How Do You Value the Priceless?

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If you are seeking to raise capital for your start-up company, or you're thinking of investing money into one, it's important to determine the company's worth. This feature article gives an overview of the methodologies used to value your company in various stage of development, a product or an intellectual property.

Professor's Personal Note

I recently spoke to a scientist and inventor to help him commercialize his product. After he demonstrated his brilliant new product, I asked a very basic question: What do you think your invention is worth? "Priceless", he said. I realized that I knew the answer before I asked it. It's like asking what your newborn is worth.

I consider myself a numbers person. As a young analyst at Bank of America in the late 1980s, my colleagues called me Captain Crunch. I spent more than 30 years in banking analyzing investment opportunities, identifying the risks and valuing companies by building spreadsheets, many, many spreadsheets. I always knew that valuing a company or an investor's equity is highly subjective. There is a lot of interpretation of the data used for the valuation methods. Although there are several methods to value a company, the valuation is both art and science. There is some judgement that goes in choosing the data. Naturally, the buyer has a different perspective than the seller and therefore the valuation assessment could be derived differently. I also learned that we can spend hours and days analyzing the value of the company but at the end of the day ***the value of anything is what someone is willing to pay.***

After giving hundreds of lectures on how to value businesses – from their start-up phase to early development, to-going-public, to even valuing companies emerging out bankruptcy, I realized that not all valuations can be calculated accurately on spreadsheets. How do you explain the stratospheric stock prices for many technology companies that had negative income and cash flows for many years in their early stage of development but the stock, representing the value of these companies continued to grow (Amazon or Facebook)? Venmo, for example, a U.S. fintech company, raised $1.5 million in seed money, and incredibly in less than three years, PayPal bought Venmo for $800 million. As I have struggled with this question, one important lesson I learned is that a valuation that is not supported by a story is insensitive. People remember stories better than spreadsheets. My willingness to expand the traditional valuation methods and incorporate new metrics help me develop a model that combines the old valuation methodologies and storytelling.

How do you value a new idea? How do you value an intellectual property, a brand name, a franchise, a trademark or a new start-up? There is recent strong emphasis on intellectual property given that the highest growth of the U.S. economy comes from new technological platforms such as FinTech, CleanTech, HealthTech and EduTech. It's no coincidence that the largest companies by market cap are technology companies such as Apple, Amazon, Google & Microsoft. All these companies started with convincing storytelling. A good story is simple, credible and persuasive. In writing this story the entrepreneur or the inventor needs to answer a few basic questions: ***1. Who wants this and how big is the market?; 2. How much cost it will take to implement or convince someone to fund your vision; and 3. Can the story be converted to numbers and value?***

Business Valuation Overview

Starting with the basics, there are many methods for valuing companies based on their life cycle including "idea" companies that own intellectual property (IP), young companies that sell to one or two customers, mature growth companies, mature companies, declining companies and distressed companies. All can be valued using traditional methodologies as illustrated below:

METHOD	DESCRIPTION	PROS	CONS	WHEN USED
Market	Based on comparable market transactions of intangibles	Market driven – based on what someone is willing to pay (reflecting market prices based on demand and supply equilibrium)	Comparable transactions are sometimes not available	Most desirable but rarely used since a lot of the intangible products (IP) are new and unique
Income	Based on future cash flows (Royalties, Licensing or other Incremental profits)	Top-down approach, based on expected economic returns on initial cost	Input information can be very challenging since the info deals with future projections	Most commonly used – building future benefits helps pricing the royalties, licensing fees based on return expectation
Cost/Replacement	Based on estimated cost of replacing or reproducing the intangible	Easier to calculate – calculate labor, materials and overhead (LMO)	The cost representing the book value does not always represent the market value	Not very common. Used as the basis before spending the money for the specific intangible.
Option Pricing	Based on option pricing models such as Black-Scholes measuring the current "out-of-money" to future "in-the-money" values	Using probability of success and sensitize to get a range.	Input variables to determine future value can be very challenging	Used when there is an obvious cash outflow before the cash inflow kicks in to value the specific intangible asset

Methods of Valuations Explained

Market methods includes using the stock price as measurement of value for a public traded company; using comparable trading values of other similar companies in the same industry; and using other comparable companies that have already being purchased by strategic and/or private equity investors, called acquisition comparable.

Income methods includes the traditional discount cash flow method (DCF) that derives the present value of a company based on future cash flows; and the leveraged buyout method (LBO) that derives the value of a company based what a private equity investor is willing to invest in order to meet their set targeted returns.

Cost or cost-to-duplicate and replacement methods includes methods that are derived starting from the actual cost of development to companies that are going through liquidation or bankruptcy where the value could be lower than the original investment.

Option pricing methods includes methods that use formulas, such as the Black-Scholes option pricing model and other probability of success models to calculate the valuation. These methods are primarily used for "idea" companies or start-ups that do not have and distressed companies that have negative income and cash flows.

Every method illustrated in the table above has its pros and cons and it's important for the analyst to choose one that is in line with the company's life cycle. The following sections describe the methodologies used that are based on the company's stage of development.

A. Valuing Well-Established Companies

These are companies that have at least five years of operating history. Obviously having the company's 5-year operating performance could be the best indication of what the future could bring unless there is clear shift in the business. The historical revenue growth from year to year, as well as the operating and capital cost components as percentage of revenues could be the basic drivers for building the projections.

Using Income Method

In the valuation methods discussed above one of the most powerful ones is the income base valuation which is based on projections.

Discount Cash Flow Method

This method called discount cash flow method (DCF) values the company based on 4 variables: 1) future stream of cash flows derived by revenue growth and cost assumptions; 2) identifying an exit year – typically 5 years; 3) calculate the value of the company at the exit year (terminal value); and 4) using the right discount rate (DR) representing the expected return based on risk of success. Today's value of the business (enterprise value) using a DCF is:

$$EV = Equity\ Value + Current\ Debt - Current\ Cash.$$

The value of Equity Value using DCF analysis is:

$$Equity\ Value = \sum_{1}^{t} \frac{CF}{(1+i)^t} + \frac{TV}{(1+i)^t}$$

where CF is the future equity cash flows, t is the exit year, i is the discount rate, TV is value of Equity at the exit year.

The following example (figure 1) shows the summary of DCF and the value of Hyatt Hotels, a publicly traded company with current stock price at $74.24 (August 5, 2019):

Hyatt Hotels Corporation
CORPORATE VALUATIONS

Stock Price (as of 8/5/2019) $ 74.24

METHOD #6 - Discount Cash Flow Valuation Analysis

Discout Cash Flow Valuation Analysis	Historical Assumptions	Projected Assumptions	Input Actual 6/30/2019	year = 1 12/31/2019	2 12/30/2020	3 12/30/2021	4 12/31/2022	5 EXIT YEAR 12/31/2023	6 12/30/2024
Revenues			2,535,000	2,661,750	2,794,838	2,934,579	3,081,308	3,235,374	3,397,142
Revenue Growth				5.0%	5.0%	5.0%	5.0%	5.0%	5.0%
Cost of Revenues (CoGS)	60.6%	60.0%	(1,537,000)	(1,597,050)	(1,676,903)	(1,760,748)	(1,848,785)	(1,941,224)	(2,038,285)
Operating Expenses (Excl. Non-rec.)	28.7%	26.0%	(727,000)	(692,055)	(726,658)	(762,991)	(801,140)	(841,197)	(883,257)
EBIT			271,000	372,645	391,277	410,841	431,383	452,952	475,600
Less Taxes (tax rate x of EBIT)		36.0%	-	(134,152)	(140,860)	(147,903)	(155,298)	(163,063)	(171,216)
Plus Depreciation	14.3%	10.0%	362,000	266,175	279,484	293,458	308,131	323,537	339,714
Less Working Capital	0.0%	0.0%		-	-	-	-	-	-
Less Capex	12.7%	10.0%	(322,000)	(266,175)	(279,484)	(293,458)	(308,131)	(323,537)	(339,714)
Cash Flow			311,000	238,493	250,417	262,938	276,085	289,889	304,384
EBITDA			633,000	638,820	670,761	704,299	739,514	776,490	815,314
Debt (assuming 5% reduction of intial principal per year)			1,712,000	1,626,400	1,540,800	1,455,200	1,369,600	1,284,000	1,198,400

Terminal Value	Assumptions	Growth		
EBITDA Multiple Method	12.96x		(EBITDA x EBITDA Multiple)	10,062,192
Perpetuity Method	7.45%	5.00%	Next Year's Cash Flow / (Discount Rate - Growth)	12,422,472
Average				11,242,332
Less Debt Outstanding (at Exit)				(1,284,000)
Plus Cash (at Exit)				-
Equity Value at Terminal				9,958,332

		PV (for $1)						
Equity Cash Flows	10.2%			238,493	250,417	262,938	276,085	10,248,221
	PV (1) =	0.9076881	$216,477					
	PV (2) =	0.8238977	$206,318					
	PV (3) =	0.7478422	$196,636					
	PV (4) =	0.6788075	$187,409					
	PV (5) =	0.6161455	$6,314,395					
	PV=		$7,121,236					

PV of Equity =	$7,121,236
+ PV of Debt =	1,712,000
+ PV of Cash =	(515,000)
Hyatt's Enterprise Value =	8,318,236
Less Debt =	(1,712,000)
Plus Cash =	515,000
Equity Value (Market Cap) =	7,121,236
Suggested Stock Price =	$ 67.95

Cost of Equity Calc	
Risk Free Rate (5 year)	2.25%
Premium based on MC =	9.00%
Hyatt Beta =	0.88x
Expected Equity Return =	10.2%

Interest 6/19 LTM ($ 000s)
44,525
2.60% Rate

WACC Calc:		% Cap	AT RoR	WACC
Debt	1,712,000	32.0%	1.664%	0.532%
BV Equity	3,642,000	68.0%	10.170%	6.918%
		100.0%		7.450%

Figure 1

The DCF valuation that falls under the income method is basically projecting the company's top line revenue and bottom-line profit to determine the equity cash flow representing one of four inputs the analyst needs to value the company. The other three variables include identifying an exit year – typically 5 years out, calculate the terminal value and using a discount rate based on the Capital Asset Pricing Model (CAPM). Figure 1 shows the equity cash flows generated based on revenue growth of 5.0% and costs as a percentage of revenue for the next 6 years. The terminal value is calculated using the average of two methods:

1. Using the industry EBITDA multiple – in this case the hotel sector trades of approximately 13.0x EBITDA; and
2. The perpetuity method of calculating next year's cash flow divided by the weighted average cost of capital (WACC) of Hyatt and 5.0% growth rate where:

$$\frac{Exit\ Years\ plus\ one\ year\ Yea\ 's\ Cas\ \ Flow}{WACC-Growth\ Rate} = \frac{\$304.4\ mm}{0.07450-.0500} = \$12.4\ billion$$

Based on the DCF model Hyatt is calculated at $67.95 as compared to the existing trading value of $74.24 suggesting that this is not a good time to buy the stock.

Leveraged Buyout Method

This method called discount cash flow method (DCF) values the company based on 4 variables: 1) future stream of cash flows derived by revenue; 2) identifying an exit year (typically 5 years out); 3) calculating the terminal value at the exit year using various market and growth model methods; and 4) apply the right discount rate that is in line of return/risk expectation.

Using Market Methods

Other valuation methods, such as market valuation approaches, for well established companies include the comparative analysis of the company the analyst is valuing to publicly traded companies in the same industry or business. For public traded companies the current stock price represents the current enterprise value (EV) of the company and is calculated as follows:

$$EV = (SP\ x\ SO) + D - C$$

Where SP is the stock option, SO is the stock outstanding representing all the stock the company issued since going public, D is the last reported debt, and C is the last reported cash.

Hyatt Hotels Corporation
CORPORATE VALUATIONS

Stock Price (as of 8/5/2019) $ 74.24

METHOD #4 -Average EBITDA Industry Trading Multiples

		SP	SO	SP * SO = EQ	D	C	Q + D - C = E	E	EV / E	
Company	Symbol	Stock Price (as of 8/5/2019)	Stocks Outstand. ($000)	Equity Value ($000)	Debt (ST&LT) ($000)	Cash ($000)	Enterprise Value ($000)	EBITDA ($mm)	EBITDA Multiple	Beta
Marriott International	MAR	$ 133.56	336,690	44,968,316	11,280,000	258,000	55,990,316	2,840,000	19.71x	1.21x
Hilton Worldwide Holdings Inc.	HLT	$ 91.92	316,880	29,127,610	9,010,000	635,000	37,502,610	1,820,000	20.61x	0.88x
Wyndham Worldwide	WH	$ 54.15	96,399	5,220,000	2,170,000	107,000	7,283,000	544,000	13.39x	1.33x
Intercontinental Hotel	IHG	$ 64.73	182,030	11,782,802	2,250,000	705,000	13,327,802	753,000	17.70x	0.86x
Park Hotels & Resorts Inc.	PK	$ 24.16	204,884	4,950,000	3,280,000	310,000	7,920,000	666,000	11.89x	1.32x
Choice Hotels International	CHH	$ 82.82	55,640	4,608,105	844,270	31,810	5,420,565	360,000	15.06x	1.00x
Marcus Corporation	MCS	$ 34.10	19,470	663,927	514,600	16,480	1,162,047	134,160	8.66x	0.52x
Hyatt	HOT	$ 74.24	104,795	7,780,000	1,712,000	515,000	8,977,000	633,000	14.18x	0.88x

EBITDA * Average Multiple	633,000	12.96x	Average	15.29x	1.00x
			Outliers	12.96x	

Hyatt's Enteprise Value	8,202,771
Less Debt	(1,712,000)
Plus Cash	515,000
Equity Value (Market Cap)	7,005,771
Suggested Stock Price	$ 66.85

Figure 2

The example shown on figure 2 shows that various hotel companies' enterprise value trade on an average 12.96 times their earnings before interest, taxes, depreciation and amortization (EBITDA). The value of Hyatt using the EBITDA trading comparable method suggests that Hyatt should be at $66.85 as compared to the current stock price of $74.24 (see figure 2):

Another market-based valuation method using comparable analysis is to compare the company to the other similar companies that have sold in the past based on the enterprise value to their reported EBITDA (EBITDA multiple) at the time of the purchase. This EBITDA multiple then is used to calculate the current price of the company that the analyst is valuing. Using a Hyatt as an example, figure 3 shows that the hotel companies that were purchased in the last few years were at 13.19 times their reported EBITDA. The value of Hyatt using this method is calculated at $68.27 as compared to the current $74.24.

Hyatt Hotels Corporation

CORPORATE VALUATIONS

Stock Price (as of 8/5/2019)

$ 74.24

METHOD #5 - Using Averge EBITDA Transaction Multiples (M&A Comparable Method)

	Calculations	AP	SO	AP * SO = EQ	ND	EQ + ND = EV	E	EV / E
Target	**Acquirer**	**Acquisition Price /Share**	**Shares Outstanding**	**Equity Value ($mm)**	**Total Net Debt ($mm)**	**Enterprise Value (EV)**	**EBITDA (last reported)**	**EBITDA Multiple**
Hilton Hotels	Blackstone Group	$ 47.50	390,400,000	$ 18,544	$ 6,180	$ 24,724	$ 1,680	14.72x
Four Seasons*	Kingtom Hotels Int'l / Gates' Cascade	$ 82.00	33,078,000	$ 2,712	$ 279	$ 2,991	$ 94	31.90x
Fairmont/Rafles	Kingtom Hotels Int'l	$ 45.00	73,335,000	$ 3,300	$ 124	$ 3,424	$ 187	18.29x
Hilton International	Hilton Hotels Corp.			$ 5,578	$ -	$ 5,578	$ 504	11.07x
Starwood Hotels	Host Marriott					$ 4,096	$ 315	13.00x
La-Quinta Corp	Blackstone Group	$ 12.22	203,000,000	$ 2,481	$ 926	$ 3,406	$ 230	14.83x
Wynham Int'l	Blackstone Group	$ 1.15	172,053,000	$ 198	$ 2,682	$ 2,880	$ 275	10.47x
John Q. Hammons Hotels	JQH Acquisition LLC	$ 24.00	19,583,000	$ 470	$ 765	$ 1,235	$ 123	10.04x
Societe du Louvre	Starwood Capital					$ 1,029	$ 91	11.30x
Intercontinental Hotels	LRG					$ 981	$ 107	9.20x
Boca Resorts	Blackstone Group	$ 24.00	40,284,000	$ 967	$ 217	$ 1,184	$ 90	13.15x
Prime Hospitality	Blackstone Group	$ 12.25	44,808,000	$ 549	$ 244	$ 792	$ 55	14.38x
Extended Stay	Blackstone Group	$ 19.93	95,077,000	$ 1,895	$ 1,232	$ 3,126	$ 225	13.90x
							Average	**14.33x**
				633,000	13.19x		Adjust. Out	**13.19x**

Haytt's Enteprise Value	**8,351,706**
Less Debt	**(1,712,000)**
Plus Cash	**515,000**
Equity Value (MC)	**7,154,706**
Suggested Stock Price	**$ 68.27**

Figure 3

B. Valuing Intellectual Property

For businesses with little or no revenue, positive cash flow or profits and uncertainty of when and how these will grow makes the valuation very tricky. As demonstrated above, for mature, publicly listed businesses such as Hyatt that has steady revenues and earnings, all methods use the EBITDA multiples. But it's a lot harder to value a new venture that's not publicly listed and may be years away from revenues and EBITDA.

Of course, for the new investor that is trying to raise capital for its start-up company, or thinking of putting money into one, it's important to determine the company's worth. A few methods used for determining such value is described below:

Using Cost, Cost-to-Duplicate or Replacement Method

The new venture investor will first need to calculate how much it would cost to build a similar company from scratch so it could compare with the one that he or she is analyzing. The idea behind this is that any smart investor will be willing to pay more than it would cost to duplicate. This approach is easy if the focus is on tangible assets. To duplicate a software business, for example, it might be calculating the total cost of designing, programming and the time to implement the software in the market. For a high-technology start-up in the cleantech or fintech space, the costs could be calculating the research and development,

patent protection, prototype development, etc. This approach (cost-to-duplicate) should be the starting point for valuing start-ups, since it is objective - knowing the precise costs.

The big problem with this approach is that it doesn't reflect the company's future potential for generating revenues, profits and return on investment. These income and option methods will be discussed later in this section. What's more, the cost-to-duplicate approach doesn't capture intangible assets, like intellectual property and brand value of the start-up. A cash flow analysis is needed to first calculate the immediate need for cash flow – typically 18 months out and then convincing the investor that such product can be commercialized and scaled to market demand.

Using Market Methods

Venture capital investors prefer the market approach, as it gives them a pretty good indication of what the market is willing to pay for a company. Basically, the market multiples' approach values the company against recent acquisitions or similar companies in the industry that are currently traded in the stock market.

Let's say that fintech application software firms are selling for three-times sales. Knowing what real investors are willing to pay for similar fintech software, we could use a three-times multiple as the basis for valuing the fintech venture while adjusting the multiple up or down to factor for different characteristics. If the fintech software company, say, were at an earlier stage of development than other comparable businesses, it would probably fetch a lower multiple than three, given that investors are taking on more risk.

In order to value a firm that has no revenue, the analyst needs to run extensive forecasts to determine what the sales or earnings of the business will be once its product or service is commercialized. One way of determining such revenue is to answer the following four questions:

1. What's the market size for fintech software?
2. What are the competitive advantages for this software versus the ones that are already fetching revenues?
3. How much will it cost to implement and commercialize including customer acquisition costs? and
4. How long before competitors crowd in?

The investors that are willing to provide capital will often provide funds to businesses where they believe in the story. While many established corporations are valued based on earnings, the value of startups often are based on revenue multiples at some future date.

Using Income Methods

For most start-ups – especially those that have yet to start generating earnings – the bulk of the value rests on future potential. Discounted cash flow analysis then represents an important valuation approach. DCF involves forecasting how much cash flow the company will produce in the future and then, using an expected rate of investment return, calculating how much that cash flow is worth. A higher discount rate is typically applied to start-ups, as there is a high risk that the company will inevitably fail to generate sustainable cash flows.

The trouble with DCF is the quality of the DCF depends on the analyst's ability to forecast future market conditions and make good assumptions about long-term growth rates. In many cases, projecting sales and earnings beyond a few years becomes a guessing game. Moreover, the value that DCF models generate is highly sensitive to the expected rate of return used for discounting cash flows. So, DCF needs to be used with much care.

Valuation by Stage

There is the development stage valuation approach, often used by angel investors and venture capital firms to quickly come up with a rough-and-ready range of company value. Such "rule of thumb" values are typically set by the investors, depending on the venture's stage of commercial development. The further the company has progressed along the development pathway, the lower the company's risk and the higher its value. A valuation-by-stage model might look something like this:

Estimated Company Value	Stage of Development
$250,000 - $500,000	Has an exciting business idea or business plan
$500,000 - $1 million	Has a strong management team in place to execute on the plan
$1 million – $2 million	Has a final product or technology prototype
$2 million – $5 million	Has strategic alliances or partners, or signs of a customer base
$5 million and up	Has clear signs of revenue growth and obvious pathway to profitability

Again, the value ranges will vary, depending on the company and, of course, the investor. But in all likelihood, start-ups that have nothing more than a business plan will likely get the lowest valuations from all investors. As the company succeeds in meeting development milestones, investors will be willing to put assign a higher value.

Many private equity firms will utilize an approach whereby they provide additional funding when the firm reaches a given milestone. For example, the initial round of financing may be targeted toward providing wages for employees to develop a product. Once the product is proved to be successful, a subsequent round of funding is provided to mass produce and market the invention.

Using Option Pricing Methods

Intangible assets defined as non-physical assets such as franchises, trademarks, intellectual property, patents, copyrights, goodwill, equities, mineral rights, securities and contracts that grant rights and privileges and have value for the owner.

Valuing intellectual properties (IP) is probably the most challenging endeavor. Before valuing these intellectual properties, the buyer needs to answer the following four questions:

1. What’s the market size?
2. What are the competitive advantages?
3. How much will it cost to implement?
4. How long before competitors crowd in?

Valuing franchises and trademarks

These assets have one common theme: none of them make immediate revenues and/or income. Since every valuation methodology looks for ongoing revenues and even better the income as a basic input to calculate the value, a preliminary process is needed to establish such revenue and income when valuing intellectual property. Franchises and brand names establish such revenue and income by comparing the difference between the revenue and income produced from non-branded companies to companies that are well recognized because of their brand or franchise name. The following example shows the methodology of finding such income:

Cost & Market Method		
Branded Product per unit	$ 1,000	
Other Unbranded Products unit	$ (800)	
Brand Value	$ 200	
Number of Units sold	1,000,000	units
Annual Brand Net Revenue	$ 200,000,000	
Less Research & Development	$ (50,000,000)	
	$ 150,000,000	
Multiple of Brands Revenue based on market comparable	**8.0x**	
Value of the brand	$ 1,200,000,000	
Multiple of Unbranded Revenue x units	**2.0x**	
Value of the unbranded Value	$ 1,600,000,000	
EV of the Company	$ 2,800,000,000	

Figure 4

Figure 4 shows that this company that is well recognized such as McDonalds, Coca-Cola, Cadbury that adds significant value, from customer point of view. Franchise and brand names build customer loyalty & aspiration are able to charge higher prices since the demand is more price inelastic. To value the brand name the incremental income that is generated because of the customer loyalty needs to be estimated and separated from the unbranded generic income. The trademark value added income is valued at a higher multiple as illustrated in Figure 4. In this example the unbranded generic product is valued at 2x revenue based on trading or acquisition multiples and the branded income is at 8.0x showing a combined enterprise value of $2.8 billion.

C. Valuating Start-ups - Converting the Story to Value

So far, we discussed how to value the company using various methods depending where the company is in their growth development. Every company has a beginning as a new start-up or a new acquisition. Before that initial start-up there is a story, a belief and an opportunity. We remember stories better than numbers on a spreadsheet. The challenge is to covert such stories to numbers and values. In telling the story the founder or the inventor needs to answer few basic questions: 1. Who wants this and how big is the market? 2. How much willit cost to implement or convince an investor to fund your vision? 3. Can the story be converted to numbers and value?

There are non-traditional methods of valuing intellectual properties such as trademarks, patents and new products or new start-ups that have not yet generated any sales. The one that is getting popularity recently is the option pricing method that includes the methodology of valuing the premiums that someone is willing to pay today for a future payoff. Such methodology involves the probability of such payment. Once the probability is established then the premium paid is calculated. Let's take a basic probability game example of a coin toss or a game of dice as illustrated in Figure 5. There is a 50% chance of winning and 50% chance of losing. If the payoff is at $20, then the fair bet is $10 calculated at (0.5 x $20) + (0.5 x $0) representing 50% x winning payoff + 50% loosing payoff. The same thinking is used for throwing a dice representing 1 in 6 chances of winning and 5 in 6 chance of losing. A fair bet can also be calculated the if the stock will go up or down from its current level based on historical information.

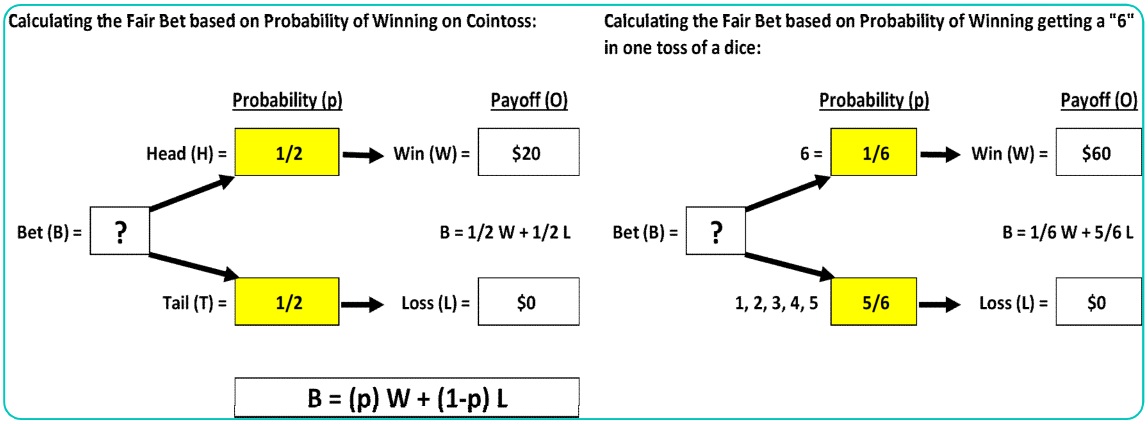

Figure 5

Using the basic probability theory, Black, Scholes came up with an approach to estimate the probability of future value or future payoff even if the value today is negative. Their famous Black-Scholes formula that earned them a Nobel price calculating the upfront bet or the Call (C) option premium is illustrated below.

$$C = \mathrm{S}\, N(d1) - Xe^{-it}N(d2)$$

Where **S** is the current price, ***X*** is the exercise price, **i** is the risk-free rate and **t** is time to expiration. The formulas for calculating the probability distribution to be used in the calculation of the intrinsic value of S – X for the call option, using the Black-Scholes model (N(d1) and N(d2)) are as follows:

$$d1 = \frac{\ln(\frac{S}{X}) + \left(i - \delta + \frac{\sigma^2}{2}\right)t}{\sigma\sqrt{t}} \text{ and } d2 = d1 - \sigma\sqrt{t}$$

Where σ is the standard deviation of the historical S and δ is the dividend yield.

To use the Black-Scholes formula for valuing start-ups you need to ask the following questions to build the input information:

1. Is there a real option embedded in a decision or an asset?
2. Does that real option have significant economic value?

3. Can that value be estimated using the option pricing model?

If all these questions have the "Yes" answer, then the options pricing model can be used to value the start-up. The following example demonstrates how to value few a start-up using the options pricing model:

Case Study – Pharma Inc.

- Pharma Inc, a biotech firm, has a patent on a drug to treat multiple sclerosis, for the next 17 years, and it plans to produce and sell the drug by itself.
- The drug will be priced at $46.50 per patient per day taking it for an average of 2 years
- After extensive market research, it was determined that 100,000 patients will be buying this drug immediately
- The total cost of development for commercial use is estimated at $2.75 billion
- Patent life is 17 years
- The 17-year treasury bond rate is 3.50%
- Variance in Expected Present Values = 0.224 based on industry average firm variance for bio-tech firms

INPUT	PROCESS
Value of the Underlined Asset (S)	PV of Cash Flows expected from the commercialization of the IP
Exercise Price on Option (X)	Cost of Development of the IP
Variance in Value of Underlined Asset (σ^2)	Variance in Cash Flows of similar assets on firm (i.e. the stock price of other companies with similar applications) or Variance in present value from capital budgeting simulation
Expiration of the Option (t)	Life of the IP patent
Dividend Yield (δ)	Cost of Delay- each year of delay translates to one less year of value-creating cash flows 1/t

Using Black-Scholes the value of this HealthTech company is as follows (figure 6):

Pharma Inc.

Using Black-Scholes Option Pricing Model

Number of Patients=	100,000	
Drug Price (per pill) - net of cost of producing =	$46.50	
Daily Use =	365	Days
Average Length for Usage =	2	Years
Present Value of =	$3,394,500,000	
Total Development Cost (X) =	$2,750,000,000	
IP Patent life (t)=	17	years
Cost of Delay (δ)=	5.882%	1/17 years
Risk Free Rate (i) =	4%	
Variance =	0.224	

USING BLACK-SCHOLES OPTION MODEL

INPUT		OUTPUT	
Standard Deviation (σ) =	47.33%	d1 =	0.8761
Expiration (in years) (T) =	17	d2 =	-1.0753
Risk-Free Rate (Annual) (i) =	4%	N(d1) =	0.8095
Stock Price (S) =	3,394,500,000	N(d2) =	0.1411
Exercise Price (X) =	2,750,000,000		
Dividend Yield (annual) (δ) =	5.882%	**Value=**	**796,844,462**

Figure 6