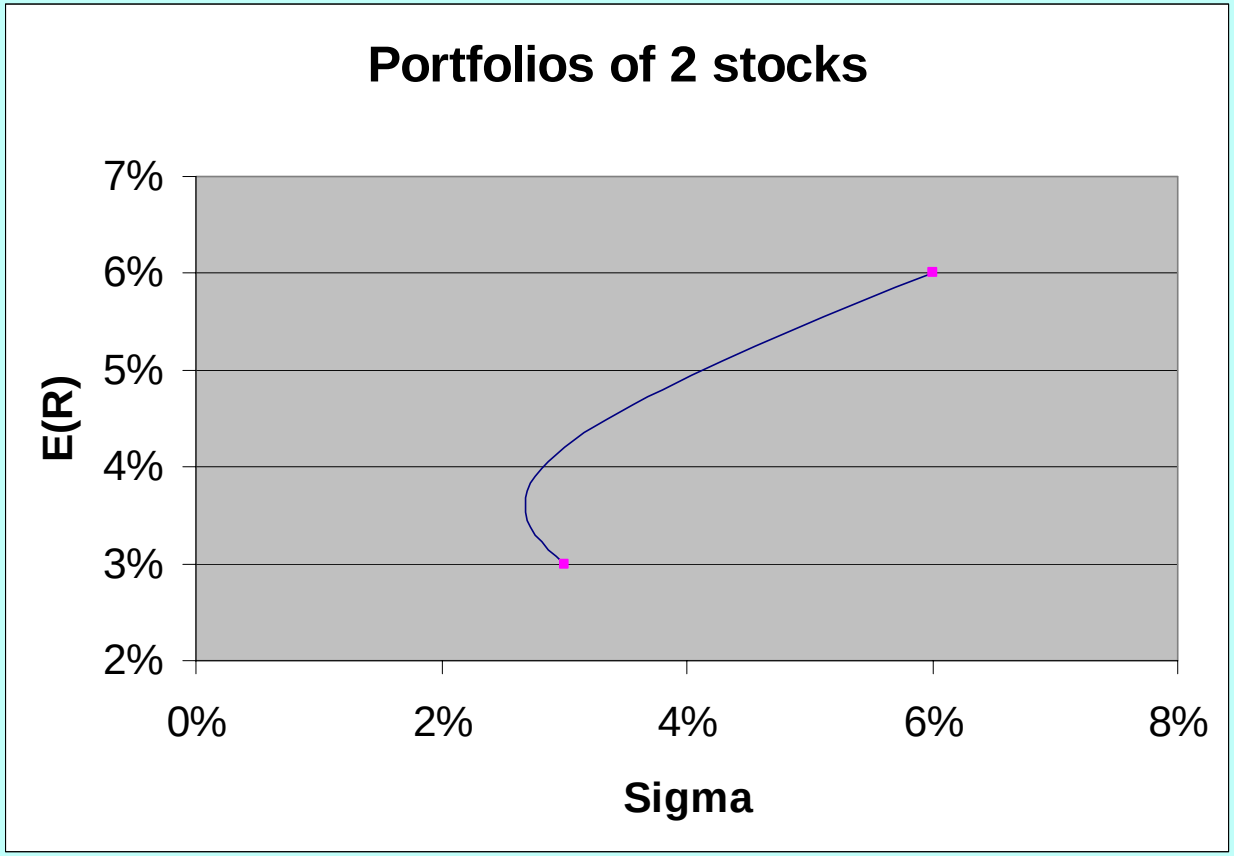
Lecture 13: CAPM continued

- Questions: How are risk and return related?
  - What kinds of risk do we care about?
  - For bearing more risk, how much extra return do we get?

- Readings:
  -- Brealey and Myers, Chapters 7 and 8
  - Reader, Chapters 13 and 14 (yes, both chapter 14's…)

Portfolios of 2 stocks

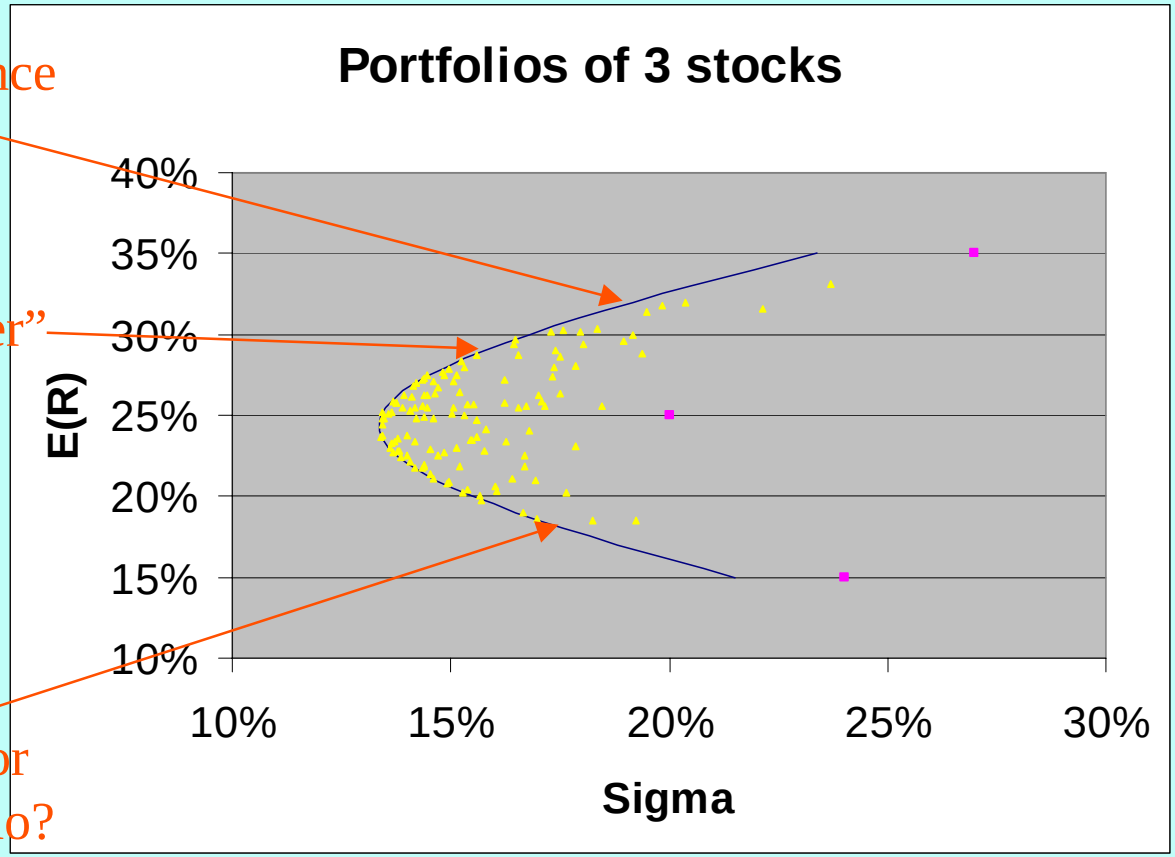


Portfolios of more than 2 stocks

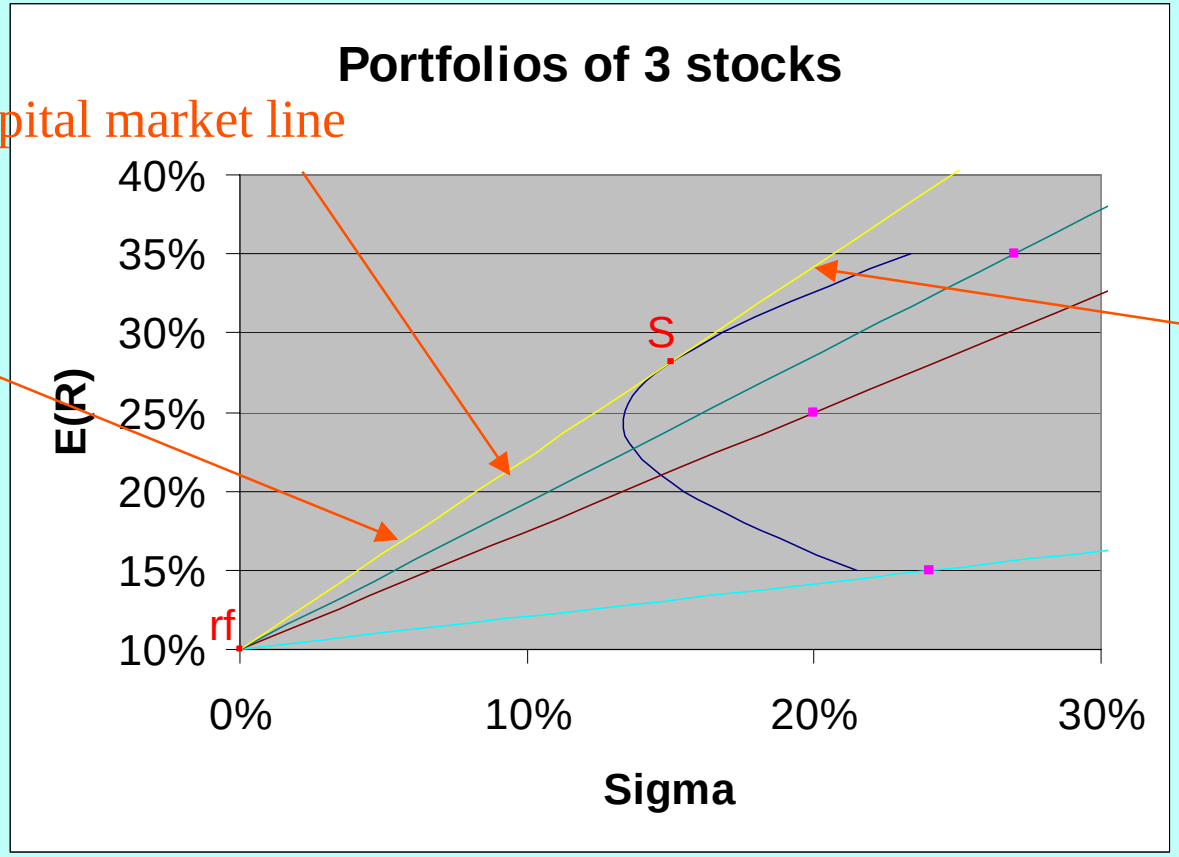
Minimum variance frontier

Top half is the "efficient frontier"

Might an investor pick this portfolio?



Combining risky portfolios with the riskless asset



- **Note**: Every investor chooses the same risky portfolio, S.

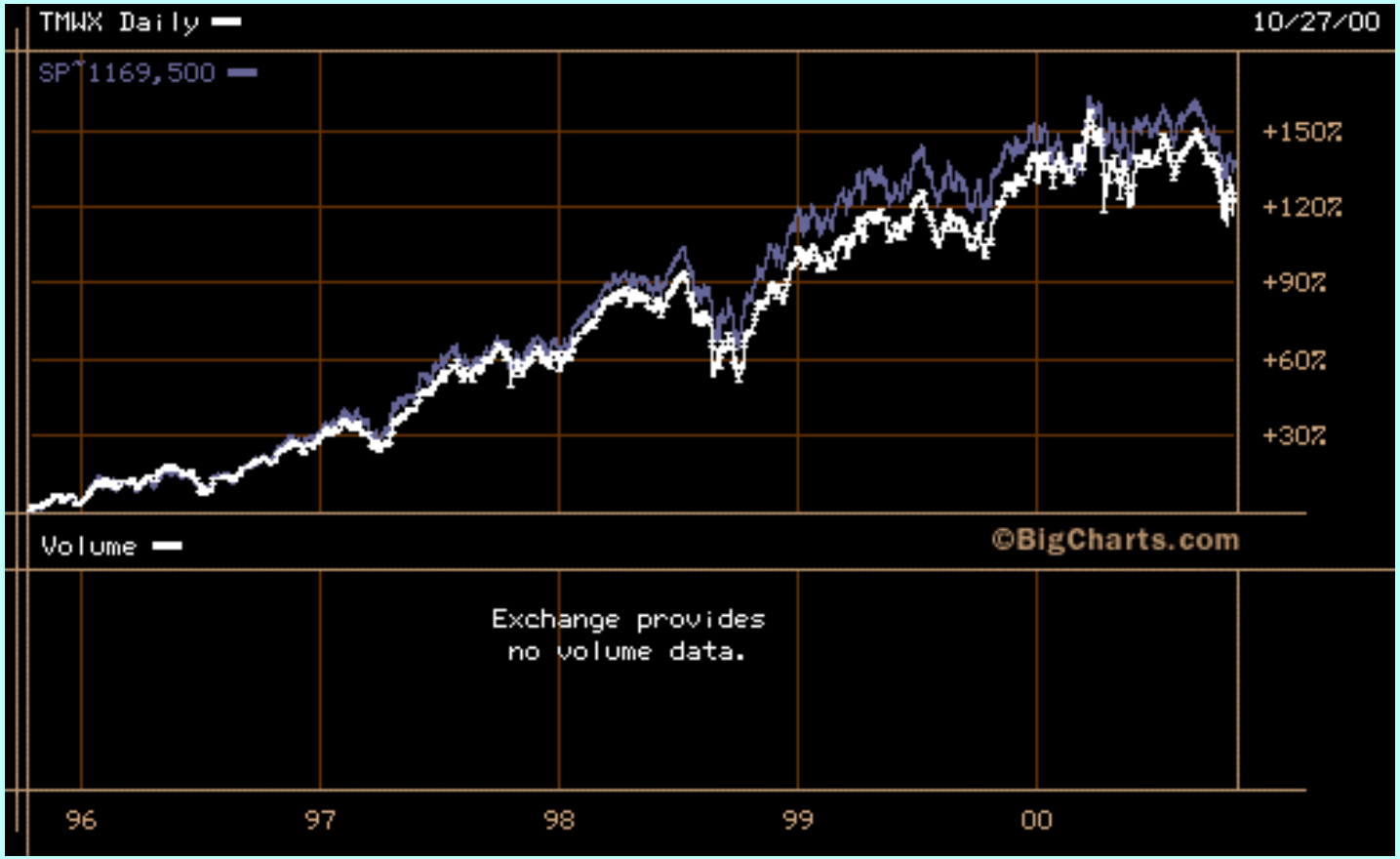
What is portfolio S?

- Suppose S contained no IBM. What would happen?
- Suppose S contained 90% Pets.com? What would happen?
- In **equilibrium**, when we add together everyone's holdings of portfolio S, we must have every share in every company.
- So S must be the **market portfolio**, M.
  - A portfolio that contains every investment in the economy in proportion to their total value.
  - Denote its return r_m.

The Market Portfolio

- We already have one key finding: All investors ought to split their money between the **market portfolio** and the risk-free asset.
- In practice, buy an **index fund**, or an **exchange traded fund** (**ETF**), such as a **SPDR**.
- These are funds designed to track a market **index.**
  - Most commonly used index: S&P 500 (^SPX)
    - » ETF: SPY
  - A broader index is the Wilshire 5000 (^TMW)
    - » ETF: WFIVX
    - » 5,000 stocks vs. 500
    - » S&P stocks represent c. 77% of the Wilshire 5000 by value
- Is the Wilshire 5,000 really the market portfolio?

Wilshire 5,000 vs. S&P 500



What about our original question?

- How does this help with our original question, though: how to calculate r?
- We're almost there…

The CAPM

- Mathematically, the market portfolio being the tangency portfolio tells us that for any asset i,

$$r_i = r_f + \frac{\mathrm{Cov}(\tilde{r}_i, \tilde{r}_m)}{\mathrm{Var}(\tilde{r}_m)}\left[E(\tilde{r}_m) - r_f\right],$$

$$= r_f + \beta_i\left[E(\tilde{r}_m) - r_f\right].$$

- The **Capital Asset Pricing Model** (**CAPM**).
- This is the relationship between risk and return we have been looking for.

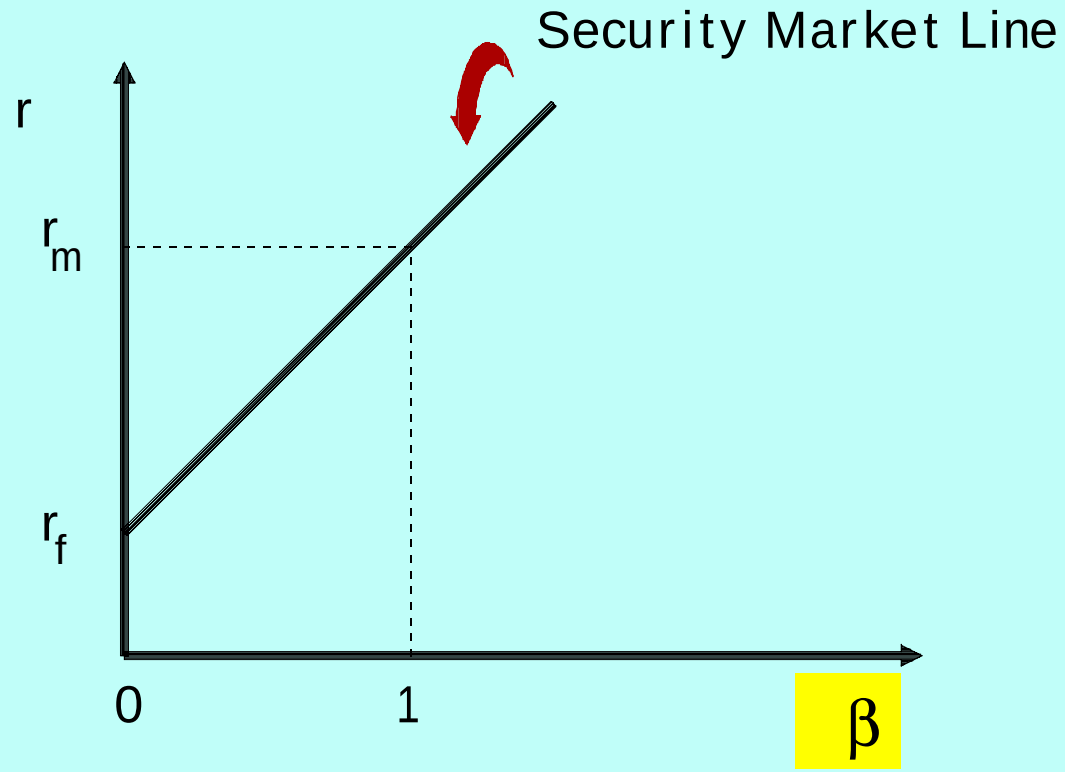
The CAPM

$$r_i = r_f + \beta_i \left[E(\tilde{r}_m) - r_f \right],$$

$$\beta_i = \frac{\mathrm{Cov}(\tilde{r}_i, \tilde{r}_m)}{\mathrm{Var}(\tilde{r}_m)}.$$

- Expected return is related to the stock's "beta"
  - Depends on covariance with the market: **Market Risk**
  - Does not depend on its variance: **Firm Specific Risk**
  - Remember our diversification example…

The Security Market Line



- Do all stocks lie on the **Security Market Line**?

Capital Market Line versus Security Market Line

	Capital Market Line	Security Market Line
Vertical Axis	Expected return	Expected Return
Horizontal Axis	Standard Deviation	Beta
Line shows	Portfolios mixing optimal portfolio with risk-free asset	Individual stock expected return as function of its Beta
What lies on the line?	Only combinations of optimal portfolio and r_f	All stocks

Expected Return and Beta

- What is the expected return on a stock with $\beta = 0$?
  - Answer is r_f: Same return as risk-free asset! Why?
  - Think about insuring lots of houses against fire.
    - » Each individually is risky, but
    - » When you diversify by insuring lots of houses, overall portfolio becomes riskless.
- What is the expected return on a stock with $\beta < 0$?
- If $\beta < 0$, then $r_i < r_f$! You'd accept a return lower than the risk-free rate? Why?