STARE INTO THE ABYSS: FACING UP TO UNCERTAINTY!

Not looking at uncertainty won’t make it go away.
The Origins of Financial Analysis

- In both corporate finance and valuation, much of what we do is built around point estimates, made with the data that we have at the time of estimation.

- The reality is that what we are estimating are distributions, with an expected value (that should be the point estimate) but also a substantial possibility of error.

- Our defense for using point estimates was that we lacked the data to estimate probability distributions and/or that doing valuations with distributions would require machine power that we did not have access to (at a reasonable price).
A Big Picture View of Simulations

- In a simulation, you estimate probability distributions for each variable that goes into an analysis.
- In each simulation, you draw an outcome from each of the distributions and estimate the end result with those outcomes. Since these outcomes can come from the low end or high end of the distributions, they will be different.
- You run as many simulations as you can and come up with a distribution of the outcomes, which you then use for decision making.
Classifying uncertainties

1. **Discrete or Continuous?** Risks that either occur or do not are discrete risks; you are not exposed to them much of the time, but when they do happen, they can be catastrophic. Risks that you are exposed to all of the time, albeit often in small does, are continuous risks.

2. **Symmetric or Asymmetric?** If positive and negative outcomes are roughly equivalent in magnitude and probability, you have symmetric risks. If large positive (negative) outcomes are more likely, you have positively (negatively) skewed risks.

3. **Extreme value likelihood, low or high?** If outcomes that are very different from your expected value happen very infrequently, you have thin tailed distributions. If they occur often, you have fat tailed distributions.
Simulation in Valuation

Value Simulation: The Steps

- Do a base case valuation, with expected values for inputs
- Identify the key value drivers
- Collect data on value drivers
- Choose probability distributions & parameters for value drivers
- Build in constraints and connections
- Run Simulations
- Value Percentiles
- Value distribution

Value Sensitivity "What ifs"

Investor fears & disagreements

Historical data

Cross Sectional Data
## Step 1: Base Case Valuation

### Apple: Base Case Valuation (May 2016)

**My Apple Narrative:** A mature company that derives the bulk of its value from a franchise (iPhone) in a market where growth is slowing and competition is increasing.

### Revenue growth of 1.5% a year in perpetuity.

### Pre-tax operating margin decreases to 25% over time.

### Sales to capital ratio of 1.60

###stable growth

- **g = 1.5%**
- **Cost of capital = 8%**
- **ROC = 12%**
- **Reinvestment Rate = 1.5%/12% = 16.67%**

### Terminal Value = 38,110/(0.08-0.015) = $586,304

### Cost of capital decreases to 8% from years 6-10

### In May 2016, Apple was trading at $93 a share.

### Riskfree Rate:

- Riskfree rate = 1.9%

### Beta:

- 1.31

### ERP:

- 6.66%

### Cost of Equity:

- 10.59%

### Cost of Debt:

- Bond rating: AA- 
  - (1.9%+0.7%)(1-.35) = 1.69%

### Weights:

- E = 89.2% D = 10.8%

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### Most recent twelve months

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
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<tbody>
<tr>
<td>Revenues</td>
<td>$227,535</td>
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<tr>
<td>Operating income or EBIT</td>
<td>$66,864</td>
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<tr>
<td>Revenue growth - LTM</td>
<td>-5.22%</td>
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<tr>
<td>Pre-tax Operating margin</td>
<td>33.28%</td>
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### Value of operating assets = $552,748

### - Debt: $64,735

### + Cash: $204,928

### Value of equity = $692,941

### - Value of options: $89

### Value of equity in common stock = $692,852

### Number of shares: 5,478.45

### Estimated value /share = $126.47

### Revenue growth rate

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<th>Year</th>
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### Revenues

- Years 1-4: $230,948, $234,412, $237,928, $241,497
- Years 5-10: $245,120, $248,797, $252,516, $256,316

### EBIT (Operating income)

- Years 1-4: $74,953, $74,136, $73,277, $72,376
- Years 5-10: $71,432, $70,442, $69,407, $68,325

### Tax rate

- Years 1-4: 26.49%
- Years 5-10: 28.19%, 29.90%, 31.60%, 33.30%

### EBIT(1-t)

- Years 1-4: $55,095, $54,495, $53,863, $53,201
- Years 5-10: $52,507, $51,666, $50,971, $50,243

### Reinvestment

- Years 1-4: $2,133, $2,165, $2,198, $2,231
- Years 5-10: $2,266, $2,298, $2,332, $2,367

### FCFF

- Years 1-4: $52,962, $52,330, $51,666, $50,971
- Years 5-10: $50,243, $48,283, $46,325, $44,369

### Value of operating assets = $552,748

### - Debt: $64,735

### + Cash: $204,928

### Value of equity = $692,941

### - Value of options: $89

### Value of equity in common stock = $692,852

### Number of shares: 5,478.45

### Estimated value /share = $126.47

### Revenue growth rate

- 1.50% per year in perpetuity

### Pre-tax operating margin decreases to 25% over time.

### Sales to capital ratio of 1.60

### Cost of capital = 10.59% (.892) + 1.0% (.108) = 9.63%
Step 2: Identify value drivers
Step 3: Collect data

Apple: Revenue Growth & Operating Margin - 1989-2015

<table>
<thead>
<tr>
<th>Year</th>
<th>Revenue Growth Rate</th>
<th>Operating Margin</th>
<th>Correlation between revenue growth &amp; margin</th>
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<td>1989</td>
<td>10.11%</td>
<td>23.60%</td>
<td>61.32%</td>
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<td>1992</td>
<td>11.30%</td>
<td>25.11%</td>
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<td>1993</td>
<td>11.55%</td>
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<td>11.79%</td>
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<tr>
<td>2015</td>
<td>16.83%</td>
<td>36.61%</td>
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The iPhone Decade

Apple: Quarterly Revenue Growth and Margins

- iPhone 2G
- iPhone 3G
- iPhone 3G Touch
- iPhone 4
- iPhone 4S
- iPhone 5
- iPhone 5c & 5s
- iPhone 6 & 6+
- iPhone 6s & 6s+

Revenue Growth Rate YoY: Blue
Operating Margin: Orange
Revenue Growth at Aging Tech Firms

Revenue Growth Rate (CAGR over 10 years) - Tech firms older than 25 years

<table>
<thead>
<tr>
<th></th>
<th>Average</th>
<th>25th percentile</th>
<th>Median</th>
<th>75th percentile</th>
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<tr>
<td></td>
<td>4.81%</td>
<td>-0.56%</td>
<td>4.63%</td>
<td>9.56%</td>
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</tbody>
</table>

26.2% of firms had negative growth rates
Step 4: Probability Distributions - Choices

- Can you estimate outcomes and probabilities?
  - Yes
  - No
  - Estimate your own probability distribution

- Is the data discrete or continuous?
  - Discrete
  - Continuous
    - Is the data symmetric or asymmetric?
      - Symmetric
      - Asymmetric

- Are the values clustered around a central value?
  - Yes
  - No
  - Uniform or Multimodal

- Are the outliers positive or negative?
  - Yes
  - No
  - Normal
  - Logistic
  - Exponential
  - Lognormal
  - Gamma
  - Weibull
  - Minimum
  - Maximum

- Where do the outliers lie?
  - No outliers, limits on data
  - Low
  - Normal
  - Lognormal
  - Exponential
  - Gamma

- How likely are the outliers?
  - Very low
  - Low
  - Normal
  - Logistic
  - Exponential
  - Lognormal
  - Gamma

- Only positive
  - Mostly positive
  - Mostly negative

- Mostly negative
  - Mostly positive
  - Mostly negative
For Apple’s revenue growth & margin

Distribution: Lognormal
Parameters:
Location = -5%
Expected value = 1.50%
Std deviation = 2.5%

Correlation between revenue growth & margin = 0.50

Distribution: Triangular
Parameters:
Minimum = 15%
Expected value = 25%
Maximum = 35%
Step 5: Constraints, Correlations and Connections

- You can build in constraints that will affect the company's operations, and its value, that are either internally or externally imposed.
  - Internal constraints can include refusal to issue new stock, borrow money or pay dividends.
  - External constraints can include failure to make debt payments or meet regulatory capital requirements.
- You can also build in correlations between the variables that you are attaching probability distributions to.
Step 6: Run the Simulation

Crystal Ball: http://www.oracle.com/us/products/applications/crystalball/crystal-ball-product/overview/index.html
The Value Distribution
Conclusion

- Not looking at what you are uncertain about does not make it go away.
- Ironically, taking a closer look at what you fear (being wrong) can make you less fearful.
- Look into the (uncertainty) abyss. It might not be as dark and dangerous as you think it is.