
Corporate Finance

Lecture 4: CAPM

Albert Banal-Estanol

“In investing money, the amount of interest you want should depend on whether you want to eat well or sleep well.”

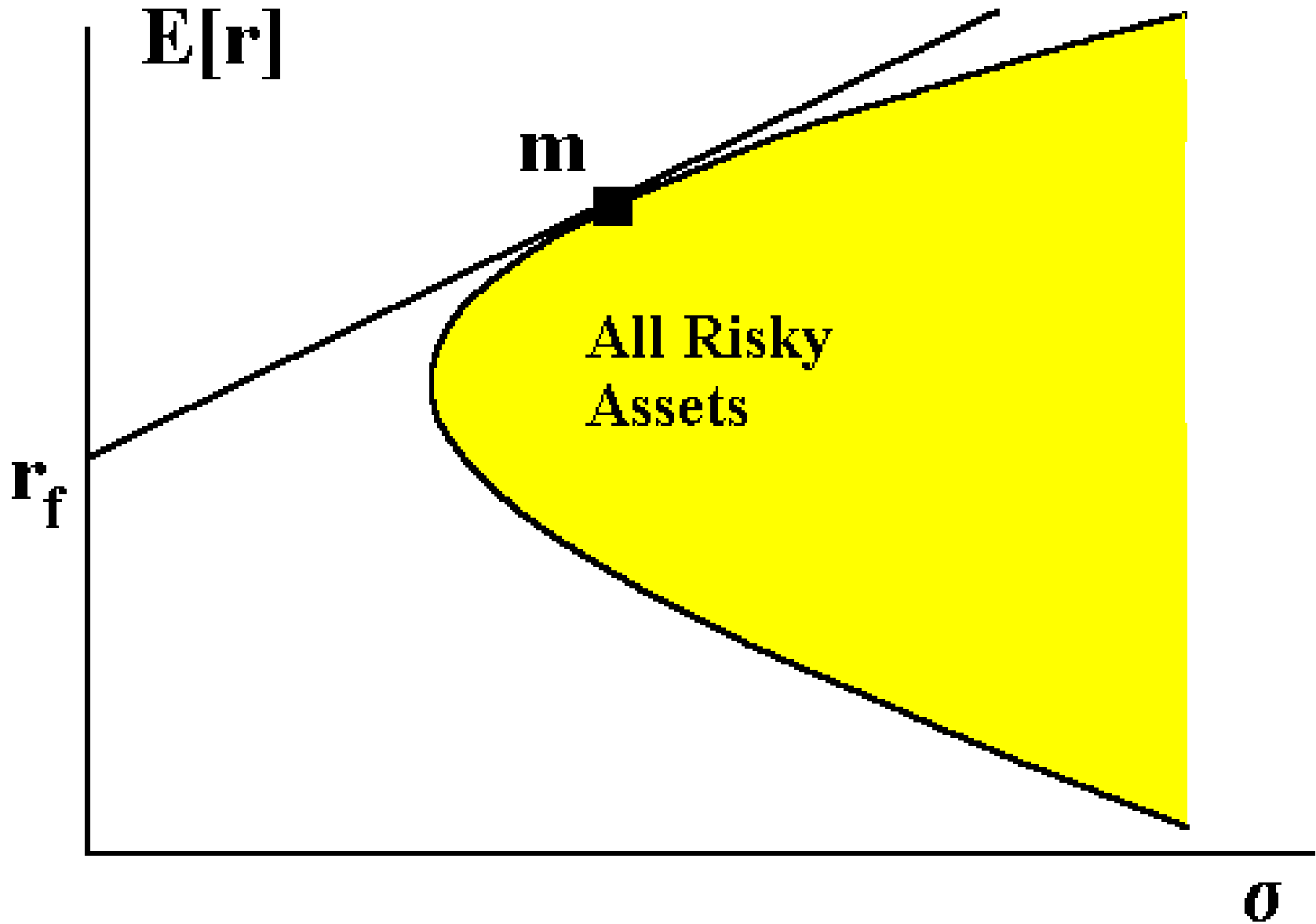
J. Kenfield Morley, *Some Things I Believe*

CAPM and some Applications

- Main questions that will be answered:
 - What is the equilibrium relation between risk and return?
 - What is risk (i.e. which uncertainty “matters”)?
 - What is the price of a unit of risk?

Assumptions and Conclusion

1. Markets are frictionless
 2. There is a risk-free asset that returns r_f
 3. All investors want to hold efficient frontier portfolios;
 4. Supply equals demand in financial markets (we are in *equilibrium*)
 5. Investors have homogenous beliefs about means and st deviations
- These assumptions are sufficient to apply some of the previous results
 - And, we also get...
 - Two fund separation between risk-free asset and **market portfolio**
 - The market portfolio (m) is the portfolio of all risky assets, where the weight of each asset is the market value (market capitalisation) divided by the total market value



Example

Consider a three-stock economy: HP, IBM, CPQ a risk-free asset (US Treasuries) and only two investors, A and B.

	HP	IBM	CPQ
Price per share	\$33	\$95	\$20.25
Shares outstanding	2 bill	1.758 bill	1.7 bill

- Market portfolio: (UST, HP, IBM, CPQ) = (0, 0.25, 0.62, 0.13)
Risk free asset: (UST, HP, IBM, CPQ) = (1, 0, 0, 0)
- Both A and B hold a combination of the risk-free and the market portfolio, i.e. the same relative positions in risky assets, e.g.:

The Big News

- Since investors all hold the market portfolio, the only thing to worry about for any asset is what the addition of that asset would do to the market portfolio
- The additional risk of any asset, when added to the market portfolio, is entirely captured by the covariance of that asset with the market.
- Mathematically, since we know that the market portfolio is mean-variance efficient, we get

$$E[r_q] = r_f + b_q (E[r_m] - r_f) \quad \text{where } b_q = b_{qm} = \frac{\sigma_{mq}}{\sigma_m^2}$$

- This is the “beta” of a security or portfolio or any other risky asset

Simple Example

State of the economy	Boom	Bust
Probability	0.5	0.5
Div_m	100	20
Div_A	2	1
Div_B	1	2

The expected dividends and the standard deviation of the assets A and B are the same.

Which one is more valuable, A or B?

Answer:

More Terminology

- That is why the positively sloped efficient frontier is called the “capital market line” (or CML). It should contain all portfolios that will be held by investors.
- The measure of risk *for an efficient frontier portfolio* is its standard deviation, and the CML gives the trade-off between risk and (expected) return.
- The price of a unit of risk for an efficient frontier portfolio is simply the slope of the CML. It is the market risk premium per unit of market standard deviation (the market **Sharpe Ratio**):

Estimating the CAPM

■ What risk free rate?

- **Theory:** The government bond rate in the same currency with the same maturity as the investment under consideration.
- **Practice:** Some people choose the short rate (because the long rate fluctuates when inflation expectations change). Some people choose the long rate to match maturity with the asset in question. From this long rate, a liquidity premium (historically ~ 1%, currently closer to 0) should be subtracted.

■ What is the Market Portfolio?

- **Theory:** The basket of all assets that the investors can invest in.
- **Practice:** Generally, choose an index of equities, because (i) we only have reliable return information on equities and (ii) the firms themselves own enough 'other assets' (real estate, oil, gold, etc.) to argue that equity index really reflects behaviour of the entire **market**.

Which Country's Market Portfolio?

- **Theory:** The one representing the investment opportunities for the representative investor in the company
- **Practice:** Often the home country's equity index of a company
- **Best Practice:** You have to look at the world through the eyes of your firm's investors
 - If your investors have access (i.e. routinely use) the world market portfolio (proxy: MSCI), this is the correct portfolio.
 - If your investors only invest in a particular portfolio - say their home country - then this is the correct portfolio.
 - I.e. even if you have a firm with operations in **Germany**, whose investors are mainly **Germans**, you would still use the World Market Portfolio if the investors have holdings around the world.

Where do we get a beta?

■ Past data

- let r_{jt} be the realised return (including dividends) of a stock j over period t
- let r_{mt} be the realized return (including all dividends) of some market index (e.g. S&P500 or FTSE100) over period t ;
- let r_{ft} be the risk-free rate over period t ;

■ Run the following regression:

$$r_{jt} - r_{ft} = a + b \times (r_{mt} - r_{ft}) + e_{jt} \quad \text{for } t = 1, \dots, T$$

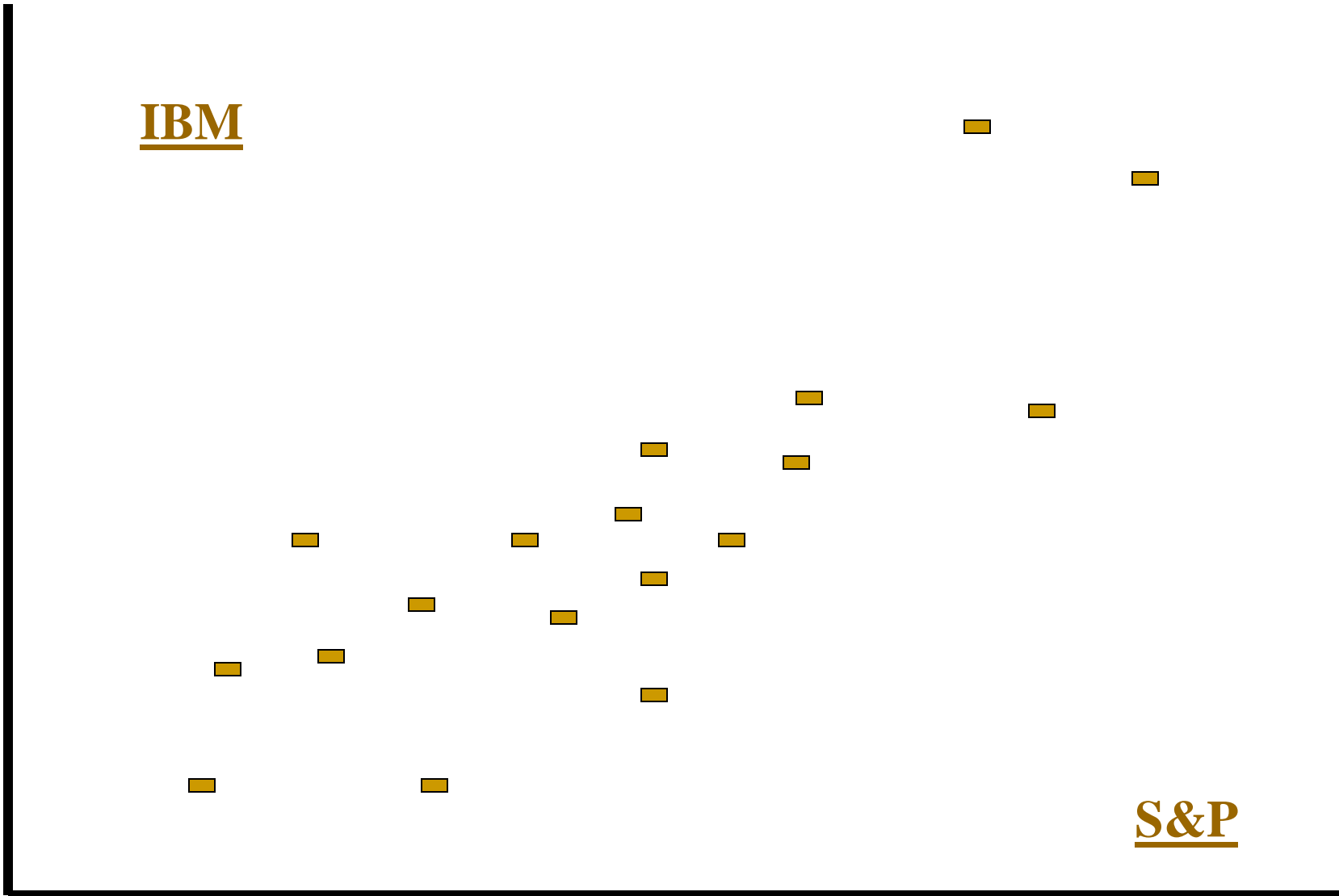
- Under some conditions, ordinary least squares estimate of b is an unbiased estimate of the beta of stock j

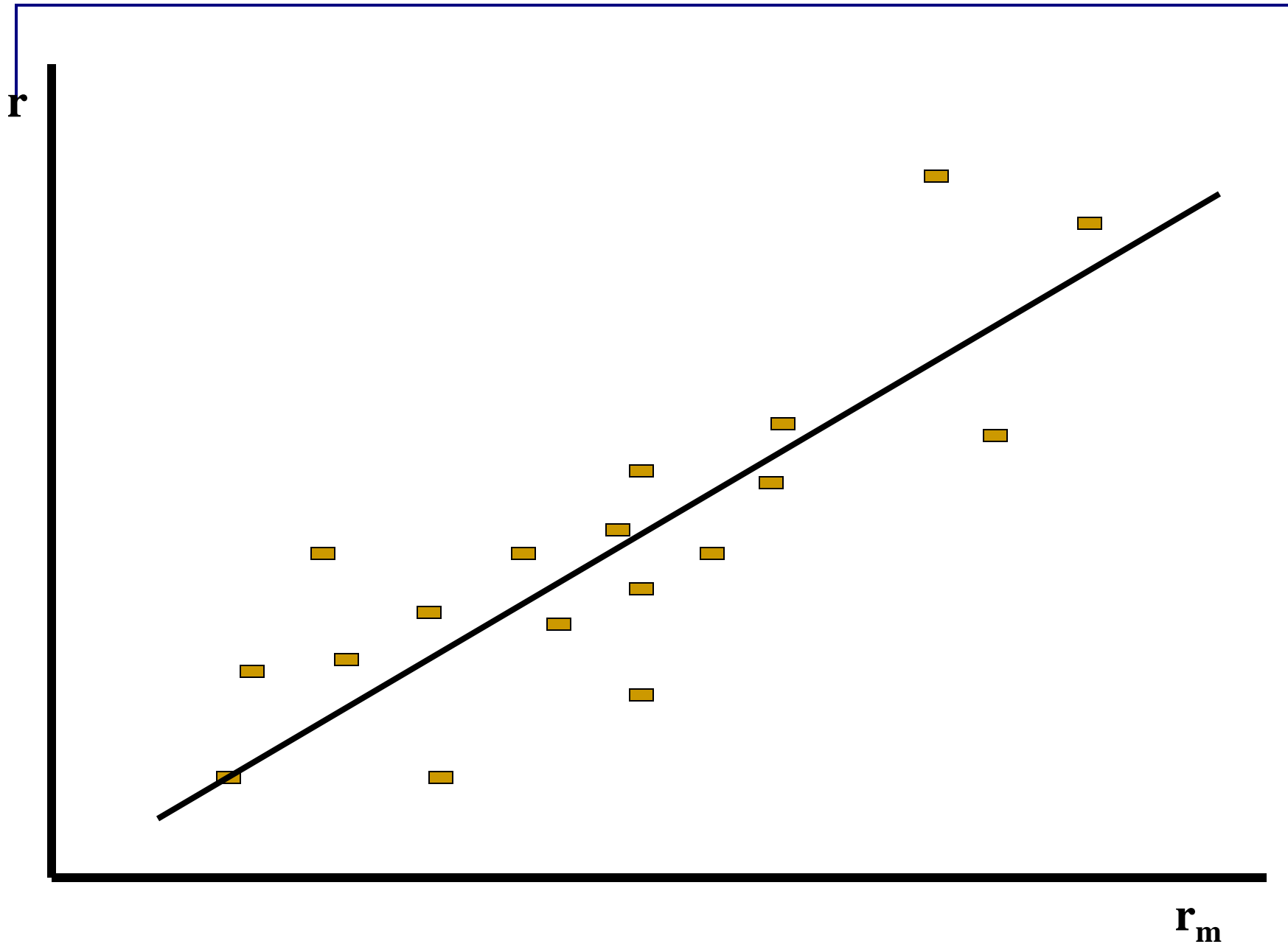
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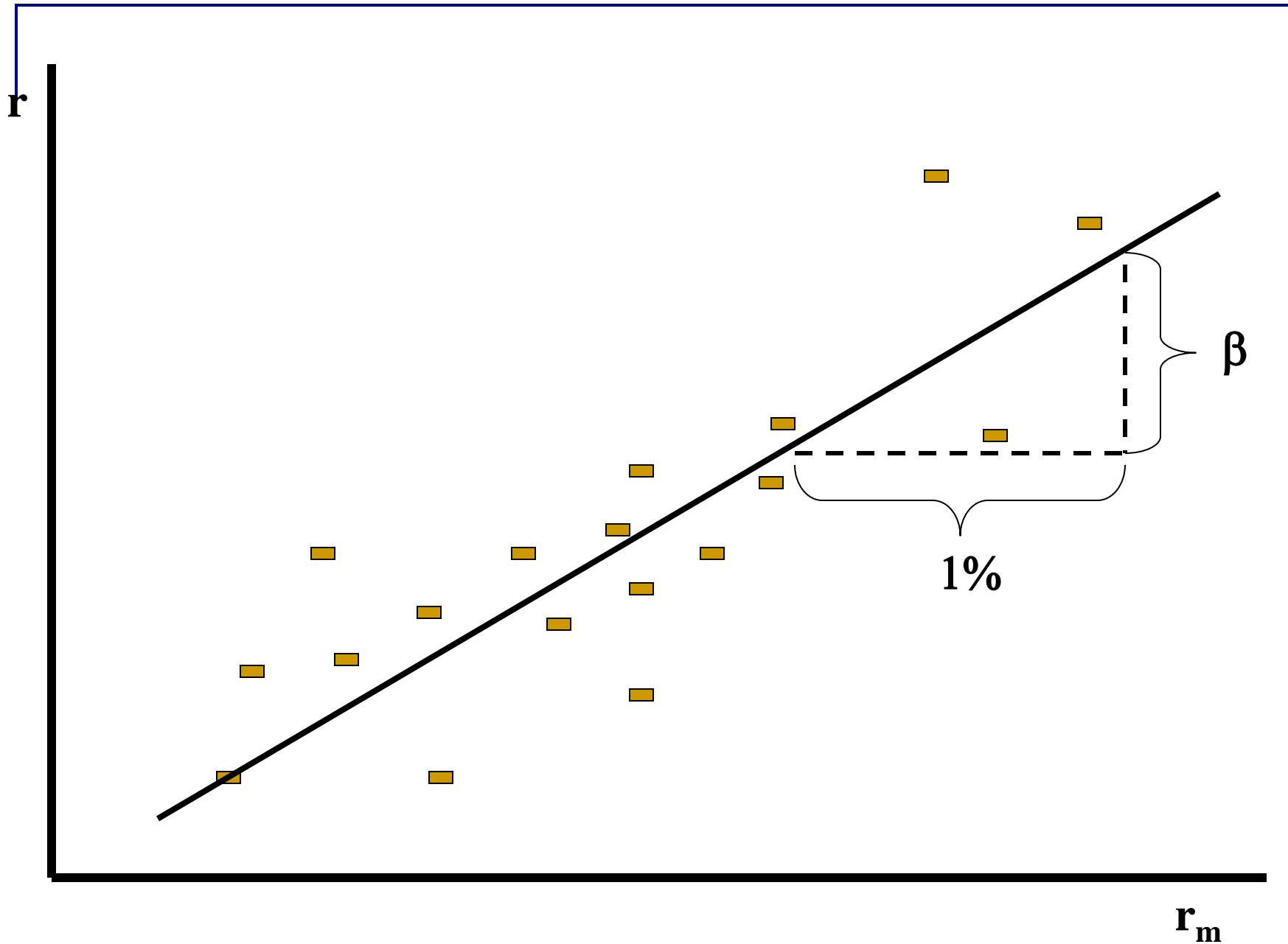
IBM

S&P

r_m







An alternative regression to get BETA

- Often, practitioners run an alternative specification, which gives very similar results
- Recall: $r = r_f + \beta \times (r_m - r_f)$
- This can be re-written as: $r = r_f \times (1 - \beta) + \beta \times r_m$
- If we treat the first part as a constant, then we are justified in running the following regression:
- $r_t = a + \beta \times r_{mt} + \varepsilon_t$ for $t = 1, 2, \dots, T$
- The discussion about how to **best** estimate beta is long and arduous

Market Risk Premium (Equity Premium)

- Once we have r_f and b , all we need is $(r_m - r_f)$,
- What is $(r_m - r_f)$?
- Historically ~ 8% (US)
- Academics: ~ 6% (US)
- Practitioners: ~ 4% (US) - recently

Finally...

- With an estimate of b_j and an estimate of the market risk premium, $r_m - r_f$, we can now form an estimate of the required rate of return on stock or project using the CAPM.
- Example: AT&T (a few years back)
 - Suppose AT&T's beta is estimated (using the S&P500 as a market proxy) at about 0.81
 - Using 5% as current risk-free rate and 5% as market premium
 - We would estimate AT&T's required rate of return as $0.05 + 0.81 \times 0.05 = 0.0905$ or 9.05%.