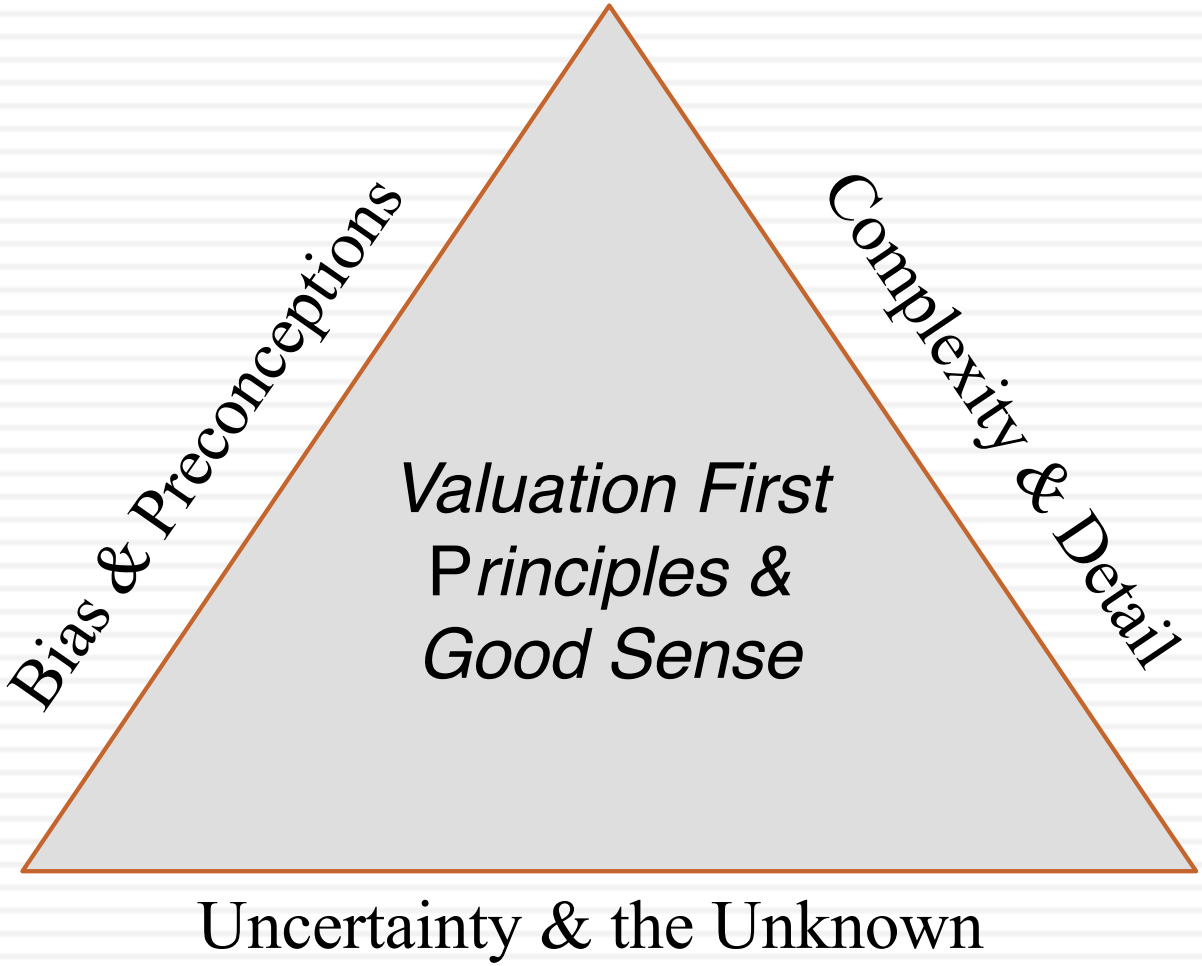
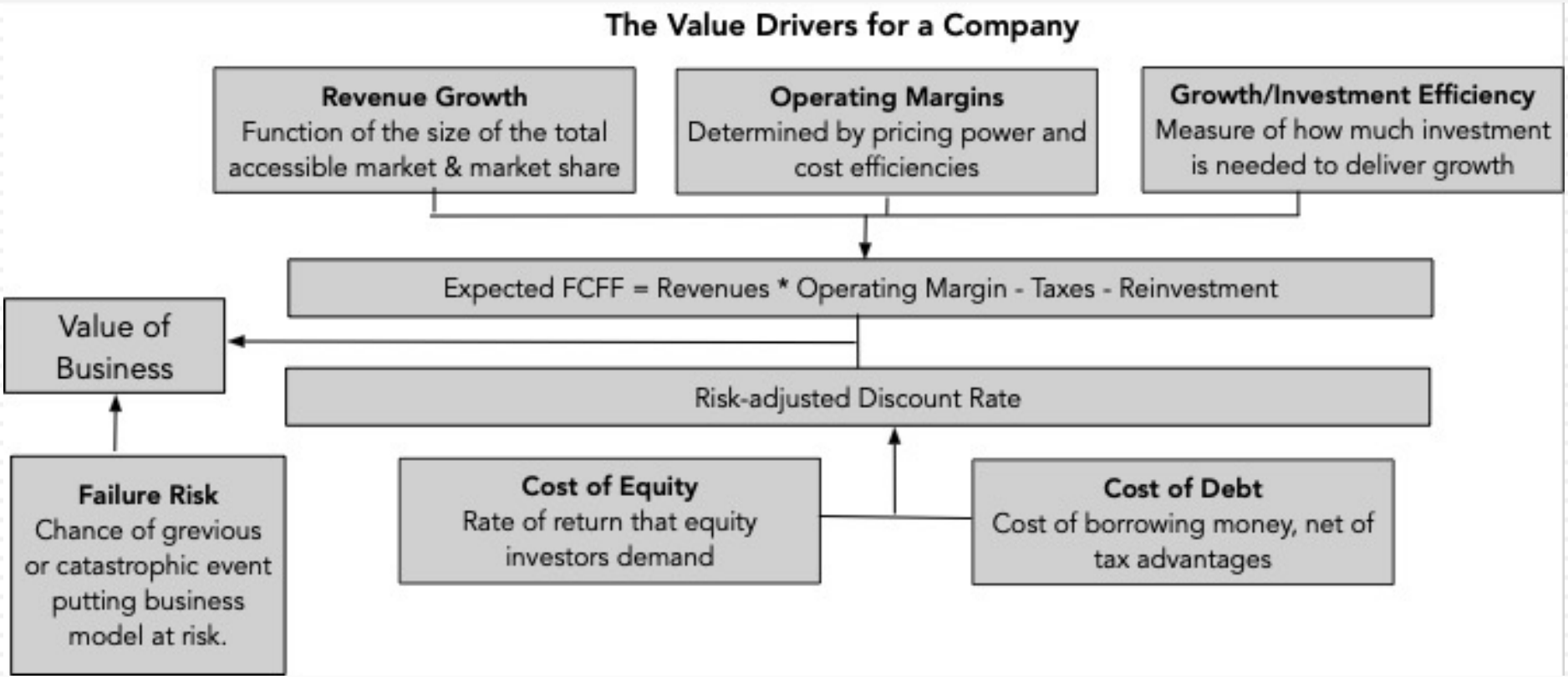
NUMBERS AND NARRATIVE: MODELING, STORY TELLING AND INVESTING

Aswath Damodaran

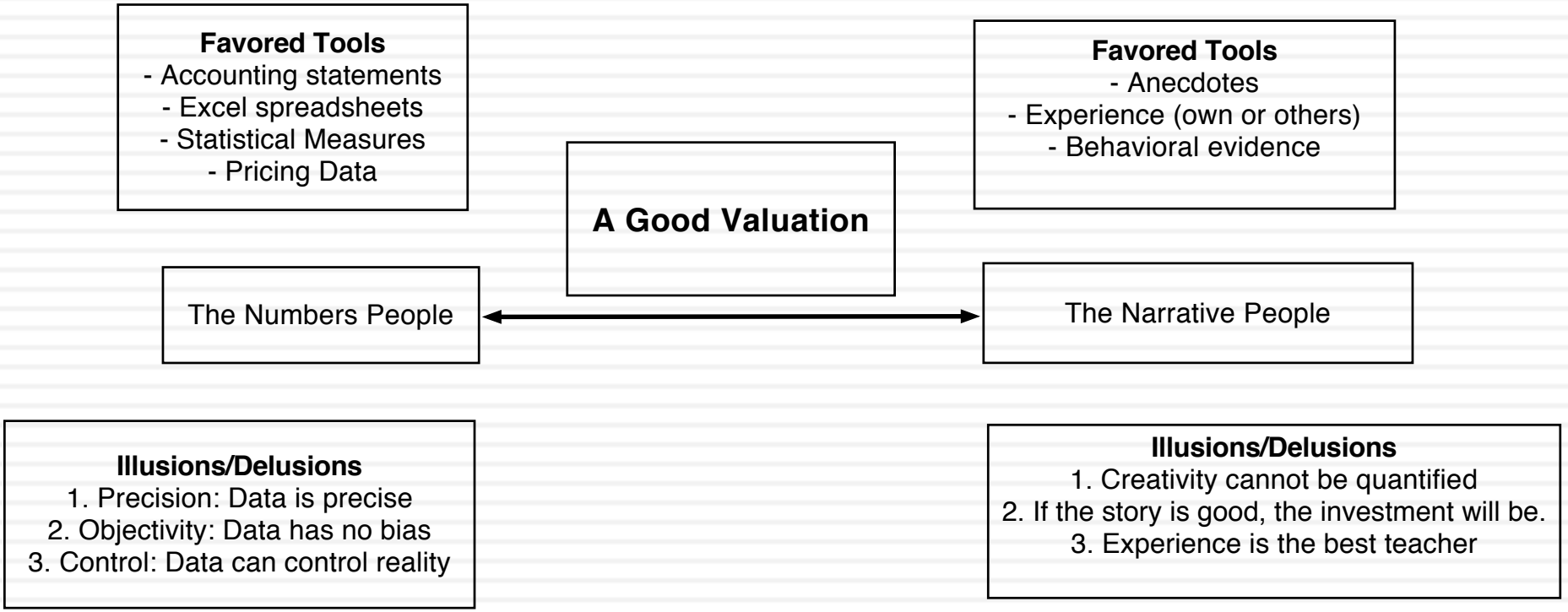
The Bermuda Triangle of Valuation



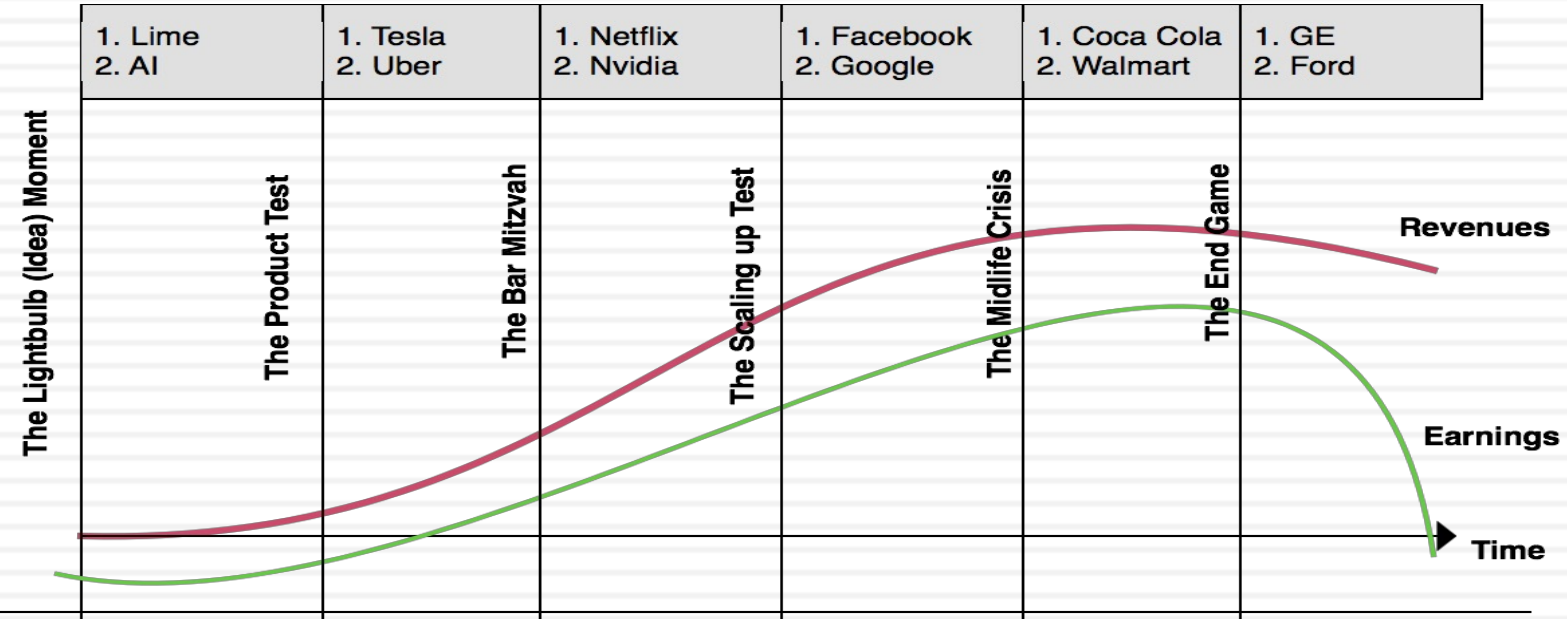
Value: The Drivers



Bridging the Gap

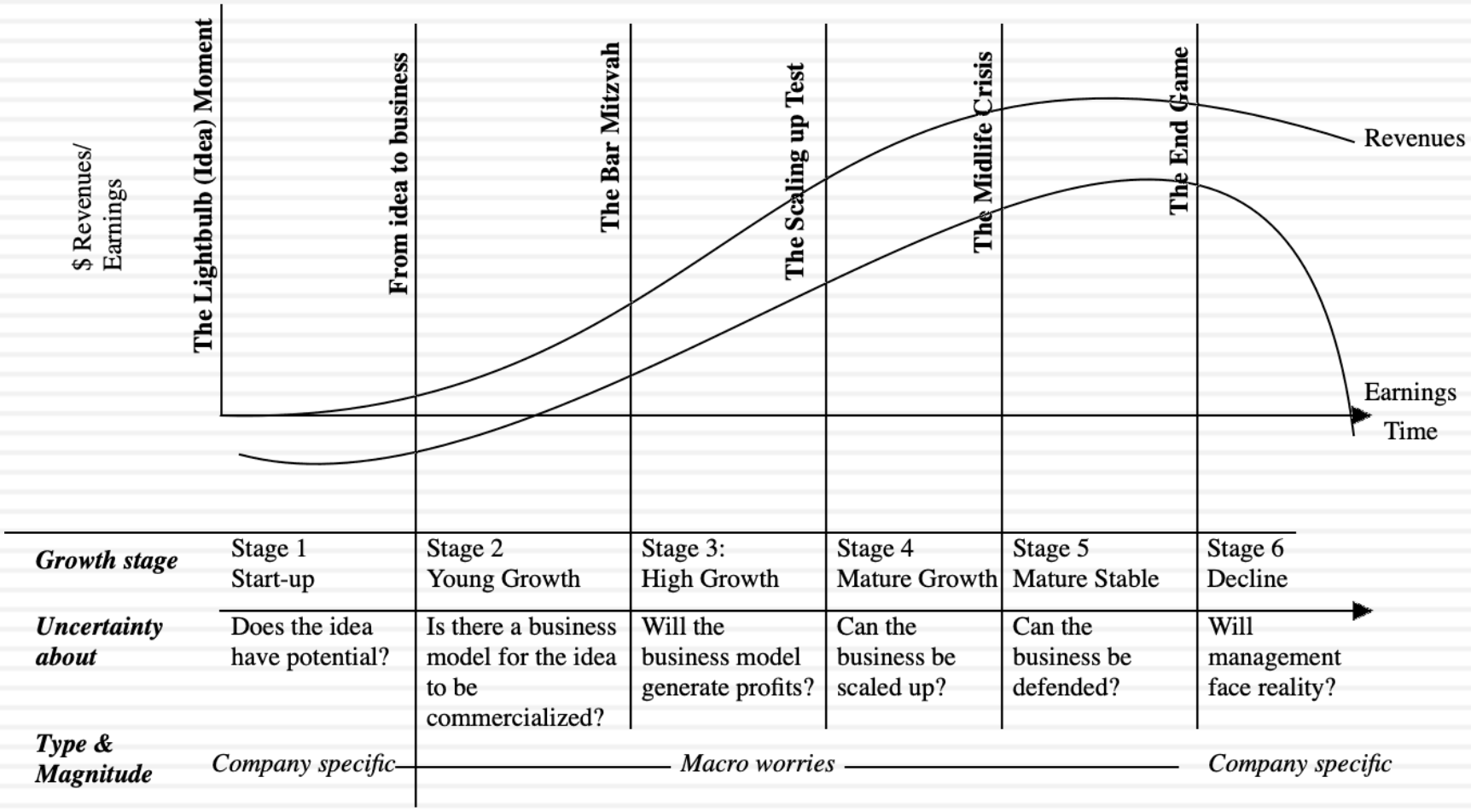


The Corporate Life Cycle

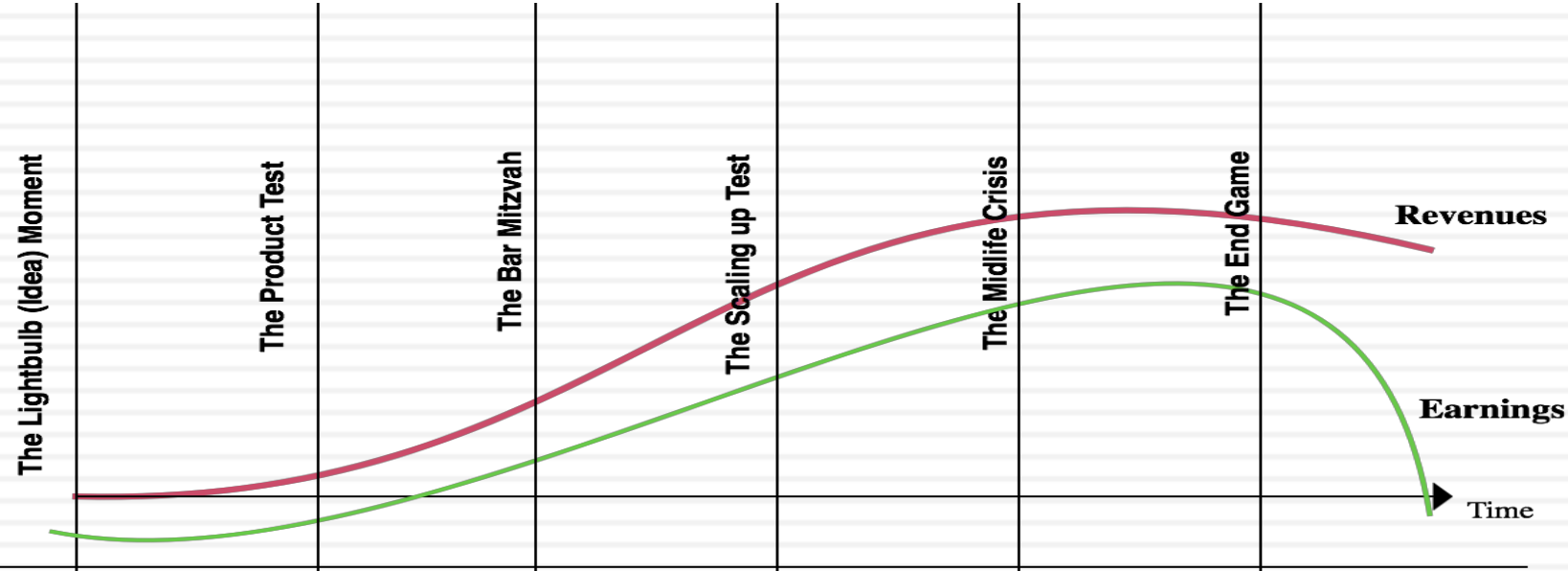


Lifecycle stage	Start-up	Young Growth	High Growth	Mature Growth	Mature Stable	Decline
Description	Have an idea for a business that meets an unmet need in the market.	Create a business model that converts ideas into revenues	Build the business, looking for scaling benefits (moving to profitability)	Grow your business, with revenue growth & higher margins	Defend your business from competitors & find new markets	Scale down your business as market shrinks.

A Life Cycle View of Uncertainty

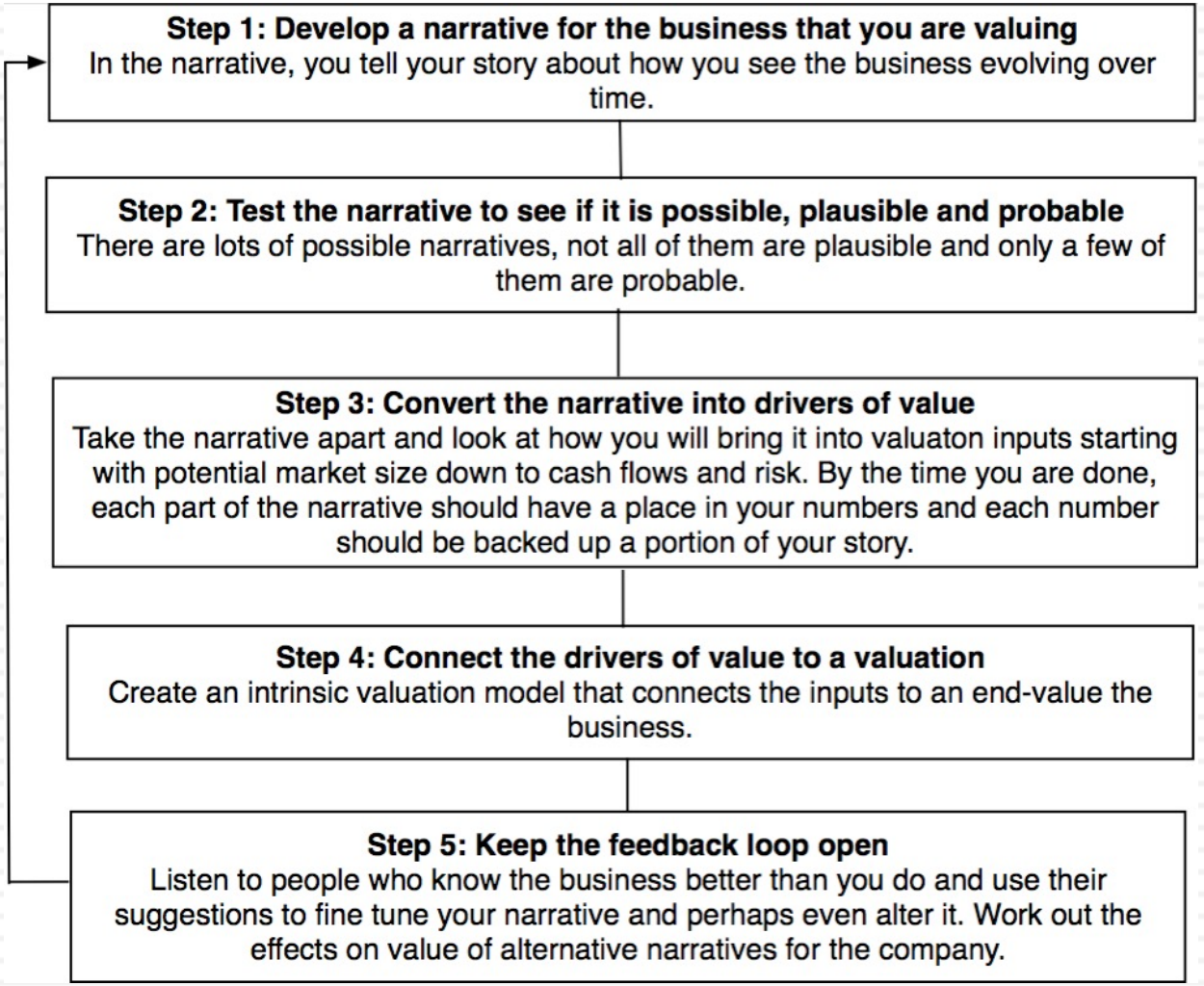


In value, the emphasis shifts as well, from narrative to numbers…



Lifecycle stage	Start-up	Young Growth	High Growth	Mature Growth	Mature Stable	Decline
Narrative versus Numbers	All Narrative	Mostly narrative	Narrative + Numbers	Numbers + Narrative	Mostly Numbers	All Numbers
Narrative Drivers	How big is the narrative?	How plausible is narrative?	How profitable is narrative?	How scalable is narrative?	How sustainable is narrative?	How happy is the ending?
Narrative Differences	Unconstrained & Large differences	*Constraints mount as numbers build up* / *Differences across investors narrow, as history deepens*				Constrained & Narrow differences

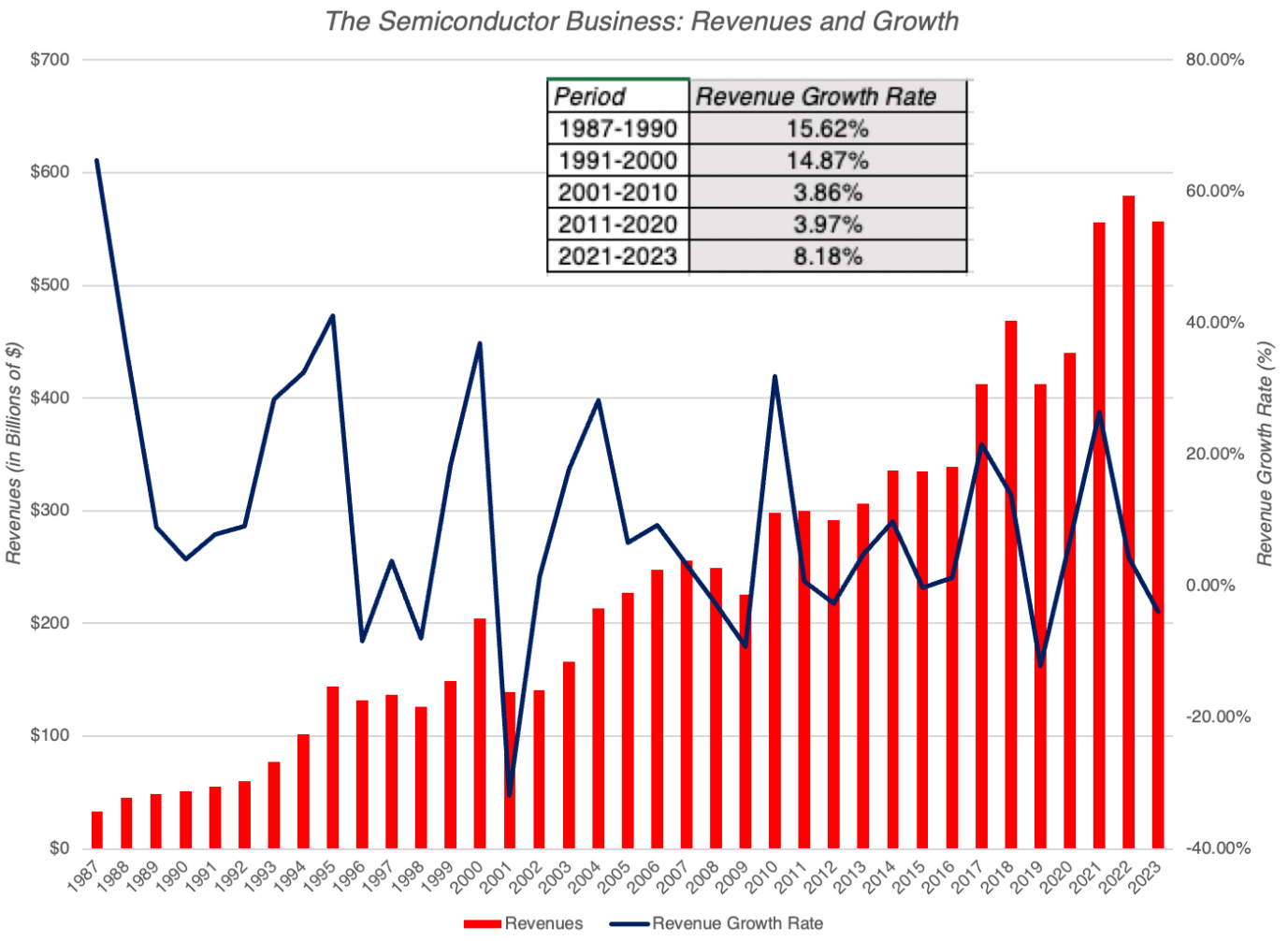
The Steps


Step 1: Develop a narrative for the business that you are valuing
In the narrative, you tell your story about how you see the business evolving over time.
Step 2: Test the narrative to see if it is possible, plausible and probable
There are lots of possible narratives, not all of them are plausible and only a few of them are probable.
Step 3: Convert the narrative into drivers of value
Take the narrative apart and look at how you will bring it into valuaton inputs starting with potential market size down to cash flows and risk. By the time you are done, each part of the narrative should have a place in your numbers and each number should be backed up a portion of your story.
Step 4: Connect the drivers of value to a valuation
Create an intrinsic valuation model that connects the inputs to an end-value the business.
Step 5: Keep the feedback loop open
Listen to people who know the business better than you do and use their suggestions to fine tune your narrative and perhaps even alter it. Work out the effects on value of alternative narratives for the company.

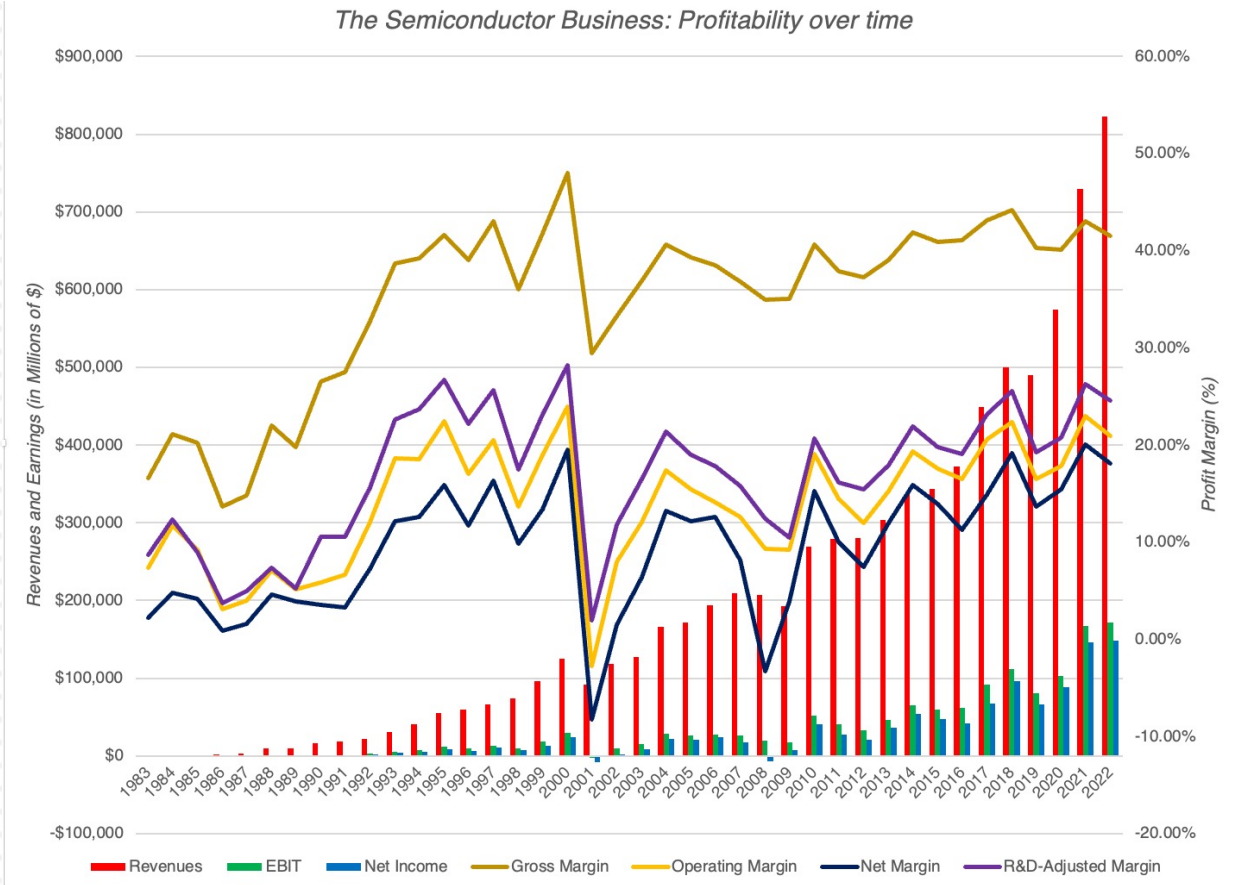
Step 1a: Survey the landscape

- Every valuation starts with a narrative, a story that you see unfolding for your company in the future.
- In developing this narrative, you will be making assessments of
  - Your company (its products, its management and its history.
  - The market or markets that you see it growing in.
  - The competition it faces and will face.
  - The macro environment in which it operates.

The Semiconductor Business – A Growth Business that is maturing!

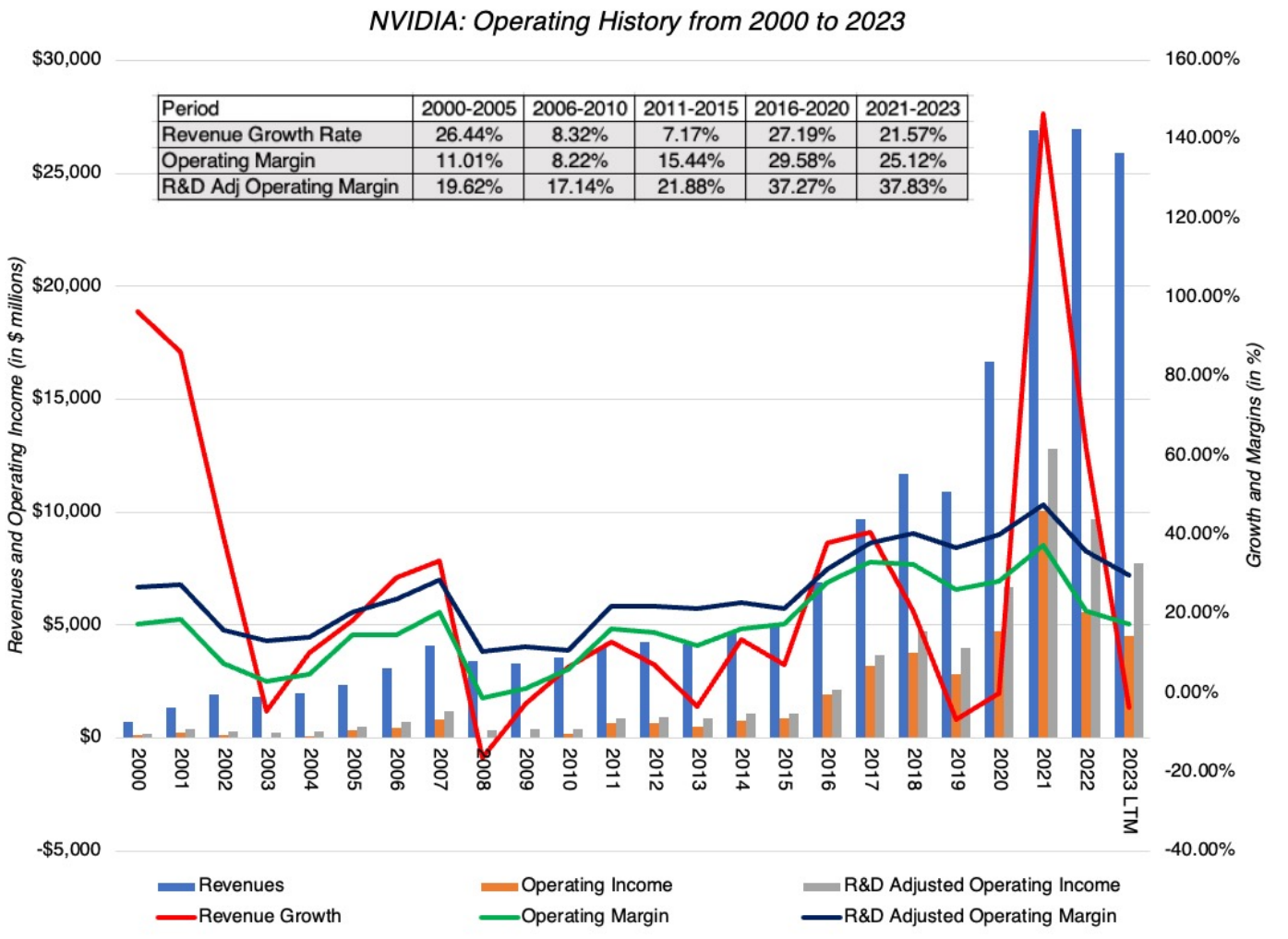


Profitable, with Cycles….

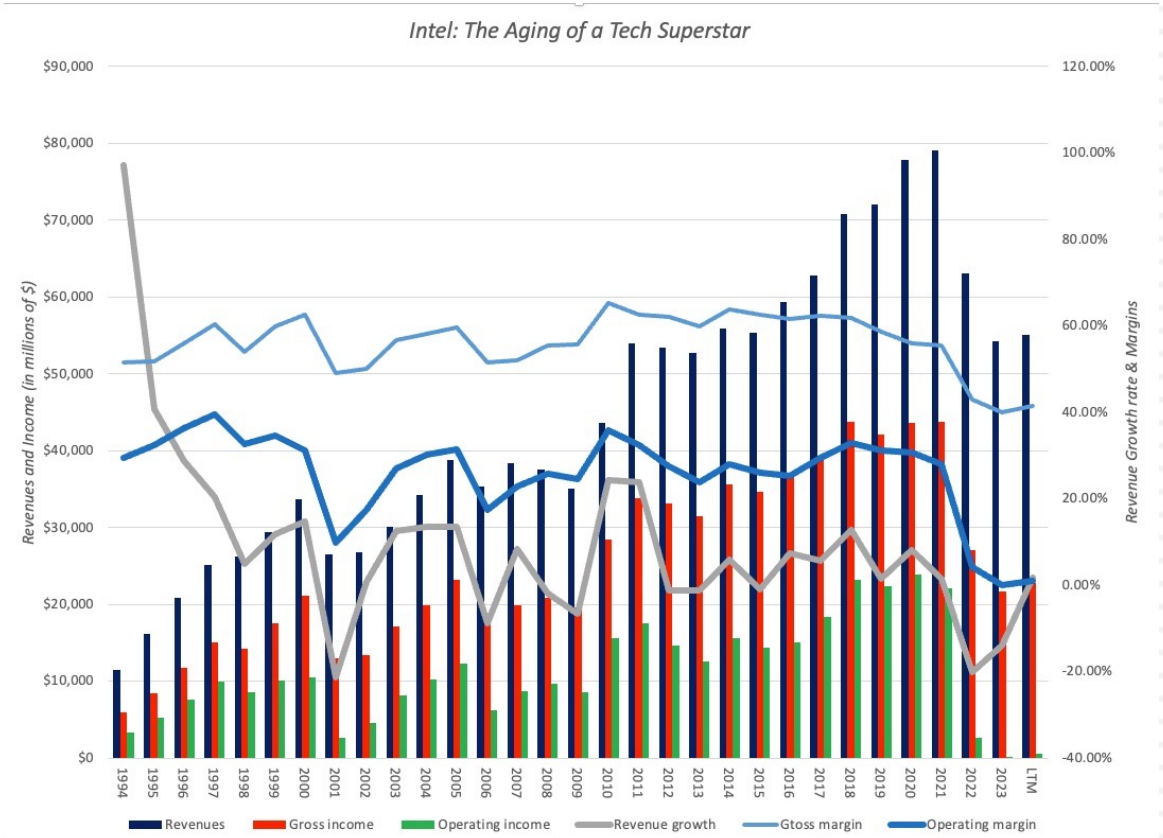


Time Period	1983-1990	1991-2000	2001-2010	2011-2020	2021-2022
Gross Margin	19.36%	38.77%	36.57%	40.58%	42.28%
Operating Margin	6.70%	17.25%	11.45%	17.23%	21.94%
Net Margin	3.23%	12.22%	6.17%	13.38%	19.08%
R&D Adjusted Margin	7.73%	21.60%	14.79%	19.90%	25.46%

NVIDIA - Opportunistic Growth



Intel- Fading Giant?



Period	Revenue Growth	Gross Margin	Operating Margin
1994-2001	14.82%	55.64%	30.68%
2002-2011	7.36%	56.72%	26.47%
2012-2021	3.88%	60.40%	28.24%
2022-2024	-11.31%	41.48%	1.69%

Step 1b: Create a narrative for the future

- Every valuation starts with a narrative, a story that you see unfolding for your company in the future.
- In developing this narrative, you will be making assessments of your company (its products, its management), the market or markets that you see it growing in, the competition it faces and will face and the macro environment in which it operates.
  - Rule 1: Keep it simple.
  - Rule 2: Keep it focused.

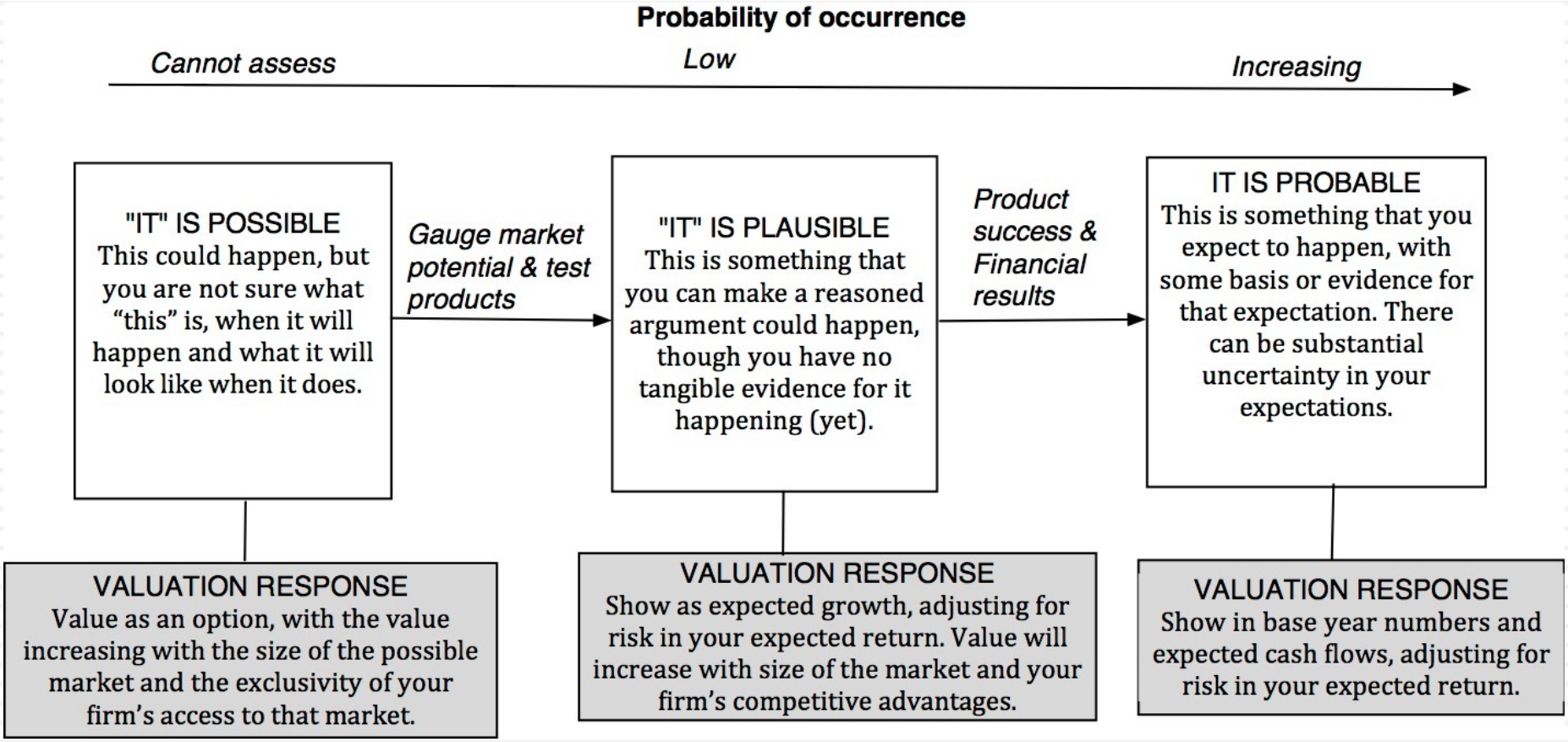
NVIDIA: The Payoff to Opportunism

- Powered by its lead in the AI chip business, Nvidia will continue on its path of high growth, but even with dominance, that growth will level off. While Nvidia might find other new markets, none of them are likely to provide the market size to allow for continued growth.
- As a design company, Nvidia will be able to generate supernormal profit margins. However, it will face push back from powerful players on the other side:
  - On the unit economics side, Nvidia will have to share more of its spoils with TSMC, as the two are locked into an embrace that neither can break away from.
  - On the customer side, Nvidia's four biggest customers are giants themselves, and will either look to competition or develop their own chips, putting stress on pricing power.
- On the reinvestment side, Nvidia will continue to reinvest in the next generations of chips, but in a market place where others are throwing large amounts of money at doing the same.

Intel: Trying too hard?

- It is my view that Intel's problems stem largely from too much me-too-ism and perhaps aspiring for growth levels that they cannot reach.
  - On both Ai and the chip manufacturing business, Intel is going up against competition (Nvidia on AI and TSMC on manufacturing) that has a clear lead and significant competitive advantages.
  - However, the market is large enough and has sufficient growth for Intel to find a place in both, but not as a leader. It is likely that even if it succeeds, Intel will revert to middle age, not high growth, but that should still make it a good investment.
- In my story, Intel's management recognizes (does it?) that the game has changed, and that rather than go after market leadership on every front, Intel plays for the portions of each market that it has an advantage, with a return to moderate growth and margins higher than the 2021-23 levels, but lower than historic levels coming into play.

Step 2: Check the narrative against history, economic first principles & common sense



The Impossible, The Implausible and the Improbable

The Impossible

Bigger than the economy
Assuming Growth rate for company in perpetuity> Growth rate for economy

Bigger than the total market
Allowing a company's revenues to grow so much that it has more than a 100% market share of whatever business it is in.

Profit margin > 100%
Assuming earnings growth will exceeds revenue growth for a long enough period, and pushing margins above 100%

Depreciation without cap ex
Assuming that depreciation will exceed cap ex in perpetuity.

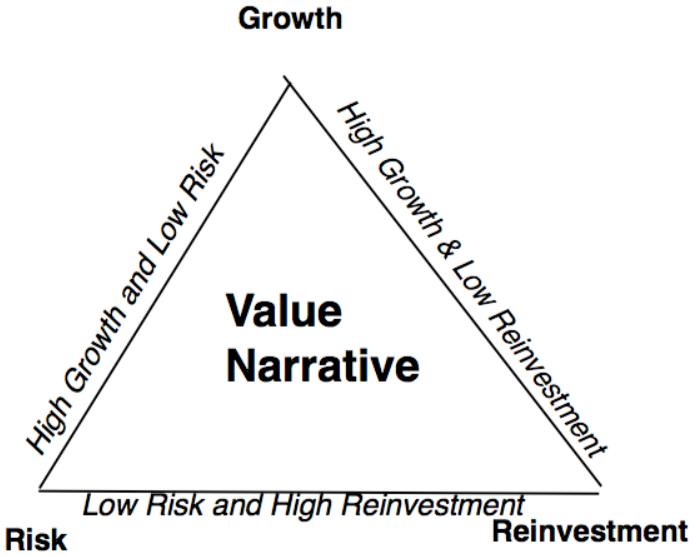
The Implausible

Growth without reinvestment
Assuming growth forever without reinvestment.

Profits without competition
Assuming that your company will grow and earn higher profits, with no competition.

Returns without risk
Assuming that you can generate high returns in a business with no risk.

The Improbable



The Runaway Story: When you want a story to be true…

- With a runaway business story, you usually have three ingredients:
  1. Charismatic, likeable Narrator: The narrator of the business story is someone that you want to see succeed, either because you like the narrator or because he/she will be a good role model.
  2. Telling a story about disrupting a much business, where you dislike the status quo: The status quo in the business that the story is disrupting is dissatisfying (to everyone involved)>
  3. With a societal benefit as bonus: And if the story holds, society and humanity will benefit.
- Since you want this story to work out, you stop asking questions, because the answers may put the story at risk.

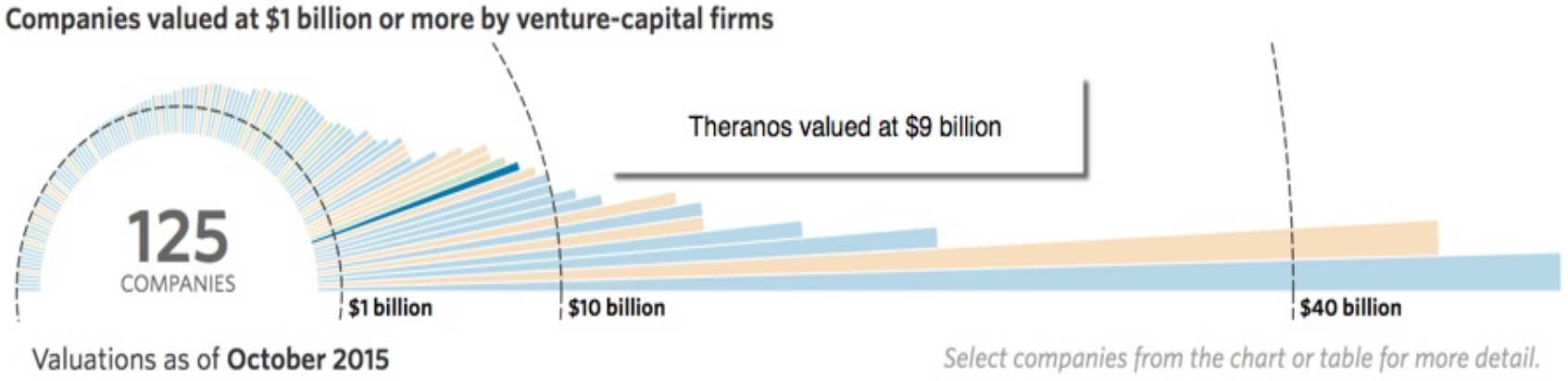
The Impossible: The Runaway Story

The Story

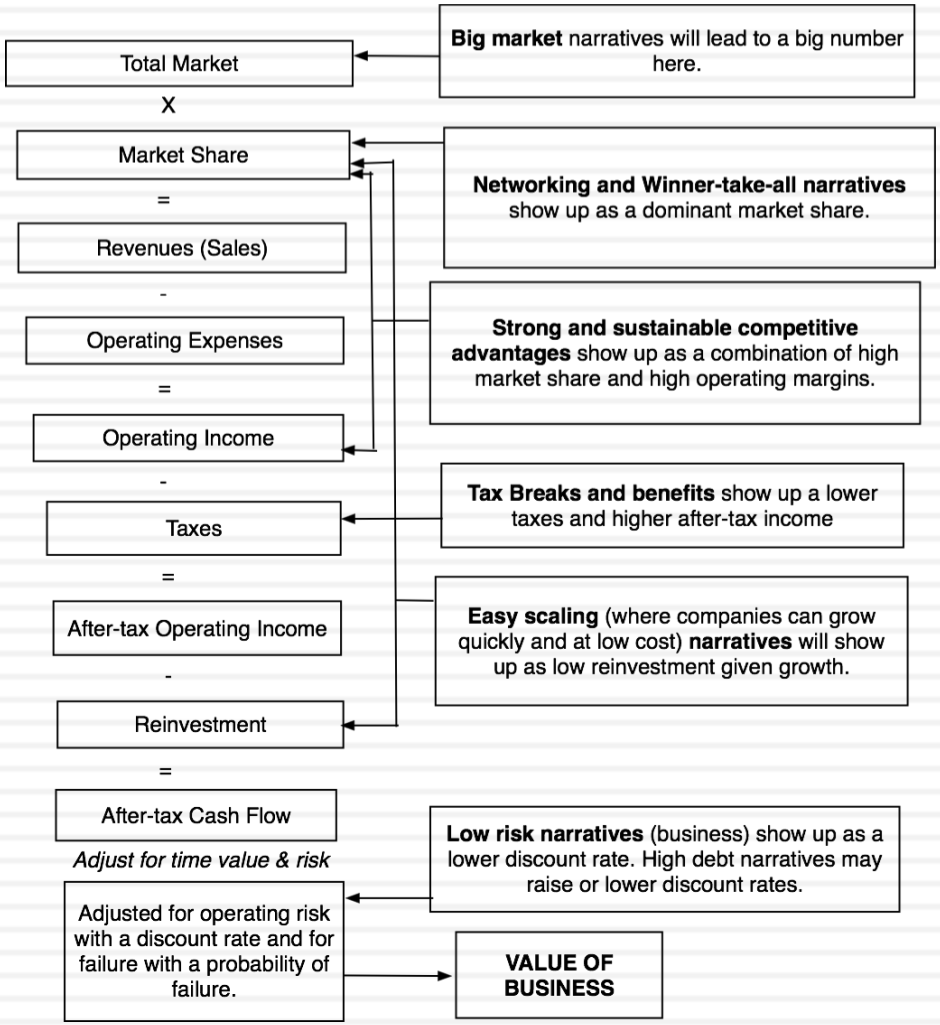
The Checks (?)

Board Member	Designation	Age
Henry Kissinger	Former Secretary of State	92
Bill Perry	Former Secretary of Defense	88
George Schultz	Former Secretary of State	94
Bill Frist	Former Senate Majority Leader	63
Sam Nunn	Former Senator	77
Gary Roughead	Former Navy Admiral	64
James Mattis	Former Marine Corps General	65
Dick Kovocovich	Former CEO of Wells Fargo	72
Riley Bechtel	Former CEO of Bechtel	63
William Foege	Epidemologist	79
Elizabeth Holmes	Founder & CEO, Theranos	31
Sunny Balwani	President & COO, Theranos	NA

Money



Step 4a: Connect your narrative to key drivers of value



Nvidia: From story to numbers

Input	*The Good News*	*The Caveats*	*The Forecast*
Revenue Growth	The rush by companies to incorporate AI into their business models has driven demand for AI chips through the roof, and as the dominant company in the space, with a market share close to 80%, Nvidia has more than doubled revenues in the last year. **AI chip market in 2023-24: $80 billion** **Nvidia market share: 80%**	The growth in the market has pushed the AI chip plans of competitors into hyper speed. While they have been slow to make inroads, that will change over time.	While Nvidia will remain the dominant player in the AI market, the growth in the market will start to slow, and competition will increase. **AI chip market in 2034: $500 billion** **Nvidia market share: 60%**
Gross Margins	Gross margins of close to 70%, driven by great unit economics. Put simply, Nvidia, as a design company, lets TSMC make its chips, and is able to mark them up, and at least for the moment, TSMC is going along. **Nvidia gross margin = 70-75% in 2024 Q2**	At current levels, there is little room for improving unit economics and as chip-making contracts get renegotiated, TSMC will have stronger bargaining power.	The higher prices that Nvidia eventually have to pay for chips will depress gross margins, albeit only slightly. TSMC has just as much to lose as Nvidia, from pushing too hard. **Nvidia gross margin in 2034 = 65%**
Operating Margins	As the dominant player providing the processing power for the fastest growing market (AI) in the world, Nvidia has significant pricing power. It is using it to full effect right now. **Nvidia operating margin = 61.9% in TTM 2024 Q2** **Nvidia R&D adj operating margin = 67.0% in TTM 2024 Q2**	Four big tech companies (MSFT, GOOG, AMZN and META) account for 40% of revenues. They need AI chips urgently to expand their AI presence, and are willing to pay Nvidia's prices.	As competition emerges, the big tech companies will start looking for alternatives (with other chip makers as well as with their own in-house chips). That will reduce Nvidia's pricing power, and operating margins. **Nvidia's R&D adj operating margin in 2034 = 60%**
Reinvestment	As a chip-design company, R&D remains the biggest reinvestment component. Nvidia spent $10.6 billion on R&D in the most recent year, and will continue to spend immense amounts, both in next-gen AI chips and in chips in other businesses. **Current sales to capital in July 2024 = 1.66** **Marginal sales to capital in TTM = 6.98**	There are two issues with R&D reinvestment (that are not specific to Nvidia): 1. *Lagged effect*: It take a while for growth to show up. Much of Nvidia's current success comes from R& D done years ago. 2. *Uncertainty*: The benefits remain uncertain, especially on the portion of R&D that is early stage.	Nvidia's R&D has been opportunistic and timely, giving the company early entry into the gaming, crypto and AI businesses. While R&D spending will continue at high levels, they will decrease relative to sales. **Marginal sales to capital between 2024 and 2034 = 2.50**
Risk	Nvidia in the last decade has largely escaped the cycles that have bedeviled the semiconductor chip business historically. Dependent on TSMC for its chap making, the company has significant exposure to China risk. **Nvidia cost of capital in 2024 = 10.70%**	Nvidia has been able to use growth in new markets (crypto, gaming and AI) to keep the chip cycle risk at bay, but that risk lurks under the surface.	Nvidia's cost of capital will remain higher than the median company, even in steady state. It is set to the third quartile of US companies. **Nvidia cost of capital in 2034 = 8.49%**

Nvidia

Sep-24

Base Year and Comparison	Company	Industry
Revenue Growth	149.90%	5.77%
Revenue	$96,307	
Operating Margin	67.02%	16.32%
Operating Income	$64,544	
EBIT (1-t)	$19,216	

Growth Story (Revenue)

Even as gaming and other chip businesses mature, NVIDIA"s investments in the AI and Auto chip businesses will deliver healthy growth over the next decade.

Profitability Story (Margin)

Margins are astronomically high, sustained by unit economics (Design costs little, chips are cheap) and pricing power, especially in AI. Over time, both will ease, as chipmakers (TSMC) and big customers push back.

Growth Efficiency Story

Sales to capital stays higher than industry aveage, as company continues to get growth off past R&D, and focuses research on new AI and auto chips.

Terminal Value	
Growth Rate	3.73%
Cost of capital	8.49%
Return on capital	20.00%
Reinvestment Rate	18.65%

Value of Rest	$458,684
Value of AI	$1,517,730
Value of Auto	$127,524
Probability of failure =	0.00%
Value of operating assets =	$2,103,937
- Debt	$9,765
- Minority interests	$0
+ Cash	$34,800
+ Non-operating assets	$1,546
Value of equity	$2,130,518
- Value of options	$0
Value of equity in common sto	$2,130,518
Number of shares	24,578.00
Estimated value /share	**$86.68**
Price per share	$106.00
% Under or Over Valued	22.28%

	1	2	3	4	5	6	7	8	9	10	Terminal year
Revenue (Gaming/Other)	$ 35,773	$ 41,139	$ 47,310	$ 54,406	$ 62,567	$ 70,542	$ 77,943	$ 84,364	$ 89,413	$ 92,748	$ 96,207
Revenue (AI)	$ 101,712	$ 137,408	$ 171,088	$ 202,752	$ 232,400	$ 248,608	$ 263,472	$ 276,992	$ 289,168	$ 300,000	$ 311,190
Revenue (Auto)	$ 3,036	$ 5,304	$ 8,004	$ 11,136	$ 14,700	$ 17,328	$ 20,172	$ 23,232	$ 26,508	$ 30,000	$ 31,119
Revenues (Total)	$ 140,521	$ 183,851	$ 226,402	$ 268,294	$ 309,667	$ 336,478	$ 361,587	$ 384,588	$ 405,089	$ 422,748	$ 438,516
R&D Adj Operating Margin	65.00%	63.00%	62.00%	61.00%	60.00%	60.00%	60.00%	60.00%	60.00%	60.00%	60.00%
Operating Income	$ 91,339	$ 115,826	$ 140,369	$ 163,660	$ 185,800	$ 201,887	$ 216,952	$ 230,753	$ 243,053	$ 253,649	$ 263,110
EBIT (1-t)	$ 79,191	$ 100,421	$ 121,700	$ 141,893	$ 161,089	$ 170,312	$ 177,944	$ 183,864	$ 187,977	$ 190,237	$ 197,332
Reinvestment	$ 16,757	$ 16,549	$ 10,724	$ 10,044	$ 9,200	$ 8,200	$ 7,064	$ 6,307	$ 6,543	$ 6,787	$ 36,802
FCFF	$ 62,434	$ 83,872	$ 110,976	$ 131,849	$ 151,889	$ 162,112	$ 170,881	$ 177,557	$ 181,435	$ 183,450	$ 160,530
										$ 3,372,476.11	
Cost of Capital	10.52%	10.52%	10.52%	10.52%	10.52%	10.11%	9.71%	9.30%	8.90%	8.49%	
Cumulated WACC	0.9049	0.8188	0.7409	0.6704	0.6066	0.5509	0.5021	0.4594	0.4219	0.3889	
Sales to Capital	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	
ROIC	136.71%	134.46%	133.40%	139.17%	143.83%	140.52%	137.51%	134.73%	131.66%	127.41%	20.00%

Risk Story

Initial cost of capital computed based upon industry((semiconductors) and Nvidia's low debt mix and geographic exposure. Over time, Nvidia's cost of capital will drift down but will remain higher (third quartile) of all companies in market.

Competitive Advantages

Strong competitive edges allow NVIDIA to earn well above its cost of capital for the next decade and beyond.

AI and Auto Business: Market Size and Market Share

	AI		*Auto*	
	Current	*In 2034*	*Current*	*In 2034*
Total Market ($ M)	$80,000	$500,000	$20,000	$200,000
Market Share	80%	60%	$0	$0
NVIDIA revenues	$64,000	$300,000	$1,200	$30,000

Intel

Sep-24

Base Year and Comparison	Company	Industry
Revenue Growth	3.32%	5.77%
Revenue	$55,121	
Operating Margin	3.35%	16.32%
Operating Income	$1,847	
EBIT (1-t)	$1,385	

Growth Story

Settle into a low growth mode, with a limited assist for its foray into the AI chip market.

Profitability Story

The company will be able to put its Foundry troubles behind it, and improve operating profitability, albeit to a lower level than they delivered historically.

Growth Efficiency Story

Maintained at industry third quartile, as R&D is redirected to more productive (albeit lower growth) areas.

Terminal Value	
Growth Rate	3.72%
Cost of capital	7.83%
Return on capital	7.83%
Reinvestment Rate	47.51%

PV(Terminal value)	$ 94,515
PV (CF over next 10 years)	$ 51,852
Probability of failure =	0.00%
Value of operating assets =	$146,367
- Debt	$53,029
- Minority interests	$5,205
+ Cash	$29,273
+ Non-operating assets	$5,824
Value of equity	$123,230
- Value of options	$0
Value of equity in common stock	$123,230
Number of shares	4,233.00
Estimated value /share	$29.11
Price per share	$18.89
% Under or Over Valued	-35.11%

	1	2	3	4	5	6	7	8	9	10	Terminal year
Revenue Growth	6.00%	6.00%	6.00%	6.00%	6.00%	5.54%	5.09%	4.63%	4.18%	3.72%	3.72%
Revenue	$ 58,428	$ 61,934	$ 65,650	$ 69,589	$ 73,764	$ 77,854	$ 81,815	$ 85,605	$ 89,180	$ 92,497	$ 95,938
Operating Margin	3.35%	12.01%	16.34%	20.67%	25.00%	25.00%	25.00%	25.00%	25.00%	25.00%	25.00%
Operating Income	$ 1,958	$ 7,438	$ 10,727	$ 14,384	$ 18,441	$ 19,463	$ 20,454	$ 21,401	$ 22,295	$ 23,124	$ 23,984
EBIT (1-t)	$ 1,468	$ 5,579	$ 8,045	$ 10,788	$ 13,831	$ 14,598	$ 15,340	$ 16,051	$ 16,721	$ 17,343	$ 17,988
Reinvestment	$ 2,202	$ 2,334	$ 2,474	$ 2,622	$ 2,569	$ 2,488	$ 2,380	$ 2,245	$ 2,084	$ 2,161	$ 8,546
FCFF	$ (734)	$ 3,245	$ 5,572	$ 8,166	$ 11,262	$ 12,110	$ 12,960	$ 13,806	$ 14,638	$ 15,182	$ 9,442
										$ 229,736.41	
Cost of Capital	9.92%	9.92%	9.92%	9.92%	9.92%	9.50%	9.08%	8.66%	8.25%	7.83%	
Cumulated WACC	0.9098	0.8277	0.7530	0.6851	0.6233	0.5692	0.5218	0.4802	0.4436	0.4114	
Sales to Capital	1.59	1.59	1.59	1.59	1.59	1.59	1.59	1.59	1.59	1.59	
ROIC	0.77%	2.88%	4.11%	5.44%	6.88%	7.17%	7.44%	7.70%	7.94%	8.15%	7.83%

Risk Story

Initail cost of capital based upon semiconductor company risk and company's financial leverage, but declines to the median company's cost of capital.

Competitive Advantages

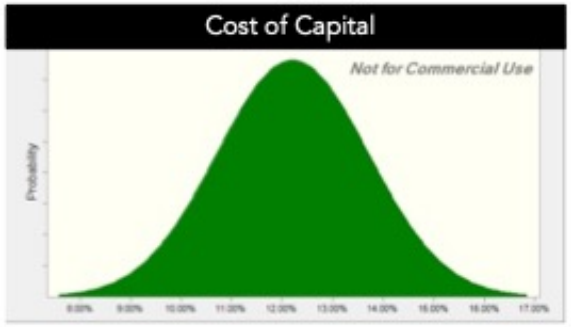
Competitive advantges, from patents and past R&D, provide some protection for the next decade, before fading in stable growth.

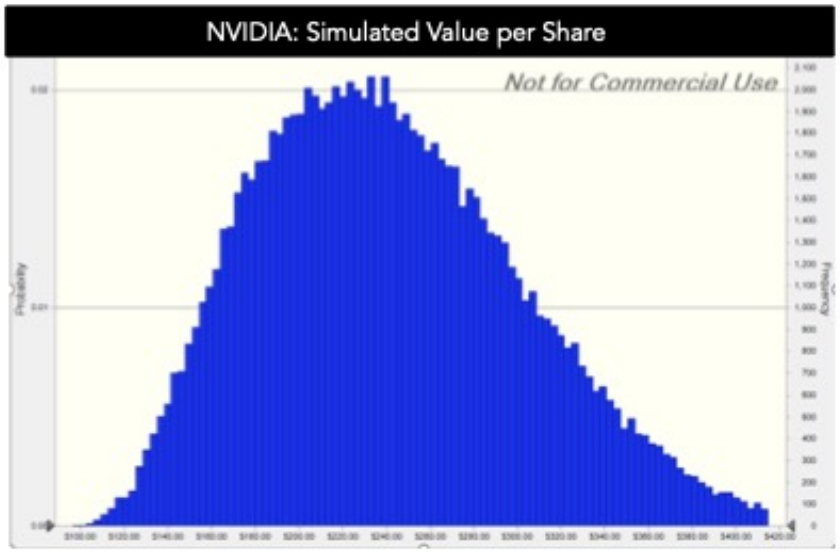
Step 5: Keep the feedback loop open

- When you tell a story about a company (either explicitly or implicitly), it is natural to feel attached to that story and to defend it against all attacks. Nothing can destroy an investor more than hubris.
- Being open to other views about a company is not easy, but here are some suggestions that may help:
  - Face up to the uncertainty in your own estimates of value.
  - Present the valuation to people who don't think like you do.
  - Create a process where people who disagree with you the most have a say.
  - Provide a structure where the criticisms can be specific and pointed, rather than general.

Facing up to uncertainty with Nvidia

NVIDIA: VALUE SIMULATION (JUNE 12, 2023)





Percentile	Value Per Share
0%	$96.51
10%	$166.01
20%	$186.59
30%	$203.88
40%	$220.23
50%	$236.28
60%	$252.97
70%	$271.77
80%	$294.04
90%	$326.17
100%	$555.75

And with Intel…

- The most dangerous value outcomes for Intel do not come from underreach, but from overreach. In short, if the company tries too hard to rediscover growth, with large reinvestment…

Intel: Value per share
Revenue Growth & Operating Margin

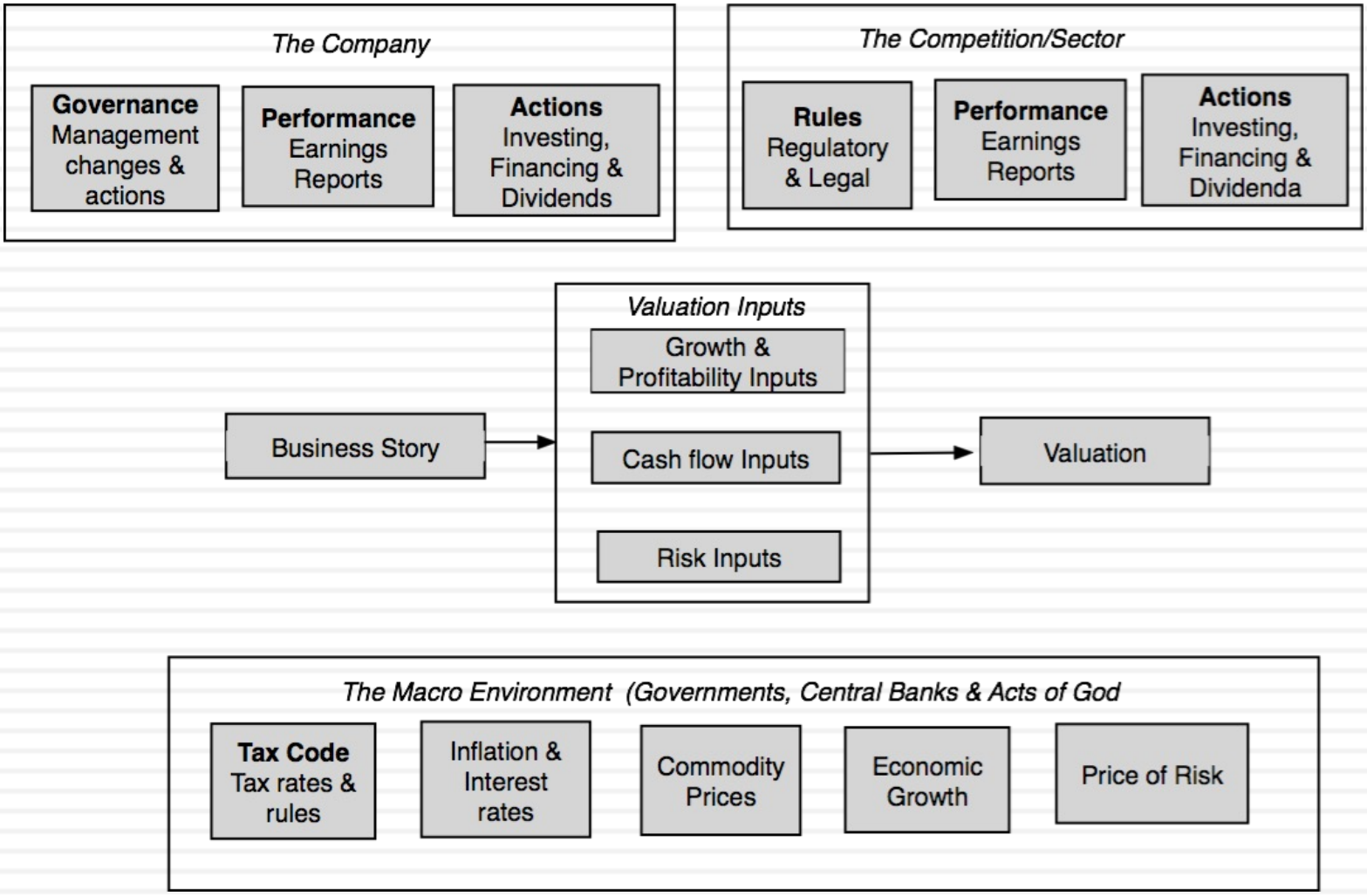
		Target Operating Margin			
		15%	20%	25%	30%
Revenue growth rate	3%	$ 11.46	$ 17.58	$ 23.70	$ 29.82
	6%	$ 13.51	$ 20.85	$ 28.20	$ 35.54
	9%	$ 15.88	$ 24.66	$ 33.45	$ 42.24
	12%	$ 18.63	$ 29.10	$ 39.58	$ 50.06

Stock was trading at $18.89/share on 9/8/24

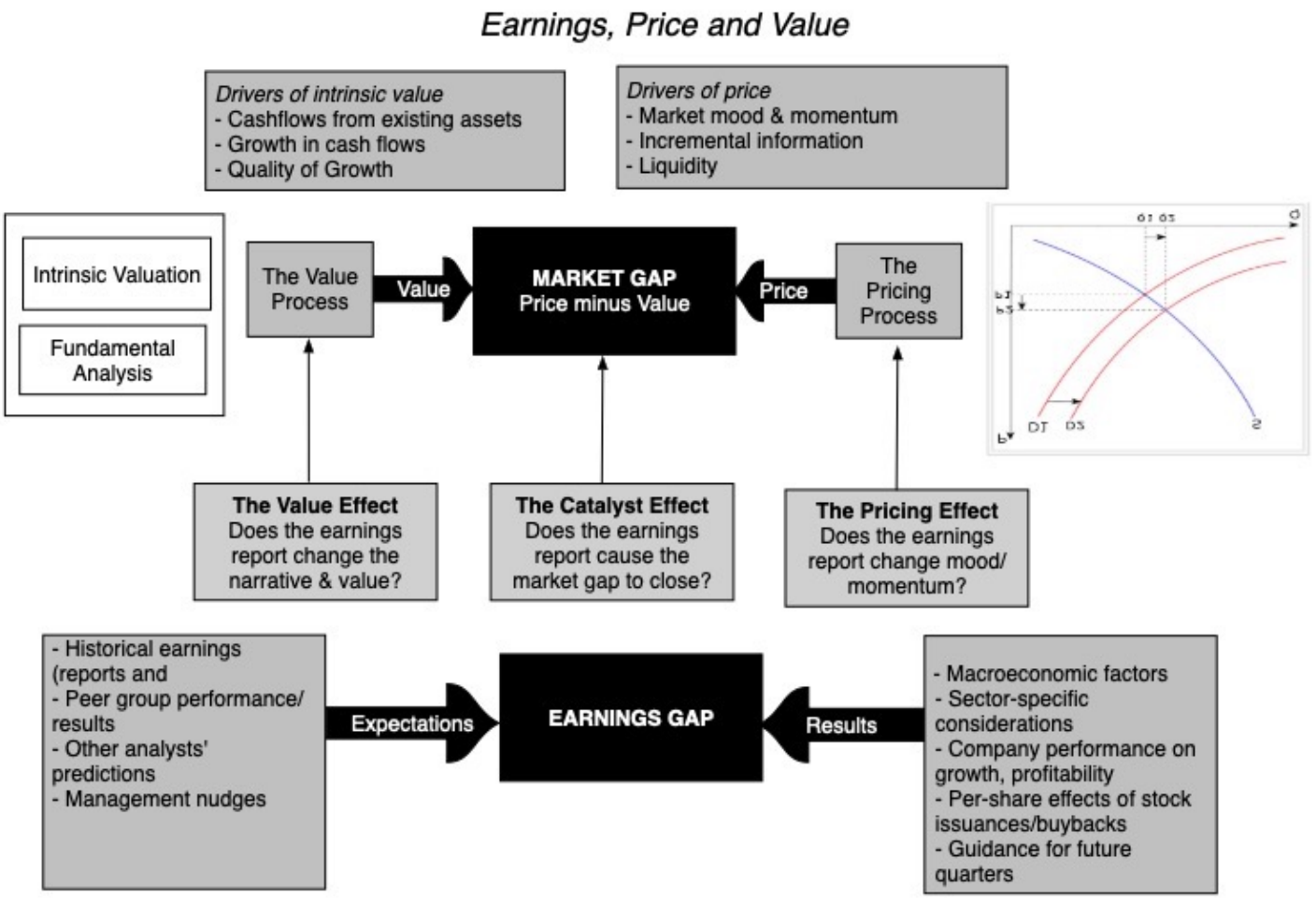
Historical Growth & Margins

Period	Revenue Growth	Operating Margin
1994-2001	14.82%	30.68%
2002-2011	7.36%	26.47%
2012-2021	3.88%	28.24%
2022-2024	-11.31%	1.69%

Why narratives change



Earnings reports: Reading the tea leaves!



How narratives change

Narrative Break/End	Narrative Shift	Narrative Change (Expansion or Contraction)
Events, external (legal, political or economic) or internal (management, competitive, default), that can cause the narrative to break or end.	Improvement or deterioration in initial business model, changing market size, market share and/or profitability.	Unexpected entry/success in a new market or unexpected exit/failure in an existing market.
Your valuation estimates (cash flows, risk, growth & value) are no longer operative	Your valuation estimates will have to be modified to reflect the new data about the company.	Valuation estimates have to be redone with new overall market potential and characteristics.
Estimate a probability that it will occur & consequences	Monte Carlo simulations or scenario analysis	Real Options

The End

"There is no real ending. It's just the place where you stop the story."