

Investments

Session 1. Introduction

EPFL - Master in Financial Engineering
Daniel Andrei

Spring 2010

Outline

I. Course Overview

- Course Essentials
- Program

II. Market Overview

- The Money Market
- The Bond Market
- Equity Securities
- Stock and Bond Market Indexes
- Derivatives Markets & Currencies
- Financial Innovation and Securitization

III. Return and Risk

- Random Events
- Probability Distributions
- Lognormality, Return and Risk

IV. Summary & Further Reading

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Schedule

- Dates: February 22 - June 01, 2010
- Location: EXTRANEF 126
- Classroom sessions: Mondays, 9h15 - 12h00
- Exercise sessions: Tuesdays, 13h15 - 15h00

Grading

- There is a midterm (MID) and a final exam (FE). Documentation is allowed. You can use a calculator.
- You will have to solve problem sets but DO NOT NEED to hand them in. Each Tuesday, some of you will help me to solve problems. This will grant you a participation bonus (PB), going from 0% to 20%. Everyone starts at $PB = 0\%$.
- The final grade will be

$$GRADE = \min \left[6, \frac{MID + FE}{2} (1 + PB) \right]$$

- Midterm date: **April 13, 2010 (Tuesday)**

Pedagogical Material

- Class notes
- Textbooks
 - ▶ Bodie, Kane and Marcus, *Investments*
 - ▶ Hull, *Options, Futures, and Other Derivatives*
 - ▶ Kritzmann, *The Portable Financial Analyst: What Practitioners Need to Know*
 - ▶ Bernstein, Peter, *Capital Ideas: The Improbable Origins of Modern Wall Street.*
- Journal Articles
- Website: www.danielandrei.net → Teaching → Investments [username and password to be given in class]

Two Parts

- ① Part One (lectures 1-7)
 - ▶ Asset Allocation, CAPM, APT, Security Analysis, Applications.
- ② Part Two (lectures 8-14)
 - ▶ Interest Rates, Term Structure, Bond Portfolios, Credit Risk, Alternative Investments.

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Short-Term Debt Securities

- The Money Market consists of very short-term debt securities that usually are highly marketable. Some examples below (definitions are from the *Oxford Dictionary of Finance and Banking*)
 - ▶ Treasury Bills
 - ★ *Definition: a bill of exchange issued by the US Treasury or the Bank of England on the authority of the US and UK governments respectively that is repayable in three months. They bear no interest, the yield being the difference between the purchase price and the redemption value.*
 - ★ Simplest form of borrowing: the government raises money by selling bills to the public.

Short-Term Debt Securities (cont.)

- ▶ Certificates of Deposit

- ★ *Definition: a negotiable certificate issued by a bank in return for a term deposit of up to five years.*
- ★ Time deposits with a bank. These time-deposits may not be withdrawn on demand.

- ▶ Commercial Paper

- ★ *Definition: a relatively low-risk short-term (maturing 60 days or less in the US) unsecured form of borrowing. Commercial paper is often regarded as a reasonable substitute for Treasury bills, certificates of deposits.*
- ★ Short-term unsecured debt issued by large, well-known companies.

Longer-Term Borrowing Instruments

- The bond market is composed of longer-term borrowing instruments than those that trade in the money market:
 - ▶ Treasury Notes and Bonds: issued by the US Treasury.
 - ▶ Corporate Bonds: issued by private corporations.
 - ▶ Municipal Bonds: issued by local governments authorities, especially in the US.
 - ▶ Mortgage Securities: securities in which cash flows derive from an underlying pool of mortgages.

Longer-Term Borrowing Instruments (cont.)

Mortgages

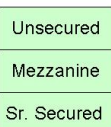


Mortgage Backed Security
a.k.a. "Collateralized Debt Obligation"
(divided into "tranches"
and sold at dif. levels of risk)

Mortgage
Pool



Risk ↑



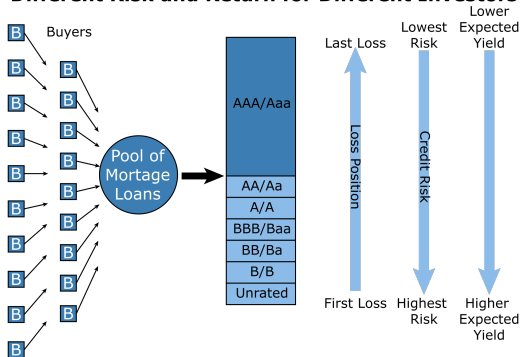
Expected
Return

a.k.a. "Derivatives"
(broken up into groups and 'derived'
from the original pool)

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Longer-Term Borrowing Instruments (cont.)

Different Risk and Return for Different Investors



Common Stock as Ownership Shares

- Common stocks, also known as equity securities or equities, represent ownership shares in a corporation. Each share of common stock entitles its owner to one vote on any matters of corporate governance that are put to a vote at the corporation's annual meeting and to a share in the financial benefits of ownership.
- The common stock of most large corporations can be bought or sold freely on one or more stock exchanges.
- Two important characteristics of common stock: **residual claim** and **limited liability**.

Common Stock as Ownership Shares (cont.)

- Calculating returns: buy at time 0 and pay P_0 , sell at time T and receive P_T and dividend D_T .
 - ▶ The percentage return is calculated as

$$r_T = \frac{P_T + D_T - P_0}{P_0} \quad (1)$$

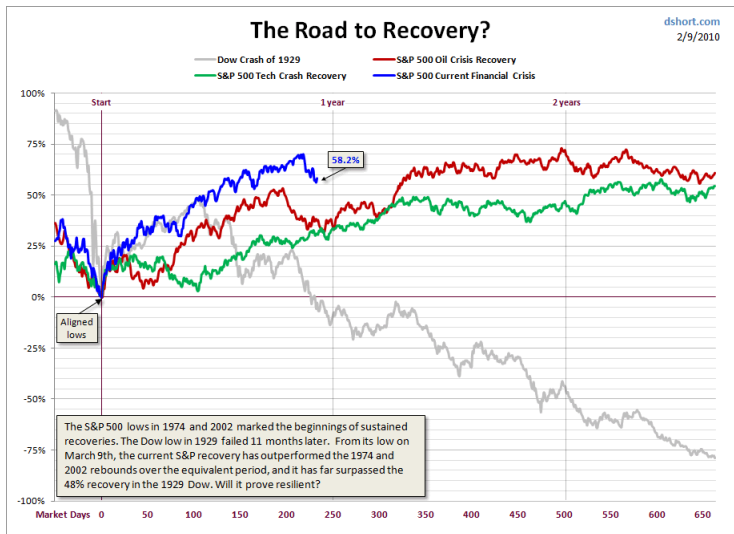
- ▶ The log-return is calculated as

$$r_T = \ln \left(\frac{P_T + D_T}{P_0} \right) \quad (2)$$

Averages

- Indexes represent measures of the performance of the stock market. They consist of several stocks from different sectors of the economy (the average can be computed equally-weighted or value-weighted). Examples: Dow Jones Industrial Average, Standard & Poor's Composite 500, FTSE, DAX, NIKKEI 300, etc.
- Bond market indexes measure the performance of various categories of bonds. The three most well-known groups of indexes are those of Merrill Lynch, Lehman Brothers, and Salomon Smith Barney.

Averages (cont.)



Futures, Options and other Derivatives

- These instruments provide payoffs that depend on the values of other assets such as commodity prices, bond and stock prices, or market index values. For this reason they are called derivative assets, or contingent claims.
- Overview of derivatives by underlying:
 - ▶ Equity Derivatives: stock options, index futures, futures options, etc.;
 - ▶ Fixed-Income Derivatives: caps/floors, swaps, swaptions, etc.;
 - ▶ Credit Derivatives: credit swap, collateralized loan obligations, etc.;
 - ▶ Other Derivatives: FX, weather, “exotics”, etc.

Currencies

- Currencies are the most liquid financial instrument.
- Currency instruments have generally spoken the same type of parameters. However, characteristics may differ, e.g. currency return volatility, which is not shaped in the same form as the equity return volatility.
- Currency positions usually have a much shorter maturity. Proprietary traders on Wall Street take positions up to half an hour.

Does Financial Innovation Add Value?

- Empirical evidence supports the statement that financial innovation does provide social wealth:
 - ▶ It caters to the investment diversity desired by the investors;
 - ▶ It improves the opportunities for investors to receive efficient risk-return trade-offs;
 - ▶ It provides risk management tools for all market participants;
 - ▶ It promotes broad distribution and liquidity to economic resources.
- Securitization is a structured finance process, which involves pooling and repackaging of cash flow producing financial assets into securities that are then sold to investors. Example: securitization of the mortgage market.

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An Example

- Imagine a series of bets on fair and independent coin tosses at times $1/2$, $3/4$, $7/8$, and so on.
- Suppose one's goal is to earn a riskless profit of α by time 1, where α is some arbitrarily large number.
- One can bet α on heads by time $1/2$. If the first toss comes up heads, one stops. Otherwise one owes α to one's opponent.
- A bet of 2α on heads for the second toss at time $3/4$ produces the desired profit if heads comes up at that time.
- Otherwise, one is down 3α and bets 4α on the third toss, and so on.
- Because there is an infinite number of potential tosses, one will eventually stop with a riskless profit of α (almost surely), because the probability of losing every one of an infinite number of tosses is $(1/2) \cdot (1/2) \cdot \dots = 0$.
- This is a classic “doubling strategy”.

The Normal Distribution

- The normal distribution is a continuous probability distribution: it assumes there are an infinite number of observations covering all possible values along a continuous scale.
- Characteristics:
 - 1 A normal distribution can be fully characterized by only two parameters: mean and variance,
 - 2 It is symmetric around its mean,
 - 3 The area enclosed within one standard deviation on either side of the mean encompasses 68 percent of the total area under the curve,
 - 4 95 percent for two standard deviations,
 - 5 99.7 percent for three standard deviations,
- It fails to capture large movements in stock prices (mathematically, the tail distribution is too thin).

Simple and log returns

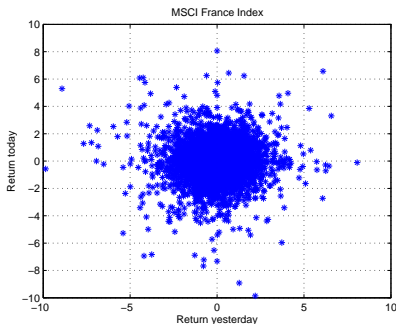
- In probability and statistics, the log-normal distribution is the single-tailed probability distribution of any random variable whose logarithm is normally distributed. If X is a random variable with a normal distribution, then $Y = e^X$ has a log-normal distribution.
- In many cases returns are assumed to be lognormally distributed.
- Difference between simple and log return [to be shown in class].
- Return and Risk [to be shown in class].

Some History

- The question whether investors can successfully forecast stock prices was addressed for the first time by Luis Bachelier in his 1900 dissertation on the “Theory of Speculation”.
- He ended up with a mathematical formula that describes the Brownian motion.
- In Bachelier’s words: “*The mathematical expectation of the speculator is zero*”. He describes this condition as a “*fair game*”.
- Bachelier was far ahead of his time. It took sixty years before Fisher Black, Myron Scholes and Bob Merton worked out the Black Scholes option pricing formula, by using the geometric Brownian motion.
- Additionally (!) the derived formula anticipated Einstein’s research into the behavior of particles subject to random shocks in space.

Random Walks in Stock Market Prices

- Paul Samuelson (economist and Nobel laureate): *“It is not easy to get rich in Las Vegas, at Churchill Downs, or at the local Merrill Lynch office”*.
- Many empirical tests of the random walk theory have been performed. Here is a simple visual test which might take you only a few minutes to perform *[Matlab code to be shown in class]*



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Summary

- Broad overview of the the financial system (markets, intermediaries, instruments, clients, etc.)
- Empirical evidence supports the statement that financial innovation does provide social wealth. However, sometimes abusive usage of financial innovation may cause disruptions.
- We use probability distributions to characterize and evaluate random events.
- There is a long tradition of using the normal distribution to characterize the fluctuations in stock prices. However, the normal distribution is not adequate to capture large surprises.
- The theory of random walks in stock market prices presents important challenges to both the chartist and the fundamentalist.

For Further Reading

- Fama, Eugene, “Random Walks in Stock Prices,” FAJ, 1965
 - ▶ why common techniques for predicting stock market prices fail (because of the theory of random walks). Both the chartist and the fundamentalist will have a hard time to add value.
- Sharpe, William, “Risk, Market Sensitivity, and Diversification,” FAJ, 1972
 - ▶ about market and non-market risk. On how diversification reduces risk. On why some securities are more sensitive to market changes than others.
- Bernstein, Peter, “Capital Ideas: The Improbable Origins of Modern Wall Street,” Wiley & Sons, 1992
 - ▶ chapter 1, about Bachelier, the Dow Jones Average, the birth of the journal *Econometrica*, etc.