LIVING WITH NOISE: INVESTING AND VALUATION IN THE FACE OF UNCERTAINTY

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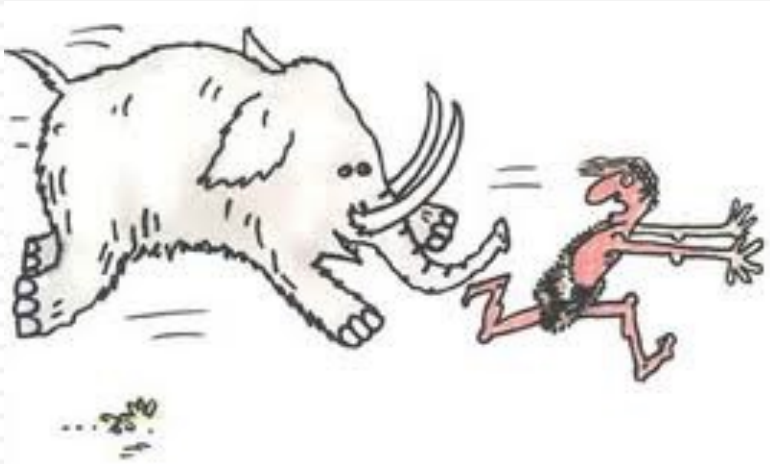
Uncertainty is a feature, not a bug.



And we deal with uncertainty as humans always have…

- Paralysis & Denial: When faced with uncertainty, some of us get paralyzed. Accompanying the paralysis is the hope that if you close your eyes to it, the uncertainty will go away
- Mental short cuts (rules of thumb): Behavioral economists note that investors faced with uncertainty adopt mental short cuts that have no basis in reality. And here is the clincher. More intelligent people are more likely to be prone to this.
- Herding: When in doubt, it is safest to go with the crowd.. The herding instinct is deeply engrained and very difficult to fight.
- Outsourcing: Assuming that there are experts out there who have the answers does take a weight off your shoulders, even if those experts have no idea of what they are talking about.
- Divine Intervention: Praying for intervention from a higher power is the oldest and most practiced risk management system of all.

Categorizing uncertainty

I. Estimation versus Economic Uncertainty

- Estimation versus Economic uncertainty
  - Estimation uncertainty reflects the possibility that you could have the "wrong model" or estimated inputs incorrectly within this model.
  - Economic uncertainty comes from real sources: that markets and economies can change over time and that even the best medals will fail to capture these unexpected changes.
- Estimation uncertainty can be mitigated by doing your homework, collecting more data or building better models, but economic uncertainty is here to stay.

II. Micro versus Macro Uncertainty

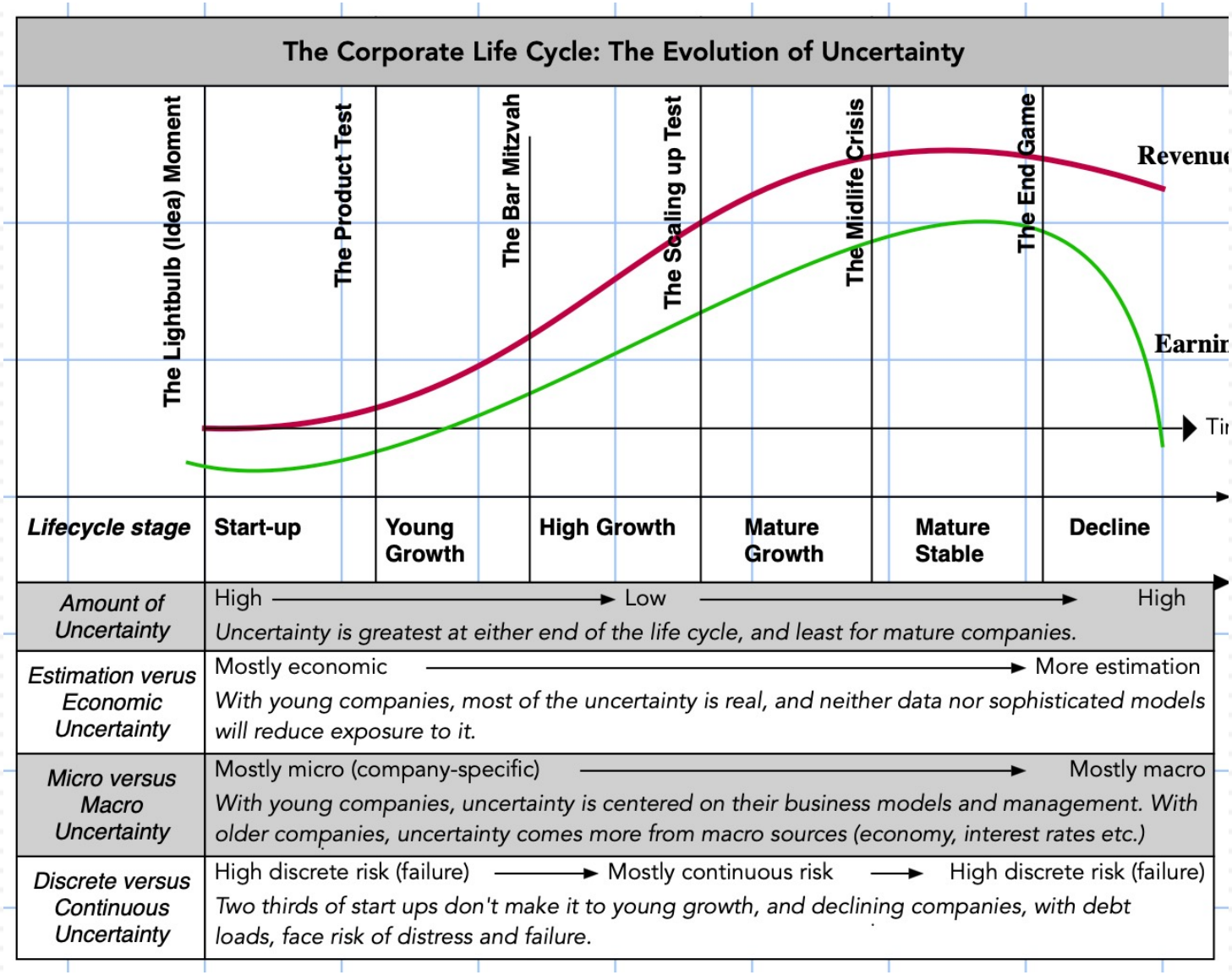
- Micro uncertainty versus Macro uncertainty
  - Micro uncertainty refers to uncertainty about the firm you are valuing and its business model - the potential market or markets for its products, the competition it will face and the quality of its management team.
  - Macro uncertainty reflects the reality that your firm's fortunes can be affected by changes in the macro economic environment –the strength of the economy, the level of interest rates and the price of risk (equity and debt).
- Micro uncertainty can be mitigated or even eliminated by diversifying across companies but macro uncertainty will remain even in the most diversified portfolios.

III. Discrete versus Continuous Uncertainty

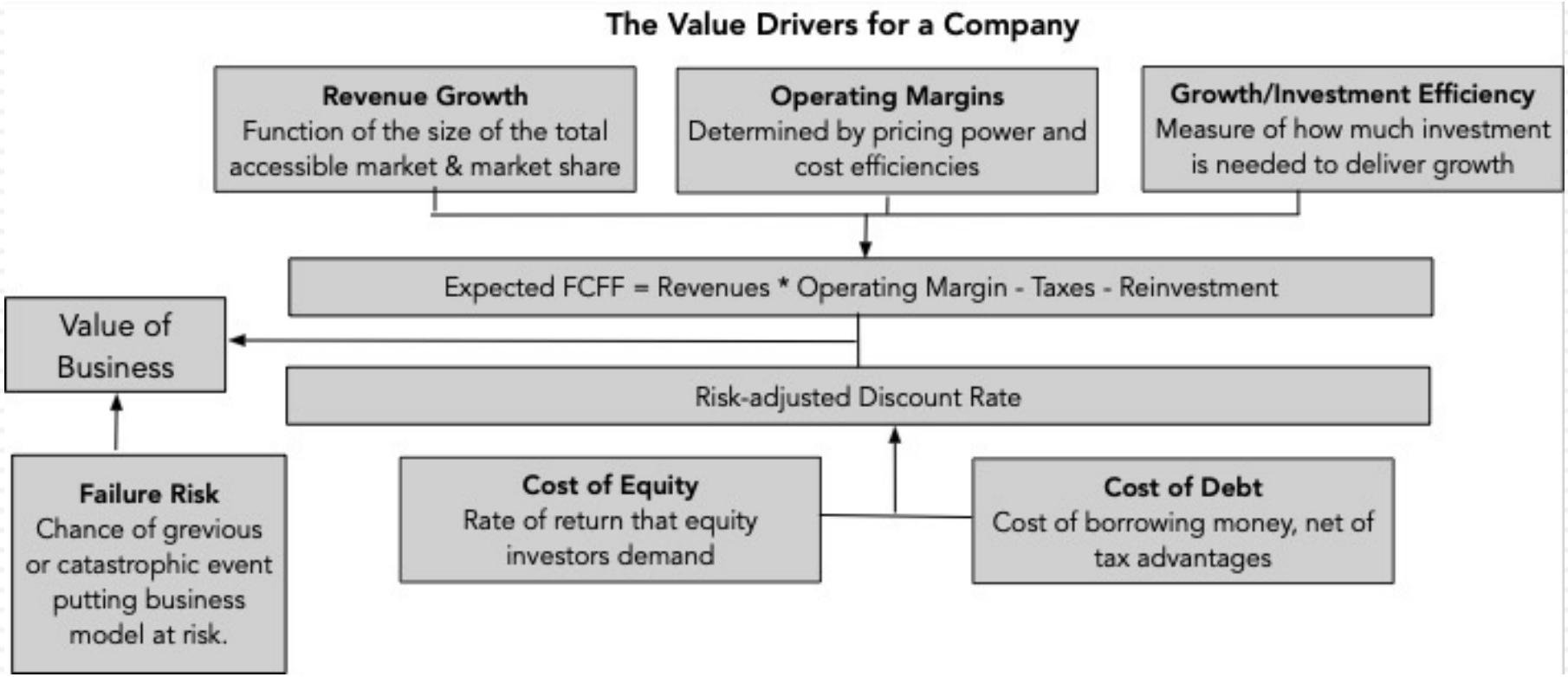
- Discrete versus continuous uncertainty
  - Some events that you are uncertain about are discrete. Thus, a biotechnology firm with a new drug working its way through the FDA pipeline may see the drug fail at some stage of the approval process. In the same vein, a company in Venezuela or Argentina may worry about nationalization risk.
  - Most uncertainties, though, are continuous. Thus, changes in interest rates or economic growth occur continuously and affect value as they happen.
- In valuation, we are better at dealing with continuous risks than with discrete risks. In fact, discount rate risk adjustment models are designed for continuous risk.

Uncertainty: A Reality Check

1. Uncertainty evolves as companies age



And they show up in business drivers



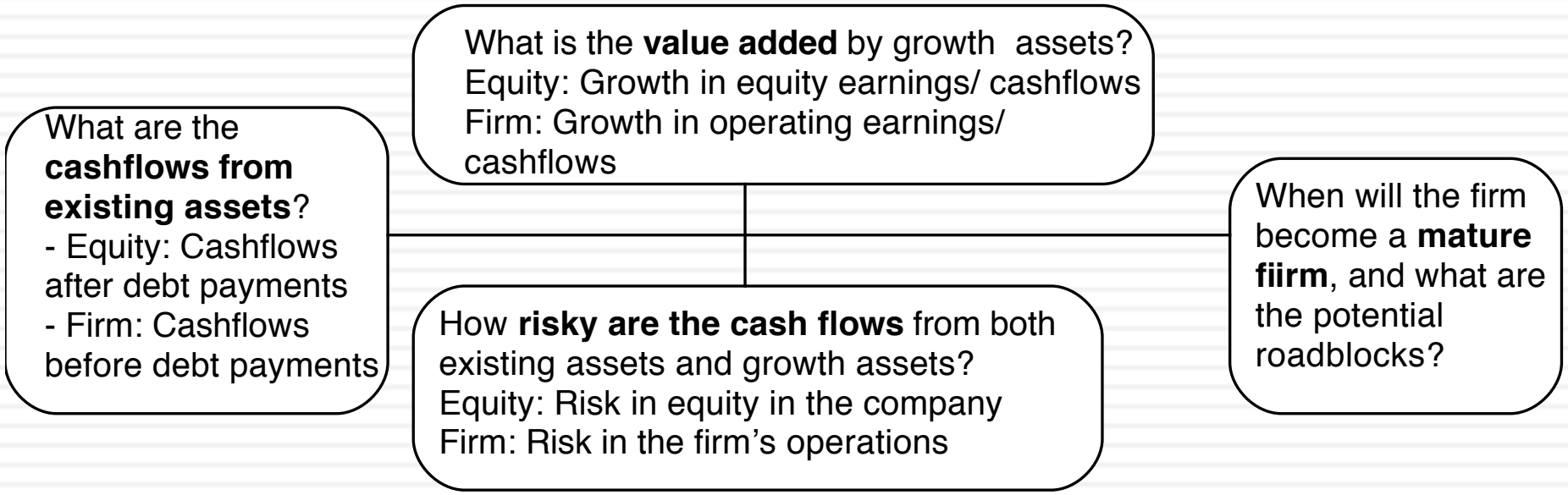
Zomato						Jul-22
The Story						
Zomato will benefit as the Indian food delivery market grows, driven by overall economic growth and more digital access, and it will be one of a few (two or three) players who will dominate the market; there will be a near term COVID bouncecback effect. While Amazon Food remains the wild card, economies of scales will allow the company to generate high operating margins, and the company will continue to reinvest (acquisitions and technology) as it grows. The risk of failure is low, given the company's post-IPO cash balance and access to capital and its operating risk reflects its exposure to Indian country risk.						
The Assumptions						
	Base year	*Next year*	*Years 2-5*	*Years 6-10*	*After year 10*	*Link to story*
Indian Food Delivery	₹ 500,000	₹ 700,000	30.00%	15.72%	₹ 4,149,008	*Indian food market rebounds in 2021 and grows to about $25 billion in year 10*
Market Share	42.60%	40.08%	→	30.00%	30.00%	*Zomato is one of two or three lead players in Indian food delivery market*
Revenues as % of GOV	16.95%	16.76%			15.68%	
Revenues (a)	₹ 36,110.00	₹ 47,016	Total Market * Market Share* Revenue as % of GOV		₹ 195,182	COVID rebound in 2021 + Growth in food delivery market in India long term
Operating margin (b)	-42.04%	-10.0%	-10.00% →	35.00%	35.00%	Margins improve as growth wanes
Tax rate	25.00%		25.00% →	25.00%	25.00%	Indian corporate tax rate over time
Reinvestment (c)		5.00	2.50	3.00	39.83%	Acquisitions & technology investments needed to sustain growth
Return on capital	-15.65%	Marginal ROIC =	157.92%		12.00%	Newworking benefits allow for high ROIC, near and long term.
Cost of capital (d)			13.56% →	11.00%	11.00%	Cost of capital reflects Indian country risk
The Cash Flows						
	Total Market	*Market Share*	*Revenues*	*EBIT (1-t)*	*Reinvestment*	*FCFF*
1	₹ 700,000	40.08%	₹ 47,015.53	-₹ 4,701.55	₹ 2,181.11	-₹ 6,882.66
2	₹ 910,000	37.56%	₹ 56,676.52	₹ 708.46	₹ 3,864.39	-₹ 3,155.94
3	₹ 1,183,000	35.04%	₹ 68,080.36	₹ 4,508.67	₹ 4,561.54	-₹ 52.87
4	₹ 1,537,900	32.52%	₹ 81,427.35	₹ 7,633.81	₹ 5,338.80	₹ 2,295.02
5	₹ 1,999,270	30.00%	₹ 96,884.17	₹ 13,170.19	₹ 5,152.27	₹ 8,017.92
6	₹ 2,498,208	30.00%	₹ 120,198.26	₹ 14,190.43	₹ 7,771.36	₹ 6,419.07
7	₹ 2,995,651	30.00%	₹ 143,199.35	₹ 27,247.87	₹ 7,667.03	₹ 19,580.84
8	₹ 3,441,044	30.00%	₹ 163,525.91	₹ 42,925.55	₹ 6,775.52	₹ 36,150.03
9	₹ 3,779,093	30.00%	₹ 178,637.54	₹ 46,892.35	₹ 5,037.21	₹ 41,855.14
10	₹ 3,959,733	30.00%	₹ 186,277.57	₹ 48,897.86	₹ 2,546.68	₹ 46,351.19
Terminal year	₹ 4,149,008	30.00%	₹ 195,181.64	₹ 51,235.18	₹ 20,408.68	₹ 30,826.50
The Value						
Terminal value			₹ 495,602.90			
PV(Terminal value)			₹ 148,784.62			
PV (CF over next 10 years)			₹ 49,535.26			
Value of operating assets =			₹ 198,319.87			
Adjustment for distress			₹ 9,915.99	Probability of failure =		10.00%
- Debt & Minority Interests			₹ 769.00			
+ Cash & Other Non-operating assets			₹ 99,606.00	Includes cash proceeds from IPO of		₹ 0
Value of equity			₹ 287,240.88			
- Value of equity options			₹ 14,850.97			
Number of shares			7,653.20			
Value per share			₹ 35.59	Stock was offered at =		₹ 41.65

Unilever						Sep-22
Aging Wunderkind						
Amazon continues on its transformation from online retailer to disruption platform, willling to enter any business that it perceives as inefficiently run, and changing it. Along the way, it will invest large amounts of capital and wait for long periods to attain profitability.						
The Assumptions						
	Base year	*Next year*	*Years 2-5*	*Years 6-10*	*After year 10*	*Link to story*
Revenues (a)	€ 52,444.00	2.0%	2.00%	2.00%	2.00%	Limited growth prospects
Operating margin (b)	18.38%	18.4%	18.38%	18.00%	18.00%	Margins stay at levels reached in most recent five years.
Tax rate	25.00%		25.00%	25.00%	25.00%	Global/US marginal tax rate over time
Reinvestment (c)		1.80	1.80	1.80	16.67%	Maintained at global industry average
Return on capital	14.39%	Marginal ROIC =	29.36%		12.00%	Stronge brands
Cost of capital (d)			8.97%	8.97%	8.97%	Cost of capital based on current financing and geographic mix.
The Cash Flows						
	Revenues	*Operating Margin*	*EBIT*	*EBIT (1-t)*	*Reinvestment*	*FCFF*
1	€ 53,492.88	18.38%	€ 9,829.74	€ 7,372.31	€ 581.71	€ 6,790.60
2	€ 54,562.74	18.30%	€ 9,985.33	€ 7,488.99	€ 593.34	€ 6,895.66
3	€ 55,653.99	18.26%	€ 10,164.12	€ 7,623.09	€ 605.21	€ 7,017.88
4	€ 56,767.07	18.23%	€ 10,346.07	€ 7,759.55	€ 617.31	€ 7,142.24
5	€ 57,902.41	18.19%	€ 10,531.23	€ 7,898.42	€ 629.66	€ 7,268.77
6	€ 59,060.46	18.15%	€ 10,719.66	€ 8,039.75	€ 642.25	€ 7,397.50
7	€ 60,241.67	18.11%	€ 10,911.42	€ 8,183.56	€ 655.09	€ 7,528.47
8	€ 61,446.50	18.08%	€ 11,106.55	€ 8,329.91	€ 668.20	€ 7,661.72
9	€ 62,675.43	18.04%	€ 11,305.13	€ 8,478.85	€ 681.56	€ 7,797.29
10	€ 63,928.94	18.00%	€ 11,507.21	€ 8,630.41	€ 695.19	€ 7,935.22
Terminal year	€ 65,207.52	18.00%	€ 11,737.35	€ 8,803.02	€ 1,467.17	€ 7,335.85
The Value						
Terminal value			€ 105,317.15			
PV(Terminal value)			€ 44,628.23			
PV (CF over next 10 years)			€ 46,626.14			
Value of operating assets =			€ 91,254.37			
Adjustment for distress			€ -		Probability of failure =	0.00%
- Debt & Minority Interests			€ 36,686.00			
+ Cash & Other Non-operating assets			€ 7,613.00			
Value of equity			€ 62,181.37			
- Value of equity options			$0.00			
Number of shares			2,569.20			
Value per share			€ 24.20		Stock was trading at =	€ 45.60

Bed, Bath & Beyond						Sep-22
Incredible Shrinking Store						
Bed Bath and Beyond is in a downward spiral, but we see a glimmer of hope, where the company shuts stores that require the most capital and get the least foot traffic over the next decade, shrinking already-shrunk revenues further, but seeing its operating margins improve to the US brick-and-mortar sector average margin, over the next five years. Along the way, the divestritures and shut downs will relase cash that can be returned and used to pay down debt. By the end of the forecast period, BB&B finds a niche market, albeit wiht a smaller footprint, growing at the same rate as the economy and earning no excess returns..						
The Assumptions						
	Base year	*Next year*	*Years 2-5*	*Years 6-10*	*After year 10*	*Link to story*
Revenues (a)	$7,868.00	-10.0%	-5.00% →	3.00%	3.00%	Disruption platform in multiple businesses
Operating margin (b)	-1.00%	-1.0%	-1.00% →	5.54%	5.54%	Margins improve, aided by cloud business & continued economies of scale.
Tax rate	25.00%		25.00% →	25.00%	25.00%	Global/US marginal tax rate over time
Reinvestment (c)		2.00	2.00	2.00	30.00%	Maintined at Amazon's current level
Return on capital	-2.80%	Marginal ROIC =	-57.31%		10.00%	Stronge competitive edges
Cost of capital (d)			8.79% →	7.50%	7.50%	Cost of capital close to median company
The Cash Flows						
	Revenues	*Operating Margin*	*EBIT*	*EBIT (1-t)*	*Reinvestment*	*FCFF*
1	$7,081.20	-1.00%	-$70.81	-$70.81	$0.00	-$70.81
2	$6,727.14	1.62%	$108.72	$108.72	-$177.03	$285.75
3	$6,390.78	2.92%	$186.89	$186.89	-$168.18	$355.06
4	$6,071.24	4.23%	$256.96	$256.96	-$159.77	$416.73
5	$5,767.68	5.54%	$319.56	$244.23	-$151.78	$396.01
6	$5,571.58	5.54%	$308.69	$231.52	-$98.05	$329.57
7	$5,471.29	5.54%	$303.14	$227.35	-$50.14	$277.50
8	$5,460.35	5.54%	$302.53	$226.90	-$5.47	$232.37
9	$5,536.79	5.54%	$306.77	$230.07	$38.22	$191.85
10	$5,702.90	5.54%	$315.97	$236.98	$83.05	$153.92
Terminal year	$5,873.99	5.54%	$325.45	$244.09	$73.23	$170.86
The Value						
Terminal value			$3,796.89			
PV(Terminal value)			$1,695.10			
PV (CF over next 10 years)			$1,644.97			
Value of operating assets =			$3,340.07			
Adjustment for distress			$396.47		Probability of failure =	23.74%
- Debt & Minority Interests			$3,085.00			
+ Cash & Other Non-operating assets			$440.00			
Value of equity			$298.60			
- Value of equity options			$0.00			
Number of shares			92.50			
Value per share			$3.23		Stock was trading at =	$8.79

2. The Macro Part of Company Valuation

General Inflation | Relative Inflation | Overall Economic Growth | Exchange Rates | Political Risk

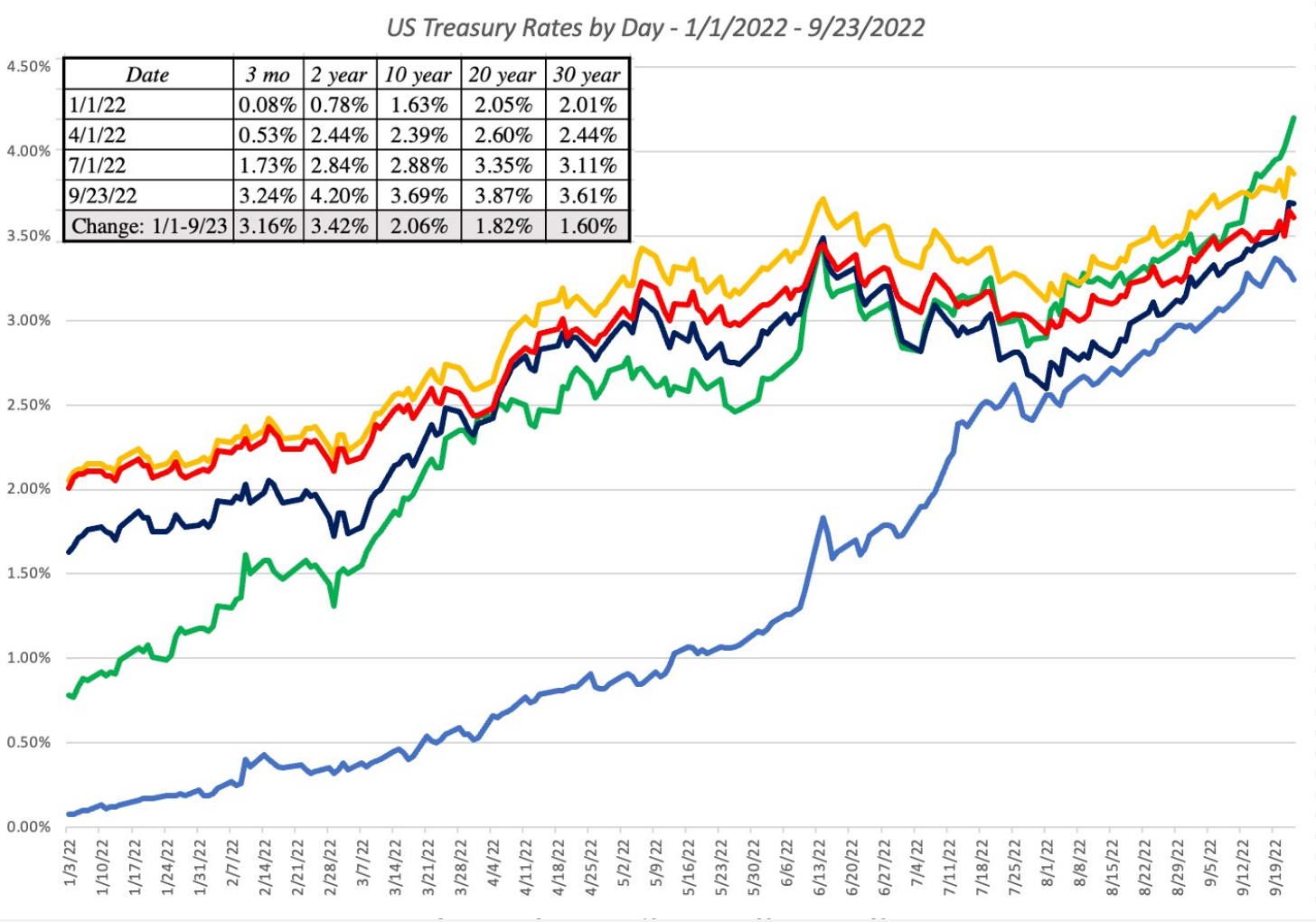


Risk free Interest Rate | Risk Premiums for equity & debt

a. Discount Rates

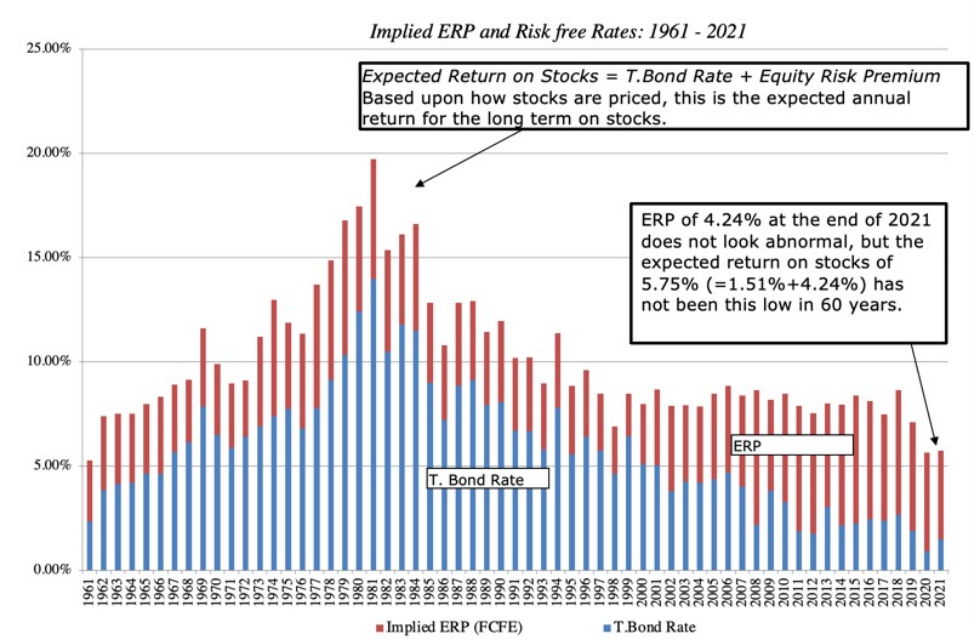
- The discount rate that you use on a cash flow will reflect the risk of that cash flow, but the overall level is affected by macro economic variables. There are two key macro components to discount rates that have little to do with the asset that you are valuing and are set by the market.
- The first is the riskfree rate, that is the base for your discount rate.
  - Risk free rate = Expected Inflation + Expected Real Interest Rate
  - The expected inflation will be a function of the currency you choose to do your analysis in
  - The expected real interest rate is set by the demand for & supply of capital in the real economy. It should increase if growth is expected to be robust and decrease if growth is anticipated to be anemic.
- The second is the risk premium that investors charge for investing in equity markets (the equity risk premium) or for lending money (default spreads).

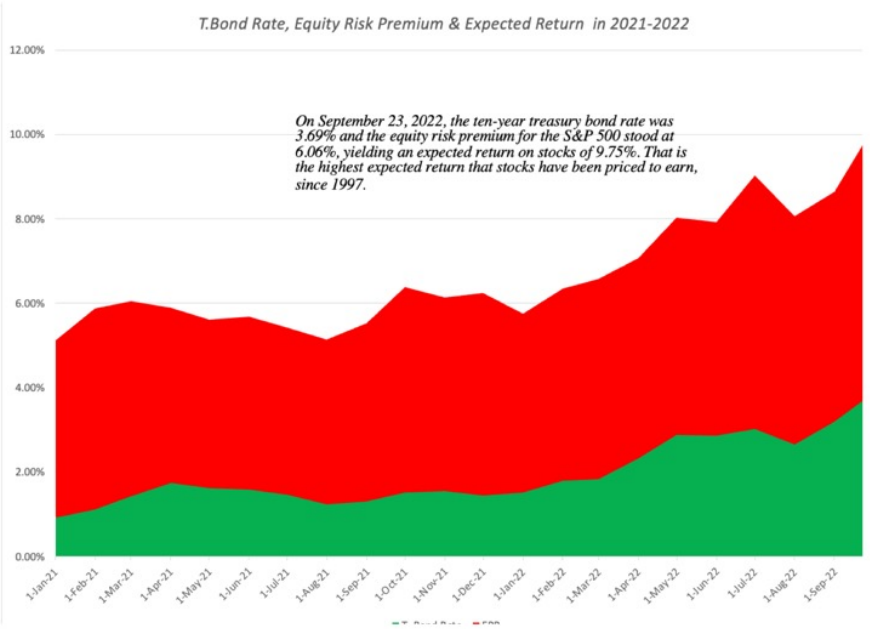
Interest Rates in 2022



Date	*3 mo*	*2 year*	*10 year*	*20 year*	*30 year*
1/1/22	0.08%	0.78%	1.63%	2.05%	2.01%
4/1/22	0.53%	2.44%	2.39%	2.60%	2.44%
7/1/22	1.73%	2.84%	2.88%	3.35%	3.11%
9/23/22	3.24%	4.20%	3.69%	3.87%	3.61%
Change: 1/1-9/23	3.16%	3.42%	2.06%	1.82%	1.60%

Equity Risk Premiums





b. Expected growth and cash flows

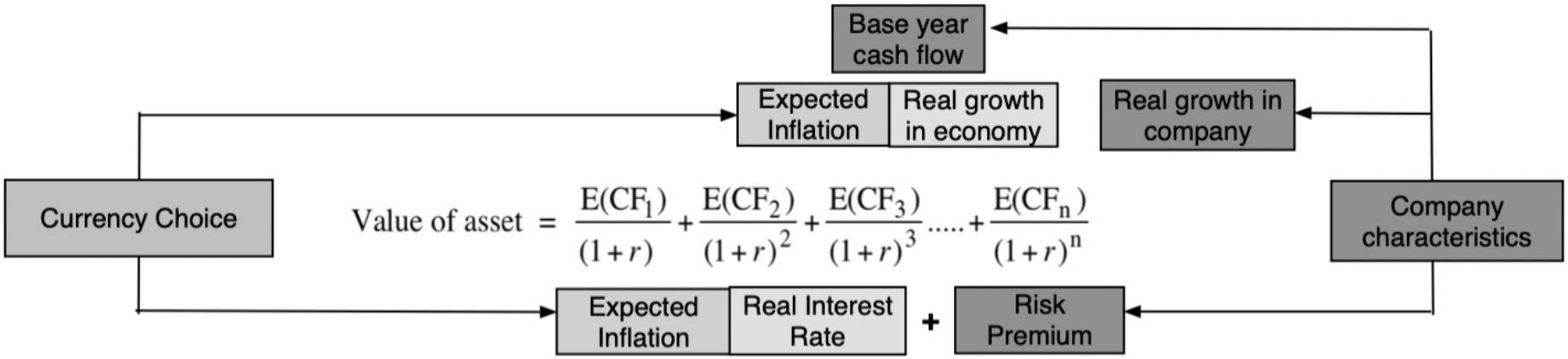
- The expected cash flows on an asset or company are determined partly by the company's choices and partly by macro variables.
  - Thus, the earnings growth for a company will be higher, other things remaining equal, if the economy grows faster.
  - In the same vein, earnings and cash flows will be affected (and not always by the same amount) by the overall level of inflation as well as relative inflation (i.e., inflation in the goods/services that the company either consumes of produces, relative to overall inflation).
  - Finally, exchange rate movement can have positive or negative effects on earnings and cash flows.
- And hanging over all of this is the possibility of a macro shock, caused by acts of God or acts of man, that can alter everything.

Rule 1: Be macro consistent
Discount rate and Cash flow assumptions

- The riskfree rate that you used to estimate your discount rate already incorporates assumptions about inflation and real growth. The cash flows that you use should reflect the same expectations.
- If you mismatch inflation or real growth assumptions, you will mis value companies.
  - If you build in higher expectations of inflation and real growth into your cash flows than you have incorporated into your discount rate, you will over value companies.
  - If you build in lower expectations of inflation and real growth into your cash flows than you have incorporated into your discount rate, you will under value companies.
- **Bottom line**: It is more important that you be consistent in your inflation/ growth assumptions than that you are right.

Inflation Consistency in Valuation

- In a scenario where inflation is volatile and you are trying to estimate its level and effects on the value of a company, trying to get it right is an impossible task. You should however always maintain internal consistency in your valuation.
- Put simply, if you expect inflation to be low (high), your discount rate and expected growth rate should both incorporate that low (high) inflation.



Rule 2: Keep your focus
Don't let the macro drown the micro

- When you are asked to value a company, you should keep your focus on what drives that value. If you bring in your specific macro views into the valuation, the value that you obtain for a company will be a joint result of what you think about the company and your macro views.
- **Bottom line**: If you have macro views, provide them separately. You should be as macro-neutral as you can be, in your company valuations.
- **Follow up**: If you find macro risk dominating your thoughts, deal with it frontally.

22

Tools for Dealing with Uncertainty

Ways of dealing with risk in analysis

- Risk Adjusted Value
  - Estimate expected cash flows and adjust the discount rate for risk
  - Use certainty equivalent cash flows and use the riskfree rate as the discount rate
- Probabilistic Approaches
  - Sensitivity Analysis: Ask what if questions about inputs into your valuation
  - Scenario Analysis: Evaluate values under different specified scenarios, with probabilities estimates for each scenario and an expected value across scenarios.
  - Decision Trees: Estimate probabilities of risky events occurring, with outcomes on each event. Work backwards to get an expected value today.
  - Simulations: Replace point estimates of input variables with distributions, and estimate distribution of value, given multiple draws from distributions.

I. Risk Adjusted Value

- The value of a risky asset can be estimated by discounting the expected cash flows on the asset over its life at a risk-adjusted discount rate:

$$\text{Value of asset} = \frac{E(CF_1)}{(1+r)} + \frac{E(CF_2)}{(1+r)^2} + \frac{E(CF_3)}{(1+r)^3} \ldots\ldots + \frac{E(CF_n)}{(1+r)^n}$$

where the asset has a n-year life, E(CFt) is the expected cash flow in period t and r is a discount rate that reflects the risk of the cash flows.

- Alternatively, we can replace the expected cash flows with the guaranteed cash flows we would have accepted as an alternative (certainty equivalents) and discount these at the riskfree rate:

$$\text{Value of asset} = \frac{CE(CF_1)}{(1+r_f)} + \frac{CE(CF_2)}{(1+r_f)^2} + \frac{CE(CF_3)}{(1+r_f)^3} \ldots\ldots + \frac{CE(CF_n)}{(1+r_f)^n}$$

where CE(CFt) is the certainty equivalent of E(CFt) and rf is the riskfree rate.

II. Probabilistic Approaches

- The essence of risk that you are unclear about what the outcomes will be from an investment. In the risk adjusted cash flow approach, we make the adjustment by either raising discount rates or lowering cash flows.
- In probabilistic approaches, we deal with uncertainty more explicitly by
  - Asking what if questions about key inputs and looking at the impact on value (Sensitivity Analysis)
  - Looking at the cash flows/value under different scenarios for the future (Scenario Analysis)
  - Using probability distributions for key inputs, rather than expected values, and computing value as a distribution as well (Simulations)

a. Sensitivity Analysis and What-if Questions…

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

What-if Analyses: Limits and Extensions

- One equation, one unknown: Since the intrinsic value is one equation, the most you can solve for is one unknown.
  - You can pick your ”key variable” (growth, discount rates, margin, CAP) and solve for that variable.
  - Implicitly, you are holding all else constant, which makes sense only if your input variables are uncorrelated with each other.
- Considering correlations: In the real world, inputs don’t move independently.
  - If your what-if is around business models, increasing one variable can come at the expense of another.
  - If your what-if is around macro shocks/changes, the shock can affect variables in the same direction.

b. Scenario Analysis

- Scenario analysis is best employed when the outcomes of a project are a function of the macro economic environment and/or competitive responses.
- As an example, assume that Boeing is considering the introduction of a new large capacity airplane, capable of carrying 650 passengers, called the Super Jumbo, to replace the Boeing 747. The cash flows will depend upon two major "uncontrollable" factors:
  - The growth in the long-haul, international market, relative to the domestic market. Arguably, a strong Asian economy will play a significant role in fueling this growth, since a large proportion of it will have to come from an increase in flights from Europe and North America to Asia.
  - The likelihood that Airbus, Boeing's primary competitor, will come out with a larger version of its largest capacity airplane, the A-300, over the period of the analysis.

Valuing easyJet: Brexit's Consequences

	No Deal Brexit	Bad Deal Brexit	Soft or No Brexit
Restructuring cost (up front)	£500 million	£300 million	$0
Revenue growth	3.00%	5.00%	5.00%
Operating Margin	6.00%	7.00%	8.00%
Sales to Capital Ratio	1.73	1.73	1.73

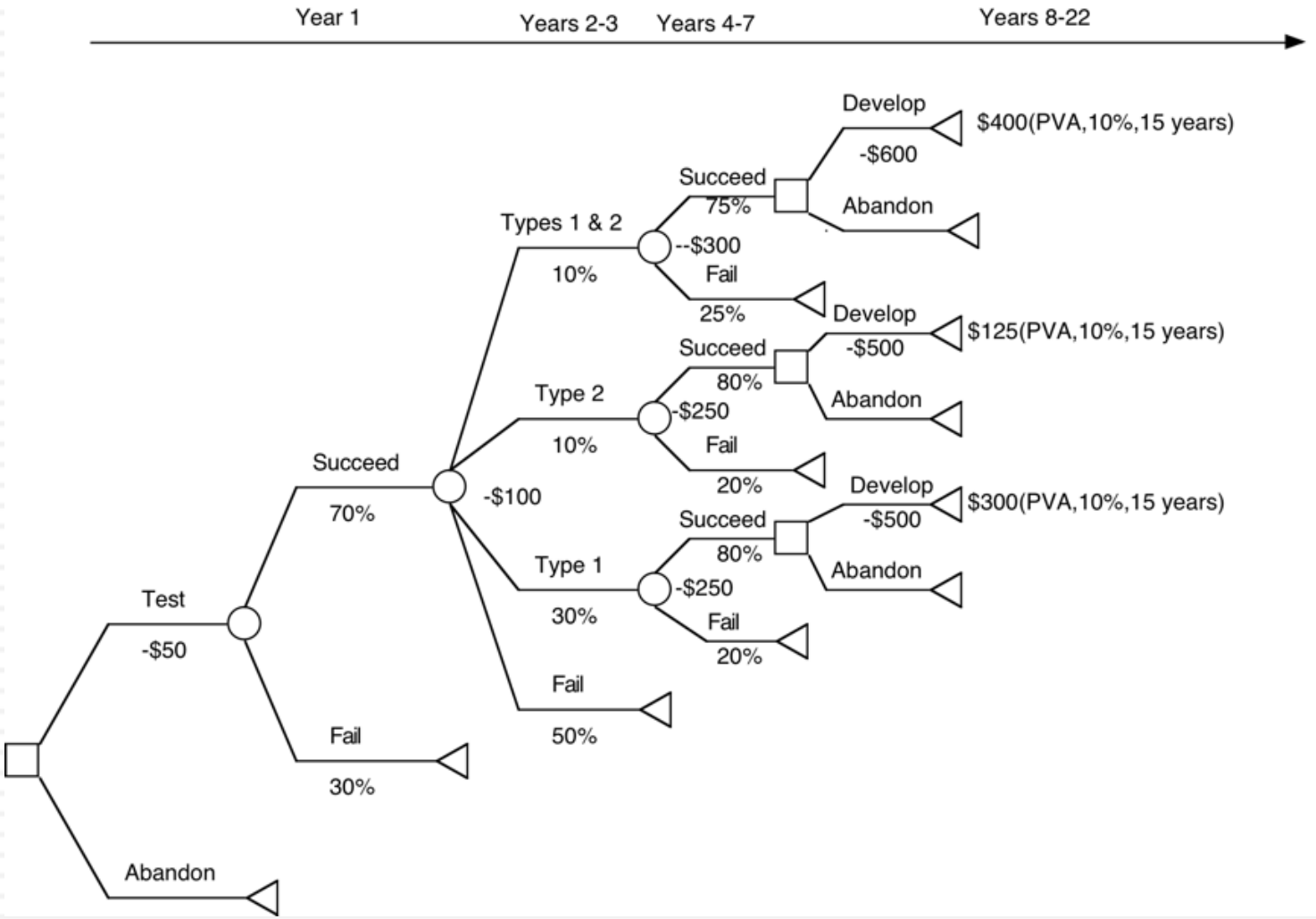
	No Deal Brexit	Delayed & Messy Brexit	Soft or No Brexit
Probability	25%	50%	25%
Value Per Share	£12.02	£15.70	£19.38

Expected Value per share = .25 (£12.02) + .50 (£15.70) + .25 (£19.38) = £15.70

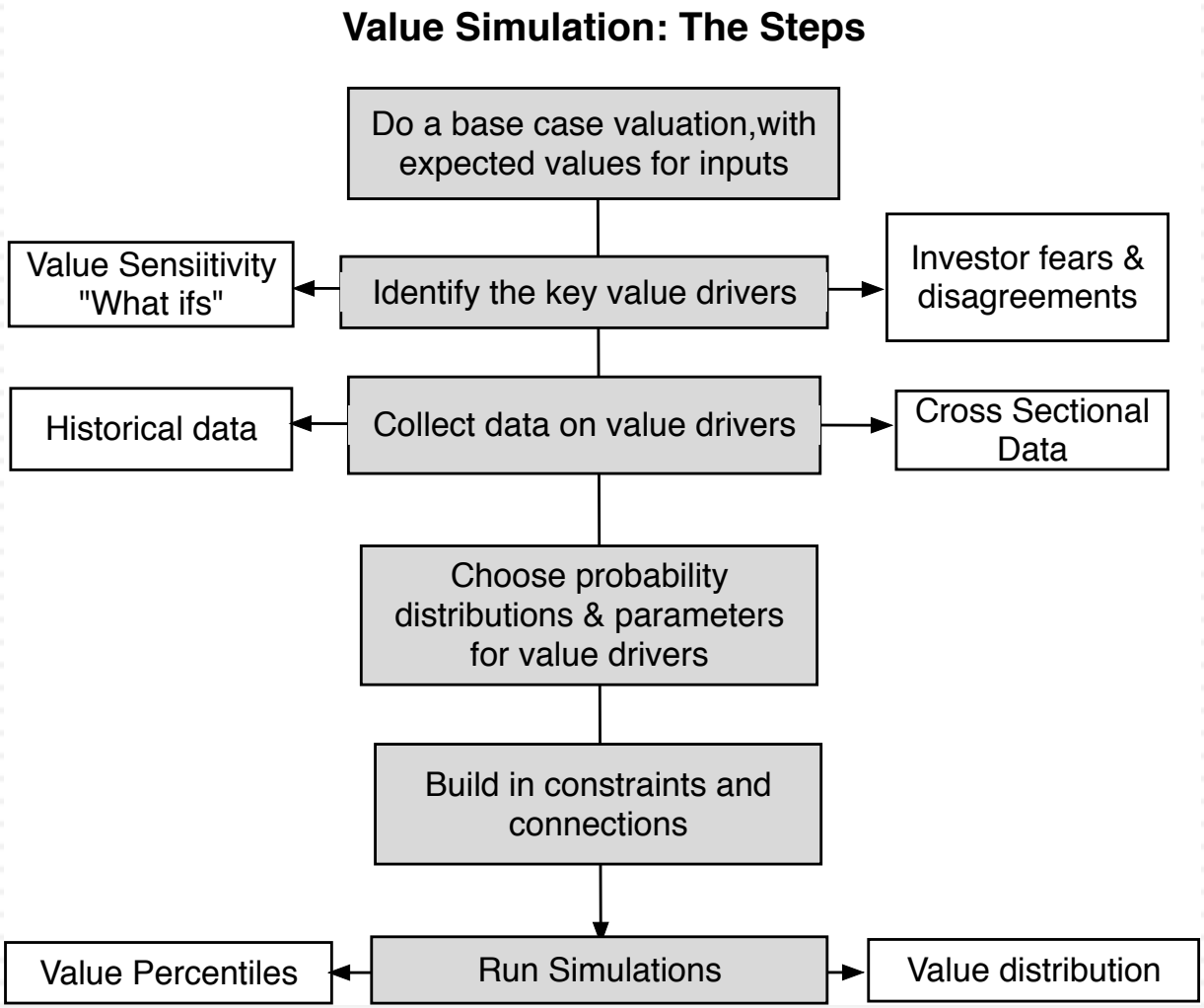
A Story-based Scenario Analysis: Zomato IPO in 2021

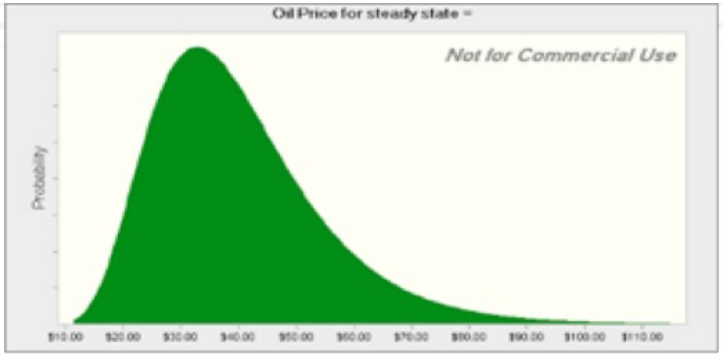
Story	TAM (in ₹ millions)	Market Share	Revenue Slice	Target Margin	Cost of Capital	Value/share	
Delivery Juggernaut	₹ 5,000,000.00	40%	25%	45%	9.50%	₹ 150.02	Plausible
Delivery Star	₹ 5,000,000.00	40%	22%	35%	9.50%	₹ 93.00	
Delivery Leader + Competition	₹ 5,000,000.00	40%	15%	35%	10.99%	₹ 61.55	
Restaurant Delivery Juggernaut + High Growth India	₹ 3,000,000.00	40%	25%	45%	9.50%	₹ 94.31	
Restaurant Delivery Star + High Growth India	₹ 3,000,000.00	40%	22%	35%	9.50%	₹ 59.02	
Restaurant Delivery + Competition + High Growth India	₹ 3,000,000.00	40%	20%	25%	10.99%	₹ 35.52	Probable
Base Case, Positive	₹ 2,000,000.00	40%	25%	45%	10.25%	₹ 56.66	
Base Case	₹ 2,000,000.00	40%	22%	35%	10.25%	₹ 39.48	
Base Case, Negative	₹ 2,000,000.00	40%	20%	25%	10.25%	₹ 26.16	
Restaurant Delivery Juggernaut + Low Growth India	₹ 1,125,000.00	40%	25%	45%	9.50%	₹ 36.48	
Restaurant Delivery Star + Low Growth India	₹ 1,125,000.00	40%	22%	35%	9.50%	₹ 24.02	Plausible
Restaurant Delivery + Competition + low Growth India	₹ 1,125,000.00	40%	20%	25%	10.99%	₹ 16.58	

c. Decision Trees



d. Simulations



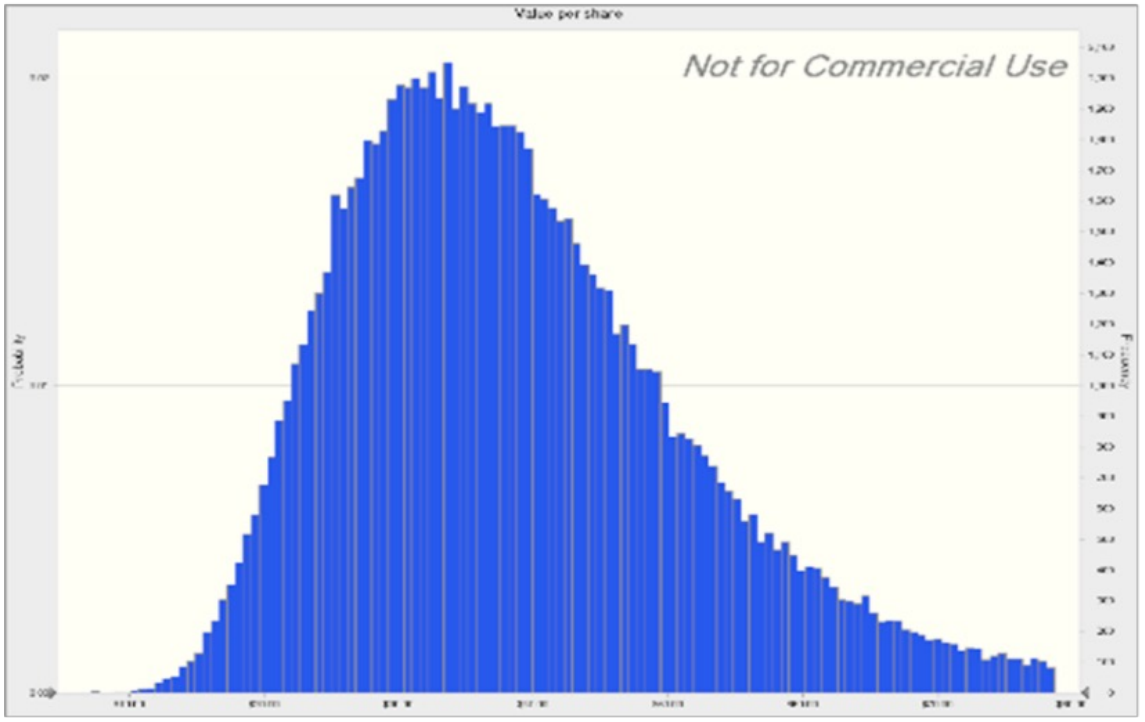


Revenue calculated from the oil price drawn from distribution
Revenue = 39992.77+4039.40*Oil Price/Barrel

Pre-tax Operating Income based on revenue & selected margin
Pre-tax Operating Income = Revenues * Operating Margin

Value Shell based on operating income, assuming other assumptions (tax rate, revenue growth, cost of capital

Percentiles:	Forecast values
0%	$6.55
10%	$23.90
20%	$27.73
30%	$30.89
40%	$33.88
50%	$36.99
60%	$40.28
70%	$44.22
80%	$49.24
90%	$57.49
100%	$197.11



34

Why bother?

Forecasting in the face of uncertainty. A test:

- In which of these two cities would you find it easier to forecast the weather?

Weather changeability for Honolulu, Hawaii

Temperature	Last Month	Last Year
Average change in high temperature day-to-day	1.7°	1.2°
Average change in low temperature day-to-day	1.5°	2.0°

Precipitation	Last Month	Last Year
Chance of dry day after a precip day	67%	81%
Chance of precip day after a dry day	7%	13%

Weather changeability for Epping, North Dakota

Temperature	Last Month	Last Year
Average change in high temperature day-to-day	8.5°	7.7°
Average change in low temperature day-to-day	7.1°	8.6°

Precipitation	Last Month	Last Year
Chance of dry day after a precip day	50%	65%
Chance of precip day after a dry day	38%	20%

But the payoff is greatest where there is the most uncertainty…

Weather changeability for Honolulu, Hawaii

Temperature	Last Month	Last Year
Average change in high temperature day-to-day	1.7°	1.2°
Average change in low temperature day-to-day	1.5°	2.0°

Precipitation	Last Month	Last Year
Chance of dry day after a precip day	67%	81%
Chance of precip day after a dry day	7%	13%

Further changeability analysis »

Weather forecast accuracy for Honolulu, Hawaii

Last Month		Last Year	
MeteoGroup	88.44%	MeteoGroup	88.50%
Persistence	81.80%	CustomWeather	85.87%
CustomWeather	78.23%	AccuWeather	81.82%
The Weather Channel	73.12%	The Weather Channel	81.56%
AccuWeather	69.89%	Persistence	80.44%
Weather Underground	62.10%	Weather Underground	67.07%
National Weather Service	48.39%	National Weather Service	59.90%
Foreca	44.35%	Foreca	57.52%
WeatherBug	32.26%	WeatherBug	37.09%

Weather changeability for Epping, North Dakota

Temperature	Last Month	Last Year
Average change in high temperature day-to-day	8.5°	7.7°
Average change in low temperature day-to-day	7.1°	8.6°

Precipitation	Last Month	Last Year
Chance of dry day after a precip day	50%	65%
Chance of precip day after a dry day	38%	20%

Further changeability analysis »

Weather forecast accuracy for Epping, North Dakota

Last Month		Last Year	
MeteoGroup	62.50%	MeteoGroup	66.97%
Foreca	61.61%	The Weather Channel	66.73%
The Weather Channel	61.31%	AccuWeather	64.86%
AccuWeather	60.42%	WeatherBug	64.80%
Weather Underground	56.85%	Foreca	62.75%
WeatherBug	56.17%	CustomWeather	62.70%
National Weather Service	54.76%	National Weather Service	62.64%
CustomWeather	54.46%	Weather Underground	61.38%
Persistence	38.01%	Persistence	44.09%