L3: Risk and Return

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Financial Decision-Making (1^{st} Quarter)

What does a discount rate represent?

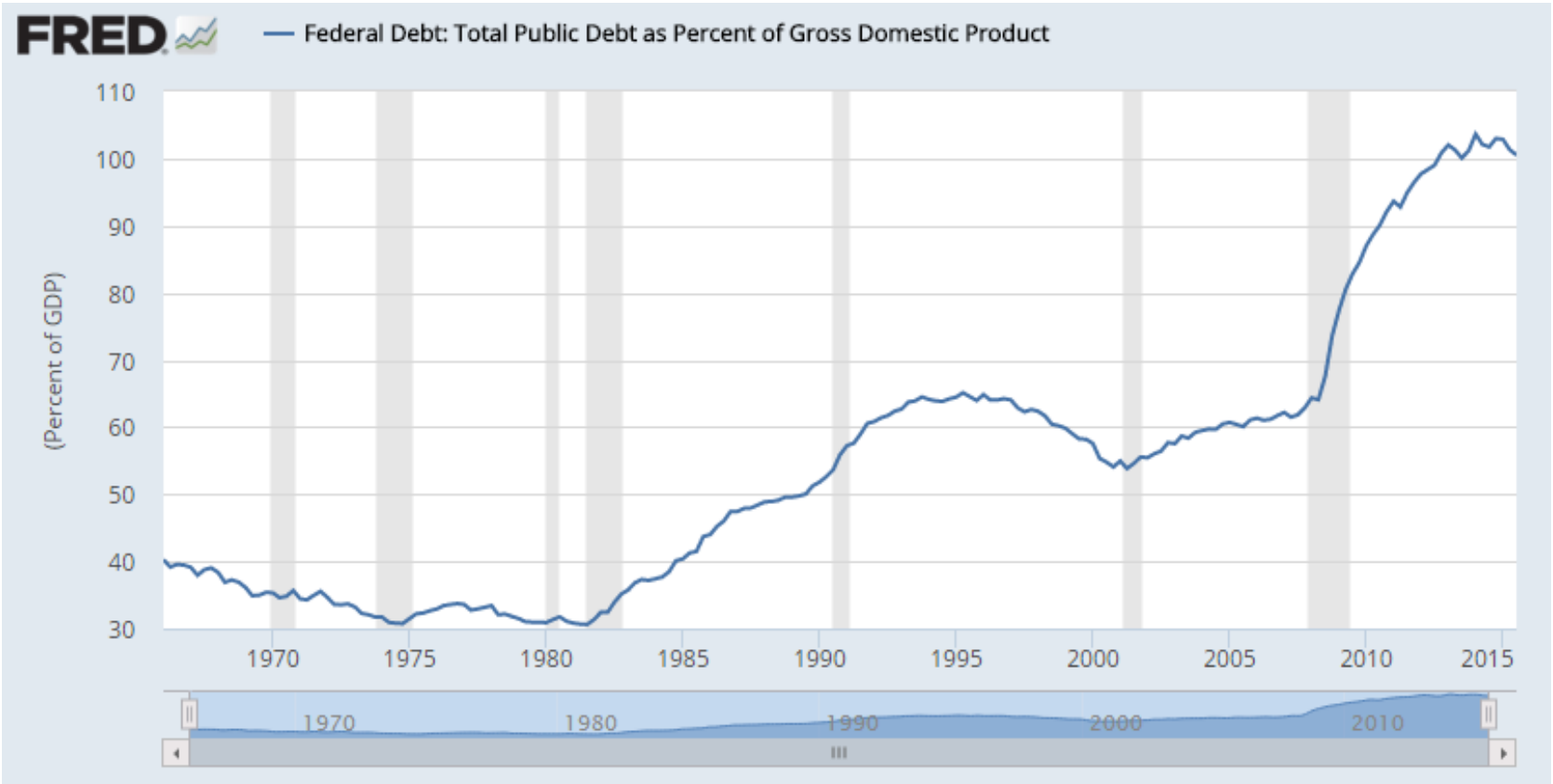
- Recall the present value formula

$$PV = \sum_{t=0}^{T} \frac{CF_t}{(1+r)^t}$$

- r in the denominator is the discount rate.
- Represents the opportunity cost of investment.
- There are two components for which we need to account:
  - Time value of money: need to compensate for lost returns.
  - Risk: need to compensate for riskiness of cash flows.
- What do I mean by risk and how do we think about compensating for it?

Riskless rate

- The return on an asset that pays-out with certainty.
- Typically we use U.S. Government bonds as a measure of the riskless rate.
- A good idea? Is it really riskless...I guess so for now at least :p



Risk premium

- When cash flows are uncertain, we typically need to provide higher compensation for certain types of risk.

Mean	7.49%
Standard error (σ)	2.38
Mean $\pm\sigma$	5.11% – 9.87%
Mean $\pm 2\sigma$	2.73% – 12.25%

risk premium of stocks over T-bills for 1927 – 2002

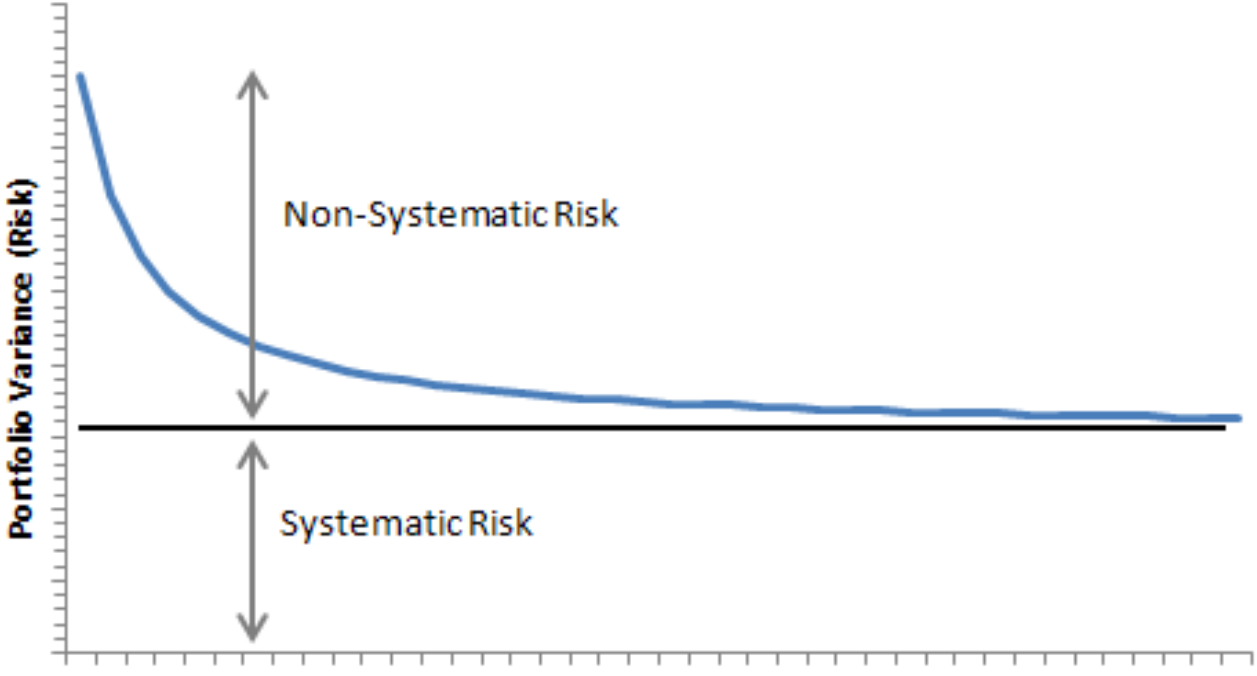
- Confidence intervals indicate that indeed there is a positive and significant premium for the risk in stocks.

Risk aversion

- People don't like risk!
- Utility: what are your preferences over wealth?
  - We capture these preferences with a **utility function**.
  - More wealth is better than less.
  - What does the **curvature** of your utility function look like?
- **Risk aversion:** when you'd prefer a certain payment rather than a risky payment with the same expected payment.
- In fact, risk averse investors are willing to accept a smaller payment with certainty than a risky payment with a higher expected payment.
- Investors aren't happy about assuming extra risk; we need to give them a higher return to make up for it.

Diversifiable v.s. undiversifiable risk (1)

- **Undiversifiable/systematic** risk: volatility in asset return that is correlated with a diversified portfolio (market portfolio).
- **Diversifiable/idiosyncratic** risk: volatility that is not correlated with a well-diversified portfolio.
- We **can't** completely eliminate risk by diversifying.
  - Can only push it down to eliminate idiosyncratic risk.



Diversifiable v.s. undiversifiable risk (2)

- Examples of idiosyncratic risk:
  - Strikes in a particular industry.
  - A company's plant burns down.
  - A drug trial fails to get approval.
- Examples of systematic risk:
  - Global financial crisis.
  - A city gets nuked.
  - Interest rate changes.

Capital asset pricing model (CAPM)

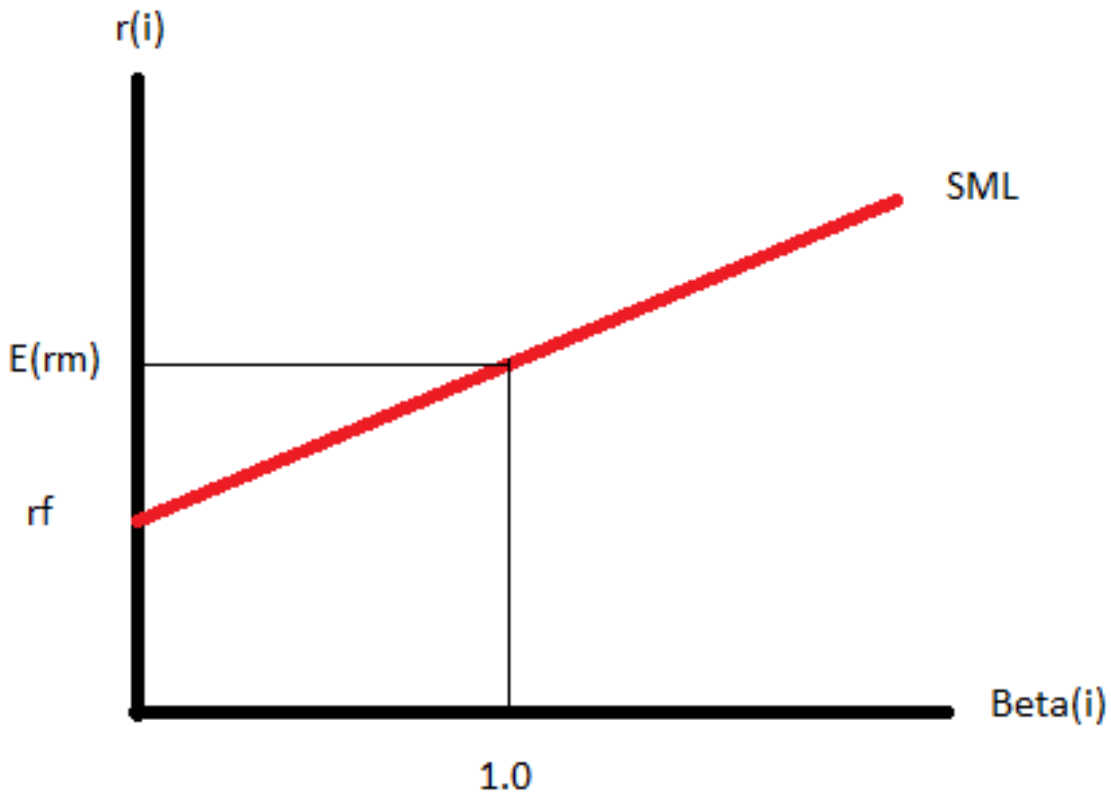
- A model that explicitly describes the relationship between risk and return.
- Systematic risk — correlation with the market captured by **one parameter** — β_i.
- The cost of capital r_i given by the following

$$r_i = r_f + \beta_i(\mathbb{E}[r_m] - r_f)$$

  where r_f is the riskless rate, β_i is some company-specific coefficient and r_m is the market rate of return.
- Think of r_m as the return on some well-diversified portfolio.
- The difference $r_m - r_f$ is known as the **market risk premium**.

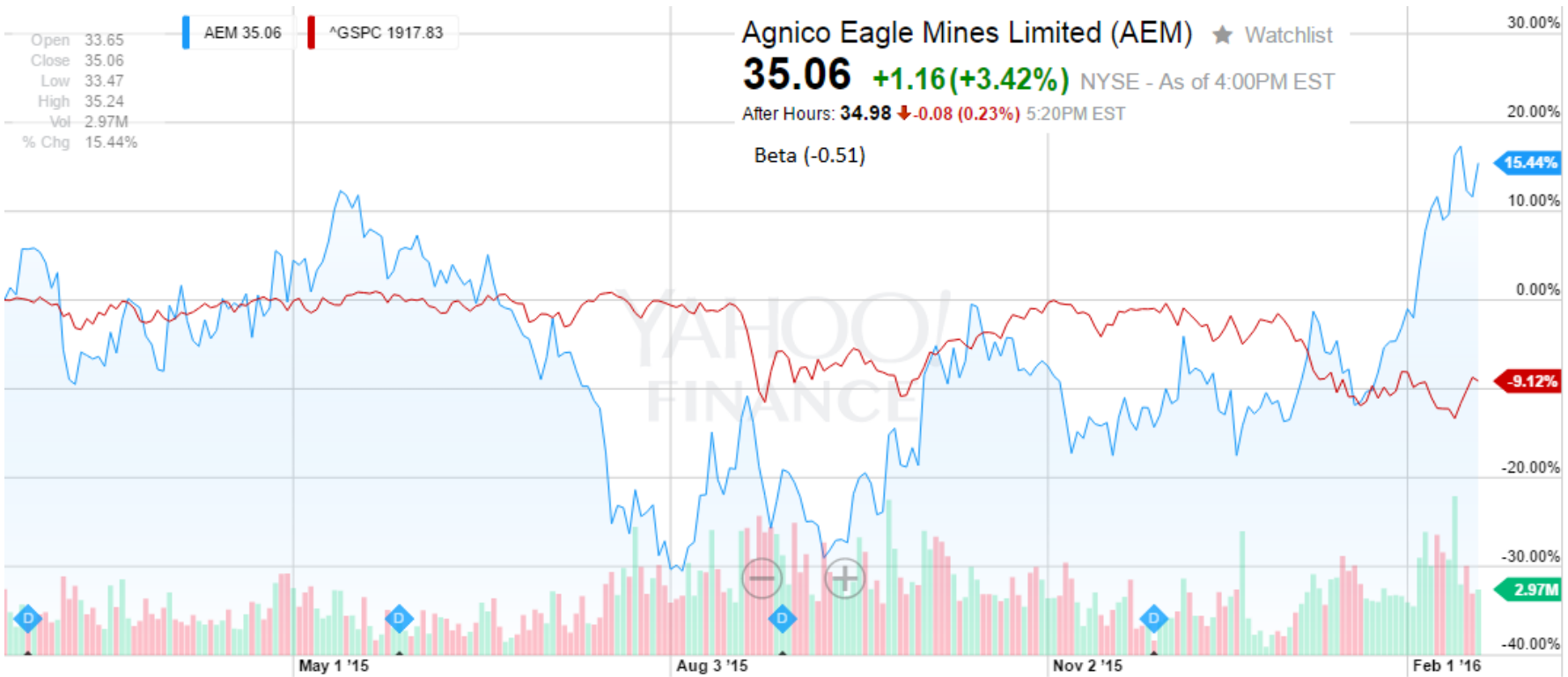
Systematic risk parameter β_i

- The expected percentage change in an asset's return given a 1% rise in the return on the market portfolio.
- This is a beautiful model; the risk associated with a particular security is entirely captured by the one parameter β_i.
- **Security market line** plots the relationship between β_i and the expected investment return.



Can we have negative β_i???

- Absolutely: just means a negative correlation with the market portfolio's return.
- CAPM formula implies that $r_i = r_f + \beta(\mathbb{E}[r_m] - r_f) < r_f$ in this case.
- "You're paying a cost for a hedge".



How do we relate β_i to data? (1)

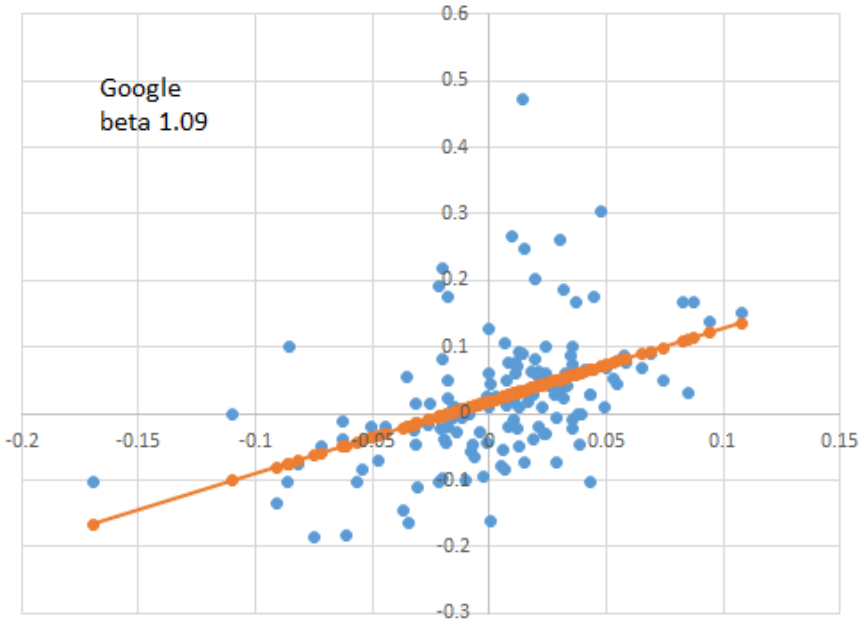
- If we have the set of returns r_i and a proxy for the market risk premium, then β_i can be interpreted as a regression coefficient.
- Note — we'd then be using historical market risk premium as a forecast for the expected future premium.
- Formula for regression $\beta_i = \frac{COV(r_i, r_m)}{VAR(r_m)}$.
- Can also use regression toolback in excel.
  - Under Data $\Rightarrow$ Analysis $\Rightarrow$ Data Analysis $\Rightarrow$ Regression.

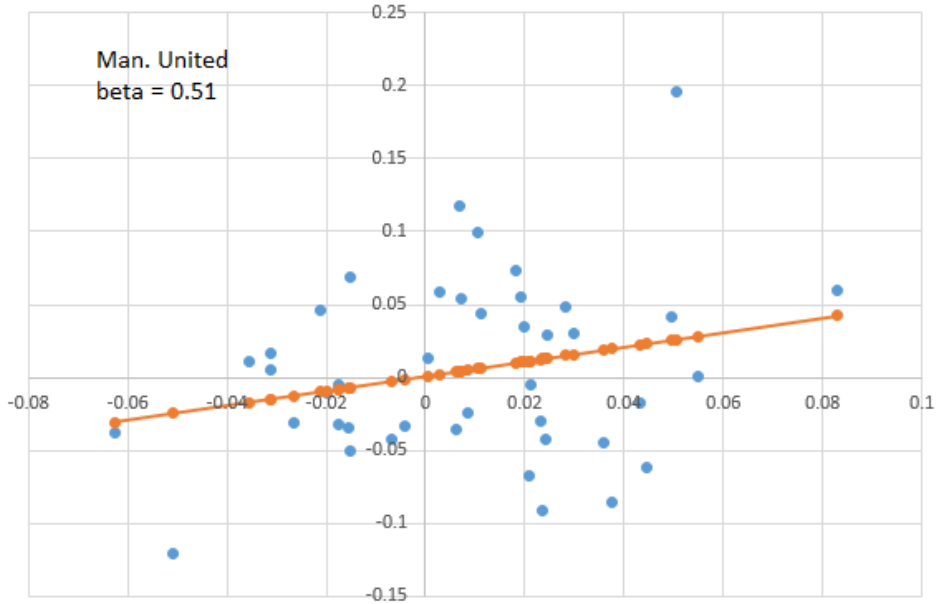
How do we relate β_i to data? (2)

- Market portfolio under CAPM theory is **value weighted**.
- Need to use a value weighted index as a proxy with data.

Date	Lehman Bros.	VW NYSE, AMEX, and NASDAQ	EW NYSE, AMEX, and NASDAQ
30-Jun-94	-0.166670	-0.027380	-0.026570
29-Jul-94	0.050000	0.030410	0.015470
31-Aug-94	0.039680	0.042830	0.036790
30-Sep-94	-0.092310	-0.018650	0.004500
31-Oct-94	0.050850	0.014870	-0.002400
30-Nov-94	-0.037100	-0.037070	-0.040570
30-Dec-94	-0.008400	0.012750	-0.012860
31-Jan-95	0.152540	0.020550	0.027710
28-Feb-95	0.069120	0.039620	0.027990
31-Mar-95	-0.006900	0.026970	0.018740
28-Apr-95	0.083330	0.024880	0.025980

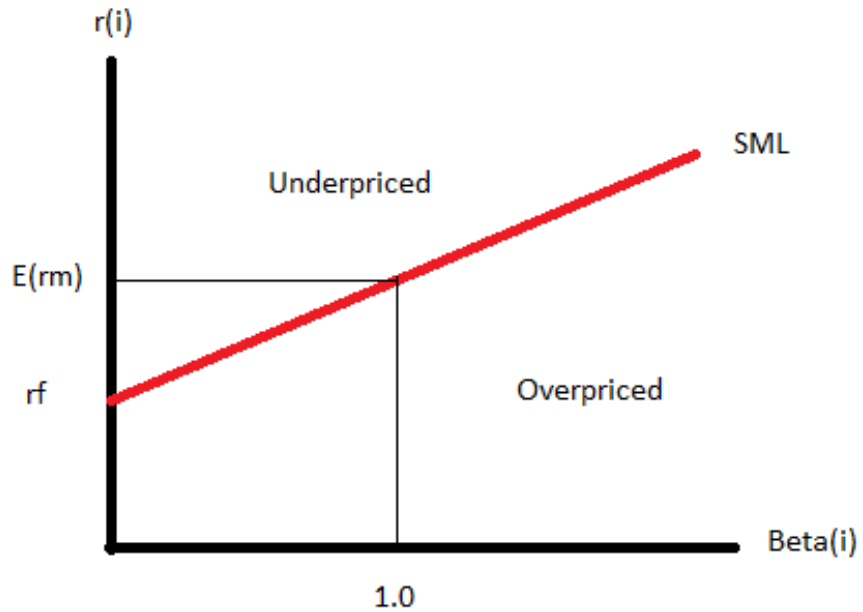
How do we relate β_i to data? (3)





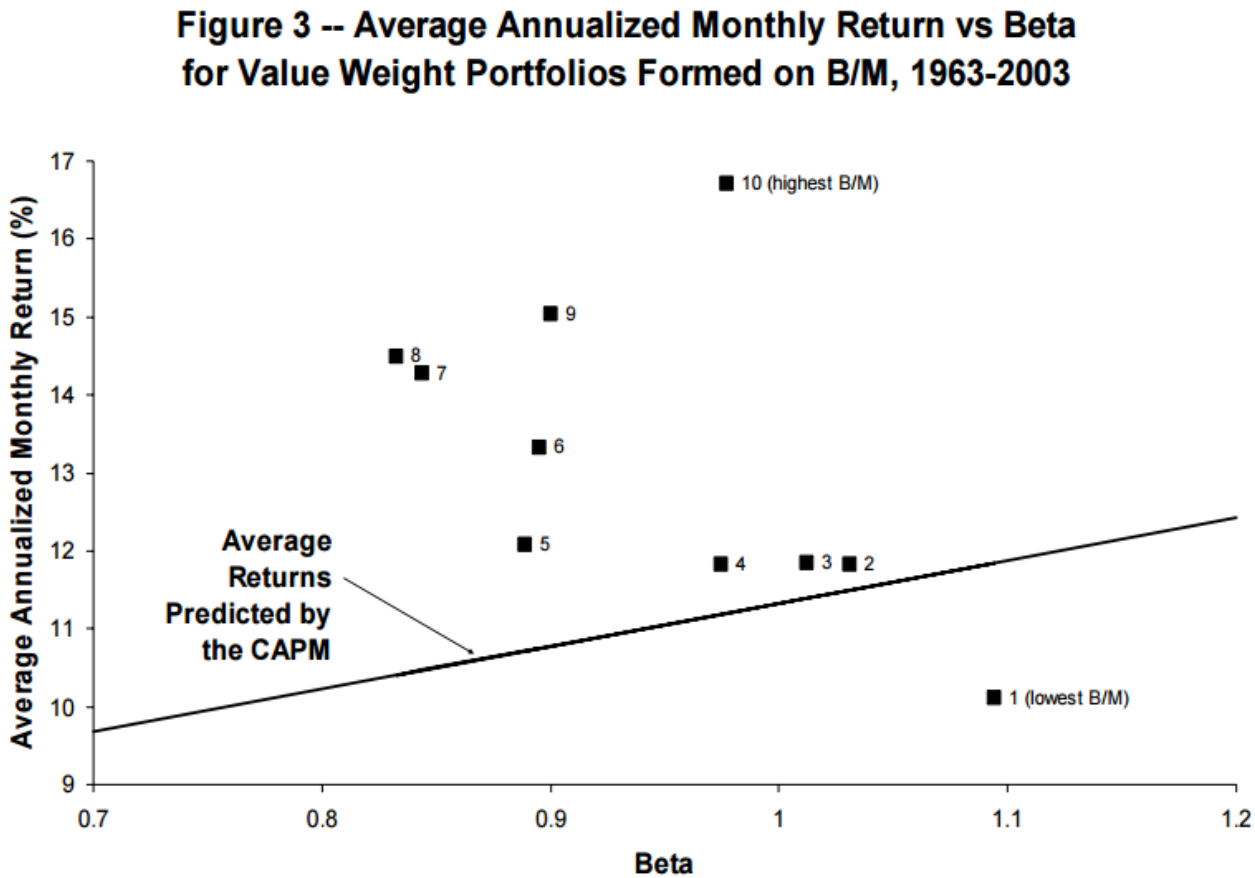
- $\beta_{Google} = 1.09$; $\beta_{MANU} = 0.51$.
- Data series: 2004 – 2016 for Google; 2012 – 2016 for MANU.

Overpricing/underpricing in CAPM



- Recall the inverse relationship between prices and returns:
  - A higher price means a lower return.
  - A lower price means a higher return.
- When we're above the SML, the return is too high relative to the CAPM.
  - Theory says that the price should rise to reduce the return **if** the model is correct.

Is the model correct?



- Figure creates ten portfolios by book to market ratio (Fama & French, 2004).
- Just shows that when sorting in this way, returns increase almost monotonically.

Fixes to the model

- **Factor models**: propose including additional variables other than just the market risk premium.

- Classical three factor model of Fama & French (1993, 1996) adds two more explanatory variables:
  - SMB (small minus big): the difference between the returns on diversified portfolios of small and big stocks.
  - HML (high minus low): the difference between returns on diversified portfolios of high and low book to market stocks.

$$r_i = r_f + \beta_{iM}(\mathbb{E}[r_m] - r_f) + \beta_{iS}\mathbb{E}[SMB] + \beta_{iH}\mathbb{E}[HML]$$

- Extra factors are acting as control variables.

- Small firms and firms with high book-market generally have higher returns.
  - High book-market means lots of book value for low price! Good deal!

- Does the market risk premium still matter when we control for this?
  - Their inclusion gives a better idea of what's driving the asset's return.

Takeaways

- Systematic risk is rewarded with a higher return in the CAPM model.
- We reward risk since investors are risk averse.
- CAPM is a **model** that is widely used in industry and government given that its simple and intuitive.
  - We will **just use the simple CAPM in this course**.
- There are alternatives that are more complicated.
- At the end of the day, it's just a **model**.