A 3-hour Tour of Finance

Free book at http://welch.som.yale.edu/

financetours.tex

1 Basic Questions

1. What's the whole point of finance?

2. What are we talking about?

3. How can corporations get money? At what price?

4. Should corporations get money? For what kind of projects?

5. How can you convince your CEO to fund your project? To hire you?

6. What's some of this stuff in the WSJ?

7. What's a security and how should we think of them?

8. What's a derivative?

2 Areas of Study

The discipline of Finance concerns itself with answering (at least) three important questions:

Valuation (Capital Budgeting) what projects to take? Is a project worth it?

Investments (Asset Pricing) where to put your $$$s? How should an investor choose an investment portfolio?

Capital Structure (Corporate Finance) should you borrow or share? How can/should a manager finance projects and disperse funds?

To answer these questions, Finance is a hybrid of

1. Economics (the science of choosing among tradeoffs),
2. Statistics (the science of dealing with uncertainty), and
3. Accounting (the language of business).

Importance is probably in this order, too.

Finance also likes "Jargon," like all "proper" disciplines. Stop me when I use language you do not understand!

3 The Basics

Finance evolves around one basic equation.

$$r_{t=0,1} \equiv r_1 \equiv \frac{C_1 - C_0}{C_0} = \frac{C_1}{C_0} - 1$$

$$\Leftrightarrow \qquad \text{Present Value (PV)} \qquad C_0 = \frac{C_1}{1 + r_{t=0,1}}$$

Q: The interest rate is 10%/year. You are promised $220 next year. (Or, you expect your molecule to earn $100 million next year. What is this worth today?

"Time Value of Money"

Rate of return, vs. (Dollar) Return. Mostly use rates of return. Often interchangeably used and confused.

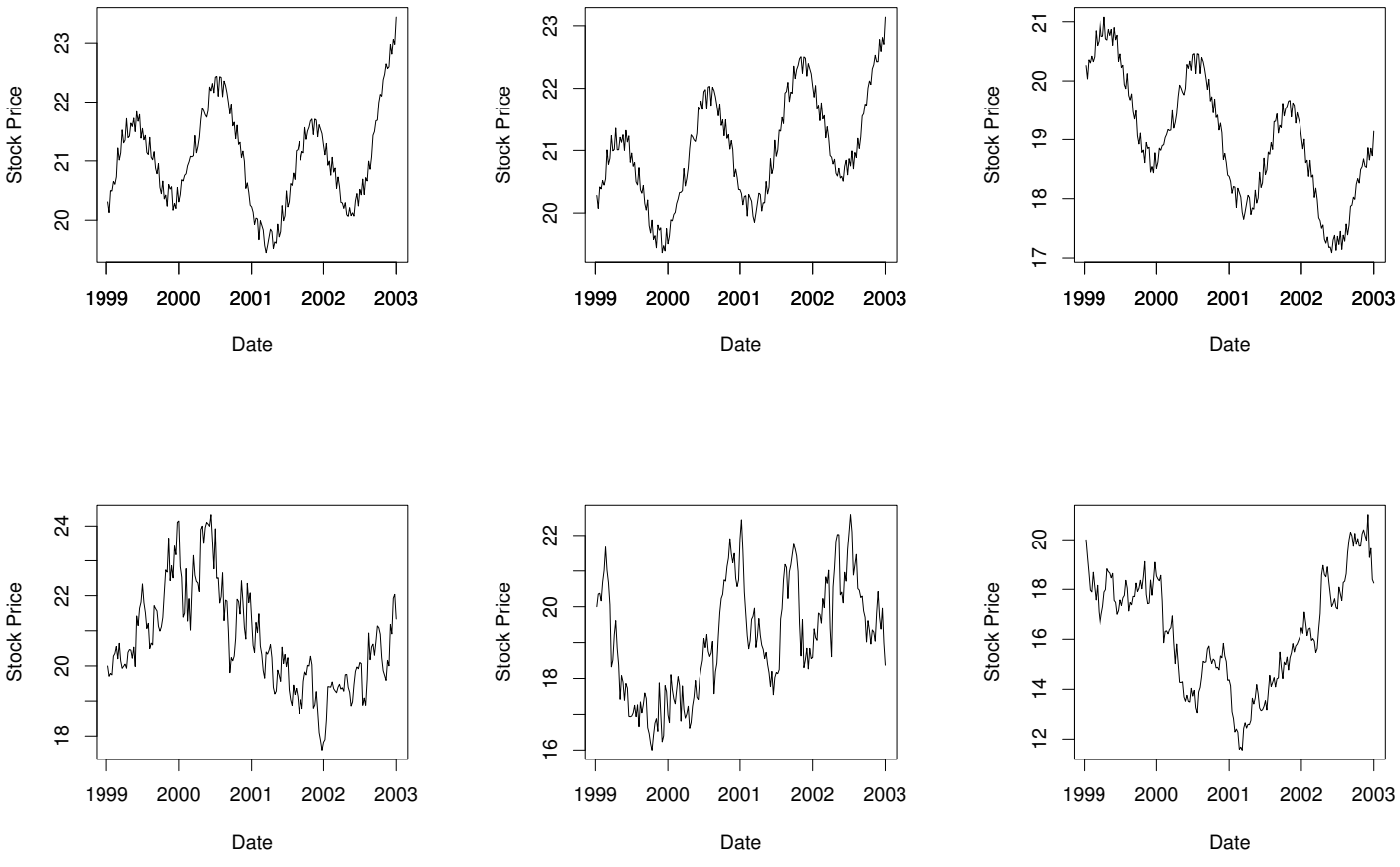
Projects are black boxes. They take money and give money. Bicycle shops, houses, spouses, children.

Firms are collection of projects, owners and rights (e.g., when who gets what money) is specified in contracts.

4 Efficient Markets

Financial Markets are often competitive. Many buyers, many sellers. So, you tend to get what you pay for, and vica-versa. Transaction costs are often small. (Compare house purchase to securities purchase.)

Taxes and other frictions are sometimes first assumed away, then reintroduced to study their effects.



Efficient Markets: The stock market sets prices appropriately. It uses all available information. Remaining Question: where should it set it?

Sometimes, random walk over short horizons works well in answering this question:

$$P_1 = P_0 + \text{noise}_{0,1} \qquad \Rightarrow \qquad E(P_1) = P_0 \qquad \Rightarrow \qquad E(r_{0,1}) = 0$$

Q: What if $E(r_{t=1}) = 3\% + 1.10 \cdot r_{t=0}$?

Not easy to get rich...but over long time intervals, a random walk is not exactly appropriate. You need some positive expected rate of return to invest! What is the appropriate order of magnitude here?

Q: Is an expected rate of return of 0.1%/day reasonable? Can you expect that you know which stock is going to go up by so much to tomorrow?

Q: Is economics and/or "perfect markets" a good assumption for children? crime? jewelry? airline tickets? funeral services? marriage? suicide? schizophrenic choices?

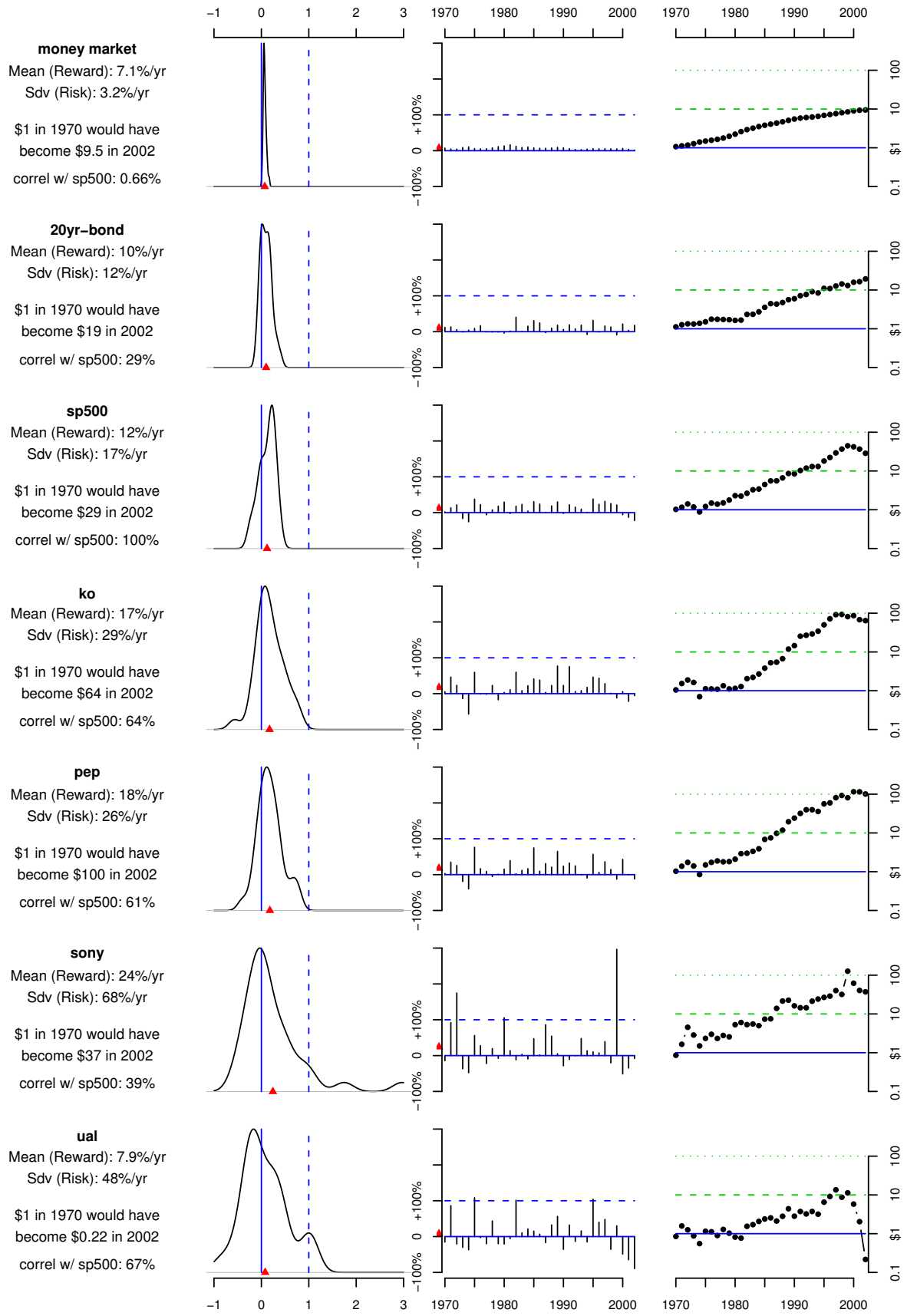
5 The Main Principles of Investments

Assumed: Never confuse promised return with expected return. (A UAL bond may promise 15% rate of return, but there is a good chance that you may not get it.)

No Arbitrage: There is no easy way to get rich for free.

Diversification: Do not put all your eggs in one basket.

Risk vs. Reward: At some point, to get more reward, you can only do so by taking on more risk.


money market
Mean (Reward): 7.1%/yr
Sdv (Risk): 3.2%/yr
$1 in 1970 would have become $9.5 in 2002
correl w/ sp500: 0.66%
20yr−bond
Mean (Reward): 10%/yr
Sdv (Risk): 12%/yr
$1 in 1970 would have become $19 in 2002
correl w/ sp500: 29%
sp500
Mean (Reward): 12%/yr
Sdv (Risk): 17%/yr
$1 in 1970 would have become $29 in 2002
correl w/ sp500: 100%
ko
Mean (Reward): 17%/yr
Sdv (Risk): 29%/yr
$1 in 1970 would have become $64 in 2002
correl w/ sp500: 64%
pep
Mean (Reward): 18%/yr
Sdv (Risk): 26%/yr
$1 in 1970 would have become $100 in 2002
correl w/ sp500: 61%
sony
Mean (Reward): 24%/yr
Sdv (Risk): 68%/yr
$1 in 1970 would have become $37 in 2002
correl w/ sp500: 39%
ual
Mean (Reward): 7.9%/yr
Sdv (Risk): 48%/yr
$1 in 1970 would have become $0.22 in 2002
correl w/ sp500: 67%
−1
0
1
2
3
1970
1980
1990
2000
−100%
0
+100%
0.1
$1
10
100

6 No Arbitrage

Two equal securities with identical (similar) payoffs should be priced identically (similarly).

Background: A bond is an financial instrument that promises a payment at a given time in the future. Usually, they are relatively safe. Its price today is determined by the interest rate, and vica-versa: if a bond promising $120 in one year costs $100, it means that it offers a 20% rate of return. if a bond promising $120 in one year offers a 20% rate of return, it means it will pay off $120. Every day, the demand and supply of bonds can change the price (implied rate of return of a bond).

Q: Assume you can both borrow and lend fixed income risk-free securities. A risk-free bond promising $100 in 1 year costs $91. Can a risk-free bond promising $100 in 18 months cost $92?

Q: Assume a share of IBM costs $100. What can a share of Microsoft cost?

7 Diversification

As an investor, consider two possible choices:

- Bet on one coin flip, $1,000.
- Bet on a thousand coin flips, $1 each.

Which do you prefer?

8 The Effect of Diversification

Do you know statistics? Sorry, one slide of pain.

What if stocks were uncorrelated and had equal risk? (They are not!) Then

$$\text{Risk}_P \approx \frac{1}{\sqrt{N}} \cdot \text{Risk}_i$$

Say, the average annual rate of return on one stock is 6% and the average risk (standard deviation) is 30%. (Incidentally, the order of magnitude is correct here.)

Q: What is your risk if you buy 1 stock?

Q: What is your risk if you buy 100 stocks?

Q: What is your risk if you buy 10,000 stocks?

9 Long Time Periods

Q: Compounding vs. adding: You make a return of 10% in the first period and 5% in the next period. What is your total return?

Q: Stock returns tend to be uncorrelated. Can you use the risk-reduction formula to infer how risky a 30-year investment is vs. a 1-year investment?

Q: Where should young people put their money? Old people?

10 What investment portfolio is best?

We know that diversification works.

We know that diversification works not perfectly. Securities are definitely correlated.

Complex problem to figure out best allocation.

Good heuristic: buy index portfolios, such as Vanguard.

11 Equilibrium

Q: Do all investors choose the best investment possible?

Q: Do all important investors do the best investment possible?

Well, if they did, then we can figure out what fair securities prices are that would make not all investors want to flock to or avoid the same securities. (They need to be held by someone!)

Q: Do you prefer a security that goes up 40% if the market goes up by 20%; or a security that goes up 10% if the market goes up by 20%; or a security that goes down 40% if the market goes up by 20%?

Q: Which securities would have to offer you a higher rate of return?

12 The CAPM

Under some additional assumptions what is best for investors, the CAPM (Capital Asset Pricing Model) tells you how prices should be set.

The CAPM says that prices need to be set in a way that

$$E(R_i) = r_f + [E(R_m) - r_f] \cdot \beta_{i,m}$$

r_f is a risk-free rate. A decent order of magnitude guess for annual rates of returns is $E(R_i) = 3\% + [6\% - 3\%] \cdot \beta_{i,m}$.

Beta measures how a security (i) comoves with the market (m). Now, for each project all you need to do is guess the appropriate beta. Intuition: if a security moves a lot with the stock market (which most investors hold), they want something that goes down when the stock market goes up. So, they are willing to purchase lower-beta stocks even if they offer lower expected rates of return.

Note: This stuff applies only to appropriately sized firms with reasonable market caps, and even there it is not perfect. But, it is the best we have for large firms. Startups are definitely not priced this way!

13 Capital Budgeting

Go back to our main equation:

$$\text{Present Value (PV):} \qquad C_0 = \frac{E(C_1)}{1 + E(r_{t=0,1})}$$

Q: What if I tell you that $E(C_1)$ is \$120, and equivalent investments offer $E(r_1)$ of 10%? How much is this project worth to you?

Q: What if you can purchase this project for a price that promises a rate of return of 20%? What would this price be? Should you?

Q: Do you need to borrow or lend?

Q: What if we do not know $E(C_1)$?

Q: What is the "cost of capital"?

Q: What to do if a two year project offers cash flows in two periods?

Note: The Net Present Value (NPV) is like the Present Value, except it subtracts the original cost, too.

Q: How does one compare different projects with different lifetimes, cash flows, and costs of capital?

14 Information

Q: Where to get $E(C_1)$ from?

Q: Where to get $E(r_{0,1})$ from?

Q: Is this easy?

15 Capital Structure (Financing)

There are thousands of different types of corporate securities. New ones get invented all the time. Two basic choices: debt and equity.

Without any frictions, the manner of financing does not matter: Investors are willing to pay the appropriate present value of cash flows, and projects are worth what they are worth. For example, think of

Project offers either $50 (bad) or $100 (good), with equal probability. The interest rate is 10% (no risk-aversion, i.e., everyone just receives the expected rate of return for an investment).

Q: What is the expected payoff of the project?

Q: What is the price of the project?

Q: What are the prices of debt and equity, if the firm finances the project with safe debt promising $40?

Q: What is the promised rate of return on the bond? What is the expected rate of return?

Q: What are the prices of debt and equity, if the firm finances the project with risky debt promising $60?

Q: What is the promised rate of return on the bond? What is the expected rate of return?

Q: What are the prices of debt and equity, if the firm finances the project with high-yield debt promising $80?

Q: What is the promised rate of return on the bond? What is the expected rate of return?

16 Distortions

We know that in perfect markets without any distortions, mix of debt and equity does not matter.

Q: What if the government now allows you to pay no taxes if you call payments “interests” rather than “dividends”?

Q: What if debt makes managers squander less money?

Q: What if debt makes firms more likely to go under and lawyers to get the whole firm?

Main Idea: Use lowest-friction capital structure. Fewer Taxes and Agency Conflicts Better than More.

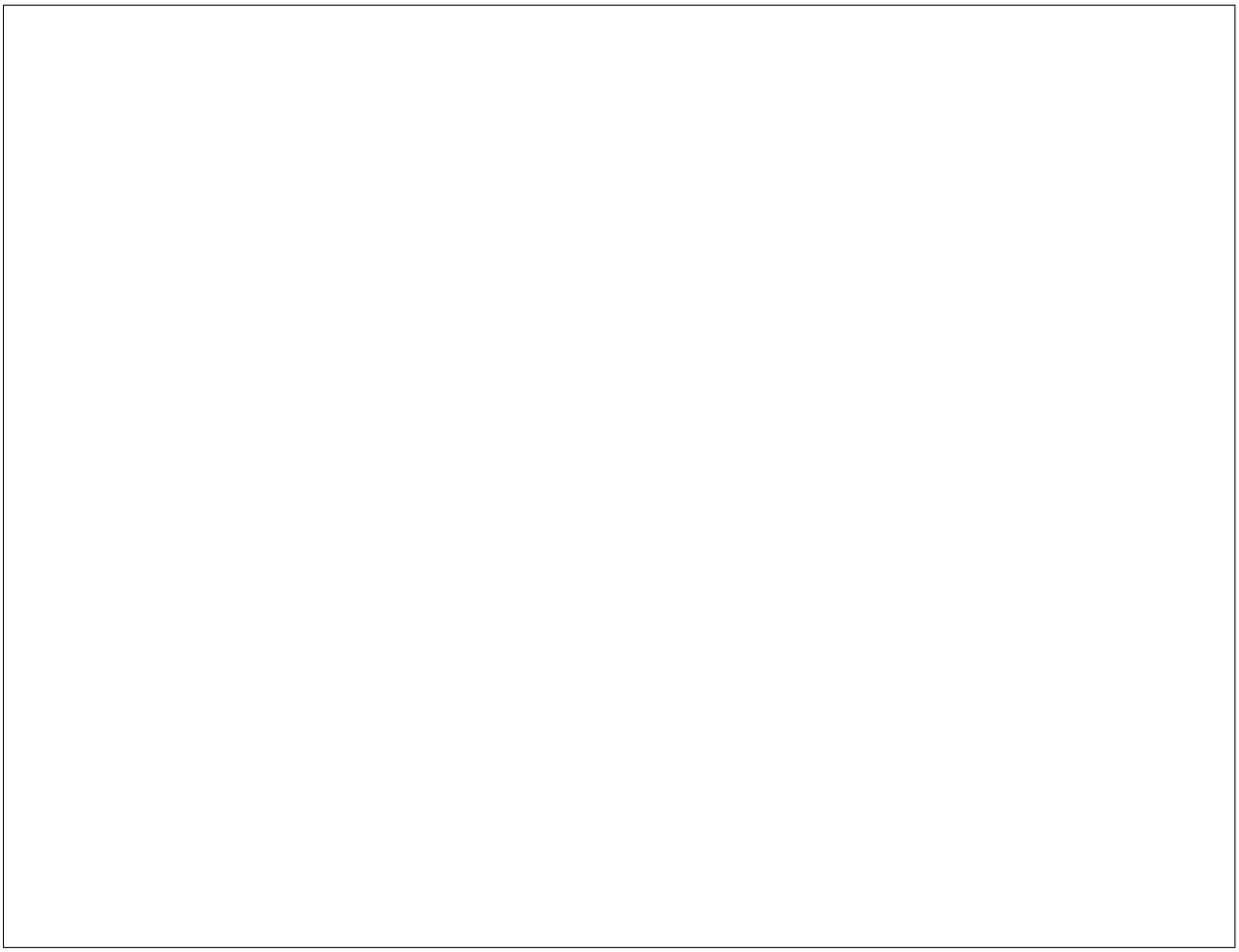
17 Options

A call option is a security that allows you to "call" a stock from a seller, but at a predetermined price. For example, see WSJ today. A put option is a security that allows you to "put" a stock to a purchaser, but at a predetermined price.

Q: What does a call option bet on?

Q: What does a put option bet on?

Q: Let me assume that $r = 10\%$. $S_0 = \$80$. $C_0(K = \$100) = \$30$. $P_0(K = \$100) = \$50$. $t = 1$. How do you get rich quick?



There are many other arbitrage relations between securities, although they are not enough to cover all relationships.

18 Black-Scholes Option Pricing Formula

The most famous arbitrage relationship is the so-called Black-Scholes option pricing formula, which tells you the price of a call if you do not know the price of a put.

The Black-Scholes Call Option pricing formula is

$$
\begin{aligned}
C(S_0, K, t, r, Sdv) &= S_0 \cdot \mathcal{N}(x_s) - \mathsf{PV}_0(K) \cdot \mathcal{N}(x_k) \\
\text{where} \quad x_s &\equiv \frac{\log_e(S_0/\mathsf{PV}_0(K))}{Sdv(\tilde{R})\cdot\sqrt{t}} + \frac{1}{2}\cdot Sdv(\tilde{R})\cdot\sqrt{t} \\
\text{and} \quad x_k &\equiv x_s - Sdv(\tilde{R})\cdot\sqrt{t}
\end{aligned}
\tag{1}
$$

PS: The formula is derived from the idea that you know how the price of an option typically changes over the next minute as the price of the underlying stock changes. You then work backwards from the time of expiration.