisions made by the firm.
 - [This minimizes the risk that the higher EVA is accompanied by an increase in the cost of capital]
3. The firm is in a sector where investors anticipate little or not surplus returns; i.e., firms in this sector are expected to earn their cost of capital.
 - [This minimizes the risk that the increase in EVA is less than what the market expected it to be, leading to a drop in the market price.]

When focusing on year-to-year EVA changes can be dangerous

1. High growth firms, where the bulk of the value can be attributed to future growth.
 2. Firms where neither the leverage nor the risk profile of the firm is stable, and can be changed by actions taken by the firm.
 3. Firms where the current market value has imputed in it expectations of significant surplus value or excess return projects in the future.
- Note that all of these problems can be avoided if we restate the objective as maximizing the present value of EVA over time. If we do so, however, some of the perceived advantages of EVA - its simplicity and observability - disappear.