Professional Standards and Ethics

CFA® Institute Standards of Professional Conduct

- The Professional Standards and Ethics section of CAIA Level I exam comprises Standards I to VI of the CFA Institute:
  - Professionalism (A – D)
  - Integrity of Capital Markets (A – B)
  - Duties to Clients (A – E)
  - Duties to Employers (A – C)
  - Investment Analysis, Recommendations and Actions (A – C)
  - Conflicts of Interest (A – C)

Applying Standard I: Professionalism

- The Professional Standards and Ethics section of CAIA Level I exam comprises Standards I to VI of the CFA Institute:
  - I(A) Knowledge of the Law
  - I(B) Independence and Objectivity
  - I(C) Misrepresentation
  - I(D) Misconduct

CFA® Institute Standards of Professional Conduct

- Study Tips:
  - Ethics is hard if you try to memorize it all
  - Don't try to memorize—try to recognize applications (in particular, violations) of the Standards
  - Think: What type of behavior is the Standard designed to prevent?
    - Read through SchweserNotes for context, but focus on practice questions in SchweserPro QBank
    - Ethics question practice in Week 9…

CFA® Institute Standards of Professional Conduct

- Selected Standard: Standard I(A): Knowledge of The Law
- Members must understand and comply with all laws, rules, and regulations (including CFA Institute Code and Standards) of any authority governing their activities.
- In the event of a conflict, follow the **stricter** law, rule, or regulation.
- Do not knowingly participate or assist in violations, and **dissociate** from any known violation.

Member Compliance: Knowledge of the Law

- Keep up with changes in applicable laws, rules, and regulations
- Review compliance procedures on an ongoing basis
- Maintain current reference materials
- Seek advice of counsel or the firm's compliance department as deemed necessary
- Document any violations when dissociating from prohibited activities
- Report violations to governmental authorities when advisable or required by law

Firm Compliance: Knowledge of the Law

- Develop and/or adopt a code of ethics
- Make information available to employees that highlights applicable laws and regulations
- Establish written procedures for reporting suspected violations of laws, regulations, or company policies

Standard I(B): Independence and Objectivity

- Use reasonable care to exercise independence and objectivity in professional activities
- Do not offer, solicit, or accept any gift, benefit, compensation, or consideration that would compromise either their own or someone else's independence and objectivity

Compliance: Independence and Objectivity (1)

- Ensure that opinions are unbiased
- Create a **restricted list** of investment banking clients and distribute only factual information about companies on the list
- Restrict special cost arrangements: Only allow issuers to pay for travel arrangements when commercial transportation is unavailable
- Limit gifts to usual and customary items not intended to influence a member's professional independence or objectivity

Compliance: Independence and Objectivity (2)

- Restrict employee investments in equity initial public offerings (IPOs) and private placements
- Implement effective supervisory and review procedures
- Develop written policies on independence and objectivity of research
- Appoint a compliance officer and provide clear procedures for reporting unethical behavior and violations of applicable regulations

Standard I(C): Misrepresentation

- Do not misrepresent facts with respect to:
  - Investment analysis.
  - Recommendations.
  - Investment actions.
  - Other professional activities.
- Trust is a foundation of the investment profession.

Compliance: Misrepresentation

- Provide employees who deal with clients or prospects a written list of the firm's services and a description of the firm's qualifications.
- Materials documenting employee qualifications should be checked to ensure accuracy.
- Maintain records of materials used to generate reports and other products intended for public dissemination.
- Properly cite sources of information to prevent **plagiarism**.
- Establish procedures for verifying third-party marketing information provided to clients.

Standard I(D): Misconduct

- Do not engage in *professional* conduct that involves:
  - Dishonesty.
  - Fraud.
  - Deceit.
- Do not do anything that reflects poorly on your:
  - Professional reputation.
  - Integrity.
  - Competence.

Compliance: Misconduct

- Develop and adopt a code of ethics
- Clearly state that unethical behavior will not be tolerated
- Give employees a list of potential violations and related sanctions
- Check references of prospective employees

Applying Standard II: Integrity of Capital Markets

- II(A) Material Nonpublic Information
- II(B) Market Manipulation

Standard II(A): Material Nonpublic Information

- Members and candidates in possession of material nonpublic information must not act or induce someone else to act on the information.
  - Information is material if its disclosure can be expected to affect the price of a security.
  - Information is nonpublic until it has been made available to the general marketplace.

Compliance: Material Nonpublic Information (1)

- Make reasonable efforts to achieve public dissemination of material nonpublic information known by non-insiders
- Adopt procedures to prevent misuse of material nonpublic information
- Maintain control over relevant interdepartmental communications through a clearance area such as the compliance department or legal department ('firewalls')
- Review employee trades
- Monitor and restrict proprietary trading while a firm is in possession of material nonpublic information ('restricted list')

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Compliance: Material Nonpublic Information (2)

Mosaic Theory:

Analysts *are* permitted to use public information and non-material non-public information to reach conclusions that would be material non-public information if it were directly communicated to the analyst by an insider.

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Standard II(B): Market Manipulation

- Do not engage in any practice intended to mislead market participants through distorted prices or artificially inflated trading volume, such as:
  - Transactions intended to deceive the market and distort the price-setting mechanism
  - Securing a controlling position to manipulate the price of an asset
  - Spreading false rumors ('information-based')

('transaction based')

Applying Standard III: Duties to Clients

- III(A) Loyalty, Prudence, and Care
- III(B) Fair Dealing
- III(C) Suitability
- III(D) Performance Presentation
- III(E) Preservation of Confidentiality

Standard III(A): Loyalty, Prudence, and Care

- Members must always act for the benefit of clients and place clients' interests before their own and their employer's interests.
- Members *must*:
  - Be loyal to clients.
  - Use reasonable care.
  - Exercise prudent judgment.
  - Determine and comply with their applicable fiduciary duty to clients.
  - Inform clients of limitations.

Compliance: Loyalty, Prudence, and Care (1)

- Provide itemized statements to clients, **at least quarterly**, showing all securities in custody and all debits, credits, and transactions
- Draft policies and procedures regarding:
  - Following applicable rules and laws.
  - The client's investment objectives and suitability of the portfolio.
  - Considering all information when taking actions.
  - Diversification.
  - Dealing fairly with all clients.

Compliance: Loyalty, Prudence, and Care (2)

- Draft policies and procedures regarding:
  - Disclosing conflicts (including '*soft dollars*').
  - Disclosing compensation arrangements.
  - Voting proxies in the best interest of clients and ultimate beneficiaries.
  - Maintaining confidentiality.
  - Seeking best execution.
  - Placing clients' interests first.

Standard III(B): Fair Dealing

- Members must deal fairly and objectively with all clients and prospects when:
  - Providing investment analysis.
  - Making investment recommendations.
  - Taking investment action.
  - Engaging in other professional activities.

Compliance: Fair Dealing (1)

- Limit the number of people who are aware that a change in recommendation will be made
- Shorten the time frame between decision and dissemination
- Publish guidelines prohibiting personnel who have prior knowledge of a recommendation from discussing or taking action on the pending recommendation
- Maintain a list of clients and holdings to ensure simultaneous dissemination regarding holdings

Compliance: Fair Dealing (2)

- Develop written trade allocation procedures (pro rata preferred)
- Disclose trade allocation procedures
- Establish systematic account review to ensure no client is given preferred treatment and that investment actions are consistent with the account's objectives
- Disclose all available levels of service

Standard III(C): Suitability (1)

- When in an advisory relationship, members and candidates must:
  - Make a *reasonable inquiry* into clients' investment experience, risk and return objectives, and constraints before making any recommendations or taking investment action.
  - Ensure investments are *suitable* to a client's financial situation and *consistent* with client objectives before making recommendations or taking investment actions.

Standard III(C): Suitability (2)

- When in an advisory relationship, members and candidates must:
  - *Reassess* information and update regularly (at **least annually**).
  - Make sure investments are *suitable* in the context of a client's *total portfolio*.
- When responsible for managing a portfolio to a specific mandate, strategy, or style:
  - Ensure investment recommendations and actions are consistent with stated portfolio objectives and constraints.

Compliance: Suitability

- Document the client's investment objectives, risk tolerance, and constraints in an investment policy statement (IPS).
- Consider the type of client, whether there are separate beneficiaries, objectives (return and risk), constraints (liquidity needs, expected cash flows, time horizon, tax, regulatory and legal circumstances), and performance measurement benchmarks.
- Periodically review client's objectives and constraints to ensure that they reflect any changes in client circumstances.

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Standard III(D): Performance Presentation

- Presentations of investment performance information must be:
  - Fair.
  - Accurate.
  - Complete.

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Compliance: Performance Presentation

- Applying the Global Investment Performance Standards (GIPS) meets the requirements of Standard

Compliance without applying GIPS:

- Consider the sophistication of the intended audience.
- Present performance of a weighted composite of similar portfolios rather than a single account.
- Include terminated accounts as part of historical performance and state when they were terminated.
- Include all appropriate disclosures to fully explain results.
- Maintain appropriate data and records.

Standard III(E): Preservation of Confidentiality

- All information about current and former clients and prospects must be kept confidential unless:
  - It pertains to illegal activities.
  - Disclosure is required by law.
  - The client or prospect gives permission for the information to be disclosed.

Compliance: Preservation of Confidentiality

- Members should avoid disclosing information received from a client to any third parties.
- An exception is disclosure to authorized co-workers who are also working for the client.
- Follow procedures for storage of electronic data and recommend adoption of such procedures if they are not in place.

Applying Standard IV: Duties to Employers

- IV(A) Loyalty
- IV(B) Additional Compensation Arrangements
- IV(C) Responsibilities of Supervisors

Standard IV(A): Loyalty (1)

- Members and candidates must place their employer's interest before their own and must not:
  - Deprive their employer of their skills and abilities.
  - Divulge confidential information.
  - Otherwise harm their employer.

Standard IV(A): Loyalty (2)

- Independent practice:
  - Disclose details of service, duration, and compensation received
  - Request consent from employer
- Leaving an employer:
  - Do not engage in competitive practice until resignation is effective
  - Do not solicit employer's clients prior to leaving firm
  - Do not take any property of employer without permission
- Genuine whistleblowing is not a breach of the Standard

Compliance: Loyalty

- Firms should draft policies on:
  - Engaging in competition.
  - Termination of employment.
  - Incident reporting.
  - Employee classification.

Standard IV(B): Additional Compensation Arrangements

- No gifts, benefits, compensation, or consideration that may create a conflict of interest with the employer's interests are to be accepted unless written consent is received from all parties.
- Written consent includes email messages.

Compliance: Additional Compensation Arrangements

- Provide a written report to the employer detailing proposed compensation and services—when compensation is in addition to that provided by the employer.
- Details, including any performance incentives, should be verified by the offering party.

Standard IV(C): Responsibilities of Supervisors

- All members and candidates must make reasonable efforts to ensure that anyone under their supervision or authority complies with:
  - Laws.
  - Rules.
  - Regulations.
  - Code and Standards.

Compliance: Responsibilities of Supervisors (1)

- Adopt a code of ethics.
- Develop adequate compliance procedures and institute a compliance program.
- Disseminate the code of ethics and compliance procedures to all relevant parties.
- Respond promptly when a violation is believed to have occurred.

Compliance: Responsibilities of Supervisors (2)

- Adequate compliance procedures should:
  - Be clearly written.
  - Be easy to understand.
  - Designate a compliance officer with authority clearly defined.
  - Have a system of checks and balances.
  - Outline the scope of procedures.
  - Outline what conduct is permitted.
  - Contain procedures for reporting violations and sanctions.
  - Structure incentives so unethical behavior is not rewarded.

Applying Standard V: Investment Analysis, Recommendation and Actions

- V(A) Diligence and Reasonable Basis
- V(B) Communication With Clients and Prospective Clients
- V(C) Record Retention

Standard V(A): Diligence and Reasonable Basis

- When analyzing investments, making recommendations, and taking investment actions, use diligence, independence, and thoroughness.
- Investment analysis, recommendations, and actions should have a reasonable and adequate basis, supported by research and investigation.

Compliance: Diligence and Reasonable Basis

- Firms are encouraged to draft policy on:
  - the requirement for research reports and recommendations to have a basis that can be substantiated as reasonable and adequate.
  - guidance for proper research and due diligence.
  - measurable criteria for judging the quality of research.
  - minimum acceptable level of scenario testing for computer-based models.
  - evaluating outside providers of information and advisers.

Standard V(B): Communication With Clients and Prospective Clients

- Disclose the basic format, principles, and processes used to analyze and select securities and construct portfolios.
- Disclose significant limitations and risks associated with the investment process.
- Use reasonable judgment in identifying relevant factors important to investment analyses, recommendations, or actions, and include factors when communicating with clients and prospects.
- Investment analyses and recommendations should clearly differentiate facts from opinions.

Compliance: Communication With Clients and Prospective Clients

- Maintain adequate records to support any research materials provided to clients and prospects.
- Be prepared to supply additional information if requested by the client or other users of the research.
- Note that judgment is required with regard to what constitutes "adequate".

Standard V(C): Record Retention

- Maintain all records supporting analysis, recommendations, actions, and all other investment-related communications with clients and prospects.
- If no other regulatory standards are in place, the Standard recommends at least a seven-year holding period.

Applying Standard VI: Conflicts of Interest

- VI(A) Disclosure of Conflicts
- VI(B) Priority of Transactions
- VI(C) Referral Fees

Standard VI(A): Disclosure of Conflicts

- Members and candidates must make full and fair disclosure of all matters that may impair their independence or objectivity or interfere with their duties to employer, clients, and prospects.
- Disclosures must be prominent, in plain language, and effectively communicate the information.

Compliance: Disclosure of Conflicts

- Any special compensation arrangements, bonus programs, commissions, incentives, and other relevant matters should be disclosed.
- These should include the following:
  - Ownership of common stock.
  - Board memberships.
  - Market-making activities by the firm.

Standard VI(B): Priority of Transactions (1)

- Investment transactions for clients and employers must have priority over those in which a member or candidate is a **beneficial owner**.
  - Client transactions take priority over firm transactions, and firm transactions take priority over personal transactions.
  - Personal transactions may be undertaken only after clients and the member's employer have had an *adequate opportunity* to act on a recommendation.

Standard VI(B): Priority of Transactions (2)

- Fee-paying family-member accounts should be treated like any client account.
- Information about pending trades should not be acted on for personal gain.

Compliance: Priority of Transactions

- The following procedures are recommended:
  - Limited participation in equity IPOs and private placements by staff
  - Establish blackout/restricted periods prior to client trades to prevent 'front-running'
  - Establish reporting procedures, including duplicate trade confirmations, disclosure of personal holdings/beneficial ownership positions, and *preclearance* procedures
  - Ensure adequate disclosure of policies

Standard VI(C): Referral Fees

- Disclose to employers, clients, and prospects any compensation consideration or benefit received from, or paid to, others for recommendations of products and services.
  - Allow all participants in the process to evaluate the full cost of the service as well as any potential impartiality.
- All types of consideration must be disclosed.

Compliance: Referral Fees

- Adopt clear procedures regarding compensation for referrals.
- Firms that do not prohibit such fees should have clear procedures for approval.
- Members should provide their employers with updates *at least quarterly* regarding the nature and value of referral compensation received.

Reminder: How to Approach Ethics

- Don't attempt to learn the wording, names, or numbers of the Standards.
- See as many applications/examples of the Standards as possible.
- Learn through answering questions.
- Focus on the key *applications* of the Standards.
  - What type of unethical behavior is each Standard designed to *prevent*?

Ethics Question 1

Sam Sanchez works for Soothsayer Investments (the firm). Sanchez has been asked to review the current compliance policy of the firm to assess whether it adheres to the requirements for independence and objectivity under the Standards of Practice of the CFA Institute. Sanchez finds the following compliance procedures listed below. Which these policies is *least likely* consistent with the recommended procedures for compliance procedure under Standard I(B): Professionalism – Independence and Objectivity?

A. Firm analysts should not accept business-related lunch invitations from issuers of securities

B. Firm's analysts require prior approval to participate in equity IPOs on their personal accounts

C. The Firm should pay for work-related transport and hotel expenses of analysts

D. The Firm should restrict opinion on issuers with which it has an investment banking relationship

Question 1 (Answer)

Correct Answer: **A**

Modest gifts and entertainment from third parties that are not likely to be perceived as compromising the independence and objectivity of the analyst are permitted under Standard I(B). However members and candidates should always be mindful of how such arrangements could be perceived, and they should be rejected if there is any suggestion of impartiality as a result of the situation.

Ethics Question 2

An analyst writes a report and includes the forecasts of an econometric model developed by the firm's research department. The analyst identifies the source of the forecast and includes all the relevant statistics concerning the model and his opinion of the model's accuracy. With respect to Standard V(A), Diligence and Reasonable Basis, the analyst has:

A. violated the Standard by including quantitative details in a report.

B. violated the Standard by giving his opinion of the accuracy of a model developed by his research department.

C. complied with the Standard.

D. violated the Standard by not testing the model himself.

Question 2 (Answer)

Correct Answer: **C**

Including quantitative details in a report is not a violation of the Standard. The analyst has more of an obligation to give an opinion on the accuracy of the model than to withhold such an opinion. Although the analyst should use reasonable care to verify information included in a report, retesting models developed by the research department of a firm is not explicitly required.

Ethics Question 3

Juan Lopez manages accounts for Street Capital. Lopez's mother is a client of the firm. Lopez does not make trades in his mother's accounts until all other clients of the firm have been given an opportunity to trade. With regard to the CFA Institute Standards of Professional Conduct, Lopez has:

A. not violated the Standards because transactions for clients should have priority over personal transactions and transactions for beneficial owners.

B. violated the Standards because family accounts that are client accounts should be treated like any other accounts.

C. violated the Standards because he is not allowed to trade in family accounts.

D. violated the Standards because he has violated his fiduciary duty to clients who are not family members.

Question 3 (Answer)

Correct Answer: **B**

Standard VI(B) Priority of Transactions: family accounts that are client accounts should be treated like any other firm accounts. Lopez should refrain from exercising excess caution since his mother is a client of the firm like all other clients.

Introduction to Alternative Investments

Overview

Introduction to Alternative Investments

- What is an Alternative Investment?
- The Environment of Alternative Investments
- Quantitative Foundations
- Statistical Foundations
- Foundations of Financial Economics
- Derivatives and Risk-Neutral Valuation
- Measures of Risk and Performance
- Alpha, Beta, and Hypothesis Testing

What is an Alternative Investment?

Need to Know Concepts

- 4 types of alternative assets as defined by *inclusion*
- 4 return characteristics of alternatives
- 4 methods of analysis applied to alternatives
- 8 “other characteristics” that define alternatives
- 5 goals of alternative investments
- 2 pillars alternative investment management

Defining Alternatives by *Inclusion*

Type	Definition	Examples
Real Assets	Direct ownership of nonfinancial assets	Natural resources, commodities, real estate, land, infrastructure, and intellectual property
Hedge Funds	Privately organized investment vehicles with little regulation	Strategies involving shorting, leverage, or derivatives; includes managed futures funds
Private Equity and Private Credit	Equity and debt positions which are not publicly traded	Venture capital, LBOs, mezzanine debt, and distressed debt
Structured Products	Instruments created to exhibit specific return, risk, taxation, or other feature	CDOs and credit derivatives

Alternative vs. Traditional

- The line between alternative and traditional assets is not always clear.

Alternative	Alternative OR Traditional	Traditional
Real Assets	Public real estate (REITs) & public equities with returns driven by real assets	Public equities with returns driven by managerial expertise (e.g., hotel company)
Hedge Funds	Liquid alternative mutual funds	Ordinary mutual funds
Private Equity	Closed-end funds with illiquid holdings	Public Equity
Complex Structured Products	Simple structured products offering traditional risk exposures	Simple derivatives

Alternatives: Return Characteristics

Characteristic	Description
Diversifiers	Low correlation with traditional assets; absolute return products
Illiquidity	Investment trades infrequently and/or with low volume; often nondivisible lumpy assets
Inefficiency	Market prices do not reflect all available information; may lead to superior risk-adjusted performance
Non-normality	Do not follow “bell curve” distribution (see reading on statistical foundations for definition of normal distribution)

Alternatives: Methods of Analysis

Methodology	Application to Alternatives
Return computation	Use cash flows due to lack of market values and more common use of leverage
Statistical	Incorporate the non-normality of returns
Valuation	Incorporate evaluation of fund managers, illiquidity, unique cash flows, active trading strategies and appraised valuations
Portfolio management	Address non-normality and illiquidity

Other Defining Characteristics

Feature	Description	Alts likely to be:
Regulatory	Role of government regulation and taxation	Less regulated/subject to different taxation rules
Structuring	Structuring of cash flows using leverage and securitization	Unlike traditional equity and debt cash flows
Trading	Role of management trading strategy/skill	High
Compensation	Fee and incentive structure of vehicles	Performance based
Institutional	Markets and institutions related to an investment	Private, non-retail

Other Defining Characteristics

Methodology	Application
Information asymmetries	More common in alternatives
Incomplete markets	Sometimes exacerbated by alternatives' structures
Innovation	Greater in alternatives

Five Goals of Alternative Investments

- **Adding value through active management:** Outperformance of a benchmark
- Generate **absolute (unrelated to markets)** or **relative (market-related)** returns
- **Arbitrage:** purchase (low price) and sale (high price) of similar positions
- **Reduced risk through diversification** (low correlations)
- **Avoid obsolescence:** take advantage of new investment opportunities

Two Pillars of Alternative Investment Mgmt.

When should a new alternative asset be added to a portfolio?

Empirical Analysis (historical data)

- Necessary, but not sufficient…

Economic Reasoning (theory)

- Unbiased assessment of ability to enhance risk-adjusted returns

2×2 Framework of Alternative Assets		Trading	
		Public	Private
Primary Objective	Return diversifier	Structured Products	Real Assets
	Return enhancement	Hedge Funds	Private Equity/Credit

Select Keyword Review

- Define these keywords and describe their role in the reading:
  - **Active risk**
  - **Lumpy assets**
  - **Moral hazard**
  - **Operationally focused real assets**
  - **Pure Arbitrage**

Select Keyword Review

- **Active risk:** risk that causes portfolio's return relative to a benchmark return due to active management
- **Lumpy assets:** assets that can only be bought or sold in large quantities
- **Moral hazard:** risk that behavior of one or more parties changes after agreeing terms of a contract
- **Operationally focused real assets:** require ongoing management decisions: real estate, land, infrastructure, and intellectual property
- **Pure Arbitrage:** simultaneous purchase and sale of identical assets to generate risk-free profits

Discussion Questions

1. Are all types of institutional quality alternative assets held by all types of financial institutions? Explain.
2. What is meant by the non-normality of alternative asset return distributions?
3. Which of the four methods of analysis are directly impacted by the need to consider the non-normality of alternative asset returns?

Discussion Questions Answers

1. No, some institutions may be prohibited from investing in alternatives, and some alternatives may not align with investment objectives.
2. A return distribution is *non-normal* if it follows a distribution that is different than the standard normal bell curve.
3. Statistical and portfolio management methodologies.

The Environment of Alternative Investments

Need to Know Concepts

- 4 types of participants
    - Buy side, sell side, outside service providers, regulators
- Limited partnership fund structures
- 4 types of financial markets
    - Primary, secondary, third, fourth
- 5 types of liquid alternatives
- The mechanics of short selling

Participants

- **Buy Side**
  - Pension plan sponsors, foundations, endowments, family office and private wealth, sovereign wealth funds, private limited partnerships, private investment pools, CTAs, SMAs, ’40 Act funds, UCITS, MLPs
- **Sell Side**
  - Large dealer banks, brokers
- **Outside Service Providers**
  - Prime brokers, accountants and auditors, attorneys, fund administrators, hedge fund infrastructure, consultants, depositories and custodians, commercial banks

Alternative Investment Structures

- **Limited Liability:**
  - Limits losses of non-control (passive) owners to a fixed amount
  - Structures include:
    - Corporations & Limited Liability Companies (LLCs) for shareholders
    - Limited Partnerships for funds
    - Special Purpose Vehicles/Special Purpose Entities (SPVs/SPEs) for bankruptcy remote entities

Alternative Investment Structures

- **Investor Taxation Differences:**
  - Master fund in offshore tax neutral location used to invest assets
  - Feeder funds (onshore/offshore) adhere to local investor tax law/regulations, used to accept funds from investors

Limited Partnership Structures

Limited Partner (LP) 1
Limited Partner (LP) 2 → **Limited Partnership (Fund)** ← General Partner (GP)
Limited Partner (LP) N
Investors

Investment Manager (LLC)

- Four key partnership documents:
  - Private-placement memoranda: describes investment opportunity
  - Limited partnership agreement (LPA): LP/GP partnership contract
  - Subscription agreement: application to invest in partnership
  - Management company operating agreement: appointment of LLC

Limited Partnership Structures

- Limited Partnership Agreement (LPA) content:
  - Investor protection clauses, Economic clauses
  - LP Advisory committee (LPAC):
    - Monitors GP: decisions by simple (50%) or qualified (75%) majority
  - Investment objective, fund size, fund terms (e.g. duration of fund life)
- Global regulations and fund structures:
  - EU/Europe – MiFID, AIFMD, UCITS, SICAVs, SICAFs, ICAVs,
  - US – Hedge funds regulations on fund registration, manager registration, marketing restrictions, operations and ongoing reporting.

Markets

- **Primary—placement of new securities**
  - IPOs/secondary issues/securitizations
- **Secondary—**trading of existing securities
  - Stock Exchanges, e.g., NYSE, NASDAQ
- **Third**
  - Regional exchanges where stocks listed on secondary markets can be traded
- **Fourth (Private)**
  - Alternative trading systems
  - Electronic communication networks; electronic crossing network; high-frequency trading

Liquid Alternative Investments

- **Five types of liquid alternative funds**
  - *Clones:* constrained vs. unconstrained
  - *Replication products:* liquidity-based vs. skill-based
  - Absolute return (diversified) products
- **Three constraints:** leverage, concentration, illiquidity

Liquid Alternative Investments

- **Four performance factors:**
  - Flexibility?
  - Ability to earn liquidity premiums?
  - Lower fees?
  - Inability to attract best managers?

Taxation

- **Income taxes**
  - Dividends, interest, capital gains
  - Favorable jurisdictions for hedge funds: Caymans, BVI, Bermuda, Ireland, Luxembourg, Guernsey, Mauritius
- **Other taxes:** real estate, wealth, estate, transaction, withholding taxes

Short Selling

Pension Fund
owns ABC stock
(Stock Lender)

Lends ABC stock to hedge fund

Posts collateral for stock loan

Hedge Fund
(Short Seller)

Short Sells ABC stock in market

Short sale proceeds

Market

- Hedge fund hopes to buy shares back at lower price & return the stock loan
- Hedge fund must pay substitute dividends on ABC Stock to the pension fund
- Hedge fund receives rebate from pension fund on collateral (interest rate – stock loan fee)

Short Selling: Example

- A short position is taken in 1,000 shares of SJT Corp at $75 per share
- SJT pays a dividend of $0.85 per share
- Collateral is subject to a 2% haircut
- Rebate is 1%
- The shares are repurchased one month later for $70 per share
- Commissions and fees total 5 cents per share
- **Calculate** the gain or loss from the trade

Short Selling: Solution

- Capital gain on trade = 1,000 × ($75 – $70) = $5,000
- Substitute dividend paid to lender = 1,000 × $0.85 = $850
- Collateral posted = 1000 × $75 × 1.02 = $76,500
- Rebate = 0.01 × $76,500 = $765
- Commission = $0.05 × 1000 × 2 ("round trip") = $100
- Total gain/loss = $5,000 – $850 + $765 – $100 = $4,815

Select Keyword Review

Define these keywords and describe their role in the reading:

- **’40 Act funds**
- **Section 1256 contracts**
- **Street name**
- **Short squeeze**
- **Universal banking**

Select Keyword Review

- **’40 Act funds:** registered (i.e., regulated) funds, often called mutual funds
- **Section 1256 contracts:** have potentially enormous U.S. tax advantages including having their income treated as 60% long-term capital gain and 40% short-term capital gain regardless of holding period; includes many futures and option contracts
- **Street name:** The legal ownership of securities by a broker on behalf of their customer who are the beneficial owners
- **Short squeeze:** a rush to cover short positions in a heavily shorted security which causes a spike up in the share price.
- **Universal banking:** a regulatory regime which allows a single institution to carry out both commercial and investment banking

Discussion Questions

1. What are three key differences between mutual funds and Separately Managed Accounts (SMAs)?
2. What is the difference between a “third” market and a “fourth” market?

Discussion Questions Answers

1. Any 3 of the 5 key differences are acceptable:
   - Investor owns assets in account
   - Objectives are tailored to investor
   - Greater transparency
   - Returns are not disrupted by redemptions of other investors
   - Account may not have limited liability
2. Third markets are regional exchanges where firms can make markets and trade without going through the primary listing market.
   Fourth markets are electronic systems that allow traders to transact exchange listed away from exchanges.

Quantitative Foundations

Need to Know Concepts

- **Compounding returns: discrete vs. continuous**
- **Returns based on Notional Principal**
- **Internal Rate of Return (IRR) calculation**
  - Issues—calculation of *MIRR*
- **Time-Weighted Return calculation**
- **PE benchmarking—ratios and PME**
- **Distribution Waterfall**
  - Carried interest: fund as a whole vs. deal by deal **calculation**
  - Clawback
  - Hard vs. soft hurdles (catch-up provision) **calculation**

Compounding Returns

- **Simple interest (R):** actual return

- **Example:**
  - Opening value = $100
  - Closing value = $108
  - What is the simple interest return?
    - R = ($108/100) – 1 = 0.08 or 8%

Compounding Returns

- ***Non***-annual compounding:

  quoted rate ≠ simple rate
- **Example:**
  - Quoted annual rate of return = 8%
  - Compounding frequency = semiannual (m = 2)
  - Actual rate of return = 4% per six months
  - Simple interest return for the year?
    - $R = (1.04)^2 – 1 = 8.16\%$

Compounding Returns

- The more frequent the compounding, *m*, the higher the equivalent annual simple rate, *R*.
- **Example:** Quoted rate of 8%

Compounding Frequency per Year (m)	Simple Annual Rate (R)
1	8.00%
2	8.16%
4	8.24%
12	8.30%

Compounding Returns

- As *m* gets very large:
  - Referred to as **continuous compounding** (m=∞)
- With a continuously compounded quoted rate $R^{m=\infty}$,

$$R = e^{R^{m=\infty}} - 1$$

- **Example:** Continuously compounded = 8%, what is the simple return?
  - $R = e^{0.08} - 1 = 0.0833$ or 8.33%

Compounding Returns

- Given a simple return *R*, $R^{m=\infty}$ is given by:

$$R^{m=\infty} = \ln(1+R)$$

- Continuously compounded returns are also called **log returns**.
- **Example:** If simple return is 8.33%,
  - $R^{m=\infty} = \ln(1.0833) = 0.08$ or 8%

Compounding Returns

Multiperiod Returns

- Simple interest returns, R, combined using **multiplication**
- Log returns, $R^{m=\infty}$, combined using **addition**

Example: Fill in the remaining cells.

Period	1	2	3	Total	Average
Simple Return	22%	10%	–5%		
Log Return					

Compounding Returns

Period	1	2	3	Total	Average
Simple Return	22%	10%	–5%	(1.22)(1.10)(0.95) – 1 = 27.49%	$[(1.22)(1.10)(0.95)]^{(1/3)} - 1$ = 8.43%
Log Return	Ln(1.22) = 19.89%	Ln(1.10) = 9.53%	Ln(0.95) = –5.13%	19.89% + 9.53% – 5.13% = 24.29%	(19.89% + 9.53% – 5.13%)/3 = 8.097%

Returns Based on Notional Principal

- **Forward contract:** agreement to transact in the future at price agreed today
  - *Zero value* at initiation
  - Returns based on the **notional principal (exposure)**

Fully collateralized

$$R_{fcoll} = \ln(1 + R) + R_f$$

✓*Equation exemption list*

Partially collateralized

$$R_{pcoll} = [L \times \ln(1 + R)] + R_f$$

✓*Equation exemption list*

Example: Notional Principal

- An investor enters into a long forward position on crude oil at a price of \$60 per barrel. The forward agreement has a size of 10,000 barrels. The continuously compounded annual risk-free rate is 1%. Assume the forward price moves to \$66 in one year's time.
  1. What is the fully collateralized return?
  2. What is the partially collateralized return if the investor initially deposited 5% collateral?

Solution: Notional Principal

Futures return = (66/60) – 1 = 10%

1. Fully collateralized return:
   $\ln(1.10) + 0.01 = 0.1053 = 10.53\%$

2. 5% collateral → $L = 1/0.05 = 20x$
   Partially collateralized return:
   $[20 \times \ln(1.10)] + 0.01 = 1.916 = 191.6\%$

Internal Rate of Return

- IRR: discount rate (%) that equates present value of *inflows* to the present value of outflows
  - Sets *Net Present Value (NPV)* of investment to zero

- **Example:** Calculate the IRR.

Time	0	1	2
Cash Flow	–50	25	35

Internal Rate of Return

Time	0	1	2
Cash Flow	–50	25	35

- Use the CF worksheet: [CF] [2nd] [CE/C]

  'CFo =' [50] [+/–] [ENTER] [↓]
  'C01 =' [25] [ENTER] [↓] [↓]
  'C02 =' [35] [ENTER]
  [IRR] [CPT] : 12.32%

Three Types of IRR

- **Lifetime IRR**
  - Captures all cash flows (realized or anticipated)
- **Interim IRR**
  - Conducted mid-way through an *investment's* life
  - Uses appraisal value for final cash flow
- **Since-Inception IRR**
  - Conducted mid-way through a *fund's* life
  - Uses appraised fund value for final cash flow

Example: Types of IRR

Calculate the IRR and **state** what type of IRR it is:

1. A new investment costs $20 and has anticipated cash inflows of $15 after one year and $10 after the second year, when the project terminates.
2. A fund invests $100 and distributes cash flows of $35 after one year. $35 after the second year. At the end of the third year, the fund is appraised at a value of $95.

Solution: Types of IRR

1. [CF] [2nd] [CE/C]

   'CFo =' [20] [+/–] [ENTER] [↓]
   'C01 =' [15] [ENTER] [↓] [↓]
   'C02 =' [10] [ENTER]
   [IRR] [CPT]: 17.54%

This is a lifetime IRR.

2. [CF] [2nd] [CE/C]

   'Cfo =' [100] [+/–] [ENTER] [↓]
   'C01 =' [35] [ENTER] [↓] 'F01 =' [2] [ENTER] [↓]
   'C02 =' [95] [ENTER]
   [IRR] [CPT]: 24.46%

This is a since-inception IRR.

Issues With the IRR Measure

- **Complex Cash Flow Patterns**
  - *Borrowing-type cash flow patterns* (+, −, −, −)
    - IRR should be viewed as a cost of borrowing
  - *Multiple sign change cash flow patterns* (−, +, −, +, −)
    - Multiple IRRs may exist (making IRR void)
- **Comparing IRRs**
  - Highest NPV should be chosen (not necessarily highest IRR)
- **Aggregating IRRs**
  - Portfolio IRR can be significantly different to the average IRR

Issues With the IRR Measure

- **IRR and the Reinvestment Assumption**
  - IRR only earned if early cash flows are reinvested at the IRR
- Reinvestment assumption and multiple solutions issues addressed with the ***modified IRR (MIRR)***:

$$\text{MIRR}_T = \left(\frac{\text{FV (inflows) @ reinvestment rate}}{\text{PV (outflows) @ cost of capital}}\right)^{\frac{1}{T}} - 1$$

- **MIRR Example:** A project has yearly cash flows of –100, –50. +75, +150. Calculate the IRR and the MIRR assuming a reinvestment rate of 5% and a cost of capital of 8%

Issues With the IRR Measure

Solution:

- The IRR of the project can be calculated using the CF worksheet as 18.98% (CF0 = –100, C01 = –50, C02 = 75, C03 = 150, IRR CPT)
- To calculate the MIRR:
  - FV(inflows)@ reinvestment rate = 75(1.05) + 150 = 228.75
  - PV(outflows)@ cost of capital = 100 + 50/(1.08) = 146.30
  - Then MIRR = $(228.75/146.30)^{(1/3)} - 1$ = 16.07%

Return Measures

- **Time-weighted return:** geometric average return of periodic returns
- **Dollar-weighted return:** IRR of investment cash flows

- **Example:**
A portfolio has initial market value of $1,000 and is appraised at $1,200 at the end of year 1. At the beginning of year 2, investors contribute an additional $500. At the end of year 2, the investment is worth $1,700. **Calculate** the annual (1) time-weighted and (2) dollar-weighted rates of return of the portfolio.

Return Measures

- **Time-weighted return:**

$$\left[\left(\frac{1{,}200}{1{,}000}\right)\times\left(\frac{1{,}700}{1{,}700}\right)\right]^{1/2}-1=9.54\%$$

- **Dollar-weighted return:**
[CF] [2nd] [CE/C]

  'CFo =' [1,000] [+/–] [ENTER] [↓]
  'C01 =' [500] [+/–] [ENTER] [↓] [↓]
  'C02 =' [1,700] [ENTER]
  [IRR] [CPT] : 7.76%

Other Performance Measures

- **Ratios as performance measures**
  - **Distribution to paid-in ratio (DPI)**
    DPI = distributions/capital paid-in
  - **Residual value to paid-in ratio (RVPI)**
    RVPI = NAV/capital paid-in
  - **Total value to paid-in ratio (TVPI)**
    TVPI = (distributions + NAV) /capital paid-in
    = DPI + RVPI

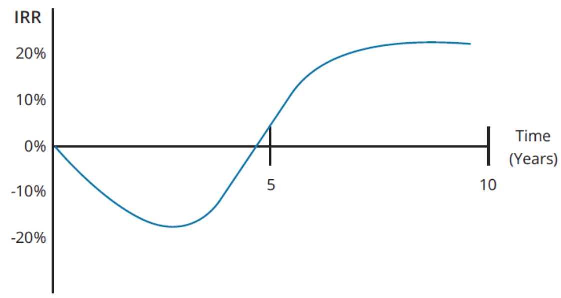
Other Performance Measures

- **The Public Market Equivalent (PME) method**
  - Measures the added value of private equity vs. investing in a public equity index
  - (Simplified) example:

	Initial cash flow	Cash flow @ T=1	IRR	PME
PE Fund	–100	130	30%	10%
Public Market	–100	120	20%	0%

Private Equity J-Curve

- Investors should expect losses in early years of PE fund, gains in later years
- Main causes:
  - **Accounting conservatism:** Revaluing losers down sooner, winners up later
  - **Fees and expenses** always immediately deducted



Cash Waterfall Terminology

- **Limited partner (LP):** commits capital
- **General partner (GP):** makes investment decisions
- **Management fees:** paid to GP based on committed capital; usually 2%
- **Carried interest:** performance fee paid to GP based on profits; usually 20%
- **Hurdle rate/ Preferred return:** return level that LPs must receive before GP earns carried interest
- **Catch-up provision:** allows manager to "catch-up" under *soft hurdle* structure
- **Clawback:** allows LPs to reclaim early carried interest paid to GPs when subsequent performance is poor

Example: Cash Waterfall

1. Fund SCR terminates and has an ending NAV of $160 million. The initial size of the fund was $80 million. Assuming an 80/20 carried interest split and no hurdle, how much carried interest is the GP entitled to?

2. The BBA fund makes two investments, X and Y, of $25 million each. Investment X is successful and generates $20 million of profit, whereas Investment Y is a complete write-off. Assuming no hurdle rate, how much carried interest would be paid to the GP under the (1) fund-as-a-whole approach and (2) deal-by-deal approach?

Solution: Cash Waterfall

1. Total profits = ($160 million – $80 million) = $80 million
   Carried interest = 0.2 × $80 million = $16 million

2. Total profits to fund-as-a-whole
   = ($20 million – $25 million) = –5 million
   - Hence no carried interest is payable

   Total carried interest under the deal-by-deal approach
   = (0.2 × $20 million) + (0.2 × $0 million) = $4 million

Hurdle Rates

Assuming hurdle rate and carried interest split of 80/20

Hard Hurdle

GP takes 20% of profits in excess of hurdle

Soft Hurdle

GP takes higher proportion (*catch-up rate*) of profits in excess of hurdle until they "catch up" back to 20% of **total** profits

Example: Hard vs. Soft Hurdle Rate

A fund's distribution waterfall is set up as follows:

Value at start of year	\$40 million
Value at end of year	\$45 million
Hurdle rate	8%
LP/GP carried interest split	80/20

1. **Describe** the distribution of cash flows under a hard hurdle structure.
2. **Describe** the distribution of cash flows under a soft hurdle structure with a catch-up rate of 50%.

Solution: Hard vs. Soft Hurdle Rate

1. **Hard Hurdle Rate**
   Return of capital to LPs: $40 million
   Preferred return to LPs: 0.08 × $40 million = $3.2 million

   Carried interest split:

   - LPs: 0.8 × ($5 million – $3.2 million) = $1.44 million
   - GP: 0.2 × ($5 million – $3.2 million) = $0.36 million

Solution: Hard vs. Soft Hurdle Rate

2. **Soft Hurdle Rate**
   Return of capital to LPs: $40 million
   Preferred return to LPs: 0.08 × $40 million = $3.2 million

   Applying catch-up rate to profits in excess of hurdle:

   0.5 × ($5 million − $3.2 million) = $0.9 million

   Hence GP takes $0.9 million, LP takes $0.9 million

   Note: The manager can not take more than 20% of total profits under the soft hurdle structure.

Select Keyword Review

Define these keywords and describe their role in the reading:

- **Catch-up rate**
- **Complex cash flow pattern**
- **Fully collateralized**
- **Preferred return**
- **Reinvestment rate assumption**

Select Keyword Review

- **Catch-up rate:** allows GP to "catch up" back to 20% of total profits under soft hurdle structure by taking a higher percentage of profits
- **Complex cash flow pattern:** a project with cash flows that have unconventional positive and negative sign patterns
- **Fully collateralized:** a derivative with up-front capital equal to contract's notional principal deposited by investors to absorb losses
- **Preferred return:** capital demanded by investors before the GP can start earning carried interest
- **Reinvestment rate assumption:** assumes early cash flows in an investment are reinvested at the IRR

Discussion Questions

1. True or false? Simple returns are always lower than equivalent log returns.
2. True or false? Less frequent compounding leads to higher simple returns.
3. What would be the distribution waterfall for the following fund with a catch-up rate of 50%?

Value at start of year	$40 million
Value at end of year	$50 million
Hurdle rate	8%
LP/GP carried interest split	80/20

Discussion Questions Answers

1. False. Simple returns are higher than log returns since they reflect the impact of continuous compounding.
2. False. More frequent compounding will lead to higher simple returns.
3. Return of capital to LPs: $40 million
   Preferred return to LPs: 0.08×$40 million = $3.2 million
   Applying catch-up rate to profits in excess of hurdle:

   0.5 × ($10 million − $3.2 million) = $3.4 million

   This is greater than 20% of total profits ($2 million), hence

   GP takes $2 million, LP takes $6.8 million − $2 million = $4.8 million.

Statistical Foundations

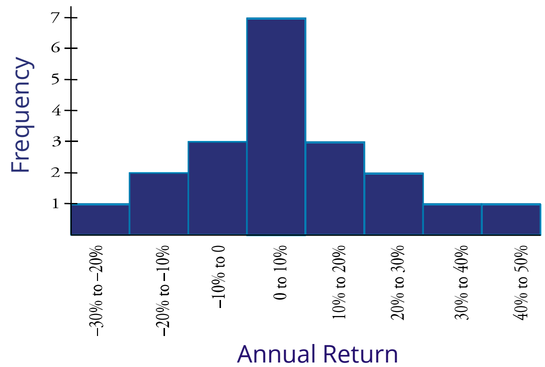
Need to Know Concepts

- Normal distribution
- Lognormal distribution
- Moments of distribution: mean, variance, skew, and kurtosis
- Correlation and covariance
  - Spearman rank correlation calculation
- Calculation of Beta
- Autocorrelation
  - Durbin-Watson test
- Properties of variance and standard deviation
- Testing for normality—Jarque-Bera Test

Return Distributions

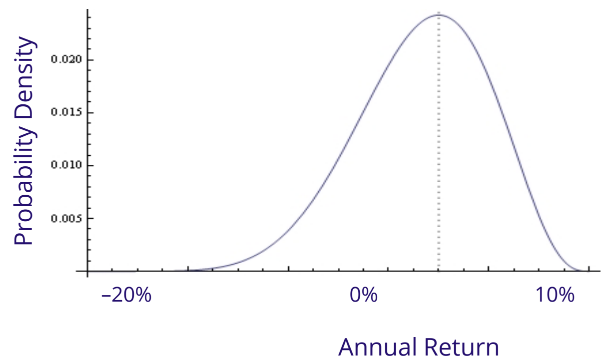
Ex Post Distributions

- Realized (past) outcomes

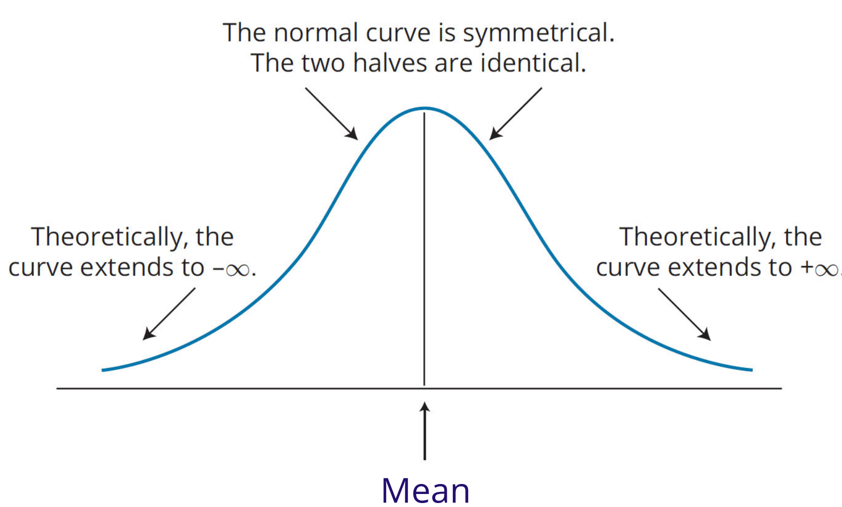


Ex Ante Distributions

- Anticipated outcomes



The Normal Distribution

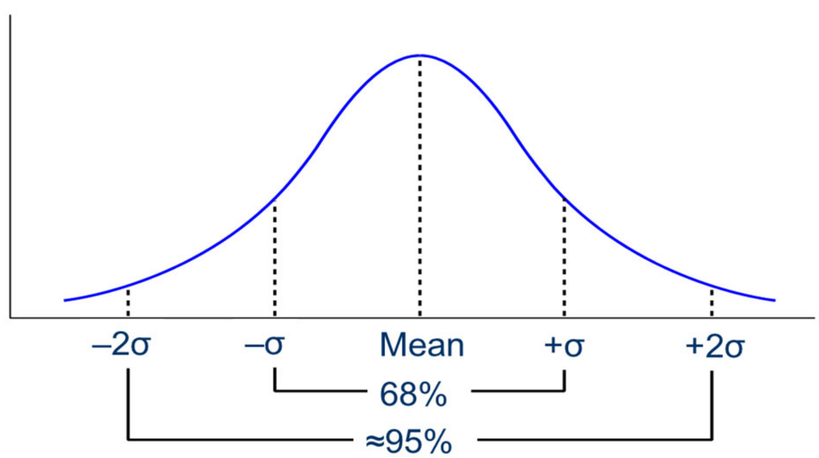


The Normal Distribution

- Distribution defined by:
  - Mean, μ (center), standard deviation, σ (dispersion)

- Values often thought of as *distance from the mean in standard deviations* (often called 'z-value')
  - For example, if returns are normally distributed with a mean of 5% and a standard deviation of 2%, then a return of 7% is (7 – 5) / 2 = 1 standard deviation above the mean.

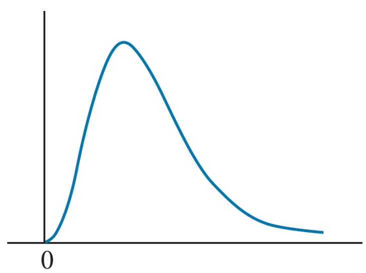
The Normal Distribution



Lognormal Distribution

- If x is lognormal → Ln(x) is normal
- Lognormal is always positive with positive “skew”

Lognormal Distribution



- Often used to model price ‘relatives’ (S_{t+1}/S_t)

Lognormal Distribution

Log returns ($R^{m=\infty} = \ln(1+R)$) are often used in financial models that assume normal returns because

The additive property of log returns preserves normality over longer time frames.

For example, normal daily returns can be added to give normal weekly returns.

Assuming normal returns is more sensible for *log returns* since the normal distribution ranges from –∞ to +∞, as does the logarithm function

Moments of the Distribution

Moments describe shape of a distribution.

"nth" Raw Moment

Expected value of the variable to the power of "n"

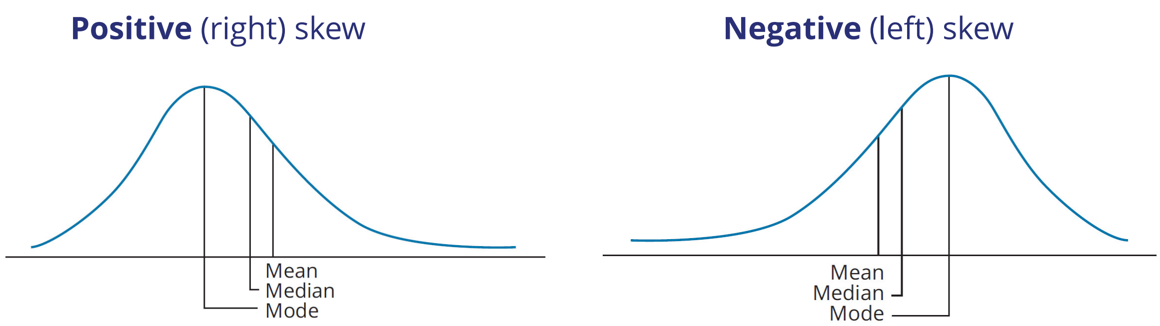
"nth" Central Moment

Expected deviation of the variable from its mean to the power of "n"

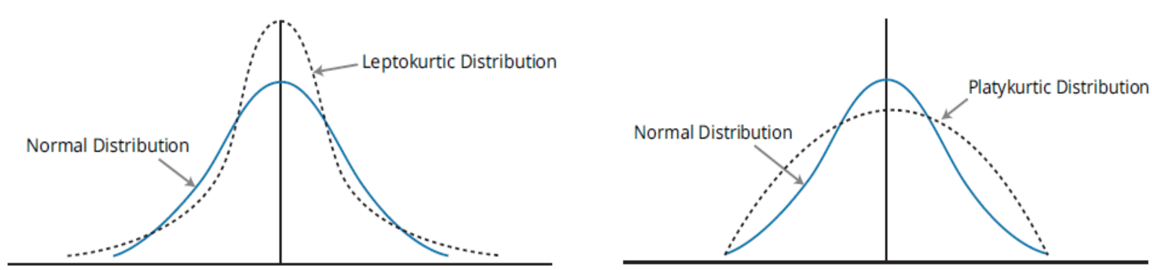
Moments of the Distribution

Name	Description	Comment
Mean	1st raw moment	
Variance	2nd central moment	Standard deviation = square root of variance
Skewness	3rd central moment (standardized)	Normal distribution has zero skew
Kurtosis	4th central moment (standardized)	Excess Kurtosis = Kurtosis – 3 Normal distribution has kurtosis of 3

Skewness



Kurtosis



- Normal distribution is mesokurtic (i.e., no excess kurtosis)

Calculating Sample Statistics

- **Sample Mean (location):** arithmetic mean of sample

$$\bar{R} = \frac{1}{n}\sum_{i=1}^{n} R_i$$

- **Sample Variance (dispersion):** based on squared deviation from the sample mean

$$s_p^2 = \frac{1}{n-1}\sum_{i=1}^{n}(R_i - \bar{R})^2$$

  - Standard deviation is the square root of variance

Example: Sample Mean & Standard Deviation

- **Calculate** the mean of this sample.
- **Calculate** the standard deviation of this sample.

Year	Return (%)
1	1.6
2	–3.7
3	7.9
4	1.4

Solution: Sample Mean & Standard Deviation

Mean = (1.6% – 3.7% + 7.9% + 1.4%) / 4 = 1.8%

Year	Return (%)	Squared Deviation From Mean
1	1.6	$(1.6 – 1.8)^2 = 0.04$
2	–3.7	$(–3.7 – 1.8)^2 = 30.25$
3	7.9	$(7.9 – 1.8)^2 = 37.21$
4	1.4	$(1.4 – 1.8)^2 = 0.16$
	Sum	67.66

$$s_p = \sqrt{\frac{67.66}{4-1}} = 4.75\%$$

Example: Population Mean & Standard Deviation

- Expected Value: $E(X) = \Sigma P(x_i)x_i$

Economy	$P(x_i)$	Return (x_i)	$P(x_i)x_i$
Recession	0.25	–0.10	–0.025
Normal	0.50	0.08	0.040
Boom	0.25	0.22	0.055
			E(X) = 0.070

Solution: Population Mean & Standard Deviation

Variance: $\sigma^2 = \Sigma P(x_i)[x_i - E(X)]^2$

E(X) = 0.070

Economy	$P(x_i)$	Return(x_i)	$P(x_i)x_i$	$P(x_i)[x_i - E(X)]^2$
Recession	0.25	–0.10	–0.025	0.00723
Normal	0.50	0.08	0.040	0.00005
Boom	0.25	0.22	0.055	0.00563
				$0.01290 = \sigma^2$

Standard deviation: $\sigma = \sqrt{0.01290} = 0.1136$

Covariance

$$\text{Cov}(R_a, R_b) = \sigma_{a,b} = \frac{\sum_{i=1}^{n}(R_a - \overline{R}_a)(R_b - \overline{R}_b)}{T - 1}$$

- Measures whether two variables tend to move in the same direction
- Range: minus infinity to plus infinity

Example: Covariance

- **Calculate** the covariance of this sample.

Year	Asset A Return	Asset B Return
1	1.6%	1.1%
2	–3.7%	6.0%
3	7.9%	–6.9%
4	1.4%	–2.6%

Solution: Covariance

Year	R_A	$R_A - \bar{R}_A$	R_B	$R_B - \bar{R}_B$	$R_A - \bar{R}_A \times R_B - \bar{R}_B$
1	0.016	−0.002	0.011	0.017	−0.000034
2	–0.037	−0.055	0.06	0.066	−0.00363
3	0.079	0.061	−0.069	−0.063	−0.003843
4	0.014	−0.004	−0.026	−0.02	0.00008
Mean	0.018		–0.006		
				Sum	−0.007427

$$\text{Cov}(R_a, R_b) = \frac{-0.007427}{4-1} = -0.00248$$

Correlation

$$\rho_{i,j} = \frac{Cov(R_i, R_j)}{\sigma_i \sigma_j}$$

- Correlation =
  - *Standardized* covariance: measures strength of *linear* relationship between two variables
- Range: minus one to plus one

Example: Correlation

Assuming covariance of –0.00248, **calculate** the correlation of this sample.

Year	Asset A Return	Asset B Return
1	1.6%	1.1%
2	–3.7%	6.0%
3	7.9%	–6.9%
4	1.4%	–2.6%

Solution: Correlation

- Standard deviation$_{\text{asset A}}$ = 4.75%
- Standard deviation$_{\text{asset B}}$ = 5.48%

$$\text{Correlation} = \frac{-0.00248}{0.0475 \times 0.0548} = -0.95$$

Spearman Rank Correlation

- Problem with correlation: heavily affected by outliers
- Solution: use ***Spearman rank correlation, ρ_s***

$$\rho_s = 1 - \frac{6\sum d_i^2}{n(n^2 - 1)}$$

Equation exception list

d_i = difference in *rank* of returns in period *i*

- **Example: Calculate** the Spearman rank correlation.

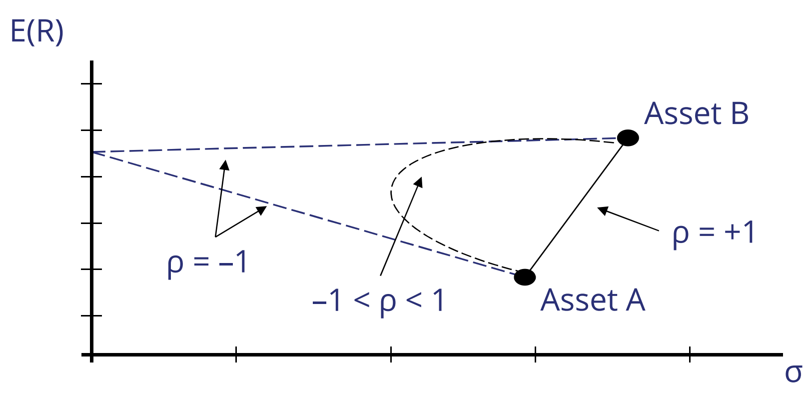
Time Period	Return of A	Return of B	Rank of A	Rank of B	Difference in Ranks (d_i)
1	60%	5%	1	2	–1
2	–2%	8%	3	1	2
3	0%	3%	2	3	–1

Spearman Rank Correlation

Time Period	Return of A	Return of B	Rank of A	Rank of B	Difference in Ranks (d_i)	d_i squared
1	60%	5%	1	2	–1	1
2	–2%	8%	3	1	2	4
3	0%	3%	2	3	–1	1

Spearman rank correlation: $\rho_S = 1 - \dfrac{6 \times 6}{3\left(3^2 - 1\right)} = 1 - \dfrac{36}{24} = -0.5$

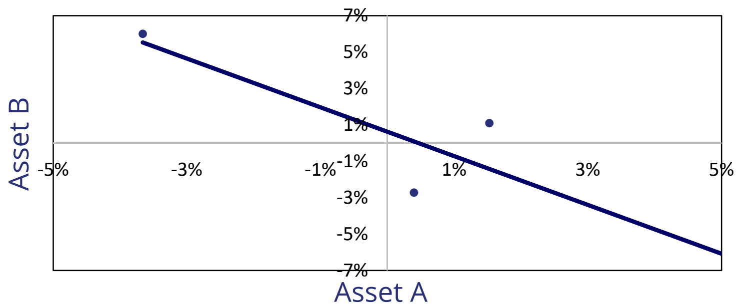
Correlation and Diversification



Lower correlation → greater diversification benefits

Regression

- Plots line of best fit through a *scatterplot* of two data series
- Point where line cuts y-axis is the *intercept*
- Equation of line: y = intercept + slope(x)



Beta

- Measures relative systematic risk in the CAPM

$$\beta_i = \frac{Cov(R_i, R_m)}{\sigma_m^2} = \rho_{i.m}\frac{\sigma_i}{\sigma_m}$$

- **Example:**
  - Covariance between Stock X and market: 0.01369
  - Standard deviation of Stock X: 15%
  - Standard deviation of market: 12%
  - **Calculate** (1) the correlation between Stock X and the market and (2) the beta of Stock X.

Beta

$$\text{Correlation} = \frac{0.01369}{0.15 \times 0.12} = 0.76$$

$$\text{Beta} = \frac{0.01369}{0.12^2} = 0.95$$

Autocorrelation

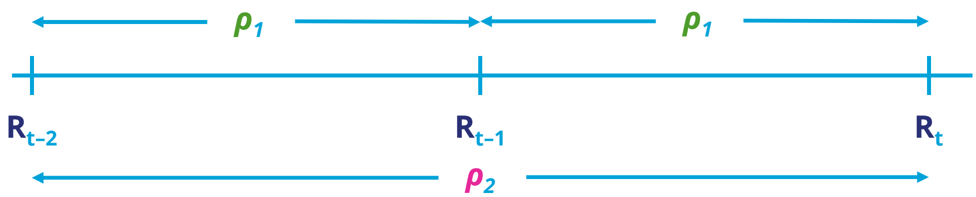
- Occurs when current returns are related to returns in a previous period
- Also called *Serial Correlation*

Positive autocorrelation → High returns today imply *high* returns in future (trending prices)

Negative autocorrelation → High returns today imply *low* returns in future (mean reversion)

Autocorrelation

First Order Autocorrelation



Second Order Autocorrelation:

Made up of:

R_{t-2} and R_t being related to R_{t-1} (ρ_1^2)

Partial Autocorrelation coefficient: directly attributable to R_t vs. R_{t-2}

$$\frac{\rho_2 - \rho_1^2}{1 - \rho_1^2}$$

Autocorrelation

- **Example:** A return series exhibits first-order autocorrelation of 0.5 and second-order autocorrelation of 0.2. What is the second-order **partial** autocorrelation coefficient?

- **Solution:**
  - The second-order **partial** autocorrelation coefficient is given by:

    $(0.2 – 0.5^2)/(1 – 0.52) = –0.0667$
  - There is a slight negative second-order autocorrelation (i.e., mean reversion) once the effect of the first-order autocorrelation is removed from the second-order autocorrelation.

Autocorrelation

- *Durbin-Watson (DW)* statistic: used to test for first-order autocorrelation
  - DW can take a value between 0 and 4
    - > 3 → evidence of negative autocorrelation
    - < 1 → evidence of positive autocorrelation
    - ≈ 2 → no evidence of autocorrelation

Properties of Standard Deviation

- Multi-period (T-period) return vs. single period return (assuming zero autocorrelation)

  $\sigma_T = \sigma_1 \times \sqrt{T}$

- Levered portfolio (σ_L) vs. unlevered portfolio:

  $\sigma_L = (\text{assets/equity}) \times \sigma_u$

- Weight (w) in market, balance in risk-free asset:

  $\sigma_{m+rf} = w \times \sigma_m$

Example: Standard Deviation

- An index has an annual volatility of 30%.
- **Calculate:**
  - The volatility of a portfolio that leverages the index 1.5 to 1
  - The volatility of a portfolio of a 60% allocation to the index and the balance in cash
  - The two-year volatility of the index
  - The six-month volatility of the index

Solution: Standard Deviation

- A portfolio that leverages the index 1.5 to 1:
  $1.5 \times 30\% = 45\%$
- A portfolio of a 60% allocation to the index and the balance in cash:
  $0.6 \times 30\% = 18\%$
- The two-year volatility of the index:
  $30\% \times \sqrt{2} = 42.43\%$
- The six-month volatility of the index:
  $30\% / \sqrt{2} = 21.21\%$

Why Are Alternative Returns Often Nonnormal?

- **Autocorrelation**
  - Leads to non-normal dispersion of *longer-term* returns
- **Illiquidity**
  - Thin trading can lead to large outliers.
  - Appraisal-based pricing leads to positively autocorrelated returns.
- **Nonlinearity**
  - Options positions and dynamic trading strategies

Testing for Normality

- To test whether sample is likely from a non-normal distribution, use the **Jarque-Bera (JB) test**.

$$JB = \frac{n}{6}\left(S^2 + \frac{K^2}{4}\right)$$

Equation exception list

- If JB statistic is greater than given critical value, normal distribution hypothesis would be rejected.

Example: Jarque-Bera Test

- Assume 48 monthly returns are sampled for a fund with sample skewness of 0.40 and sample excess kurtosis of 0.60.
- Critical value for the test = 5.99.
- **Conduct** a test of the hypothesis that the fund's returns follow a normal distribution.

Solution: Jarque-Bera Test

JB $= (48 / 6)\ ((0.4)^2 + (0.6)^2 / 4)$

$= 8(0.16 + 0.09) = 2$

- JB statistic (2) is less than the critical value (5.99).
- Therefore, we would **not** reject the hypothesis that this fund's returns follow a normal distribution.

Forecasting Volatility

- **GARCH model:** Popular model for forecasting volatility:
  - **G**eneralized
  - **A**uto**R**egressive
  - **C**onditional
  - **H**eteroskedasticity
- **ARCH models:** less robust models that only use recent return dispersion

Select Keyword Review

- Define these keywords and describe their role in the reading:
  - **Spearman rank correlation measure**
  - **Homoskedasticity**
  - **Lognormal**
  - **Mesokurtosis**
  - **Ex post returns**
  - **Autocorrelation**

Select Keyword Review

- **Spearman rank correlation measure:** based on ranking of data rather than values; avoids impact of extreme outliers
- **Homoskedasticity:** condition where variance of dependent is constant across different values of independent variable
- **Lognormal:** random variable is lognormally distributed when its logarithm is normally distributed
- **Mesokurtosis:** same kurtosis as the normal distribution (i.e., 3)
- **Ex post returns:** Past, observed returns
- **Autocorrelation:** occurs when return series is correlated with lagged version of itself

Discussion Questions

1. Describe the difference between positive autocorrelation and negative autocorrelation
2. True or false? Investors prefer low even moments and high odd moments.
3. If the covariance of two assets is equal to the product of their standard deviations, what is the level of diversification benefit achieved by combining the two assets?
4. An asset with a daily volatility of 1% has positive autocorrelation. What range of values could monthly volatility take if there are 20 trading days in the month?

Discussion Questions Answers

1. Positive autocorrelation occurs when a higher than average return is likely to be followed by a higher than average return. Negative autocorrelation occurs when a higher than average return is likely to be followed by a lower than average return.
2. True. Investors prefer low volatility and kurtosis and high mean and skew.
3. Covariance = product of standard deviations × correlation, hence correlation must be equal to one. In this case, there are no diversification benefits from combining the two assets.
4. With zero autocorrelation, monthly volatility will equal 1% × √20 = 4.47%. With autocorrelation equal to one, monthly volatility will be 1% × 20 = 20%. The actual monthly volatility will be somewhere between these two numbers.

Foundations of Financial Economics

Need to Know Concepts

- **Informational Market Efficiency**
  - 3 forms of market efficiency
  - 6 factors driving efficiency
- **Time Value of Money: Bond Prices and Rates**
  - Calculating and quoting **Spot Rates**, **Bond Yields**, and **Forward Rates**
- **Interest Rate Risk: Duration & Modified Duration**
- **Arbitrage-Free Models: Binomial trees for options**
- **Asset Pricing Models**
  - Single factor CAPM (ex-ante and ex-post)

Informational Market Efficiency

"Efficient" → asset prices reflect information

Level	Information Type
Weak	Past prices & volumes (market data)
Semistrong	All public information
Strong	All information (public & private)

Factors Driving Efficiency

1. Higher dollar value
2. Greater trading frequency
3. Lower trading frictions (costs/taxes)
4. Fewer regulatory constraints
5. Easier access to better information
6. Less valuation uncertainty

Time Value of Money, Prices, and Rates

- The simplest fixed income security ("bond") is a zero-coupon bond (ZCB)
  - Offers a single cash flow of *face value* at maturity, *t*
  - The rate offered by a single cash flow at a specified maturity is called the '**spot rate**' at that maturity.
- Given details of a ZCB, the TVM keys of the calculator can be used to calculate rates/prices…

Zero-Coupon Bonds

Examples:

1. A 5-year ZCB has a price of $88 for $100 of face value. Calculate the quoted annual rate of the bond for a compounding frequency of (a) annual and (b) semi-annual.

2. What is the price of $50 face value of a 3-year ZCB that offers an annual rate of 3% quoted using quarterly compounding?

Zero-Coupon Bonds

Solution to 1a)

2^{nd} FV,

5 N,

88 +/– PV,

100 FV,

CPT I/Y: 2.590%

Quoted annual rate = 2.590% × 1 = 2.590%

Solution to 1b)

2^{nd} FV,

10 N,

88 +/– PV,

100 FV,

CPT I/Y: 1.2865%

Quoted annual rate = 1.2865% × 2 = 2.573%

Solution to 2)

2^{nd} FV,

3 × 4 =12 N,

3 / 4 = 0.75 I/Y,

50 FV,

CPT PV: –45.71

(ignore the sign here)

Zero-Coupon Bonds

Note for continuously compounded rates (log returns) we use the definition:

$$r_t^{m=\infty} = \frac{\ln(Face/Price)}{t}$$

Example: A 5-year ZCB has a price of $88 for $100 of face value. Calculate the quoted continuously compounded annual rate of the bond.

Solution: $r_t^{m=\infty} = \frac{\ln(100/88)}{5} = 2.56\%$

Coupon-Paying Bonds

- Coupon paying bonds have regular coupons paid over the life of the bond, defined as a percent of face value

A bond's Yield to Maturity (YTM) is the single rate, y, that sets PV(*all* cash flows) = current price

- A bond's **yield** is a (non-simple) average of the **spot** rates that apply to the individual cash flows of the bond

Bootstrapping

Bootstrapping: derives term structure of **spot rates** from bond **yields**

Example:

A six-month ZCB is priced at 99.5% of par.

A twelve-month 2% semi-annual coupon bond is priced at 99% of par.

Calculate the implied 6-month and 12-month **spot rates** expressed on a semi-annual compounding basis.

Bootstrapping

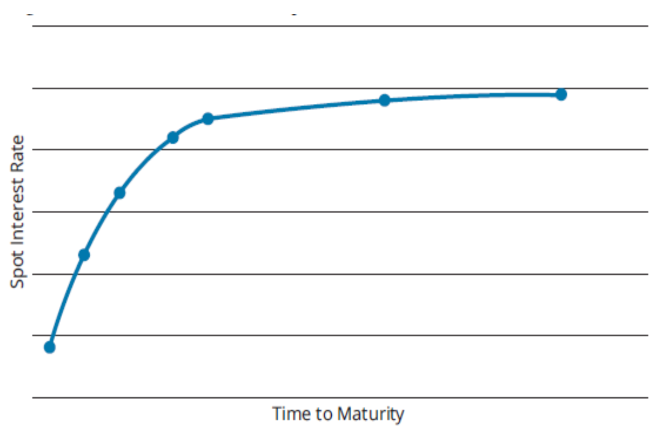
Solution:

- Semi-annual return of the 6-month ZCB = 100 / 99.5 – 1 = 0.5025%
- → Annualized 6-month spot rate = 0.5025% × 2 = 1.005% (semi-annual compounding)
- 12-month bond pays a CF of $1 after 6-months and $101 after 12-months
- The present value of the 12-month CF of the 12-month bond

  = 12-month bond price – PV(coupon paid at 6 months)

  = 99 – (0.995 × $1) = $98.005
- Semi-annual return earned by CF at 12-months = ($101 / $98.005)$^{1/2}$ – 1 = 1.5165%
- → Annualized 12-month spot rate = 1.5165% × 2 = 3.033%

Term Structure of Spot Rates

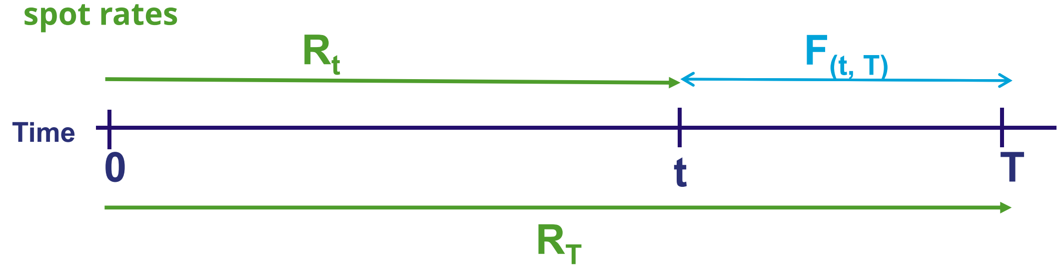


Theories of the Term Structure of Rates

1. **Unbiased Expectations**
   - Term structure driven purely by interest rate *expectations*
   - All bonds have the same returns over the same time horizon (no risk premiums)
2. **Liquidity Preference**
   - Longer dated bonds offer positive maturity risk premiums for interest rate risk
3. **Market Segmentation (Preferred Habitat)**
   - Rates are driven by supply/demand at different maturities

Forward Rates

- **Forward rates** are implied for *future periods* by the term structure of **spot rates**



- No arbitrage implies (for continuous rates):

$$F_{(t,\ T)} = \frac{R_T T - R_t t}{(T - t)}$$

Forward Rates

Example:

The continuously compounded spot rates corresponding to years 4 and 6 are 5% and 6% respectively. What is the implied annual interest rate from time 4 to time 6, $F_{(4,\ 6)}$?

Solution:

$F_{(4,\ 6)} = [(6\% \times 6) - (5\% \times 4)] / 2 = 16\% / 2 = 8\%$

The Fisher Equation

Nominal interest rate (r)

= real interest rate (i) + expected inflation rate (π)

- Incorporating taxes, T, gives the *modified* Fisher equation:

$$r = \frac{i + \pi}{(1 - T)}$$

Arbitrage-Free Models

- Based on the "Law of One Price":
  - Two identical assets should have the same prices/returns

- In *spot markets*:
  - Identify two sets of transactions with identical outcomes
  - E.g., USD per EUR = \$1.10. EUR per GBP = €1.09

    → USD per GBP = 1.10 × 1.09 = \$1.199

Arbitrage-Free Models

- Over *time*:
  - A **carry trade** goes long high-yielding assets and short low yielding-assets
- Example:
  - GBP interest rates = 1%, USD interest rates = 1.5%
  - A carry trade would borrow GBP to deposit in USD and earn the 0.5% interest rate differential
  - An investor looking to sell forward USD to hedge the carry trade should find USD trading at 0.5% *discount* to reflect the risk-free nature of the *hedged* carry trade.

Interest Rate Risk

- **Duration** = average time to receive cashflows, weighted by the present value of the cash flows.
- For *discretely compounded rates* (e.g., semiannual),
  - **Modified duration** = Percentage change in a bond's price for a 1% change in yield

$$\text{Modified Duration} = \frac{\text{Duration}}{(1 + (y/m))}$$

- For *continuously compounded rates*, m→∞, hence:

Modified Duration = Duration

Interest Rate Risk

Example:

1. What is the duration and modified duration of a 1-year 6% coupon bond with semi-annual coupons with a price of $1,005 for $1,000 of par?
2. What is the duration of a portfolio consisting of a 50% weight in the bond above and a 50% weight in a four-year ZCB?

Interest Rate Risk

Solution:

1. The yield of the bond is calculated using the TVM keys of the calculator:

   Semi-annual return is given by:

   2nd FV, 2 N, 1005 +/– PV, 30 PMT, 1000 FV, CPT I/Y: 2.7397%

   Note this implies annual quoted yield, y = 2.74% × 2 = 5.4794%

   Duration (average time) = 0.0145 + 0.971 = 0.9855 yrs

   Modified Duration (%ΔP for 1%Δy) = 0.9855 / 1.027397 = 0.9592

Time	CF	PV(CF)	Weight	Weighted Time
0.5	30	30/1.027397 = 29.20	29.20/1005 = 0.029	0.5 × 0.029 = 0.0145
1	1030	$1030/1.027397^2$ = 975.80	975.80/1005 = 0.971	1 × 0.971 = 0.971

Interest Rate Risk

2. Recall the duration of coupon bond = 0.9855 yrs

Duration of a four-year ZCB = 4 yrs

Duration of an equally-weighted portfolio:

$D_p = (0.5 \times 0.9855) + (0.5 \times 4) = 2.49275$

Managing Duration

Example:

An investor holds the following bonds in their portfolio:

Bond A: Duration = 8 years, Bond B: Duration = 12.5 years

What weights should investor hold to target a portfolio duration of 10 years?

Managing Duration

Solution:

Need weight in bond A, w_A, such that: $10 = (w_A \times 8) + [(1 – w_A) \times 12.5]$

Solving for w_A gives:

$10 = w_A \times 8 + 12.5 – 12.5w_A$

$–2.5 = –4.5w_A$

$\rightarrow w_A = 2.5/4.5 = 55.6\%$, $w_B = 1 – 0.556 = 44.4\%$

Managing Duration

Example:

An investor with a \$1m portfolio with a duration of 10 wishes to target a duration of 8. What ***short*** position in a 5-year ZCB should the investor take to achieve their objective?

Solution:

The investor requires a short position in the 5-year zero V_5, such that:

$(\$1,000,000 \times 10) + (V_5 \times 5) = (\$1,000,000 \times 8)$

Solving for V_5: $V_5 = (\$8m\ 2\ \$10m)/5 = –\$400,000$

Hence the investor should short \$400,000 of the 5-year zero.

Duration: Other Points

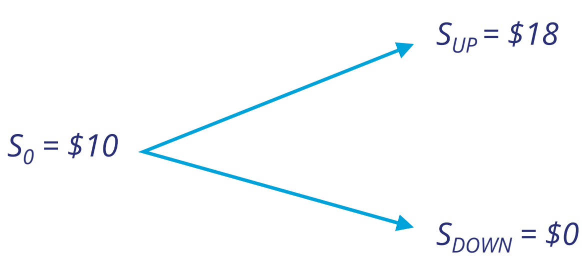
- A *Floating Rate Bond* has coupons which vary with interest rates (e.g., Reference Rate + 1%)
- This implies a low duration since when interest rates rise the cash flows of the bond will rise at the next reset period:

Duration of Floating Rate Bond = time to next reset period

- Bonds that can be prepaid *prior* to maturity (e.g., callable bonds or mortgage backed securities) require a valuation model to establish duration

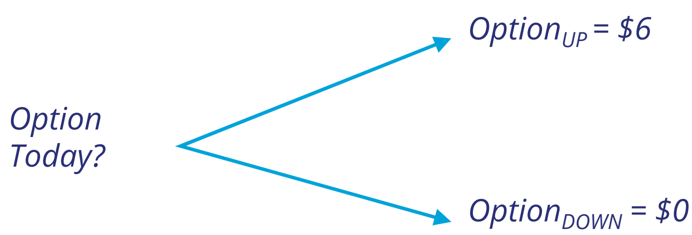
Binomial Models

Used to Price *Option Contracts*



What is the right to buy these shares at $12 in one period's time worth today?

Binomial Models



Given the option will always be worth one-third of the underlying asset price, it must be worth 1/3 × \$10 = \$3.33 today.

Risk-Neutral Models

- Note the previous binomial tree valued an option *without* specifying a risk-premium used to discount cash flows
  - This is the assumption of *risk neutrality*
- The assumption of risk neutrality can be made if the probabilities of an up-move and a down-move are also assumed to be *risk-neutral*
- This is common in the valuation of options because it allows us to discount at the risk-free rate

Ex Ante CAPM

- Single-factor ‘asset pricing model’
- Calculates fair *expected* return for a security:

$$E(R_i) = R_f + \beta_i \underbrace{[E(R_m) - R_f]}_{\text{Market risk premium}}$$

Risk-free rate

Beta (systematic risk)

Example: Ex Ante CAPM

Example: Given a risk-free rate of 0.5%, an expected market return of 6%, and a beta of the JST Fund of 1.3, what is the ex ante CAPM return of the fund?

Solution:

CAPM expected return

= risk-free rate + beta × market risk premium

= 0.5% + 1.3 × (6% – 0.5%) = 7.65%

Ex Post CAPM

- *Actual* return ≠ expected ex ante CAPM return
- Ex post CAPM looks at *actual returns in a given period*:

$$R_{i,t} = R_f + \beta_i(R_{m,t} - R_f) + \varepsilon_{i,t}$$

Idiosyncratic return for period t

- From a *risk* perspective: $\sigma_i^2 = \beta_i^2\sigma_m^2 + \sigma_\varepsilon^2$

Example: Ex Post CAPM

Example: Given a risk-free rate of 0.5%, an actual market return last year of 10%, a beta of the JST Fund of 1.3, and an actual fund return last year of 15%:

What is the idiosyncratic portion of the return from the previous year?

Solution:

Idiosyncratic Return = actual return – CAPM return
= 15% – [0.5% + 1.3(10% – 0.5%)]
= 2.15%

Select Keyword Review

- Define these keywords and describe their role in the reading:
  - **Interest rate immunization**
  - **Key externality of arbitrage activities**
  - **Recombining binomial tree**
  - **Term structure of implied forward rates**

Select Keyword Review

- **Interest rate immunization:** A rate relevant to a period starting in the future implied by the current term structure of interest rates
- **Key externality of arbitrage activities:** similar assets are driven to similar prices which improves global market efficiency
- **Recombining binomial tree:** has n+1 possible outcomes for n times steps since up, down gives the same result as down, up. Note a non-recombining tree would have 2^n possible outcomes since up, down would give a different result to down, up.
- **Term structure of implied forward rates:** a graphical plot of forward rates vs. the periods in the future to which they apply

Discussion Questions

1. For each of the three forms of market efficiency, which of the following investors can outperform the market if efficiency holds?

Investor	Weak	Semi-Strong	Strong
Technical Trader			
Fundamental Portfolio Manager			
Company Director			

2. True or False? A Floating Rate Note will most likely have a lower duration than a ZCB with a similar maturity.
3. True or False? The traditional duration of a bond is both average time and a measure of price elasticity relative to yields when discrete compounding is used.

Discussion Questions Answers

1. If efficiency holds, can the investor beat the market?

Investor	Weak	Semi-Strong	Strong
Technical Trader	No	No	No
Fundamental Portfolio Manager	Yes	No	No
Company Director	Yes	Yes	No

2. True. A floating rate note has a low duration equal to the time until the next coupon reset date. A ZCB has a duration equal to its maturity which is likely to be longer than a single coupon period.
3. False. The statement would be true if continuously compounded rates were used. With discretely compounded rates duration needs to be modified before it represents price elasticity vs. yields.

Derivatives and Risk Neutral Valuation

Need to Know Concepts

- Pricing forward contracts
  - Equity, commodity, T-bill, and FRA contracts
- **Valuing a forward contract**
- **Futures margin**
  - Marking contracts to market
- Option payoffs
  - Single option positions, bull/bear spreads, straddles and strangles, risk reversals
- Option put-call parity
- **Option sensitivities: "The 5 Greeks"**

Pricing Forward Contracts

Forward contract: agreement for deferred delivery (time *T)* of an asset at a price agreed today, $F_0(T)$

Time 0 T

$F_0(T)$ Agreed

Long pays short $F_0(T)$
Short delivers asset to long

Pricing Forward Contracts

No arbitrage condition:

Fair $F_0(T)$ = cost of buying spot asset & holding it to delivery

Costs of carry ↑ ⇒ Fair futures prices ↑

Benefits of carry ↑ ⇒ Fair futures prices ↓

Example: equity futures with interest rate *r*, dividend income *q*

$$F_0(T) = P_0 \times e^{(r-q)T}$$

Example: Pricing Equity Forwards

- Consider an equity index:
  - Trading at 1,750
  - Interest rate (continuous) is 3%
  - Continuous dividend yield is 2%
- **Calculate** the no-arbitrage price for a six-month forward on the index.

Solution: Pricing Equity Forwards

- The no-arbitrage price is

$$\begin{aligned} FP &= 1{,}750 \times e^{(0.03-0.02)\times(0.5)} \\ &= 1{,}758.77 \end{aligned}$$

Commodity Forward Pricing

	Financial Assets	Real Assets
Benefits	Dividends, coupons (*d*)	Convenience (*y*)
Costs	Interest (*r*), custody fees	Interest (*r*), storage (*c*)

- Arbitrage more complicated for commodities vs. financial assets due to difficulty creating *short* positions in underlying asset
  - Commodity forward pricing relationship more accurately expressed as

$$F(T) \leq P_0 e^{(r+c-y)T}$$

- Complications also arise due to differing convenience yields & storage costs

Example: Pricing Commodity Forwards

- Consider the following forward contract:
  - Nine-month delivery
  - Spot price = $30
  - Market-wide convenience yield = 3%
  - Storage costs = 1%
  - Financing costs = 5%

- Assuming no barriers to arbitrage, **calculate** the fair price of the forward contract.

Solution: Pricing Commodity Forwards

Cost of carry = (0.05 + 0.01 – 0.03) × (9/12) = 0.0225

Forward price = \$30 × $e^{0.0225}$ = \$30.68

Valuing Forward Contracts

- The fair price sets value to ***zero*** at initiation (t = 0)
- Value to long side, $V_{L,t}$, at some time *t after* initiation*:

$$V_{L,t} = F_{t,T} - F_{0,T} = P_t e^{(r+c-y)(T-t)} - F_{0,T}$$

*Note: this value is technically a value realized at time *T*.

Example: Valuing Forward Contracts

A commodity has a spot price of \$60. The commodity has storage costs of 3%, financing costs of 6%, and a convenience yield of 2%. Three months ago, an investor sold a 9-month forward contract at a price of \$64. What is the value of the contract to this investor?

Solution: Valuing Forward Contracts

- Value to the long side, V_L:

$$V_{L,t} = P_t e^{(r+c-y)(T-t)} - F_{0,T}$$

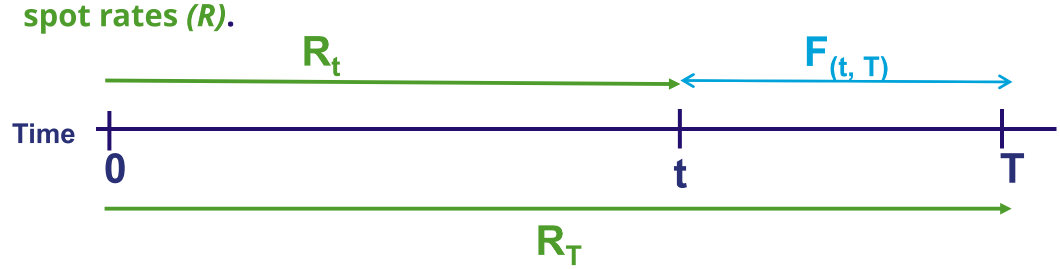
$(r + c - y)(T - t) = (0.06 + 0.03 - 0.02) \times (9/12 - 3/12) = 0.035$

So, $V_L = (\$60 \times e^{0.035}) - \$64 = \$62.14 - \$64 = -\$1.86$

- Value to the short side = \$1.86

Recall: Forward Rates (Saw Last Week)

- **Forward rates** are implied for *future periods* by the term structure of **spot rates *(R)***.



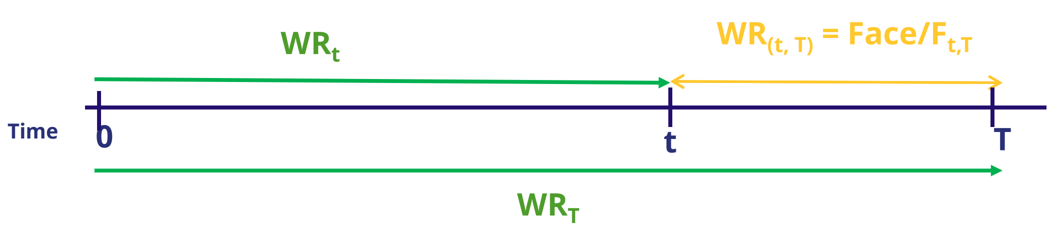
- No arbitrage implies (for continuous rates):

$$F_{(t,\,T)} = \frac{R_T T - R_t t}{(T - t)}$$

Treasury Bill Forward Prices

"wealth ratio$_t$" (WR_t) = (1 + R_t) = face/price$_{\text{T-bill with maturity } t}$

- Forward price for delivery of T-bill at time *t* with maturity (T – t), $F_{t,T}$, given by no-arbitrage relationship:



$$WR_t \times WR_{(t,T)} = WR_T$$

Example: T-Bill Forward Price

- **Note, for \$1,000 par and T-bill prices P_t and P_T, wealth ratio formula simplifies to**

$$F_{t,T} = (P_T / P_t) \times \$1{,}000$$

- **Example:** price of a three-month T-bill, P_3 = \$995 per \$1,000 par
- Price of a one-year T-bill, P_{12} = \$950 per \$1,000 par
- What is the fair price of a three-month forward contract on a nine-month T-bill?

- **Solution:** $F_{3,9}$ = (\$950 / \$995) × \$1,000 = \$954.77

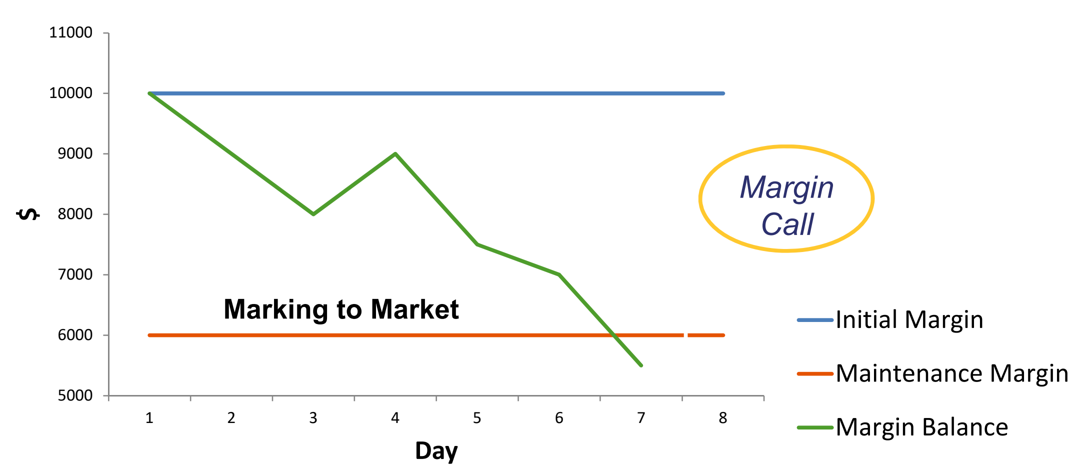
Recall: Theories of the Term Structure of Rates

1. **Unbiased expectations**
   - No risk premiums: forward rate = expected spot rate
     - forward price = expected spot price
2. **Liquidity preference**
   - Risk premiums related to maturity: forward rate > expected spot rate
     - forward price < expected spot price
3. **Market segmentation (preferred habitat)**
   - Rates are driven by supply/demand at different maturities
     - Forward prices and spot prices driven by market supply/demand

Futures vs. Forwards

Futures	Forwards
Exchange traded	Over-the-counter (OTC)
Standardized	Customized
Clearing house (central counterparty)	No clearing house
Low credit risk	Potentially high credit risk (crisis at maturity)
Mark to market (margin)	No mark to market

Futures Margin Requirements



Example: Margin Balance

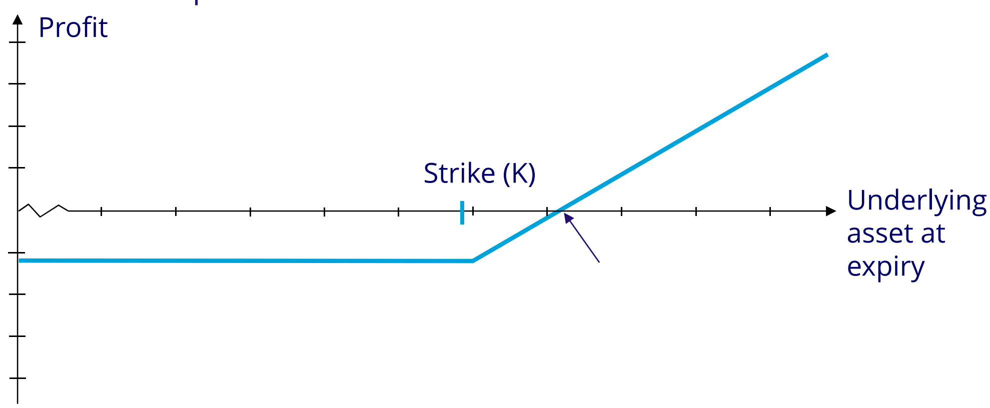
- Consider a long position of 10 August wheat contracts:
  - One contract = 5,000 bushels
  - Contract price = $3.00
  - Initial margin = $170
  - Maintenance margin = $100
- **Compute** the margin balance after:
  - –$0.03 change in price on Day 1
  - +$0.01 change in price on Day 2
  - –$0.02 change in price on Day 3

Solution: Margin Balance

Day	Required Deposit	Daily Change	Gain/Loss	Balance
0	$1,700	0	0	$1,700
1	0	–$0.03	–$1,500	$200
2	$1,500	+$0.01	+$500	$2,200
3	0	–$0.02	–$1,000	$1,200

Option Exposures

- **Long call option:** pays a premium for the *right* to buy underlying asset at a fixed strike price *K*



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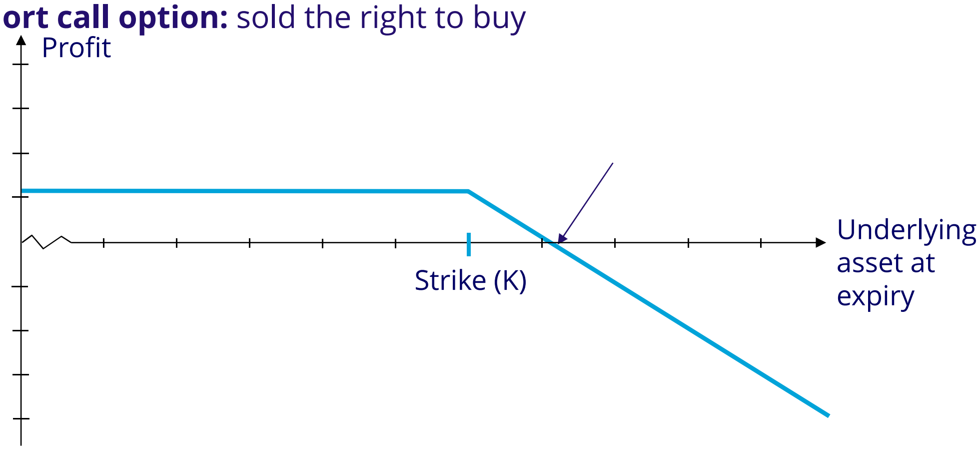
Option Exposures

- **Short call option:** sold the right to buy



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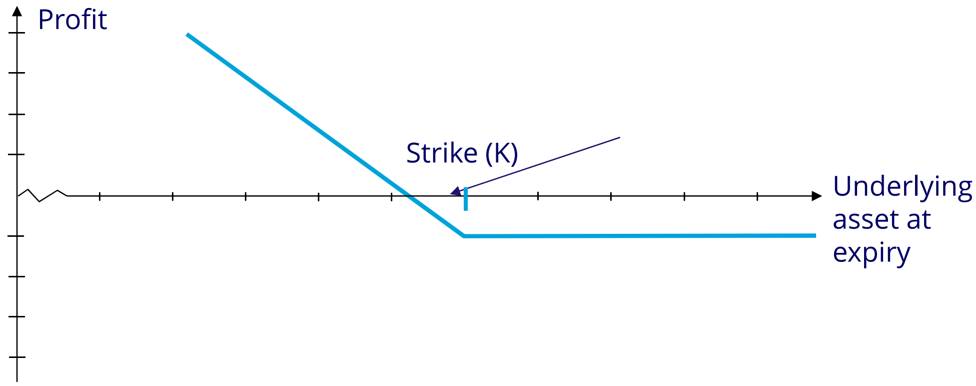
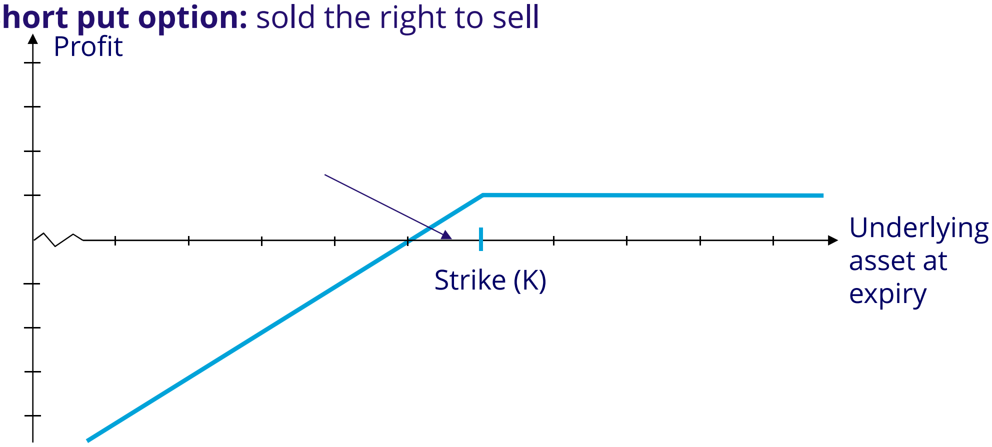
Option Exposures

- **Long put option:** pays a premium for the *right* to sell underlying asset at a fixed strike price



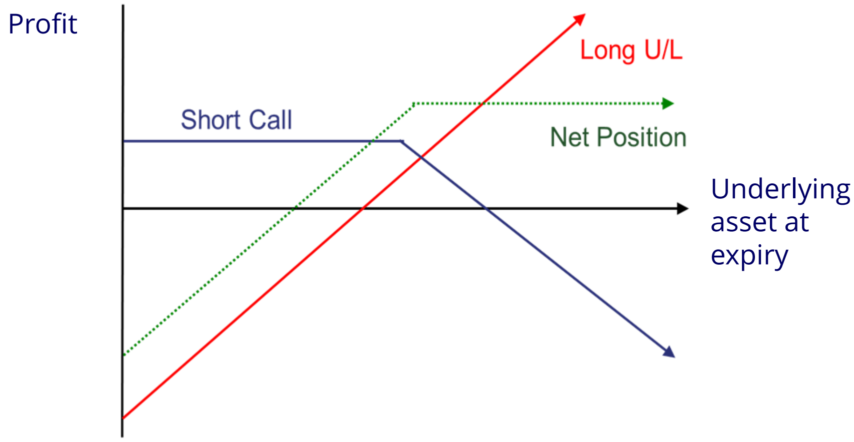
Option Exposures

- **Short put option:** sold the right to sell



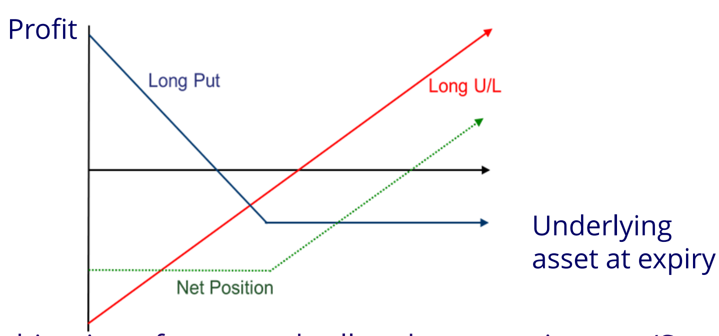
Option Strategies

- **Covered call:** long underlying asset (S), short call (–c)



Option Strategies

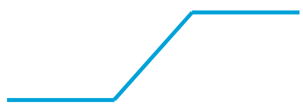
- **Protective put:** long underlying asset (S), long put (p)



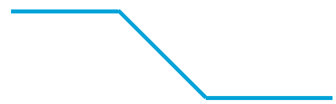
- **Note:** a combination of a covered call and a protective put, (S – c + p), is called a collar.

Option Strategies

- **Bull spread**
  - Long low strike, short high strike (calls or puts)

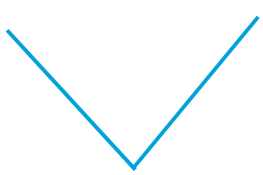


- **Bear spread**
  - Long high strike, short low strike (calls or puts)



Option Strategies

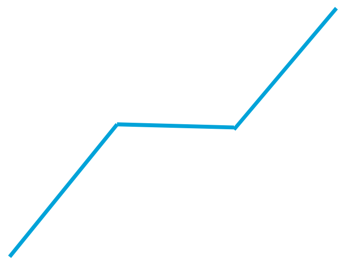
- **Long straddle**
  - Long call, long put, same strike



- **Long strangle**
  - Long call, long put, different strikes

Option Strategies

- **Risk reversal**
  - Long call, short put, different strikes



  - Same strikes → unfunded long exposure

Put-Call Parity

- **No-arbitrage relationship:**

call – put + bond = underlying asset

$$C - P + PV(X) = S$$

Option Pricing Models

- The Black-Scholes call option formula inputs:

Input	Greek (sensitivity measure)
Underlying asset price, S	Delta
Volatility of underlying asset, σ	Vega
Risk-free rate, r_f	Rho
Time to expiration, t	Theta
Strike price, K	N/A

- Gamma = rate of change in delta vs. stock price

Select Keyword Review

- Define these keywords and describe their role in the reading:
  - **Elasticity**
  - **Naked option**
  - **Omicron**
  - **Omega or lambda**
  - **Open interest**
  - **Rolling contracts**

Select Keyword Review

- **Elasticity:** percentage change in a value with respect to a percentage change in another value
- **Naked option:** a short option position that is unhedged
- **Omicron:** option sensitivity to change in credit spread
- **Omega or lambda:** elasticity of the option price relative to the underlying
- **Open interest:** number of futures contracts held by market participants for a specific delivery date
- **Rolling contracts:** process of closing a near-dated futures contract and opening a longer-dated futures contract to maintain long-term exposure to the contract

Discussion Questions

1. True or false? If liquidity preference theory holds, on average, investors will earn higher returns from long forward contracts vs. investing in the T-bill spot market for the equivalent period.
2. True or false? When dividend yields are higher than interest rates, spot prices on equities will be higher than forward prices.
3. Which option strategies benefit from falling volatility in the underlying asset?
4. A 6-month T-bill is priced at 99% of par. A 2-month T-bill is priced at 101% of par. What is the unannualized implied 4-month rate in 2 months' time?

Discussion Questions Answers

1. True. Under liquidity preference theory, forward rates are comprised of expected spot rates *plus a risk premium* for interest rate uncertainty. An investor will earn more on average from a forward contract that will incorporate the risk premium rather than investing in the spot market for the equivalent period.
2. True. If dividend yields are higher than interest rates, there will be a net benefit of carry causing forward prices to be lower than spot prices.
3. Short straddle, short strangle.
4. The fair forward price for $100 par of a 4-month T-bill delivered in 2 months' time = 99/101 × $100 = $98.0198. This implies a forward rate of 100/98.0198 – 1 = 2.02%.

Measures of Risk and Performance

Need to Know Concepts

- **Alternative risk measures: semivariance, target semivariance, tracking error, drawdown**
- **Value-at-risk calculation**
- **Performance measure calculations:**
  - Sharpe ratio
  - Treynor ratio
  - Sortino ratio
  - Information ratio
  - Return on VaR
  - Jensen's alpha
  - M2 (M-squared)

Semivariance and Semistandard Deviation

- Focuses on the *downside* of the distribution
- Dispersion of values that lie *below* the mean
- Apply usual variance formula to returns *below* the mean

$$\text{sample semivariance} = \frac{\sum_{\text{for } R_t < E(R)} [R_t - E(R)]^2}{T - 1}$$

- Semistandard deviation = √semivariance

Example: Semistandard Deviation

Calculate the sample semistandard deviation of the following return series:

Year	Return
1	–1.1%
2	2.7%
3	–6.9%
4	–2.7%

Example: Semistandard Deviation

- Mean = (–1.1 + 2.7 – 6.9 – 2.7) / 4 = –2.0%
- Sum of squared deviations below mean:
  $[-6.9 - (-2)]^2 + [-2.7 - (-2)]^2 = 24.5$
- Sample semivariance = 24.5 / (4 − 1) = 8.167
- Sample semistandard deviation = $\sqrt{8.167}$ = 2.86%

Other Left-Tail Risk Measures

- **Semivolatility:**

$$\text{semivolatility} = \sqrt{\frac{\sum_{\text{for } R_t < \bar{R}} \left[R_t - \bar{R}\right]^2}{T^* - 0.5}}$$

where:

T* = number of observations less than the mean

Other Left-Tail Risk Measures

- **Target semivariance and target semideviation:**
  - Dispersion of values that lie *below* a *target*
  - Calculated as per semivariance but with *target return* in place of mean return
- **Shortfall risk:** probability a target return will *not* be met

Tracking Error

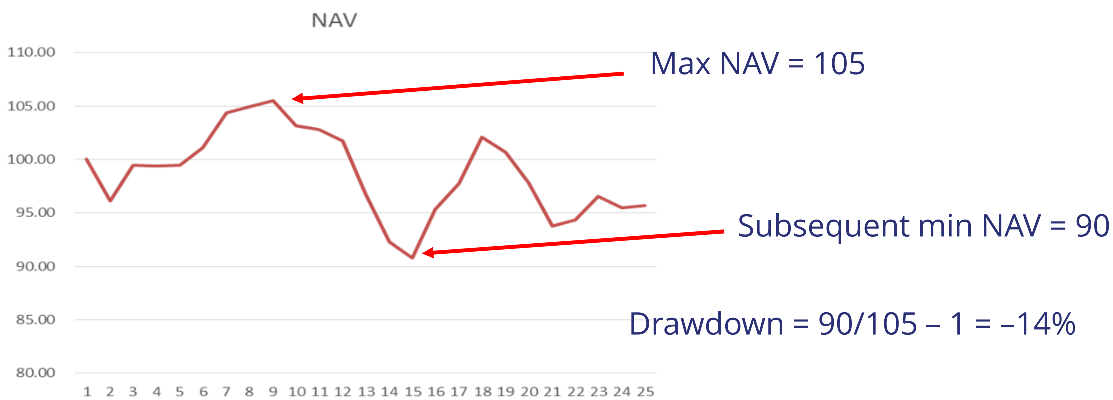
- Measure of *relative risk*
- Dispersion of returns *relative* to a benchmark return
- Apply usual variance formula to *relative returns*

$$\text{tracking error} = \sqrt{\frac{\sum_{t=1}^{T}(R_t - R_B - M)^2}{T-1}}$$

where:
M = average of $R_t - R_B$

Drawdown

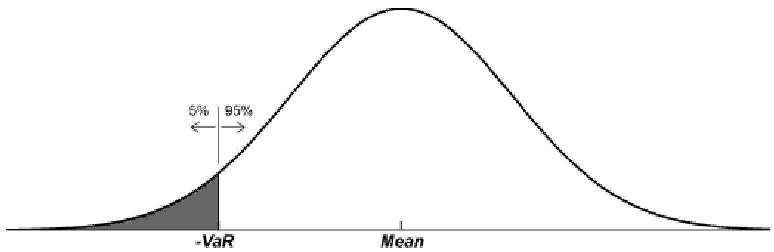
- Maximum loss in value of an asset in percentage return



Drawdown = 90/105 – 1 = –14%

Value at Risk (VaR)

- Maximum loss over a specified period with a specified probability (confidence)



- Can also be defined as minimum loss over a specified period with a specified probability (significance)

Parametric VaR

Parametric VaR = $z \times \sigma \times \sqrt{\text{days}} \times \text{value}$

where:

z = number of standard deviations associated with VaR probability

σ = daily standard deviation

days = number of days specified

value = market value of the portfolio

- Assumes normal distribution

Example: Parametric VaR

The JMO Fund has a market value of $10 million and an estimated daily standard deviation of 0.58%.

Calculate the 5% 10-day VaR of the fund. (The relevant *z*-value for 5% significance is 1.65.)

Solution: Parametric VaR

5% 10-day VaR = $1.65 \times 0.0058 \times \sqrt{10} \times \$10$ million = $302,630

Value at Risk

- **Historical approach**
  - Rank recent price movements and directly observe relevant percentile return
  - Using the 1,000 days of returns, the 5% daily VaR will be the 50th worst return in the sample
- **Monte Carlo approach**
  - Computer simulation of potential returns given analyst assumptions of asset price behavior
  - Rank simulated returns and directly observe relevant percentile return

Aggregating VaR

- Aggregate VaR of two equally weighted assets with equal individual VaRs will depend on their *correlation coefficient*:
  - Correlation = 1
    - Total VaR = sum of individual VaRs
  - Correlation = 0
    - Total VaR ≈ √ sum of squared VaRs
  - Correlation = –1
    - Total VaR = 0

Example: Performance Measures

- **Calculate** the Sharpe, Treynor, Sortino, and information ratios and the M^2 measure of a fund using the following information:

Expected return	7%
Standard deviation	12%
Beta	1.15
Target return	3%
Target semistandard deviation	15%
Tracking error vs. the market	8%

Expected return of market	5%
Standard deviation of market	10%
Risk-free rate	2%

Solution: Performance Measures

- Sharpe ratio = $[E(R_p) - {}_{rf}] / \sigma_p$

  = (7% – 2%) / 12% = 0.42

- Treynor ratio = $[E(R_p) - r_f] / \beta_p$

  = (7% – 2%) / 1.15 = 4.3%

- Sortino ratio = $[E(R_p)$ – target] / target semistandard deviation

  = (7% – 3%) / 15% = 0.27

Solution: Performance Measures

- Information ratio = $[E(R_p) - E(R_m)]$ / tracking error

  = (7% – 5%) / 8% = 0.25

- $M^2 = r_f + [\sigma_m / \sigma_P] [E(R_p) - r_f]$

  = 2% + (10% / 12%)(7% – 2%) = 6.2%

Select Keyword Review

- Define these keywords and describe their role in the reading:
  - **Value at risk**
  - **Conditional VaR**
  - **Return on VaR (RoVaR)**
  - **Information ratio**
  - **Jensen's alpha**

Select Keyword Review

- **Value at risk:** loss that is only expected a small specified percentage of the time
- **Conditional VaR:** average loss in the tail of a distribution
- **Return on VaR (RoVaR):** expected return of asset divided by value at risk
- **Information ratio:** expected outperformance of investment vs. the benchmark divided by tracking error
- **Jensen's alpha:** outperformance of investment vs. the capital asset pricing model (CAPM)

Discussion Questions

1. The 1% VaR of a portfolio over a 20-day period is estimated to be $1.5 million. What does this number mean?

Expected return of Asset *i*	9%
Sharpe ratio of Asset *i*	0.30
Beta of Asset *i*	1.50
Variance of the market	0.0196
Market risk premium	4%
Risk-free rate	1%

2. What is the correlation between Asset *i* and the market?
3. Is the M^2 measure for Asset *i* likely to be higher or lower than the market return? Explain.

Discussion Questions Answers

1. There is only a 1% chance that the portfolio will suffer a loss of \$1.5 million over the next 20-day period.

   Equivalently, there is a 99% chance that losses will *not* exceed \$1.5 million over the next 20-day period.

Discussion Questions Answers

2. Beta = correlation × (σ_p / σ_m)
   1.5 = correlation × (σ_p / √0.0196)
   1.5 = correlation × (σ_p / 0.14)

   Utilize Sharpe ratio to determine asset volatility:
   0.3 = ($E(R_p) - r_f$) / σ_p = (9% – 1%) / σ_p
   σ_p = 8% / 0.3 = 26.67%

   1.5 = correlation × (0.2667 / 0.14)
   correlation = 0.79

Discussion Questions Answers

3. The M^2 of an asset will be higher than the market return when it has a Sharpe ratio that is higher than the market.

   Because the Sharpe ratio of the market is $0.04 / \sqrt{0.0196} = 0.29$ and the Sharpe ratio of the asset is 0.3, the asset will have an M^2 that is higher than the market return.

Alpha, Beta, and Hypothesis Testing

Need to Know Concepts

- Return attribution using CAPM
  - **Ex ante alpha vs. ex post alpha**
- Attribution issues
  - 3 common model misspecifications
  - 2 causes of nonstationary betas
  - Ex ante alpha and persistence
- Return drivers
  - Beta drivers vs. alpha drivers
  - Product innovators vs. process drivers

Need to Know Concepts

- 4 steps of hypothesis testing
- p-values: when to reject the null hypothesis
- 4 common problems interpreting p-values
- Type I and Type II errors
- Sampling and testing: problems with data
- Statistical issues in analyzing alpha and beta
  - Three fallacies of alpha estimation
  - Three fallacies of beta estimation

Sources of Return

Beta

Nondiversifiable systematic risk

Alpha

Excess return over risk-free rate & beta

Ex ante: forecasted (skill)

Ex post: observed (skill & luck)

CAPM Return Attribution

- **Ex ante alpha** = forecast return – CAPM ex ante return

$$\boldsymbol{\alpha = \text{forecast return} - \{R_f + \beta_i[E(R_m) - R_f]\}}$$

Attributable to **skill**

- **Ex post alpha** in single period *t*, $\boldsymbol{\varepsilon_{i,t}}$ (idiosyncratic return)

$$\boldsymbol{\varepsilon_{i,t} = \text{past return} - \{R_f + \beta i[R_{m,t} - R_f]\}}$$

Attributable to both **skill** and **luck**

Example: CAPM Return Attribution

- Perform a CAPM performance attribution on the JST Fund for the previous year given the following data:
  - Risk-free rate = 0.5%
  - Expected market return = 6%
  - Beta of JST Fund = 1.3
  - Expected return of JST Fund = 10%
  - Actual fund return last year = 15%
  - Actual market return last year = 10%

Solution: CAPM Return Attribution

CAPM expected return = risk-free rate + beta × market risk premium
= 0.5% + 1.3 × (6% – 0.5%) = 7.65%

Ex ante alpha = expected return – CAPM expected return
= 10% – 7.65% = 2.35%

Since luck is always expected to have an average value of zero, this must be **skill**.

Solution: CAPM Return Attribution

- Ex post alpha = actual return – CAPM return
  = 15% – (0.5% + 1.3(10% – 0.5%)) = 2.15%
- Idiosyncratic return = 2.15%
- Skill = ex ante alpha = 2.35%
- Luck = ex post alpha – ex ante alpha
  = 2.15% – 2.35% = −0.2%

Return Attribution Using CAPM

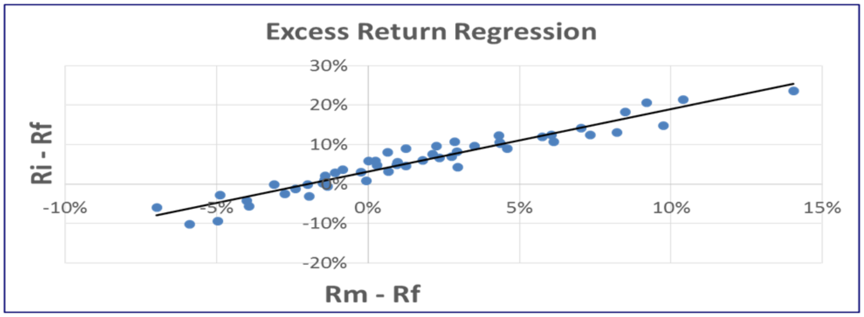
Summary:

1. **Calculate** the ex ante alpha of the fund. This is deemed to be attributable to *skill*.
2. For any given period, **calculate** the ex post alpha of the fund. This is a combination of *skill* and *luck*.

Skill = ex ante alpha

Luck = ex post alpha – ex ante alpha

Ex Post CAPM: Multiple Periods



Intercept (a)	**3.10%**
Slope (b)	**1.59**

Equation of line: $\mathbf{R_{i,t} - R_f = a_i + b_i[R_{m,t} - R_f] + e_{i,t}}$

Intercept = skill

Error = luck

Ordinary Least Squares Regression

- **Calculates** coefficients to minimize the sum of squared errors

Breaches of assumptions

Outliers in data

Autocorrelation of residuals

Heteroskedasticity

Interpreting Goodness of Fit (r^2)

- **Goodness of fit, *r*-squared:**
  - Percentage of total variation in dependent *Y* variable explained by independent *X* variable
  - R^2 of 0.20 means *X* explains 20% of the variation in *Y*
- **Caution:** you cannot conclude causation from high r^2

Model Misspecifications

Omitted/misidentified systematic return factors	Beta dressed up as alpha
Misestimated betas	Underestimating betas → inflated alpha
Nonlinear risk-return relationships	Errors due to assumption of linearity

Beta Nonstationarity

Beta creep	Increasing market risk to remain competitive
Beta expansion	Increased correlations in times of financial distress

Ex Ante Alpha: Persistence

- Skill could also be estimated through empirical analysis of **abnormal return persistence:**
  - Test whether ex post alphas in subsequent periods are correlated with those in previous periods
  - Positive correlation → increased confidence in manager skill

Return Drivers

Beta drivers

Asset gatherers

Process drivers

Alpha drivers

Product innovators

Hypothesis Testing Example

You are looking for evidence that a manager has skill (i.e., non-zero active return).

You collect a random *sample* of monthly manager active returns of size 100.

You calculate the *sample* mean to be 3.73%.

Hypothesis Testing Example

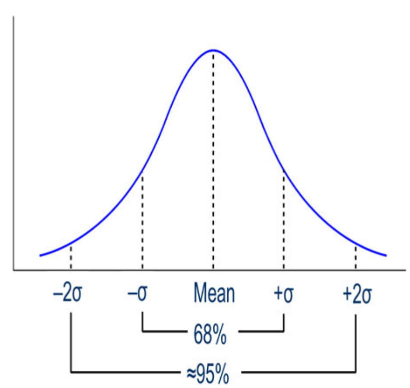
- **Central limit theorem:**
  - The **sample mean** is an approximately normally distributed **random variable** with expected value equal to the true population mean and a standard deviation called standard error.
- Assume, in this case, that the standard error is 1.14%.

Hypothesis Testing Example

Normally distributed variables lie within 1.96 standard errors of the true mean 95% of the time.

The observed sample mean is 3.27 standard errors away from a hypothesized mean value of zero:

$$(3.73\% - 0\%) / 1.14\% = 3.27$$



Hypothesis Testing Example

The observed sample mean lies outside the 95% confidence range under the hypothesis the manager has no skill. This implies one of the following:

1. The manager has no skill and we have observed a *very unlikely* sample (less than 5% chance, lucky manager)

OR

2. *The hypothesis the manager has no skill is not true* → **REJECT**

Formal Steps of Hypothesis Testing

1. State the **null hypothesis** and the **alternative hypothesis**.
2. Design the test:
   - State a **significance level (α)/confidence level** (given).
   - Derive a **critical value** for the test (given).
3. Take a sample and calculate the **test statistic**.
4. Make a decision: reject/fail to reject.

Formal Steps of Hypothesis Testing

In our example:

Test Feature	
Null hypothesis	Manager active return = 0
Alternative hypothesis	Manager active return ≠ 0
Significance level, α	5%
Confidence level	95%
Critical value	1.96
Test statistic	3.27

Test statistic (3.27) > critical value (1.96) → **reject**

Regression Coefficient *t*-Test

- Use *t*-test:

$$t_{b_i} = \frac{\hat{b}_i - b_i}{s_{\hat{b}_i}} = \frac{\text{estimate} - \text{hypothesized}}{\text{standard error}}$$

- Usually test statistical significance:

$$H_0\text{: } b_i = 0 \text{ vs. } H_a\text{: } b_i \neq 0$$

$$t_{b_i} = \frac{\hat{b}_i - 0}{s_{\hat{b}_i}} = \frac{\text{estimate}}{\text{standard error}}$$

Example: Test Slope Coefficient

- **Test** statistical significance of slope coefficient of 0.9 from stock return regression at 5% significance level, assuming standard error is 0.17
  - H_0:
  - H_a:
  - *t*-stat =
  - Critical *t*-value = 1.96
  - Decision:

Solution: Test Slope Coefficient

- **Test** statistical significance of slope coefficient of 0.9 from stock return regression at 5% significance level, assuming standard error is 0.17
  - H_0: $b_1 = 0$
  - H_a: $b_1 \neq 0$
  - *t*-stat = 0.90 / 0.17 = 5.3
  - Critical *t*-value = 1.96
  - Decision: Reject H_0: conclude slope coefficient significantly different from zero

P-Value

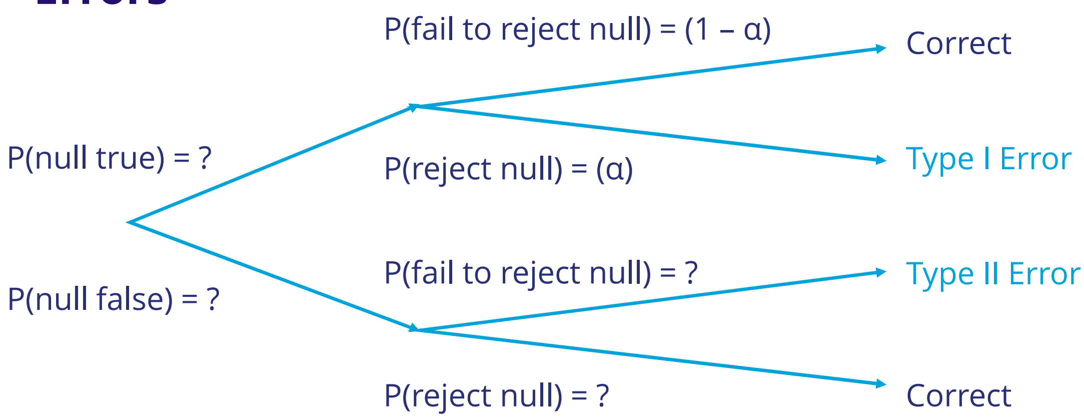
- Probability of observing a value as extreme as one observed in sample, assuming null hypothesis is true
- If *p*-value is lower than significance level of test, null hypothesis should be ***rejected***

Problems Interpreting *P*-Values

Four common ***misinterpretations*** of *p*-values:

1. A lower *p*-value implies a stronger relationship.
   - **False**: *p*-values do not measure strength of relationships.
2. A low *p*-value always indicates economic significance.
   - **False**: other factors may have more economic significance in explaining returns.
3. There is 95% chance or greater the alternative hypothesis is true when rejecting the null at 5% significance.
   - **False**: this implies 5% chance a true null was incorrectly rejected.
4. The *p*-value is only as meaningful as the test assumptions.

Errors



With a significance level of α, what is the probability of the alternative hypothesis being true given we have rejected the null?

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Sampling and Testing Problems

Potential problems with data used in statistical tests:

- **Unrepresentative data sets** (do not represent population)
  1. Self-selection bias
  2. Survivorship bias
  3. Backfill bias
- **Data dredging** (total number of experiments is ignored)
  1. Backtesting—overfitting
  2. Cherry picking & chumming

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Fallacies of Alpha Estimation

Null hypothesis: manager has zero alpha ($\alpha = 0$)

Alternative hypothesis: manager has non-zero alpha ($\alpha \neq 0$)

1. Non-normal returns will lead to erroneously concluding that managers have skill due to outliers.
2. Model misspecification could cause misclassification of beta as alpha.
3. Rejection of the null hypothesis that the manager has zero alpha with 1% significance does not mean there is a 99% chance the manager has skill (misinterpretation #3).

Fallacies of Beta Estimation

Null hypothesis: manager has zero exposure to factor ($\beta = 0$)

Alternative hypothesis: manager has exposure to factor ($\beta \neq 0$)

1. Failure to reject the null hypothesis of no relationship only implies no *linear* relationship between the manager and the factor in question. There may still be a *nonlinear* relationship.
2. Rejecting the null hypothesis of no relationship implies correlation only, not necessarily *causation*.
3. Rejection of the null hypothesis that the manager has zero exposure with 1% significance does *not* mean there is a 99% chance the manager actually has systematic exposure (misinterpretation #3).

Select Keyword Review

- Define these keywords and describe their role in the reading:
  - **Abnormal return persistence**
  - **Equity risk premium puzzle**
  - **Full market cycle**
  - **Data mining**
  - ***p*-value**
  - ***t*-statistic**
  - **Type II error**

Select Keyword Review

- **Abnormal return persistence:** occurs when there is a correlation between ex post alpha across time; suggests the abnormal return is skill rather than luck
- **Equity risk premium puzzle:** long-term tendency for U.S. equities to have higher returns than predicted by traditional models of risk aversion and utility maximization
- **Full market cycle:** a period of time containing a large representation of market conditions; can be helpful in specifying attribution models correctly
- **Data mining:** vigorous use of data to uncover valid relationships

Select Keyword Review

- ***p*-value:** probability of observing a value as extreme as the one that was observed in the sample, assuming the null hypothesis is true
- ***t*-statistic:** distance of an observed sample statistic away from a hypothesized value measured in standard errors
- **Type II error:** error of failing to reject the null hypothesis when it is actually false

Discussion Questions

1. Assume the risk-free rate is 3%, the long-run market expected return is 6%, and the market returned 8% last year. What are the ex ante alphas and ex post alphas of the following funds?

Investment	Description	Last Year's Return
Fund A	Perfect index tracker with expense ratio 75 bps above industry average	+7.2%
Fund B	Imperfect index tracker with expense ratio of 5 bps	+8%
Fund C	Active manager with a beta of 1.1 and expected return of 9%	+8%

Discussion Questions

The output of a statistical test of a fund manager's excess return is as follows:

Sample mean excess return	2.50%
Standard error	1.00%
Critical value	1.96
Significance level	5%
p-value	1.24%

2. If the null hypothesis states that the manager has zero excess return, what decision should be made from this output data?

Discussion Questions

3. True or false? The confidence level of a test denotes the probability that the null hypothesis will not be rejected when it is true.
4. True or false? A p-value of 2% indicates that there is a 98% chance that the alternative hypothesis is correct.

Discussion Questions Answers

1. **Fund A:** Fund will match index return prior to expenses. Given the fund returned 80 bps lower than market and has costs that are 75 bps above industry average, industry average costs must be 5 bps. Since we *expect* fund to underperform index by 80 bps, this is all ex ante alpha. Contribution to ex post alpha from luck is zero. Ex post alpha is therefore the same as ex ante alpha: −80 bps.

Discussion Questions Answers

1. **Fund B:** Fund expected to underperform index on average by 5 bps; hence, this is ex ante alpha. Given the fund actually matched index, there must be contribution to ex post alpha from luck of +5 bps, though this is random and not expected to recur. Ex post alpha is zero.

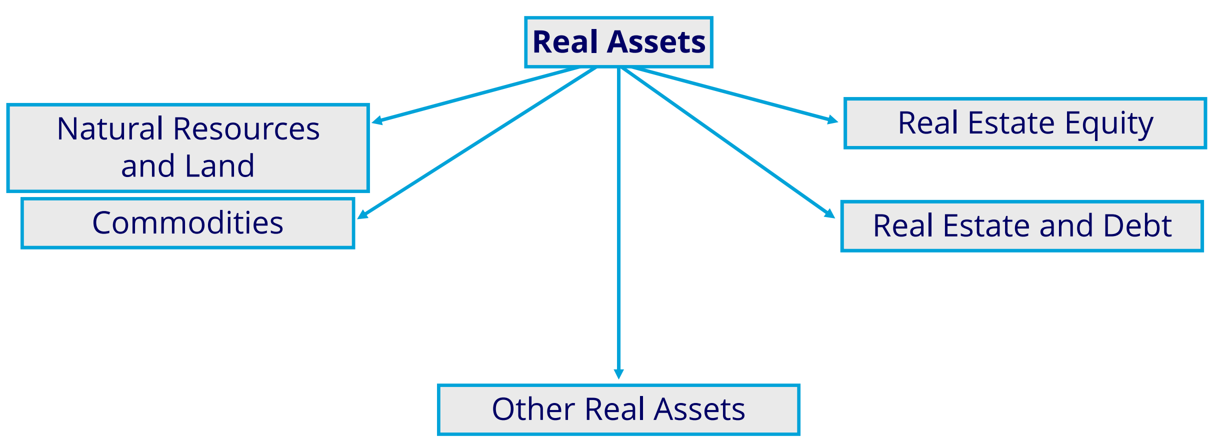
   Fund C: CAPM expected return: 3% + 1.1(6% – 3%) = 6.3%. Hence, ex ante alpha = 9% – 6.3% = 2.7% deemed as skill. During the most recent year, the fund had ex post alpha of 8% – [3% + 1.1(8% – 3%)] = –0.5%, deemed luck and skill; hence, contribution due to luck is –3.2%.

Discussion Questions Answers

2. The null hypothesis should be rejected because the *p*-value of the test is lower than the significance level of the test. We should conclude that there is evidence that the manager's excess returns are non-zero with 95% confidence.
3. True. The confidence level relates to the confidence we have that we correctly fail to reject the null hypothesis when it is true.
4. False. A *p*-value of 2% indicates that there is only a 2% chance we would have observed our sample if the null were true. It does not tell us the actual probability that the alternative hypothesis is true.

Real Assets

Overview



Natural Resources and Land

Need to Know Concepts

- Valuing **natural resources as an exchange option**
- Valuing **land as a call option** (binomial approach)
- Calculating the expected return of land
- Pros and cons of **timberland** investment
- Pros and cons of **farmland** investment
  - **Capitalization rate** valuation (calculation)
- Causes and impact of **smoothing** on real asset valuations
  - Smoothing models: mean return and volatility calculations

Natural Resources

- **Natural resources**
  - Real assets with no or almost no human alteration
    - Example: undeveloped land and minerals

Surface rights

Usually privately owned

Minerals

Usually government owned

Access

- Direct ownership
- Leases/rights
- Pure plays (rare)

Natural Resources as Exchange Options

- **Exchange option**
  - An option to deliver out an asset to receive another asset

    - Mineral rights
    - Extraction costs

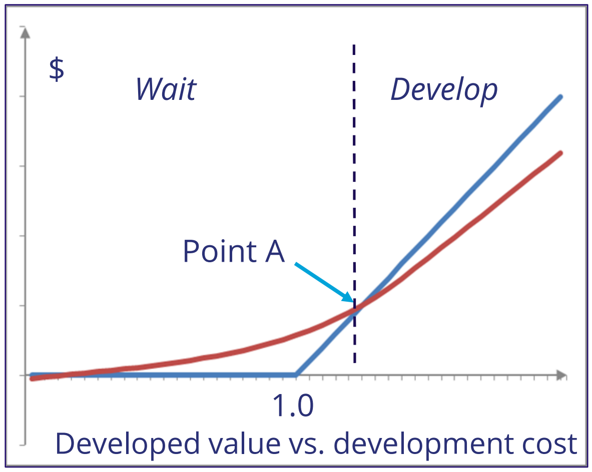
    - Processed minerals (i.e., commodity)

  - Option value depends on:
    - Volatility of price of asset being delivered
    - Volatility of price of asset being received
    - Correlation between the two

Natural Resources as Exchange Options

Value if exercised immediately

Value if exercised later (deferred basis)



Land as a Call Option

- Value of raw land can be attributed to development option
- Can be modeled as a call option with:
  - **Strike:** costs of construction
  - **Underlying asset:** land + completed development
  - **Time to expiration:** unlimited
  - **Moneyness:** completed development – costs of construction
- Option will be exercised when net benefits of development exceed the net value of retaining the option

Example: Binomial Model Approach

Today

economy improves
property value = $500,000 (UpVal)
construction costs = $375,000

economy deteriorates
property value = $300,000 (DownVal)
construction costs = $325,000

- Risk-free rate: 0%
- Value of equivalent property today: $370,000
- **Calculate** the value of call option

Solution: Binomial Model Approach

- **Step 1:** Use the **values** of the property to solve for the probability of an improvement in the economy (UpProb).
- **Step 2:** Use the Step 1 probabilities to calculate the value of the right to develop the land (property will not be developed in poor economy).

Solution: Binomial Model Approach

- **Step 1:**
  $370,000 = (UpProb × $500,000) + (1 – UpProb) × $300,000
  UpProb = $70,000 / $200,000 = 0.35

- **Step 2:**
  Option value = [0.35 × ($500,000 – $375,000)] + [0.65 × 0] = $43,750

Example: Binomial Model Approach

- Factors affecting valuation:
  - What will be the impact of construction costs being fixed at $342,500 (weighted-average cost)?
  - What will be the impact of a wider dispersion of end property values?

Solution: Binomial Model Approach

- Factors affecting valuation:
  - Land value = 0.35 × ($500,000 – $342,500) = $55,125. Fixed construction costs increase the value of the option.
  - Wider dispersion of end property values lead to higher profits when the economy improves, increasing the value of the option.

Risk and Return of Investing in Land

- If the land is developed, expected returns will be higher than if the land remains undeveloped.
- **Expected return:**

$$E(R) = [P_d \times E(R_d)] + [(1 - P_d) \times E(R_{nd})]$$

where:

P_d = probability of developing land

$E(R_d)$ = expected return of developed land

$E(R_{nd})$ = expected return of undeveloped land

Timberland Investments

Methods of accessing

Direct/private → Timberland investment management organizations (TIMOs)

Publicly traded vehicles →

- Listed timber companies
- ETFs
- REITs
- Lumber futures

- Most common institutional method

Pros and Cons of Timberland

Pros

1. Low correlation with stocks and bonds
2. Potential inflation hedge
3. Flexible harvest/*rotation* schedule (timing option)

Cons

1. Values tied to cyclical industries (housing)
2. Technology/recycling may diminish timber demand
3. Natural disaster/legal risk

Farmland Investments

Methods of accessing

Direct/private

Publicly traded vehicles

- Listed agricultural companies
- ETFs
- REITs
- Agricultural futures

Investing in Farmland

Farmland returns

- Linked to commodity prices; steady lease income

Demand driven by:

- Growth in population
- Higher incomes and increased protein diets
- Increased biofuel demand

Investing in Farmland

Supply driven by:

- Changing yields (transgenic modification, agronomy, increased fertilizers, increasing mechanization)
- Improved infrastructure
- Increasing quantity of land under cultivation

Pros and Cons of Farmland

Pros

1. Low correlation with stocks and bonds
2. Potential inflation hedge
3. Supply more constrained than demand for agricultural products

Cons

1. High transaction and search costs
2. Agency risk due to leasing out management of farm
3. Political risk due to government policy change
4. Illiquid with exposure to natural disaster risk

Cap Rate Valuation

- **Capitalization rate** (a.k.a. return on assets or yield) equals operating cash flow divided by total value:

$$\text{cap rate} = \frac{\text{annual operating income}}{\text{total value}}$$

- Given a cap rate, the fair value is:

$$\text{value of real estate} = \frac{\text{annual operating income}}{\text{cap rate}}$$

Example: Cap Rate Valuation

An investor purchases a parcel of farmland for $2.2 million. The investor finances 80% and puts 20% equity in the deal. The bank loan rate is 5%. The investor leases the farm for annual revenue of $150,000. Total taxes and insurance are $30,000.

- **Calculate** the ROE (net income / equity) for this property.
- **Calculate** the cap rate for this property.

Solution: Cap Rate Valuation

ROE = net income / equity

net income = \$150,000 – \$30,000 – (0.05 × 0.8 × \$2.2m)
= \$32,000

equity = 0.2 × \$2.2m = \$440,000
= \$32,000 / \$440,000 = 7.27%

cap rate = (revenue – expenses) / land value

= (\$150,000 – \$30,000) / \$2,200,000 = 5.45%

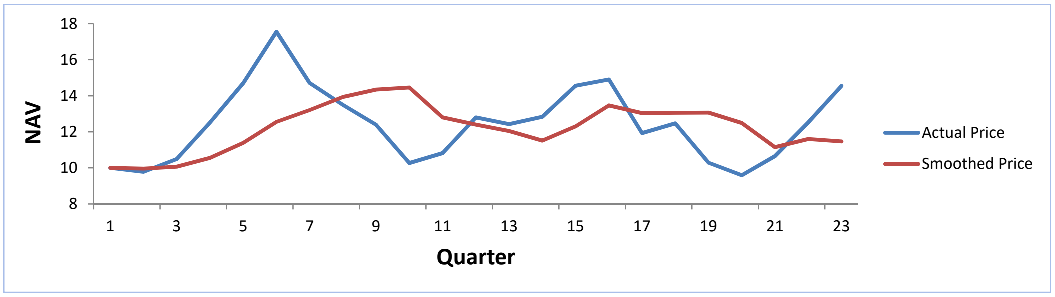
Farmland as a Multiple Use Option

Option's value will be ***high*** if there is:

- ***Low correlation*** between the profitability of alternative crops
- ***High volatility*** of the profitability of alternative crops
- ***Similar profitability*** of alternative crops

Real Asset Valuation and Volatility

- Most real assets are unlisted
- Valued by ***appraisal*** rather than by transaction prices



- **Price volatility:** actual (26.5%) vs. smoothed (11.7%)

Real Asset Valuation and Volatility

Appraisal process may cause smoothing due to:

- Time lags:
  - Deal struck vs. deal published
  - Appraisal input data vs. market conditions
- Biased selection for valuation
- Anchoring

- Managerial discretion over valuations may lead to *managed returns* through:
  - A favorable mark
  - Selective appraisals
  - Model manipulation
  - Market manipulation

Impact of Smoothed Prices

Smoothing leads to:

- Prices that *lag* true price movements
- Estimates of volatility biased downward
  - Sharpe ratios biased *upward*
- Estimates of correlations with other assets biased *downward*

Overallocation to real estate in portfolio

Stale Pricing Model

$$r_t^* = \alpha r_t + (1 - \alpha) r_{t-1}$$

where:
r_t^* = smoothed (observed) return in time *t*
r_t = true return in time *t*
α = weight of current true returns in smoothed returns

Stale Pricing Model: Mean Returns

Mean stale returns, u^* vs. mean true returns, u over periods 1 to T:

$$u^* = u + (1/T)[(1 - \alpha)(r_0 - r_T)]$$

Example: The mean of a series of stale returns over the previous 12 months is 2.54%. The return in the month preceding this series was 5.25%, and the return in the most recent month was –6.50%. What is the true mean monthly return over the previous year if α is estimated to be 0.4?

Stale Pricing Model: Mean Returns

Solution: Using the formula:

$$u^* = u + (1/T)[(1 - \alpha)(r_0 - r_T)]$$
$$2.54\% = u + (1/12)[(1 - 0.4)(5.25\% - (-6.50\%)]$$
$$2.54\% = u + 0.5875\%$$

True mean, u = 2.54% – 0.5875% = 1.9525%

Note the mean based on smoothed prices is *higher* than the true mean because the smoothed mean overweights the early high return (r_0) of 5.25% and underweights the low recent return (r_{12}) of –6.50%.

Stale Pricing: Volatility

- Stale returns could also be modeled as an equally weighted average of true returns over the previous N periods
- If true returns are also independent and homoskedastic:

$$\sigma(r_t^*) = \sigma(r_t)/\sqrt{N}$$

- **Example:** Volatility of stale returns = 2%. Volatility of true returns over the same period is estimated as 6%. Assuming that observed returns are an equally weighted moving average of true returns, how many periods are used to estimate true volatility?

Stale Pricing: Volatility

Solution: Using the formula:

$$2\% = 6\%/\sqrt{N}$$

Hence √N = 3, so N = 9.

Note: key takeaway here is that smoothing causes the volatility of observed returns to be *lower* than that of true returns.

Timber vs. Farmland Returns

Asset Class	Average Return	Standard Deviation	Sharpe Ratio	Skewness	Excess Kurtosis
NCREIF Timber	5.6%	4.8%	0.6	1.3	6.5
NCREIF Farmland	11.5%	6.8%	1.3	3.4	14.7
World equities	4.3%	15.5%	0.1	–0.6	1.5

Note: both timberland and farmland returns exhibited high 4-order partial autocorrelation based on quarterly data (=> one-year smoothing lag)

Period: Jan. 2000–Dec. 2020

Select Keyword Review

Define these keywords and describe their role in the reading:

- **Paper lots**
- **Blue top lots**
- **Finished lots**
- **Split estates**
- **Land banking**
- **Rotation**

Select Keyword Review

- **Paper lots:** land approved for development, not ready for building
- **Blue top lots:** land where owner has paid all fees, rough grading is done, ready for building
- **Finished lots:** land where full infrastructure is in place, ready for construction and occupancy
- **Split estates:** when surface rights and mineral rights are separately owned
- **Land banking:** buying vacant lots of raw land for eventual development or disposition
- **Rotation:** time between seed and harvest for timber

Discussion Questions

1. According to the call option view of undeveloped land, when should the option to develop be exercised? Define the strike price for this type of option.
2. An investor owns a series of paper lots that is expected to increase in value by 2% if they remain undeveloped. Should the land be developed, the expected return is 30%. If the probability that the lots will be developed is 15% over the next period, what is the expected return of the land?

Discussion Questions

3. Calculate the ROE and cap rate for a farmland project with the following details:

Purchase price	$375,000
Financing	$200,000
Annual revenues	$35,000
Property taxes	$5,000
Insurance	$3,000
Interest	$8,000

Discussion Questions Answers

1. The option to develop the land should be exercised when the present value of the expected income from developing the land is higher than the value of the option.

   The strike price consists of construction and other costs required for developing the land.

2. Expected return = (0.15 × 30%) + (0.85 × 2%) = 6.2%

Discussion Questions Answers

3.	Net income	= \$35,000 – \$5,000 – \$3,000 – \$8,000
		= \$19,000
	Equity	= \$375,000 – \$200,000 = \$175,000
	ROE	= \$19,000 / \$175,000 = 10.9%
	Cap rate	= (revenue – expenses) / value
		= (\$35,000 – \$5,000 – \$3,000) / \$375,000
		= 7.2%

Commodities

Need to Know Concepts

- 5 methods of investing in commodities
  - Hotelling theory for returns on spot prices
  - CLN effective cost calculation
- Term structure of commodity forward prices
  - Backwardation vs. contango
  - Normal backwardation vs. normal contango
  - Theory of Storage (Working Curve)
  - Market segmentation
  - Option-based theories
- 4 diversification benefits of commodities

Investing in Commodities

1. Futures and Forwards
   - Most popular method—discussed in the reading *Derivatives and Risk Neutral Valuation*
2. Direct physical (spot) ownership
   - Unattractive to financial institutions due to
     - Storage and transportation costs
     - Lack of convenience yield earned by financial investors
     - Opportunity cost of capital needed to finance position

Investing in Commodities

- **Hotelling theory applied to commodity spot prices:**
  - Owner of exhaustible natural resource has two options:

Option 1:
Produce now for price P_0 → Invest P_0 at interest rate *r* → Wealth = $\mathbf{P_0e^{rT}}$

Option 2:
Do not produce today → Wait → Produce at time 1 for price $\mathbf{P_T}$

In equilibrium, producer is indifferent, hence $\mathbf{E(P_T) = P_0e^{r^*T}}$
→ ***Commodities rise at the nominal risk-free rate plus a risk-premium, r*, over the long term***

Investing in Commodities

- Empirical evidence: very long-term real returns on many spot commodities have been negative
  - Contradicts Hotelling theory
- Adjusting Hotelling theory for technological changes by decreasing cost of extraction → *lower* growth rates/price declines
  - Historically argued successfully by Julian L. Simon

Investing in Commodities

3. Commodity-related equity investments
   - May *not* correlate with underlying commodities due to:
     - Hedging of commodity exposure by company
     - *Valuations* driving stock prices (P/E) rather than earnings
     - Stock-specific risks
   - *Two* betas:
     - One linked to commodities
     - One linked to equity markets…diversifying??

Investing in Commodities

4. Exchange-traded funds (ETFs) and notes (ETNs)
   - Underlying assets of ETF…physical/leveraged?
   - ETNs face counterparty risk of issuing bank (e.g., Lehman)

5. Commodity-linked notes (CLNs)
   - *Advantages*:
     - No rolling required by CLN investor
     - Bond classification
   - Disadvantage: face default risk of issuing company

Example: CLN Effective Cost

An investor holds a one-year, $2,000,000 par value CLN with the following details:

- Reference index: Bloomberg Commodity Index (BCOM)
- Initial BCOM Index value = 92
- Bond pays at least the par value of the bond and the coupon payment, and any index performance above a value of 100.

Example: CLN Effective Cost

- The coupon rate of the CLN is 2%.
- Ordinary bonds of issuer have an interest rate of 8%.
- At maturity, the value of the BCOM is 110.

Calculate the effective cost of the commodity exposure and the payout of the CLN at maturity.

Solution: CLN Effective Cost

Effective cost of the commodity exposure:
= (2% – 8%) × ($2,000,000) = −$120,000

Payout at maturity:
= (0.02 × $2,000,000) + [$2,000,000 × (110 / 100)]
= $2,240,000

Recall: Pricing Forwards/Futures

Costs of carry $\uparrow$ $\Rightarrow$ Fair futures prices $\uparrow$

Benefits of carry $\uparrow$ $\Rightarrow$ Fair futures prices $\downarrow$

	Commodities	Financial Assets
Costs	Interest (r), storage (c), *spoilage? shrinkage?*	Interest (r), custody fees
Benefits	Convenience (y)	Dividends, coupons (d)

$$\boxed{F_0(T) \leq P_0 \times e^{(r + c - y) \times T}}$$

Example: Cost of Carry

Note for short time frames the curriculum presents costs/benefits of carry discretely, as per the following example:

The spot price of a commodity is \$4.25; the three-month futures price is \$4.20. The annual financing rate is 1%, the annual spoilage rate is 2%, and the storage cost is \$0.01 per month.

What is the implied annualized convenience yield?

Solution: Cost of Carry

- Futures price = spot + cost of carry

  → cost of carry = \$4.20 − \$4.25 = −\$0.05
- Financing cost = \$4.25 × 0.01 × (3 / 12) = \$0.010625
- Spoilage cost = \$4.25 × 0.02 × (3 / 12) = \$0.02125
- Storage cost = \$0.01 × 3 = \$0.03

Solution: Cost of Carry

- Since cost of carry = financing cost + spoilage cost

  + storage cost – convenience yield

  −\$0.05 = \$0.010625 + \$0.02125 + \$0.03 – \$CY

- Hence, \$CY = \$0.1119, then %CY = \$0.1119 / \$4.25 = 2.63%
- Then annual convenience yield = 2.63% × (12 / 3) = 10.5%

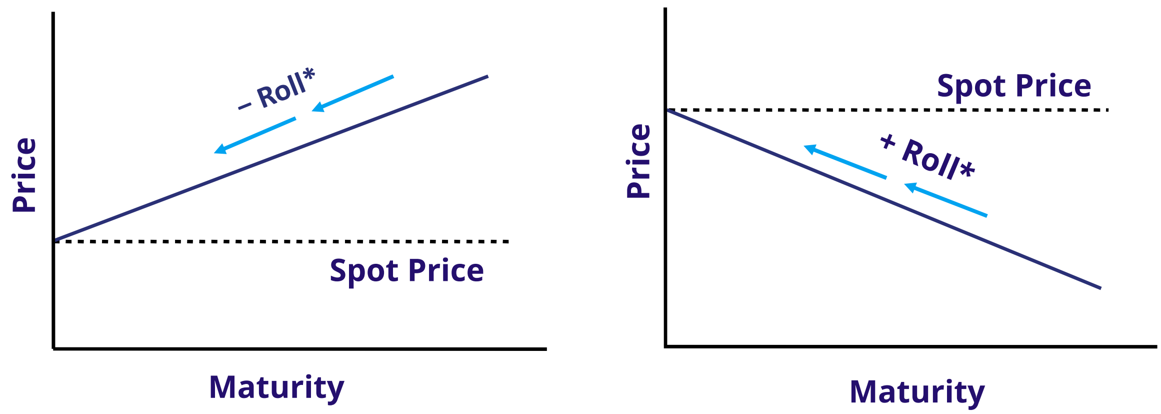
Demand and Supply Influences

$$\left.\begin{array}{r}\text{High demand volatility}\\ \text{+ Inelastic demand}\\ \text{+ Inelastic supply}\end{array}\right\}\ \text{High convenience yield}$$

- Storage costs and convenience yields vary through time and per participant
  - Commodity curve more complex than financial asset forward curve
  - More opportunity to generate alpha in commodity forward markets

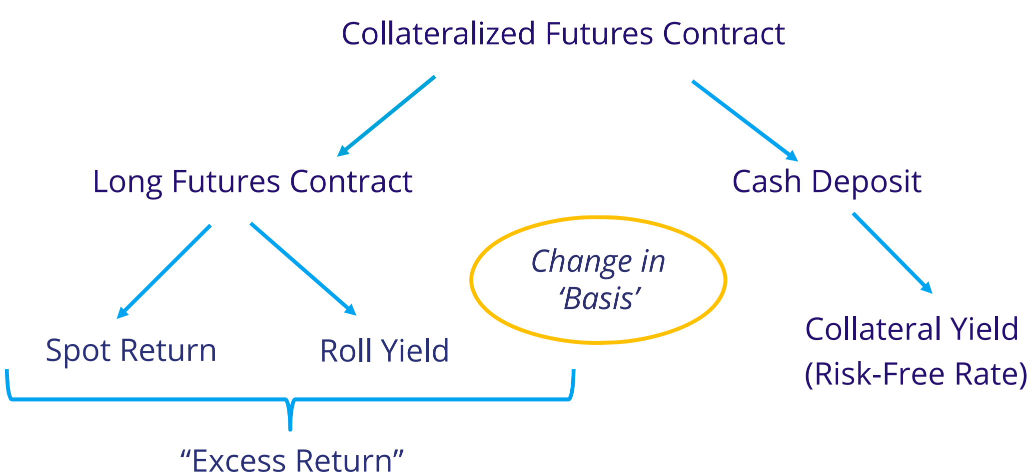
Term Structure of Forward Prices

Contango Market (S < F) **Backwardated Market (S > F)**



*assuming curve doesn't change shape

Components of Futures Return



Three Propositions Regarding Roll Yield

Proposition #1:

Roll return is earned by *holding contracts over time*, NOT by closing one position and opening another position.

Proposition #2:

Backwardated markets do NOT always generate positive roll returns.

Proposition #3:

Positive roll returns do NOT always signify alpha.

Spreads

basis = $S_0 - F_0(T)$
calendar spread = $F_0(T + t) - F_0(T)$

- How would an investor use a calendar spread to profit from the view that costs of carry will increase?
- What will be the impact of a change in spot price on this position?

Spreads

- How would an investor use a calendar spread to profit from the view that costs of carry will increase?
  - *Long the distant contract, short the near dated contract*

- What will be the impact of a change in spot price on this position?
  - *No impact if notional value of longs and shorts are the same*

Normal Backwardation and Normal Contango

- **Expected Spot Price, $E_0(S_T)$** vs. Futures Price, $F_0(T)$
  - **Normal** contango: $E_0(S_T) < F_0(T)$
  - **Normal** backwardation: $E_0(S_T) > F_0(T)$

Normal Backwardation Theory

Producers of commodities want to hedge long exposure *more* than users want to hedge short exposure

Hedgers are ***net sellers*** of futures contracts

Futures prices trade below expected spot prices, $E_0(S_T)$ in order to offer risk premium to speculators

→ ***Normal backwardation***

Other Theories of the Forward Curve

- **Storage models:**
  - Current & expected storage levels influence futures prices
  - Forecast *upward* sloping forward curves when commodity inventory levels are above demand ("*Working* curve")
- **Market segmentation/preferred habitat hypothesis:**
  - Hedging supply and demand varies across maturity depending on preferences of producers/users of commodity
  - Risk premiums: may be available for long and short futures holders at different maturities

Other Theories of the Forward Curve

- **Option-based models (real options):**
  - **Extraction option:**
    - Producers will shut down before selling futures contracts below cost of production

      → dampens volatility of forward prices
  - **Inventory option:**
    - Upside volatility in commodities higher than downside volatility *(volatility asymmetry)*
    - Favors owning spot or near-dated contracts over longer-dated contracts

      → flat/backwardated curves

Diversification Benefits of Commodities

1. Commodity prices driven by supply and demand rather than discounted cash flows
2. Positively correlated with inflation
3. Affected by short-term conditions, rather than long-term expectations
4. Significant increase in commodity costs will decrease corporate profits and the price of stocks and bonds

Diversification Considerations

Diversification

Equilibrium
Hold market weight

Disequilibrium
Optimal weight dependent on investor's situation

Inflation risk
Offer protection because:
1. Component of inflation
2. Real price should be same across countries

Expected Returns on Commodities

- Spot commodity prices have low/zero betas => low expected returns (CAPM).
- Commodity spot prices tend to fall over the long term due to technological advances in production.
- Commodity futures investors *can still earn competitive returns when futures prices reflect expected falls in spot prices*.
- When efficiently priced, commodities play a more valuable role in *risk reduction* rather than *return enhancement*.

Commodity Futures Indices

	S&P GSCI	Bloomberg Commodity Index (BCOM)	CRB
Weighting scheme	Production levels	Trading activity (i.e., liquidity) Max sector weight: 33%	Tiered sector weightings based on importance to economic development

Commodity Risks and Returns

- **Event risk:**
  - Commodities benefit from reduced supply & increased prices
  - Positively skewed (upside shocks)
  - Uncorrelated events
  - Events that benefit commodities tend to hurt stocks and bonds
- **Commodity futures as defensive investments:**
  - May lower downside risk during market stress
- **Institutional acceptance leading up to 2007:**
  - Financialization of commodities may impair diversification benefits

Commodity Performance (Jan. 2000–Dec. 2020)

Asset Class	Average Return	Standard Deviation	Sharpe Ratio	Skewness	Excess Kurtosis
Commodities	1.2%	23.4%	–0.1	–0.6	1.9
World equities	4.3%	15.5%	0.1	–0.6	1.5

Note: commodities had massive maximum drawdown of –87.2% (vs. –55.4% for equities)

Select Keyword Review

Define these keywords and describe their role in the reading:

- **Basis risk**
- **Excess return of a futures contract**
- **Humped curve**
- **Normal contango**
- **Stock-out**
- **Working curve**

Select Keyword Review

- **Basis risk:** the risk of loss due to changes in the relationship between spot and futures prices.
- **Excess return of a futures contract:** The return attributable to changes in a futures price (comprising spot and roll returns).
- **Humped curve:** A forward term structure which exhibits contango in the short term and backwardation in the long term.
- **Normal contango:** price pattern where forward price is *above* the expected future spot price and converges to that price from above over time
- **Stock-out:** Inventory of a commodity falling to zero due to a shortage of supply.
- **Working curve:** predicts high inventory levels will lead to contango due to higher costs of storage and low convenience yields.

Discussion Questions

1. Consider the following commodity information: spot price = $1,200, risk-free rate = 1%, storage costs = 2%
   a. What is the fair price of a 6-month future to a firm that earns a convenience yield of 4%?
   b. Based on the fair price, is this market in backwardation or contango?
   c. What is the basis of the market?
   d. If the expected spot price is $1,100, how can this market be described?
   e. How could a manufacturer take advantage of an arbitrage if futures prices are actually $1,150?

Discussion Questions

2. Are the following statements regarding a market in normal backwardation true or false? Explain.
   a. Risk premiums are earned by investors shorting futures contracts.
   b. The hedging activities of producers force futures prices below current spot prices.
   c. The basis of the market will always be positive.

Discussion Questions

3. Identify the two sources of roll yield for a futures position.
4. A pension fund is prevented by regulations from investing directly in commodities or commodity-related futures. Describe an instrument that could be used to access the returns of commodity markets.
5. True or false? An investor long a futures contract in a contango market always suffers negative roll yield.

Discussion Questions Answers

1.a) Fair price to manufacturer = 1,200 × $e^{(0.01+0.02-0.04)\times 0.5}$ = 1,194

1.b) The market is in backwardation because futures prices are below spot prices.

1.c) Basis of the market = Spot – Futures = 1,200 – 1,194 = 6

1.d) The expected spot is below the futures, so the market is in normal contango.

1.e) Short cash, long futures, as futures price is too low

Discussion Questions Answers

2.a) False. Risk premiums are earned by investors going long futures contracts.

2.b) False. The hedging activities of producers force futures prices below expected spot prices.

2.c) False. The market could be in normal backwardation, yet it could also be in contango where the futures price is higher than the current spot price and the basis is negative.

Discussion Questions Answers

3. The two sources are (1) futures price movement along the curve as time passes and (2) changes in the shape of the forward curve.
4. The pension fund could buy a commodity-linked note (CLN), which would be classified as a bond by the regulator and, therefore, allowable. The CLN would give the investor access to a coupon that varied in line with an underlying commodity index.
5. False. Should the curve move into steeper contango, the investor could realize a positive roll yield.

Other Real Assets

Need to Know Concepts

- Commodity producers
  - Natural resource prices as driver of performance
- Master limited partnerships (MLPs)
  - Basic characteristics: tax/valuation
- 12 attributes of investable **infrastructure**
- Valuation of **intellectual property** (calculation)
- 5 entry/exit strategies for **R&D and patent investing**

Commodity Producers

- Theoretical drivers of correlation of ***firms*** and their ***goods***:
  - Price elasticity of demand and supply for the good
  - Level of hedging
- Empirical evidence:

	Gold	Gold Miners
2002–2012	up 6×	up 3×
Sep.–Nov. '08	up slightly	down 1/3

  - Much of the volatility in oil *company share prices* is driven mostly by *equity* valuations
- **Conclusion**:
  - Investments are more *equity* than *commodity pure plays*

Master Limited Partnerships (MLPs)

- Listed limited partnership units
  - 90% income from specified source (e.g., energy)
- "Midstream" MLPs—process, transport, and store energy
- Tax characteristics:

	Corporate Tax on Income?	Individual Income Tax on Distributions?
Corporations	Yes	Yes
Investment companies	No	Yes
Limited partnerships*	No	No

* Partners taxed on net income as it is earned (not when distributed)

Master Limited Partnerships (MLPs)

- *Criticisms* of MLPs:
  - Unsustainably high distribution rates and high valuations
- Argument *for* high valuations of MLPs:
  - High valuations reflect superior future growth opportunities
- Argument *against* high valuations of MLPs:
  - High tax-free distributions rates are not sustainable

    → Early valuations not sustainable

Infrastructure

"Underlying assets and systems providing basic services, facilities, and institutions upon which a society depends"

Economic
transport, energy, communications

Social
education, health, courts, prisons

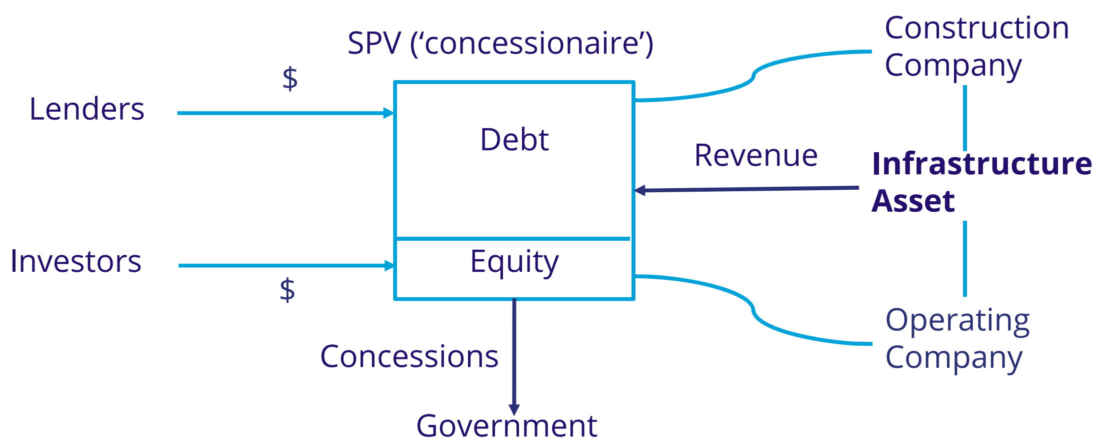
Seven elements:

1. Public use
2. Monopolistic nature
3. Government involvement
4. Essential product (inelastic demand)
5. Cash income stream
6. Conducive to privatization
7. Capital intensive

Infrastructure: Key Terms

Greenfield project	New, yet-to-be-constructed project (risky)
Brownfield project	Existing asset converted to private ownership
Privatization	Sale of infrastructure from government to private parties
Public-private partnership (PPP)	Private-sector party is involved in delivery of public infrastructure (often in exchange for a lease payment)

Public-Private Partnerships (PPP) Example



Governmental Influence

- Positive factors
  - Constrained fiscal budgets in the developed world
  - Economic growth outstripping government funds in developing world
- Potential negative factors
  - **Regulated pricing:** governments approve pricing of service
  - **Regulatory risk:** governments may block asset sales or revoke licenses granted to private operators
  - **Political risk:** expropriation of assets

Types of Infrastructure Investments

- **Indirect investment vehicles**
  - Listed stocks
  - Listed funds
  - Closed-end funds (like PE funds)
  - Unlisted (evergreen) open-end funds
- **Direct investment vehicles**
  - Require substantial capital and expertise
  - Increasing popularity

12 Attributes of Infrastructure

1. Inelastic demand
2. Monopolistic market position
3. Regulated entities:
   - Regulation target return mitigates downside risk
4. Capital intensive—low operating costs:
   - Strong operating margins, supports high leverage
5. Low volatility of operating cash flows
6. Resilience to economic downturns

12 Attributes of Infrastructure

7. Technology risk
8. Long-term horizons
9. Potential inflation-linked cash flows
10. Stable yield
11. Low correlation with other asset classes
12. Potentially low idiosyncratic risk

Infrastructure: Asset Allocation

- Similarities with other asset classes
  - **Fixed income:** high current yield, steady cash flows, long duration
  - **Real estate:** physical assets generating cash flows
  - **Private equity:** control, ability to add value through financial engineering or operating improvements

- Return expectations
  - **Mature projects:** 7–10% (similar to core real estate)
  - **Development projects:** >10% (similar to value-added real estate)

Intellectual Property (IP)

"An intangible asset that can be privately owned (*excludable*)"

- Types
  - **Wasting:** loses value over time (e.g., patents)
  - **Capital accumulation:** value growth over time (e.g., brands)
  - **Unbundled:** standalone from entity that created the IP

- IP risk premiums associated with variability in returns (higher for newly created IP), complexity of valuation, and liquidity

IP and Six Characteristics of Real Assets

1. **Low operating risk:** true for mature IP
2. **Positive correlation with inflation:** no clear evidence
   - Likely to be an inflation *diversifier*
3. **Preserve value in times of stress:** IP is low beta
4. **Benefit from scarcity of inputs:** unlikely ✕
5. **Essential part of economic infrastructure:** IP now considered significant part of U.S. GDP
6. **Long-term liability matching:** may be suitable

IP Discounted Cash Flow (DCF) Approach

$$V_{IP,0} = \frac{p \times CF_1}{r - g}$$

where:
p = probability of generating large positive cash flows
CF_1 = cash flow expected in Year 1
r = investor's required rate of return
g = growth rate (likely to be negative)

Example: IP DCF

The estimated probability of large positive cash flows for a horror film in production is 8%. Investors have a required return of 35%, and cash flows from a successful film release are expected to decline at an annual rate of 5%.

What is the value of the film's IP for each dollar of cash inflow that would be generated?

Solution: IP DCF

Normalizing with a value of $1 for CF_1 gives:

$$V_{IP,0} = \frac{0.08 \times \$1}{0.35 - (-0.05)} = \$0.20$$

Film Production and Distribution

- Revenue sources rapidly changing due to technology
- **Film production life cycle:**
  - **Acquiring rights to the story:** license books/screenplays
  - **Pre-production period:** script, set design, costume, casting
  - **Production of the film (principal photography):** pay actors, producers, directors, construct set
  - **Post-production period:** editing, scoring, special effects
- Costs of above referred to as *negative* costs

Costs and Financing of Film Production

Equity financing structures:

- Slate equity financing:
  - Investor funds a set of films from a studio
- Corporate equity
- Miscellaneous third-party financing:
  - Ad-hoc financing common for independent films
- Co-production:
  - Two or more studios share costs

Costs and Financing of Film Production

Debt financing structures:

- Senior secured debt—security provided by:
  - Negative pickup deal:
    - Distributor agrees payment up front
  - Foreign pre-sales:
    - Distribution rights sold pre-production
  - Tax credits/grants:
    - Incentives to film in particular locations
- Gap financing
- Super gap financing/junior debt

Art as an Investable Asset Class

- Evidence:
  - Median real returns approximately 2.2%
    - Based on *hammer prices*—commissions can be up to 15% to both buyer and seller
  - Annualized volatility of 17%
  - Poor risk-adjusted returns potentially explained by:
    - Investors aiming to *preserve* rather than increase wealth
    - High "aesthetic effect" of personal ownership

R&D and Patents

Five key entry/exit (monetization) strategies:

1. Acquisition and licensing
2. Enforcement and litigation
3. Sale license-back (SLB)
4. Lending strategies
5. Sales and pooling

Accessing R&D Through Patents

- **Acquisition and licensing:**
  - Built around royalty streams:
    - Key provisions: minimum royalty, field of use, reservation of rights, improvement, audit/reporting, exclusivity
- **Enforcement and litigation:**
  - Acquire patents being infringed upon, then enforce a licensing agreement
  - Litigation is a threat rather than a formality

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Accessing R&D Through Patents

- **Sale license-back (SLB):**
  - Patent holder sells and licenses back the patent
  - Allows the inventor to monetize patent
- **Patent lending strategies:**
  - Securitization or mezzanine lending secured by IP collateral
- **Patent sales and pooling:**
  - Patent buyer intends to license multiple patents to external users
  - Can set the standards for a new industry (e.g., MPEGs, DVDs)

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Risks to Investments in Patents

- **Illiquidity:** may be difficult to monetize a patent
- **Operational/technological risks:** cash flows depend on the successful use of a patented technology
- **Expiration:** life of a patent without extensions is 20 years
- **Macroeconomic risks:** macroeconomic factors may cause an industry to decline, influencing the ability to generate cash flows and decreasing the patent's value
- **Regulatory risks:** government could change how patents are granted and impose regulations on the use of patented technologies
- **Legal risks:** patent acquirers must understand legal implications of acquiring a patent to experience its full value

Select Keyword Review

Define these keywords and describe their role in the reading:

- **Double taxation**
- **Evergreen funds**
- **Downstream operations**
- **Upstream operations**

Select Keyword Review

- **Double taxation:** taxation of profits at the corporate income tax level and taxation of distributions at the individual income tax level
- **Evergreen funds:** unlisted open-end funds allowing investors to subscribe to or redeem from these funds on a regular basis
- **Downstream operations:** refining, distributing, and marketing oil and gas
- **Upstream operations:** exploration and production

Discussion Questions

1. True or false? Returns from the shares of oil equipment and services companies have an insignificant correlation with crude oil returns.
2. An investor values the rights to a new untested drug at $20 million. They estimate that the drug could generate revenues of $60 million next year if it wins FDA approval, but there is only a 6% chance of this happening. Due to competition, the investor estimates that cash flows will decay by 5% per year. What is the required return of the investor?

Discussion Questions Answers

1. False. The returns of shares in oil equipment and services companies have a relatively high correlation with crude oil returns. However, they have a higher correlation with U.S. equity prices. The correlation of crude and equities in general is lower, suggesting that the returns of oil firms are driven more by equity valuations than by oil prices.

Discussion Questions Answers

2. Using the formula for the value of IP:

$$V_{IP} = (p \times CF_1) / (r - g)$$

Rearranging this formula gives:

$$r = [(p \times CF_1) / V_{IP}] + g$$

Hence in this case:

$$r = [(0.06 \times \$60 \text{ million}) / \$20 \text{ million}] - 0.05$$
$$= 0.13 \text{ or } 13\%$$

Real Estate Assets and Debt

Need to Know Concepts

- Real estate characteristics:
  - 5 advantages, 3 disadvantages, 3 styles
- Mortgages: calculating a payment—fixed rate, interest only, variable rate
- Ratios: LTV, interest coverage, DSCR
- Mortgage-backed securities
  - RMBS, CMBS
  - **Calculating prepayment speeds: CPR and PSA speeds**
- REITs: types and advantages

Five Categories of Real Estate

1. **Equity** (owner) **versus debt** (mortgages)
2. **Domestic versus international**
   - International more diversifying, but more challenging.
3. **Residential** (owner occupied) **versus commercial**
   - Institutional investor focus on commercial
4. **Private** (non-exchange) **versus public** (exchange traded)
5. **Market size**
   - Primary, secondary, and tertiary.

Features of Real Estate

Five Potential **Advantages**

1. Absolute rather than relative returns
2. Hedge against unanticipated inflation
3. Diversification vs. stock and bond returns
4. Cash inflows
5. Income tax advantages

Three **Disadvantages**

1. Heterogeneity
2. Lumpiness
3. Illiquidity

NCREIF Real Estate Styles

Safe ⟷ Risky

Core	Value-Added	Opportunistic
Return: mainly income	Income and price growth	Price growth
Low volatility	Moderate volatility	High volatility
Developed and leased	Less well developed and new unleased buildings	Substantial development
Similar to a bond		Similar to equity

Using Attributes to Classify Real Estate

	Core	Value-Added	Opportunistic
Property type	Major types: apartments, retail, industrial, and office	Major types, plus hospitality, senior housing, specialty retail, storage, and low-income housing	Raw land or speculative
Occupancy	High	Moderate	Low
Life-cycle phase	Fully operational	Operational, perhaps not fully leased	New construction or raw land development
Use of leverage	Low (~20%)	Moderate (up to 40%)	High

Using Attributes to Classify Real Estate

	Core	Value-Added	Opportunistic
Recognition in the marketplace	Well recognized	Emerging markets that are becoming recognized	Secondary, tertiary, and international markets
Near-term rollover	Low	Moderate	High
Control level	Direct control	Moderate control	Minimal control

Three Purposes of Style Analysis

1. **Performance measurement**
   - Benchmarks, risk and return objectives, and performance attribution better understood
2. **Monitoring style drift**
3. **Style diversification**
   - Understanding and controlling risk

Using Style Boxes

50%	15%	5%	Primary
10%	5%	0%	Secondary
10%	5%	0%	Tertiary
Core	Value-added	Opportunistic	

Example: Fixed-Rate Mortgage

A borrower takes out a $150,000, 25-year mortgage at a 2% fixed annual interest rate.

- **Calculate** the monthly payment required if the mortgage is fully amortizing.
- **Calculate** the interest and principal split of the 1st payment.
- **Calculate** the interest and principal split of the 201st payment.

Solution: Fixed-Rate Mortgage

Monthly payment:

2^{nd} FV

(25 × 12) = 300 N

2 / 12 = 0.1667 I/Y

150,000 PV

CPT PMT = –635.78

Solution: Fixed-Rate Mortgage

Interest and principal split of the 1st payment: Use the AMORT function

2nd PV

P1 = 1 ENTER ↓

P2 = 1 ENTER

Use the down ↓ key to see that principal (PRN) = 385.78 and interest (INT) = 250

Solution: Fixed-Rate Mortgage

Interest and principal split of the 201st payment:

2nd PV

P1 = 201 ENTER ↓

P2 = 201 ENTER

Use the down ↓ key to see that principal (PRN) = 538.25 and interest (INT) = 97.53

Example: Interest-Only Mortgage

A borrower takes out a $150,000, 10/15 interest-only mortgage at a 2% annual interest rate.

- **Calculate** the required 1st monthly payment.
- **Calculate** the interest and principal split of the 1st payment.
- **Calculate** the required 201st payment.
- **Calculate** the interest and principal split of the 201st payment.

Solution: Interest-Only Mortgage

- **1st monthly payment:**
  $150,000 × (0.02 / 12) = $250

- **Interest and principal split of the 1st payment:**
  Interest: $250
  Principal: $0

Solution: Interest-Only Mortgage

- **Size of the 201st payment:**
  After 10 years of interest payments, loan will amortize over 15 years
  (15 × 12) = 180 N
  2 / 12 = 0.1667 I/Y
  150,000 PV
  CPT PMT = –965.26

- **Interest and principal split of the 201st payment:**
  This will be the 81st payment of the amortization period:
  2nd PV
  P1 = 81 ENTER ↓
  P2 = 81 ENTER
  Use the ↓ key to see principal (PRN) = 817.19 and interest (INT) = 148.07

Example: Variable-Rate Mortgage

A borrower takes out a $150,000 ARM for 25 years at a rate of 2% over LIBOR.

- **Calculate** the 1st monthly payment required if LIBOR is 0.75%.
- **Calculate** the 13th monthly payment required if LIBOR moves to 2%.

Solution: Variable-Rate Mortgage

1st monthly payment:

(25 × 12) = 300 N

2.75 / 12 = 0.2292 I/Y

150,000 PV

CPT PMT = –691.97

Solution: Variable-Rate Mortgage

13th monthly payment:

Need to calculate the balance at the end of the first year

2nd PV

P1 = 12 ENTER ↓

P2 = 12 ENTER

Use the down ↓ key to see that end balance (BAL) = 145,768.33

Solution: Variable-Rate Mortgage

This is the PV for the start of second year at rate of 2% + 2% = 4%

(24 × 12) = 288 N

4 / 12 = 0.3333 I/Y

145,768 PV

CPT PMT = –788.15

Alternative Mortgage Structures

- **Graduated payment mortgages:**
  - Low early payments, larger later payments
- **Option adjustable-rate mortgage loans** (option ARMs):
  - Payment flexibility in early years
- **Balloon payment loans:**
  - Require a large final payment (i.e., a balloon payment) to pay off the loan

Default Risk for Residential Mortgages

- Historically, interest rate risks and prepayment risks were the focus of mortgage investors.
- The financial crisis made clear that **default risk** is also important in the subprime sector. Considerations include:
  - Debt-to-income ratio
  - Loan-to-value ratio
  - Credit score

Commercial Mortgages

- Commercial/financial borrowers
- **Default risk** more of a concern than for residential mortgages due to lack of government insurance
- Properties generate **rental cash flows**
- Partially amortized mortgages **(balloon payment)**
- Numerous **covenants**
- **Cross-collateral provisions**—pooling of risks
- For short-term development projects or long-term investment in developed properties

Financial Ratios for Commercial Mortgages

$$\text{loan-to-value (LTV) ratio} = \frac{\text{balance of the loan}}{\text{market value of the property}}$$

$$\text{interest coverage ratio} = \frac{\text{NOI}}{\text{annual interest payment}}$$

$$\text{debt service coverage ratio (DSCR)} = \frac{\text{NOI}}{\text{total loan payment (interest + principal)}}$$

$$\text{fixed charges ratio} = \frac{\text{NOI}}{\text{all fixed payments}}$$

Mortgage-Backed Securities

- **Mortgage-backed security** (MBS)
  - Security that is secured by a pool of mortgages
  - *Pass-through MBSs* and *collateralized mortgage obligations* (CMOs) are common types
- **Residential MBS** (RMBS)
  - Credit risk: **not** a major concern for agency securities since backed by the U.S. government
  - **Prepayment risk:** borrower's right to repay mortgage early is a key risk since it affects size and timings of returns (like a short call option)

Prepayment Risk

***Lower* interest rates** → *Higher* prepayment speeds due to:

- Higher refinancing activity
- Higher turnover (moving house)
- Less opportunity cost of paying down mortgage

Reinvestment risk

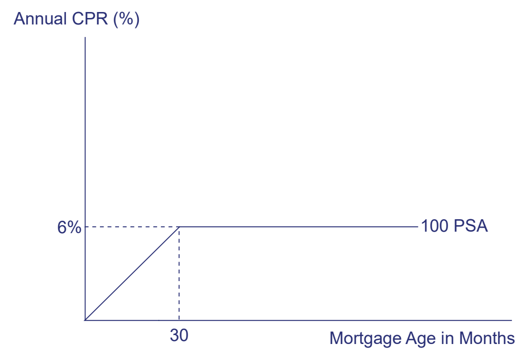
Path dependent: may not lead to higher prepayments if rates already fell in past *(refinancing burnout)*

Other factors leading to higher prepayments:

- Increased economic activity
- Characteristics of the underlying loans (geography, maturity)

Estimating Prepayment Speeds

- **Public Securities Association (PSA) benchmark**:
  - Annual prepayment speed = conditional prepayment rate (CPR)
- Standard "100 PSA" (= 100% of PSA):
  - Assumes CPR = 0.2% for first month
  - Increasing by 0.2%/month up to month 30
  - 6% thereafter
- 200 PSA = 2 × (CPR of 100 PSA), etc.



Example: Prepayment Speeds

- **Compute** the CPR for the 12th month of a mortgage pool estimated to have a prepayment speed of 150% PSA.

Solution: Prepayment Speeds

CPR for the 12th month:

CPR for 100% PSA = 12 × 0.2% = 2.4%

CPR for 150% PSA = 2.4% × 1.5 = 3.6%

CMOs and Default Risk

Models focus on forecasting the cash flow streams from underlying mortgage pools.

- *Agency RMBS:* primary risks are prepayment risk and interest rate risks. Credit risk not a primary risk since insured by the government.
- *CMBS and subprime mortgage products, especially junior tranches of each:* focus is primarily on credit risks, default correlation, and expected default rates.

REITs

- **Real estate investment trusts (REITs):** exchange-traded corporations that invest in real estate assets
  1. **Equity REITs.** Owns equity of underlying properties
  2. **Mortgage REITs.** Invests in loans used to finance property purchases
  3. **Hybrid REITs.** Combines equity and mortgage investments

Advantages of REITs

- No corporate taxation on income distributed as dividends
  - Restrictions:
    - 75% of income must be derived from real estate
    - 90% of income must be paid out as dividend
    - Restrictions on concentrated holdings by investors

Advantages of REITs

- Liquidity
- Professional management
- Steady income
- Corporate governance
- Asset allocation advantages

Mortgage REIT Returns

Asset Class	Average Return	Standard Deviation	Sharpe Ratio	Skew	Excess Kurtosis
Mortgage REITs	10.6%	22.8%	0.4	–2.8	20.0
World equities	4.3%	15.5%	0.1	–0.6	1.5

Period: Jan. 2000–Dec. 2020

Select Keyword Review

Define these keywords and describe their role in the reading:

- **Idiosyncratic prepayment factors**
- **Interest rate cap**
- **Recourse**
- **Margin rate**
- **PSA benchmark**

Select Keyword Review

- **Idiosyncratic prepayment factors:** drive prepayment speeds; related to the specific mortgage characteristics
- **Interest rate cap:** limit on how high interest payments can go in a floating coupon instrument
- **Recourse:** ability of lender to pursue recovery of defaulted loan through taking possession of borrower's assets outside those used to secure the loan
- **Margin rate:** spread by which mortgage rate is set relative to index rate
- **PSA benchmark:** benchmark for prepayment speeds used in pricing mortgage-backed securities

Discussion Questions

1. Explain the concept of refinancing burnout and why it is important in valuing RMBSs.

2. An investor finances a $1.5 million property with LTV of 0.6 using a 30-year, fixed-rate, fully amortizing 5% mortgage. By how much will monthly payments fall if the investor agrees to a balloon payment of $500,000?

Discussion Questions Answers

1. Refinancing burnout occurs when a fall in rates does not lead to a rise in prepayment speeds as might be expected. This is because the path that interest rates have taken has given borrowers the opportunity to refinance in the past. It is important in valuing RMBSs because prepayments affect the timing and size of expected cash flows from the asset.

2. *No balloon:* 360 N, 0.4167 I/Y, 900,000 PV, CPT PMT = –4,831
   With balloon: 360 N, 0.4167 I/Y, 900,000 PV, –$500,000 FV,
   CPT PMT = –4,231
   Balloon payment reduces monthly payments by:
   $4,831 – $4,231= $600

Real Estate Equity

Development as a Series of Real Call Options

- Stages of a potential real estate development project
  - **Option 1: Feasibility study**—Assess potential profitability of planned development project
  - **Option 2: Purchase land**—Following favorable feasibility study, purchase suitable vacant land
  - **Option 3: Construction**—Construct building(s) following the purchase of land

Need to Know Concepts

- Valuing development projects as **series of options** (calculation)
- Real estate valuation methods:
    - Comparable sales, profit, cost, cap rate, transaction based
        - Income approach to valuation: calculating NOI and discount rate
- Alternative investment vehicles: pros and cons
- NCREIF NPI features
- Impact of smoothed returns

Example: Decision Tree Analysis

Consider the decision of whether to build an apartment block in a part of town that may benefit from a potential new rail station.

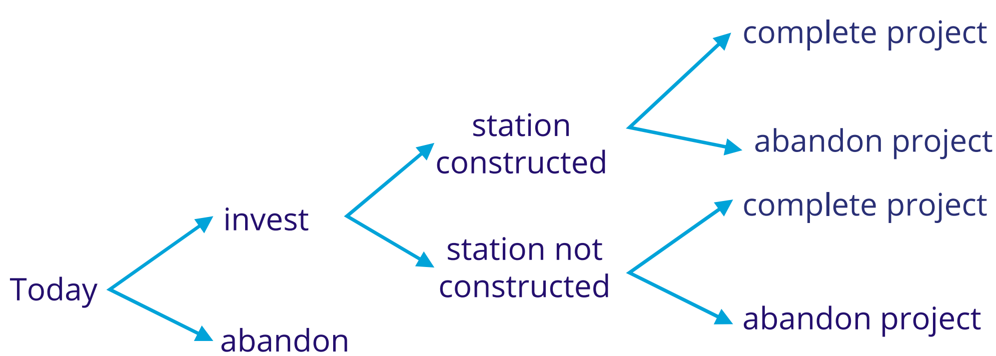
- Governmental decision on rail station occurs in one year.
- If rail station construction occurs, apartment block will be needed two years later (three years from today).
- Apartment block will take three years to develop (must start today).

Example: Decision Tree Analysis

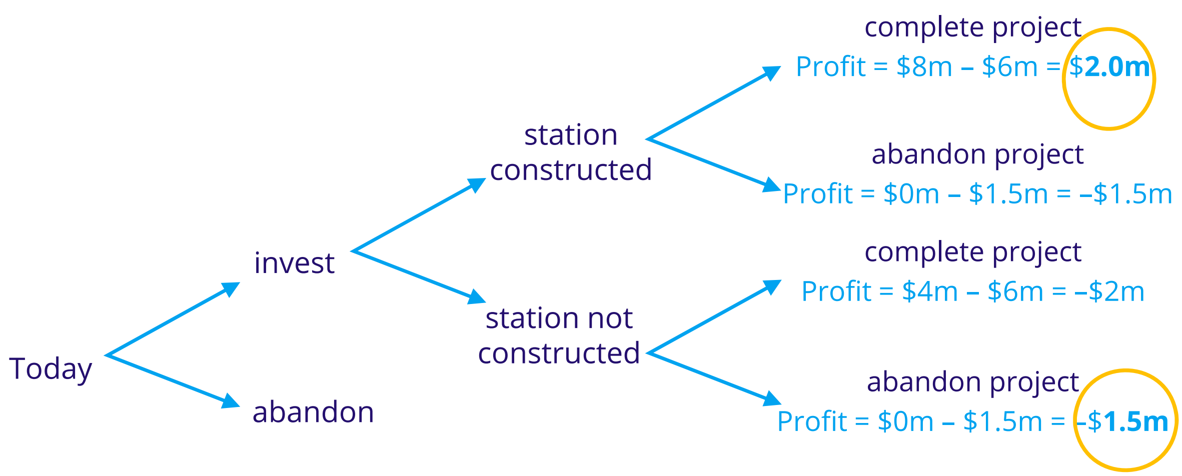
Time	Costs	Amount ($ million)
Year 1	Purchase land, permits, planning costs	1.5
Year 2	Build exterior	2.5
Year 3	Build interior and fittings	2.0
	Total	6.0

- Assume the above costs for apartment block
- Estimated probability rail construction goes ahead: 50%
- If rail construction occurs, the value of apartment block will be $8 million. If no construction, apartment value will be $4 million. Assume risk-free rates are zero.
- What is the value of the project today?

Solution: Decision Tree Analysis



Solution: Decision Tree Analysis



Value of project today = (0.5 × $2.0 million) + (0.5 × –$1.5 million) = $0.25

Real Estate Valuation Approaches

- **Comparable sales approach:** uses data regarding recent transactions in similar properties
  - Useful for non-income-producing properties
  - All properties are unique, hence judgement-based adjustments will be required
- **Profit approach:** value is driven by the *business use* of the premises
- **Cost approach:** value driven by cost to replace the property (including the value of the land)
- **Cap rate and perpetuity valuation:** $Cap\ Rate = \ NOI/Value$
  - Seen in the reading *Natural Resources and Land*

Real Estate Valuation Approaches

- **Transaction-based methods:** repeat sales and hedonic pricing
  - Advantages vs. appraisal-based methods:
    - Objective, not based on opinion
    - More current (not stale)
    - Does not understate volatility
    - Does not require data from comparable properties
  - Disadvantages vs. appraisal-based methods:
    - Small sample sizes of transactions
    - Properties can be appraised more frequently than the frequency with which transactions occur

Discounted Cash Flow Approach

- Also known as the **income approach**
- Property value = present value of expected cash flows

$$V_0 = \frac{NOI_1}{(1+r)^1} + \frac{NOI_2}{(1+r)^2} + \ldots + \frac{NOI_n}{(1+r)^n} + \frac{NSP}{(1+r)^n}$$

where:
NOI = net operating income (rent minus expenses)
NSP = net selling proceeds of property
r = required return on investment

Discounted Cash Flow Approach

Potential gross income	X
(Vacancy loss rate)	(X)
Effective gross income	X
(Operating expenses)	(X)
Net operating income	X

r = risk-free rate + liquidity premium + risk premium

Example: DCF Approach

Current potential gross income	$400,000
Growth in potential gross income	4%
Vacancy losses	10% of PGI
Property tax plus insurance	$56,000
Investment horizon	3 years
Net selling price	$5 million
3-year risk-free rate (annualised)	0.75%
Liquidity risk premium	1.00%
Project risk premium	3.20%

Variable operating costs will be 25% of EGI in the first year.
In subsequent years, total operating costs will move in line with EGI.
If the property has an asking price of $4.8 million, what investment decision should be made?

Solution: DCF Approach

	Year 1	Year 2	Year 3
Potential gross income	416,000	432,640	449,946
Vacancy losses	41,600	43,264	44,995
Effective gross income	374,400	389,376	404,951
Total operating costs	149,600	155,584	161,807
NOI	224,800	233,792	243,144

Discount rate = 0.75% + 1.00% + 3.20% = 4.95%
PV of NOI = $(224,800/1.0495) + (233,792/1.0495^2)$
$+ ((243,144 + 5,000,000)/1.0495^3)$ = \$4,962,157

- Buy the property

NCREIF National Property Index (NPI)

- Value-weighted, quarterly, unleveraged, pre-tax, appraisal-based U.S. property index
- Started Q4 1977, now has 7,500 properties (retail, industrial, multi-family, office, hotels) worth about $600bn
- Total return = income return + capital gain
  - Income = NOI/opening appraised value
  - Capital gain = change in value/opening appraised value

Alternative Real Estate Investment Vehicles

- Types of **private equity** real estate funds (PERE) often structured as *limited partnerships:*
    - *Commingled real estate funds (CREFs):* negotiable (i.e., tradable) units in pooled fund for large financial institutions
    - Syndications: initiated by developers for specific project
    - Joint ventures: small number of investors forming real estate business enterprise
- General features of limited partnerships:
    - Similar to private equity funds: long term, illiquid, ability to use *gearing*, provide diversification across properties, and manager expertise

Alternative Real Estate Investment Vehicles

- Types of **public** real estate funds:
- Real estate mutual funds:
    - Open ended: daily liquidity at NAV (subject to restrictions). Stale pricing issues? Liquidity disruption/mismatch?
    - Closed ended: exchange-traded fund with fixed amount shares outstanding, no liquidity disruptions, able to use leverage, and premiums/discounts to NAV?
- Options and futures on real estate indices: basis risk?
- Exchange-traded funds (ETFs): low cost, tax efficient, liquid, pay dividends, and ability to short sell
- Equity REITs

Equity REIT Performance

Asset Class	Average Return	Standard Deviation	Sharpe Ratio	Skew	Kurtosis
Equity REITs	10.6%	22.8%	0.35	–2.8	20.0
World equities	4.5%	15.0%	0.1	–0.7	1.6

Period: Jan. 2000–Dec. 2020

Select Keyword Review

Define these keywords and describe their role in the reading:

- **Backward induction**
- **Depreciation**
- **Effective gross income**
- **Equity residual approach**
- **Information node**
- **Net lease**

Select Keyword Review

- **Backward induction:** process of evaluating option's intrinsic value at expiry then discounting to today to get present value
- **Depreciation tax shield:** lowering of taxes due to charging depreciation against income
- **Effective gross income:** potential gross income less vacancy costs
- **Equity residual approach:** post-financing property valuation which incorporates financing outflows and mortgage balance
- **Information node:** point in binomial tree where information is received which will affect decision to exercise option
- **Net lease:** lease where tenant is responsible for expenses, lowering size of the required rental payment

Discussion Questions

1. A property yields $160 per year in taxable income and an additional final cash flow of $10,000 in five years. The current price of this investment is $9,000. Any capital gain on this investment is taxable. **Calculate** the pre-tax and post-tax yields to maturity of this investment for an investor in the 30% tax bracket.

Discussion Questions

2. A core real estate property has NOI of $450,000 per year, and cap rates on similar properties are 6%. What is the estimated value of the property?
3. NCREIF only publishes data on appraisal-based indices. True or false?

Discussion Questions Answers

1. Pre-tax yield
   5 N
   −9,000 PV
   160 PMT
   10,000 FV
   CPT I/Y = 3.84%

   Post-tax yield
   5 N
   −9,000 PV
   160×0.7 = 112 PMT
   10,000 – 0.3(1,000) = 9,700 FV
   CPT I/Y = 2.72%

Discussion Questions Answers

2. Value = NOI/Cap rate = \$450,000/0.06 = \$7.5m

3. False. NCREIF publishes many different indices both on a speciality level (e.g. farmland and timberland) and on a regional level. Most of these indices are appraisal based (as is the flagship NPI), however there does exist NCREIF TBI (transactions-based index) calculated using a hedonic pricing model on NPI transaction data.

Private Securities

Overview

- **Private Securities**
  - Private Equity Assets
  - Private Equity Funds
  - Private Equity Fund of Funds
  - Evolution of Investing in Private Equity
  - Private Credit and Distressed Debt

Private Equity Assets

Need to Know Concepts

- Features of the three main types of private equity
- Five stages of VC financing
- VC and growth equity valuation (calculations)
  - VC EV/EBITDA multiples
  - Growth Equity EV/Revenue multiples
- Five categories of buyout opportunities
- LBO return on investment (calculation)
- Six exit strategies for a buyout

Pre-IPO Private Equity Investing

	Venture Capital	Growth Equity	Buyouts
Company type/size	New, $10m+	Established, $100m+	Established, $100m+
Revenue	Up to $10m	$25m+	$25m+
Control	Minority team approach	Minority	Full
Use of capital	Establish business	Expand business	Earnings growth
Time horizon	5–10 yrs	3–7 yrs	3–5 yrs
Potential upside	5–20x	3–8x	2–5x
Target IRR	30%–60%	25%–40%	20%–35%
Risk	Very high	Moderate/high	Moderate

Venture Capital: Overview

VC Fund Investors

$

New Company

$

convertible preferred stock/debt

High ***cash burn rate***

VC Manager

- Active investor (director)
  - Hires/fires
  - Advises on ***business plan***
- Introduces start-up to
  - Consultants, accountants, lawyers, and bankers
  - Potential customers
- Develops ***exit plan***
  - Strategic buyer/IPO

Stages of VC Financing

- **Angel investing:** friends, family, and fools; idea development (alpha testing)
- **Seed capital:** business plan and prototype (beta testing)
- **First/start up/early stage:** revenues generated
- **Second (and later) stage:** high sales growth; break-even point and commercial viability
- **Mezzanine stage:** prior to exit (strategic buyer/IPO); proven winner

- Each stage provides option to invest in next stage subject to *milestones* **(compound options)**

VC Valuation

VC valuation typically uses two key inputs for the target company

EBITDA
- Earnings before interest, tax, depreciation, and amortization
- Proxy for before-tax cash flow of the company

Enterprise Value (EV)
- Total value of operating assets
- EV = equity value + debt value – cash on balance sheet

VC Valuation

Typical VC valuation process:

1. Forecast firm EBITDA on exit at time T
2. Forecast fair EV/EBITDA multiple on exit at time T
3. Use required IRR to discount future value back to today:

$$\textbf{Value of Venture} = \frac{\boldsymbol{EBITDA \times EV/EBITDA\ multiple}}{\boldsymbol{(1 + IRR)^T}}$$

VC Valuation

A VC manager expects a new company, if successful, to have EBITDA of $30m in six years. On exit, the manager assumes an EBITDA multiple of 6.5, and requires a 40% return from the investment.

Calculate the value of a 35% stake in the company.

Solution:

$$\textbf{Total Value} = \frac{\boldsymbol{Forecast\ EBITDA_T \times EBITDA\ multiple}}{\boldsymbol{(1+IRR)^T}} = \frac{\boldsymbol{\$30m \times 6.5}}{\boldsymbol{(1.4)^6}} = \boldsymbol{\$25.90m}$$

Value of 35% stake = 0.35 × $25.90m = $9.065m

VC Valuation

- VC discount rates: 50%–70% for early stage, 30%–60% for later stage ventures
- Reasons for high discount rates:
  - Illiquidity (less chance of exit for earlier stage ventures)
  - VCs need to provide more advice/time to earlier stage ventures
  - Adjustment to founder's overconfidence bias in results

Pre- and Post-Money Valuation

post-money valuation = pre-money valuation + investment

ownership stake of VC = investment/post-money valuation

Growth Equity

- Exact demarcation with VC is not well defined, but company is *later stage*
- *Protective provisions* in investment agreements allow PE investor to veto key strategic and business decisions of the company
- Valuation metrics similar to VC, but based on revenue rather than EBITDA:

$$\textbf{Value of Venture} = \frac{\boldsymbol{Forecast\ Revenue_T \times EV/Revenue\ multiple}}{\boldsymbol{(1 + IRR)^T}}$$

Growth Equity

Redemption rights grant investors power to redeem

Triggers
- Time
- Performance
- Breach of covenant

Sources of Funds
- Legally available funds
- Forced sales
- Promissory notes

Value
- Original capital + preferred return
- Multiple of original capital
- Fair value

Default remedies
- *Springing board* – investor designates majority of board
- Forced sales

Types of Buyouts

- Leveraged buyout (LBO)
  - Takes control with using substantial leverage
- Management buyout (MBO)
  - LBO conducted by current management team
- Management buy-in (MBI)
  - LBO conducted by outside management team

Types of Buyouts

- Buy-in management buyout
  - Hybrid of MBO and MBI
- Secondary buyout (SBO) (replacement capital)
  - PE firm 1 sells private company to PE firm 2
- Rescue capital (turnaround)
  - Companies in financial difficulty

Buyouts

Returns → Capital structure optimization

Returns → Operational efficiency optimization

- Three key economic and agency issues:
  - Are markets still *segmented* and *informationally inefficient*?
  - Are MBOs a breach of *fiduciary duty* to shareholders?
  - *Perverse incentives* for MBI? (e.g., golden parachutes?)

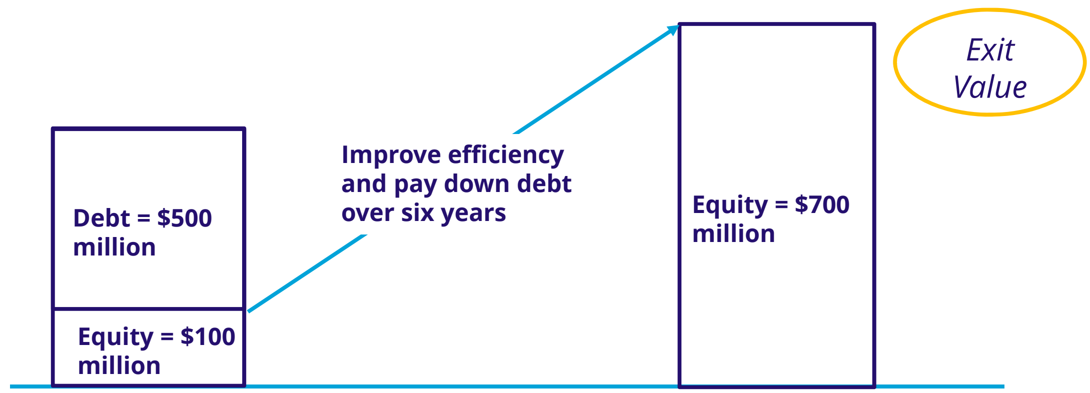
LBO Categories

Efficiency buyouts	Diverse shareholder group is replaced by LBO firm
Entrepreneurship stimulators	Freeing management to concentrate on innovations
Conglomerates	Dismantling overstuffed corporations
Buy-and-build strategies	Strategic alignment and value creation through synergies
Turnaround strategies	Underperforming firms

LBO Benefits to Target Companies

- Tax shield on interest payments
- Less scrutiny from public markets and regulators
- Freedom from a corporate parent allowing focus
- Alignment of management and shareholder incentives

Stylized LBO



Return to LBO fund = $(700/100)^{(1/6)} - 1 = 38.3\%$

Stylized LBO

- Exit value for LBO deal estimated as:

$$\text{Value} = \frac{\text{EBITDA}}{r - g}$$

where:

EBITDA = Earnings Before Interest, Tax, Depreciation, and Amortization (after efficiency increases)

r = discount rate

g = growth in EBITDA

Example: Detailed Stylized LBO

Company PFC, pre-LBO deal:

- Market value of equity is $600 million; outstanding debt of $200 million
- EBITDA of $90 million per year
- Annual return on total capital of 11.25% [= 90 / (600 + 200)]

LBO deal:

- Deal size: $1 billion
  - Finance: $300 million equity, $700 million 10% coupon debt
- Outstanding debt paid face value of $200 million
- Original shareholders receive $800 million (premium of 33%)

Example: Detailed Stylized LBO

Subsequent to the LBO:

- EBITDA increases from $90 million to $150 million per year
- Free cash flow used to pay down the debt in seven years
- From year 8 onwards, EBITDA is expected to grow at 5%

Compute the return to the LBO fund if the discount rate is:

1. 12%
2. 8%
3. 12% and the investment duration is nine years

Solution: Detailed Stylized LBO

1. Exit value = $150 million / (0.12 – 0.05) = $2.14 billion
   Compound annual return
   = ($2.14 billion / $300 million)$^{1/7}$ – 1 = **32.4%**

2. Exit value = $150 million / (0.08 – 0.05) = $5 billion
   Compound annual return
   = ($5 billion / $300 million)$^{1/7}$ – 1 = **49.5%**

3. Compound annual return
   = ($2.14 billion / $300 million)$^{1/9}$ – 1 = **24.4%**

→ The substantial differences illustrate the importance of accurate forecasting.

PE Exit Strategies

Strategy	Description	Notes
Strategic merger	Sell to corporate competitor	Most common exit for VCs and buyouts over recent years
Buyout-to-buyout deal	Sell to another buyout firm (secondary buyout)	Increasing recently for buyouts
IPO	Public listing using underwriter bank	Most common exit for VC and buyouts in 1990s

PE Exit Strategies

Strategy	Description	Notes
Direct listing	Public listing without using underwriter	
Another LBO (leveraged recapitalization)	Debt reintroduced by current owners	
SPAC	Sell to a listed special purpose acquisition company (SPAC)	

PE Exit Strategies

IPO

- Activity down 60% since 2002 due to increased regulation (Sarbox)
- Median time to IPO for VC has been increasing
- Dependent on market conditions
- Prospectus and road show required
- Projections of financial performance prohibited
- Lockup periods of 90 to 180 days for existing shareholders

Direct Listing

- Existing private shares are introduced to a public exchange
- Cheaper and faster than IPO
- Usually no lockup period
- Historically lacked ability to raise new equity (this changed in the U.S. in Dec. 2020)
- Lack of underwriter => need high-profile name (e.g., Spotify)

SPAC Timeline

2 years to find private company to acquire

<u>SPAC IPO</u>
Sponsor arranges public listing of SPAC shares

<u>De-SPAC transaction</u>
Private company **merges** with SPAC & assumes public listing (requires SPAC shareholder approval)

SPACs vs. IPOs

- SPAC sponsor *is* allowed to make financial projections for de-SPAC merger
- SPAC has no financials or operating history to report at IPO => easy listing
- No private company details need to be registered at IPO of SPAC => faster than IPO of underlying private company

Typical SPAC Deal

SPAC IPO "unit" issued for $10

Common shares

Dilutive!

Warrants: Right to subscribe to extra shares at $11.50 for 5-years after business combination. Mandatory conversion if shares trade above $18 for more than 30 days.

- SPAC shareholders receive $10 back if no private company identified
- SPAC shareholders can redeem shares in SPAC even if merger is approved and hold on to warrants
  => Downside risk limited, upside exposure remains
- Including dilution, median cost/proceeds ≈ 50%

Private Equity: History/Current Markets

- 1979 change in the U.S. Prudent Person Standard opened up PE to pension funds
- Growth in *junk bond* market in 1980s fueled financing for LBO market
- VCs taking longer to exit post financial crisis
- Number of public listed firms in United States has been decreasing
  - Concerns over increasing regulation
  - Pressure for short-term performance from public shareholders
  - Decline in number of IPOs per year by about 2/3 since 2000

Select Keyword Review

Define these keywords and describe their role in the reading:

- **20-bagger**
- **Merchant banking**
- **Unicorns**
- **Winner-takes-all market**

Select Keyword Review

- **20-bagger:** a VC investment that increases in value by 20 times or more
- **Merchant banking:** buyouts performed by financial institutions on non-financial companies
- **Unicorns:** successful VC investments which reach a private market capitalisation of $1bn or more in a short space of time
- **Winner-takes-all market:** a market that generates large returns for few participants (like a successful VC investment)

Discussion Questions

1. An increase in the required returns of the buyer in an LBO exit will increase the returns to the LBO fund on the deal. True or false?
2. A buy-and-build LBO investment strategy is similar to a conglomerate LBO strategy. True or false?
3. True or False:
   a) Promote paid to the sponsor of a SPAC decreases the cost of issuance to the private company
   b) Sponsors with operational experience in the business sector of the target private company run SPACs that outperform SPACs sponsored by generalist investment managers

Discussion Questions Answers

1. **False.** The required return of the buyer in an LBO exit is the discount rate applied in the exit valuation. As this increases, the exit valuation will decrease.
2. **False.** These two LBO transaction types utilize distinct value creation methods. Buy and build combines PE investments to earn synergies, while conglomerate deals aim to break up inefficient conglomerates to release value.
3. **a) False.** Shares/warrants granted to the sponsor as promote increase dilution to existing shareholders and increases the cost of issuance to the private company.

   b) True.

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Private Equity Funds

Need to Know Concepts

- Five primary functions of PE funds
- Four forms of PE intermediation
- Five stages of the VC fund J-curve
- Four significant PE risks
- Three stages of the LP/GP relationship
- SLOCs (calculation)
- Business Development Companies (BDCs) (return calculation)
- Private Investments in Public Equity (PIPEs)
  - Toxic structured PIPEs

PE Funds as Financial Intermediaries

Advantages of PE fund intermediation:

- Provide funds when banks will not
- Limited partnership structure provides limited liability
- Fee structure aligns interests of management and investors

PE Funds as Financial Intermediaries

Five primary functions of PE funds:

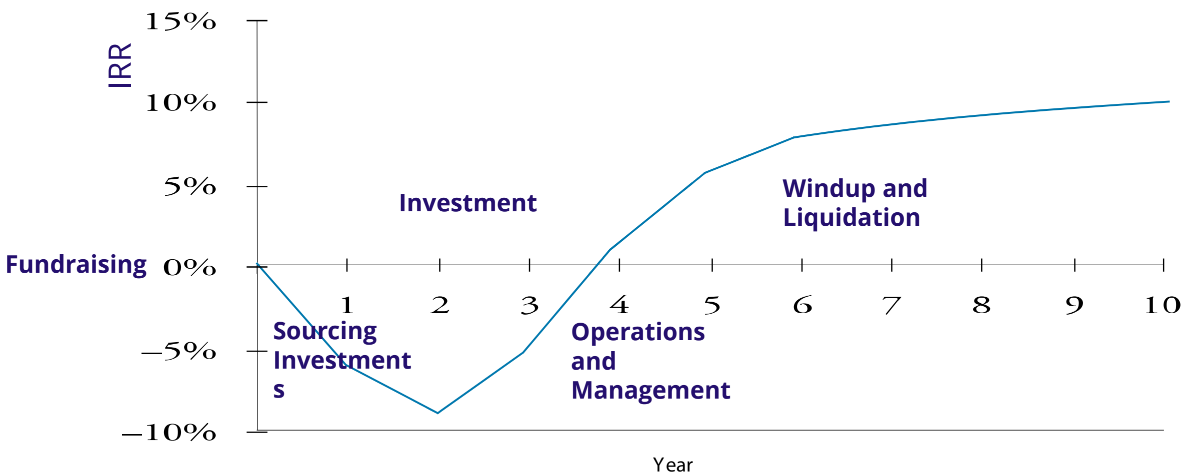
- *Pooling* of investor capital
- Investment due diligence *(expertise)*
- Provide *finance* to private companies
- Controlling/coaching and *monitoring* portfolio companies
- Sourcing *exit* opportunities

Forms of PE Fund Intermediation

PE (LP) investment programs:

- **Direct investment:** investing in private companies directly
- **PE fund:** investing in limited partnerships (funds)
- **PE fund with *co-investment*:** hybrid of methods 1 and 2
- **Fund-of-funds:** investing in limited partnership, which buys other limited partnership units

PE Fund J-Curve



Four Significant PE Risks

Risk	Description	Mitigation
Market risk	Changes in valuation causing unrealised losses	Diversification across funds
Liquidity risk	Inability to sell fund units without conceding significant discounts	Plan to hold funds to maturity
Commitment or funding risk	Unpredictable timing and size of drawdowns and distributions	Commitment management
Realization risk	Not recovering the value of invested capital	Diversification across funds

LP/GP Relationship

Benefits of establishing a close relationship:

- *General partners:*
  - Long-term relationships with LPs who are knowledgeable, financially secure, and dependable
  - More efficient planning with reliable funding
- *Limited partners:*
  - Lower-cost search process for successful GPs
  - Co-investment opportunities
  - Access to follow-on funds of successful GPs

LP/GP Relationship Phases

	Entry and Establish Phase	Build and Harvest Phase	Decline or Exit Phase
Characteristics	Differentiation of fund; fundraising is difficult	"Star" brand established; loyal limited partners	Unexciting; limited partners leave and are replaced
Manager Performance	Unknown	Top-quartile performer	No longer top performer
Fund Size	Too small	Appropriate	Too large
Relationship	Management team is still forming	Interests are aligned	Spinout or "made-it"

Subscription Lines of Credit, SLOCs

- GP uses borrowed funds to delay capital calls from LPs
- Boosts periodic IRR, *lowers return multiple and total profit*

Example:
A buyout fund calls $1,000 from LPs in Year 1.
In Year 4, the fund distributes $100 back to LPs
In Year 5 the fund liquidates and returns $1,500 to investors

How are IRR and total profit affected by the use of a SLOC delaying drawdowns to year 3?
Assume simple annual interest cost of SLOC = 2.5%.

Subscription Lines of Credit, SLOCs

Solution:
LP cash flows *without* the use of the SLOC:

Year	1	2	3	4	5
LP Cash Flow	–1,000	0	0	100	1,500

IRR: 12.7%, Total Profit = 600

LP cash flows *with* the use of the SLOC:

Year	1	2	3	4	5
LP Cash Flow	0	0	–1,050	100	1,500

IRR: 24.4%, Total Profit = 550

GP borrows 1,000 under SLOC to make investment for first two years

Drawdown in year 3 repays SLOC & interest of 1,000 × 2.5% × 2 = 50

Limited Partnership Key Features

Distribution waterfall (seen in *Quantitative Foundations*)

- Distribution of realizations/exits to LP/GP (assume 80/20 profit split)
  - LPs are returned invested capital plus **preferred return** (set by **hurdle rate**)
  - GPs receive **carried interest** on profits in excess of hurdle
    - Potential soft hurdle *catch-up* => GP receives all or major share of profits until they gets back to 20% of ***total*** profits
    - Profits in excess of catch-up split 80/20

Limited Partnership Key Features

- **General partner contribution:**
  - *Hurt money*
  - Lowers tendency for GP to take excessive risks to earn carried interest
- **Perverse** incentives:
  - Excessive risk taking when hurdles are too high
  - Realization of early high returns to bank carried interest, when more modest returns over longer time frame would have generated a bigger increase in capital
- **Clawback** GPs must return early carried interest to LPs if subsequent performance is poor

Limited Partnership Key Features

Monitoring provisions:

- **Key person provision.** LPs suspend contributions/terminate fund if key manager leaves and is not properly replaced.
- **Termination and divorce clauses.** Underperforming GPs are replaced through the following:
  - For-cause removal **(bad-leaver clause)**
    - Simple majority (50%)
  - Without-cause removal **(good-leaver clause)**
    - Qualified majority (75%)

VC Risks and Returns

Business risk

Sources of VC risk premium → **Liquidity risk**

Specific risk

Two key drivers of performance:

- Access
- Diversification across *vintage*, industry, geography

Leveraged Buyouts (LBO)

LBO funds: Similar structure to VC funds:

Fees:
- Management
- Incentive
- *Transaction*
- *Breakup*
- *Divesture*
- *Directors*

Agency Costs:
- Lower for LBO investments

Market features:
- LBO auctions
- Club deals

PE Liquid Alternatives

Business Development Companies (BDCs)
- Exchange traded *closed end* funds
- No corporate taxation on distributed profit

Premium or Discount = (Market Price/NAV) − 1

PE Liquid Alternatives

Business Development Companies (BDCs)

- Not effective diversifiers
  - Highly correlated with small cap listed stocks
- Underperformed listed stocks in general
  - Quality of management teams is key

Trends and Innovations in PE

More active secondary markets

Increased hedge fund competition, often at a fee/required return disadvantage

Private Investment in Public Equity (PIPE)

- Traditional vs. structured PIPEs
- Toxic PIPEs

Publicly Traded PE Firms

- Conflicts arise public shareholders vs. LP investors in funds
  - Structures and jurisdictions selected by PE firm tend to reduce fiduciary duties to shareholders
  - PE firms tend to exclude normal board control and opt out of stock exchange governance rules
- Public vs. Private governance issues:
  - *Diversification:* PE portfolios tend to run concentrated portfolios
  - *Liquidity:*
    - Listed PE tend not to be diversifying vs. stocks
    - Short sellers may make listed PE prices more efficient
  - *Public Market Regulation:* too burdensome for PE firms?

Long-Hold Buyout Funds

- New type of PE fund with stated life of 15 years or more

Benefits	Drawbacks
1. Lower transaction costs	1. Increased illiquidity
2. Lower due diligence costs	2. Lower IRRs
3. Deferred capital gains taxes	3. Delay in exits => incentives?
4. Greater flexibility on exit timing	4. Limited scope for value-add in target companies

Select Keyword Review

Define these keywords and describe their role in the reading:

- **Auction process**
- **Club deal**
- **Death spiral**
- **Dry powder**
- **In-kind distributions**
- **Vintage year**

Select Keyword Review

- **Auction process:** multiple private equity firms bid to buy a target company
- **Club deal:** multiple LBO firms work together on the details of a single deal
- **Death spiral:** a structured PIPE with a conversion ratio that rises as the share price falls can get trapped in a spiral of earnings dilution and falling share price
- **Dry powder:** committed capital not yet drawn down by PE funds
- **In-kind distributions:** A non-cash distribution to LPs consisting of securities in a portfolio company
- **Vintage year:** the year of the first capital call for a PE fund

Discussion Questions

1. A fund raises $200m in committed capital. The management fee is 2.5%. In the first year, the fund draws down $25m of capital. What is the management fee in the first year as a proportion of paid-in capital of the fund?
2. A J-curve effect is likely to apply to the profitability of VC funds but not to the profitability of VC fund investments. True or false?
3. Shares of a closed-end fund are trading at a premium of 10%. The NAV per share is $20. If the NAV falls by 20% and the share price moves to a 10% discount, what would be the return to investors?

Discussion Questions Answers

1. The annual management fee is charged on committed capital: 0.025 × $200m = $5m.

   Management fees as a proportion of paid-in capital in the first year is $5m / $25m = 20%.

Discussion Questions Answers

2. False. J-curves are likely to apply to both VC funds and VC fund investments, as both are unprofitable in their early years.
3. The original share price is 1.1 × \$20 = \$22.

   The NAV falls by 20% from \$20 to \$16 and the new share price is at a 10% discount (0.9 × \$16 = \$14.40).

   Hence, share price return = (\$14.40 / \$22) – 1 = –34.5%.

Private Equity Fund of Funds

Need to Know Concepts

- 4 benefits, 4 costs of the FoF approach
- 3 factors driving PE FoF market
- FoF fees (calculation)

Funds of Funds vs. In-House Programs

Benefits of the FoF approach:

- Expertise and education in fund selection
- Diversification
  - Lower capital commitments *(scaling up smaller investors)*
  - Spreads costs across assets *(scaling down)* and lower negotiated fees
- Access to LPs and liquidity management
- Proper management incentives (carried interest)

Funds of Funds vs. In-House Programs

Costs of the FoF approach:

- A second layer of management fees
- Relationships with GPs remain with the FoF
- Less transparency and control
- Lack of liquidity in FoF fund units

Funds of Funds Process

Investment objectives:

- Geography, style (VC vs. buyout), level of diversification

Types of FoFs:

- Primary vs. secondary

Investment process:

- Portfolio construction (top-down)
- Manager and fund selection (bottom-up)
- Ongoing monitoring

Funds of Funds Process

Factors driving PE FoF market:

- Easy access for new, smaller PE investors
- Complement to existing PE fund program
- Increasing operational and regulatory complexity of GPs

FoF Fees Example

An LP invests $50m in a FoF. The LP expects a net annual IRR from underlying funds of 8% per year and to hold the FoF for 7 years. The FoF applies a 1/10 fee structure.

Assume that all committed capital is called and invested by the FoF GP immediately, and management fee is calculated based on committed capital.

- **What is the total fee paid to the FoF GP over the life of the FoF?**
- **If an in-house team costs $1m per year, recommend whether the LP should run an in-house or outsourced PE program**

FoF Fees Solution

- Annual management fee = \$50m × 0.01 = \$0.5m
- Total management fee = \$0.5m × 7 = \$3.5m
- Ending gross value of FoF = \$50m × 1.08^7 = \$85.69m
- Carry to FoF GP = 0.1 × (\$85.69m – \$50m – \$3.5m) = \$3.22m
- Total fee to FoF GP = \$3.5m + 3.22m = \$6.72m

- Fee as % of committed capital = \$6.72 / \$50m = 13.4%
- The in-house team will cost a total of \$1m × 7 = \$7m, hence it is marginally cheaper to allocate to the FoF.

PE FoF Historical Performance

Research findings:

- PE FoFs ***do*** offer diversification by reducing performance dispersion vs. single PE funds with the same vintage
    - More so for VC than buyout
- PE FoFs outperform public markets (based on KS-PME ratio)
- PE FoFs underperform a portfolio of PE funds
    - Exception: VC FoFs outperform portfolio of VC funds

Evolution of Investing in Private Equity

Need to Know Concepts

- 3 methods of direct investment
  - 3 co-investment structures
- 3 motivations for LPs to engage in direct investing
- Co-investment fees (calculation)
- 8 advantages of co-investing
- 6 disadvantages of co-investing

Direct PE Investment by LP

Increasing risk/resource required by LP

Method	Description
Co-investment	LP invited GPs to invest in deals alongside main fund
Partnership	LP invests directly alongside other LPs or GPs (partners)
Solo investing	LP invests directly without any deal other partners

Co-investment structures

1. Top-up/annex Funds
2. Direct
3. Co-investment programs

Motivations for LP

1. Improve returns and manage risk
2. Control
3. Cost efficiency

Co-investment Fees

Three main fee structures for co-investments, depending on level of involvement of GP in sourcing and performing due diligence on deals

- No fees
- 1% management, 10% promote
- 0% management, 20% promote

Example:

- An asset owner invests $50m in a PE program with expected return of 15% per annum over the next 7 years. Calculate the proportion of gross profit lost to fees under 1/10 and 0/20 fee structures.

Co-investment Fees

Solution

- Gross ending value of investment = $50m × 1.15^7 = $133m
- Gross profit = $133m – $50m = $83m

1/10 fee structure:

- Cumulative management fee = 0.01 × $50m × 7 = $3.5m
- Promote = 0.10 × ($133m – $50m – $3.5m) = $7.95m
- Total fees = $3.5m + $7.95m = $11.45m
- Proportion of gross profit lost to fees = $11.45m / $83m = 13.8%

Co-investment Fees

0/20 fee structure:

- Cumulative management fee = $0
- Promote = 0.20 × ($133m – $50m) = $16.6m
- Total fees = $16.6m
- Proportion of gross profit lost to fees = $16.6m / $83m = 20%

Co-investment Process

Limited Partner

- Reserve 10%–20% for co-investments
- Should state co-investment intentions to GP from outset
- Respond to deal invites in a timely manner
- Needs insight into individual deals

General Partner

Sources deals and invites LPs

Co-investment Advantages and Disadvantages

Advantages

- Superior returns (fees↓)
- Targeted investment
- Diversification management
- Mitigating dilution
- Dual review by both LP & GP
- Improved monitoring of GP
- Invitation-only fund relationships
- Reduction of the J-curve

Disadvantages

- Unbalanced portfolios
- Increased fiduciary risk to LP
- Conflicts of interest (co-investments vs. funds)
- Disagreements over failing investments
- Allocation of expenses (GP, LP, co-investors)

Co-investment Challenges

LP

- Need in-house expertise
- Access to GPs with co-investment deal flow
- Reduced diversification
- Organization constraints inhibiting due diligence of private companies

GP

- Most LPs talk but don't act
- Slow responses/negotiations with LPs
- Additional costs of reporting/structuring
- Conflicts of interest with other LPs with no co-investment relationship

Co-investment Returns

Evidence on performance is mixed:

- Small study (Fang et al. 2015) found that co-investment deals underperformed their corresponding funds
- *Larger, more comprehensive study (Braun et al. 2016) found that co-investments outperformed.*

Co-investment Returns

Requirements for LP success:
- Build internal expertise
- Source own co-investments
- Respond to GP in a timely manner
- Risk management (size of positions)

Impact on J-curve:
- Co-investments expected to mitigate J-curve
- Some co-investments may amplify J-curve if distributions occur late

Select Keyword Review

Define these keywords and describe their role in the reading:

- **Bridging**
- **Lock-step provision**

Select Keyword Review

- **Bridging:** GP makes an investment in the main fund and at the same time agrees to sell the investment to co-investors at a later date
- **Lock-step provision:** a term in a co-investment agreement specifying that the terms of the co-investor-GP relationship are the same as the terms of the LP-GP relationship

Discussion Question

1. For each of the following investment functions, state whether the role would most likely be carried out by:
   - GP only
   - GP or asset owner (AO)
   - AO or shared
   - AO only

a) Sourcing deals under solo investment

b) Sourcing deals under a co-investment program

c) Ongoing asset management under a partnership program

d) Ongoing asset management under a co-investment program

Discussion Questions Answers

1. For each of the following investment functions, state whether the role would most likely be carried out by:

a) Sourcing deals under solo investment: **AO only**

b) Sourcing deals under a co-investment program: **GP only**

c) Ongoing asset management under a partnership program: **AO or shared**

d) Ongoing asset management under a co-investment program: **GP or asset owner (AO)**

Private Credit and Distressed Debt

Need to Know Concepts

- Four main types of private credit
- Four types of debt covenants
- Layers of the capital stack
- Mezzanine debt improvement on WACC (calculation)
- Features of mezzanine debt investments
- Three distressed debt investment strategies
- Chapter 11 process timeframe
- Bankruptcy terms
- Venture debt: dilution calculation

Private Credit

- Private credit types:
  - Leveraged loans, direct lending, mezzanine debt, and distressed debt
- Market grew from $200bn in 2007 to $600bn in 2017
  - Banks reduced lending to less credit-worthy firms post financial crisis due to increased regulations

Private Credit

- Private credit **vehicles:**
  - Hedge funds, PE funds, and BDCs discussed in last topic
  - *Interval funds:* unlisted closed-end funds with redemptions available at regular time intervals
  - *Drawdown funds:* PE funds with indefinite term or fixed life

- Private credit fund **strategies:**
  - *Loan-to-own:* making loans with focus on the repossession of assets in the event of default
  - *Fulcrum securities:* senior-most debt of a defaulting borrower that is *not* repaid in cash during a bankruptcy reorganization

Bonds vs. Loans

	Bonds	**Loans**
Market	Public	Private
Regulation	Higher	Lower
Liquidity	Higher	Lower
Default risk	Less senior (riskier)	More senior (less risky)
Interest rate risk	Higher (fixed coupon)	Lower (floating coupon)

Fixed Income Analysis—Duration

- **Interest rate risk (duration) was covered in *Foundations of Financial Economics.***
- **Duration** = average *time* to receive cashflows, weighted by the present value of the cash flows.
- For *discretely compounded rates* (e.g., semiannual),
  - **Modified duration** = %Δbond's price for a 1% change in yield

$$Modified\ Duration = \frac{Duration}{(1 + (y/m))}$$

- For *continuously compounded rates,* m→∞, hence:

Modified Duration = Duration

- Duration of *Floating Rate Bond* = Time to next reset period

Fixed Income Analysis—Credit Risk

Corporate bond yield ≈ Benchmark rate (e.g., Treasury) + **Credit spread**

- Investment grade
- Low credit risk
- Low yield/spreads

Moody's	S&P/Fitch
Aaa	AAA
Aa	AA
A	A
Baa	BBB
Ba	BB
B	B
Caa	CCC
Ca	CC
C	C
D	D

Typical private credit rating

- Speculative grade
- High credit risk
- High yield/spreads

Fixed Income Analysis—Covenants

Indenture: legal contract between lender and borrower

Covenants: designed to improve credit quality of debt

Affirmative: borrower *will* do (e.g., maintain assets)
Negative: borrower *will not* do (e.g., increasing debt)

Incurrence: specifies conditions under which covenant must be met
Maintenance: must *always* be met

Growth of **"cov-lite"** loans with minimal covenants since 2007

Fixed Income Analysis—Covenants

Five ways covenants can control risk:

1. Preservation of collateral: maximum loan-to-value ratios
2. Appropriation of excess cash flow: restrictions on payments to equity holders
3. Control of business risk: limits on investments, mergers, and debt levels
4. Performance requirements: maintaining solvency ratios/restricting capital expenditure
5. Reporting requirements: performance, litigation, and regulatory issues

Fixed Income Analysis—Capital Stack

- High priority
- High recovery rates
- Low risk/return

- Low priority
- Low recovery rates
- High risk/return

Senior Secured First-Lien Debt

Senior Secured Second-Lien Debt

Senior Unsecured Debt

Junior/Mezzanine/Subordinated Debt

Preferred Equity

Common Equity

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Leveraged Loans

- Syndicated bank loans to non-investment grade (BB or below) borrowers:
  - First or second lien
  - Pays coupon of 1.25%–2.00% above LIBOR
- Growth in leveraged loans:
  - Secondary market boosted by assignment of credit ratings in 1990s => **originate to distribute** model at banks
- Market relies on the demand from CLOs and mutual funds

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Direct Lending

- Lending to mid-sized borrowers *without* bank as intermediary
- Usually first-lien *asset-based* lending:
  - *Revolving:* secured against inventory/accounts receivable
  - *Term:* secured against PPE
- *Key investor skillset:* credit analysis, legal knowledge (workouts and restructurings), and access to deal flow
- *Key advantage to investors:* fees typically charged on invested, not committed, capital (less of a J-curve)
- Growing subset: institutional interest in internet-based *peer-to-peer* consumer lending

Mezzanine Debt

- **Mezzanine debt:** hybrid of equity and debt
  - Convertible bonds
  - Subordinated bonds + warrants
  - Convertible preferred shares
- Exit strategy: company goes public or obtains capital through large equity issuance
  - J-curve not such an issue (immediate cash return)

Example: Mezzanine Debt Issuance

- Main advantage to issuers: lower weighted average cost of capital (WACC)

Before	After
Debt = 40% **Cost of debt = 6%**	**Debt = 40%** **Cost of debt = 6%**
	Mezz = 30% **Cost of mezz = 15%**
Equity = 60% **Cost of equity = 25%**	**Equity = 30%** **Cost of equity = 30%**

- Calculate the improvement in the company's WACC.

Solution: Mezzanine Debt Issuance

- Firm's initial WACC:

  (0.60 × 0.25) + (0.40 × 0.06) = 17.4%

- After issuing mezzanine debt, firm's new WACC:

  (0.30 × 0.30) + (0.40 × 0.06) + (0.30 × 0.15) = 15.9%

- The WACC has declined by 1.5%

Comparison of Financing Types

	Leveraged Loans	High-Yield Bonds	Mezzanine Debt
Borrower size	Large	Large	Medium
Seniority	Most senior	Subordinated	Lowest seniority
Asset claim	First/second lien	Unsecured	Unsecured
Credit rating	Required	Required	Not required
Covenants	Extensive	Moderate	Limited
Term	5 years	7–10 years	4–6 years
Principal repayment	Installment payments	Bullet payment	Bullet payment

Comparison of Financing Types

	Leveraged Loans	High-Yield Bonds	Mezzanine Debt
Coupon form	Cash	Cash	Cash or payment in kind
Coupon rate	Floating: LIBOR + spread	Fixed: 5%–8%	Fixed: 8%–11%
Prepayment penalty	None	Large	Moderate
Equity kicker	No	Potentially	Normally
Recovery rate	60%–100%	40%–50%	20%–30%
Liquidity level	High	Low	Minimal

Uses of Mezzanine Financing

1. Management buyouts
2. Growth and/or expansion
3. Acquisitions
4. Recapitalizations
5. Commercial real estate financing
6. Leveraged buyouts
7. Bridge financing

Mezzanine Debt Investors

The primary groups of lenders/investors are:

- Mezzanine funds
- Insurance companies
- Traditional senior lenders
- Traditional venture capital firms

→ Mezzanine investors are typically passive investors with no interest in obtaining control of the company.

Characteristics of Mezzanine Debt

- **Board representation**
- **Restrictions on the borrower**
- **Flexibility**
- **Negotiations with senior creditors:** *intercreditor agreement*
- **Subordination:** blanket and springing subordination
- **Acceleration**
- **Assignment:** usually not able to sell without senior creditor agreement
- **Takeout provisions:** option to repay senior debt

Criteria for Distressed Debt

Debt that has "deteriorated in quality" since issue:

- Credit rating equal to or lower than CCC/Caa
- Market price less than 50% of par
- Yielding 10 percentage points more than the risk-free rate

The Bankruptcy Process

Bankruptcy

Chapter 7

Liquidation

Chapter 11

Reorganization

- Within 120 days: debtor files plan
- Next 60 days: creditors consulted
- After 180 days: any claimant may file plan

U.S. Bankruptcy Terms

Prepackaged filing	Pre-agreed by creditors before filing with courts
Classification of claims	Grouping together of similar types of debt securities
Acceptance level	Half number and two-thirds value of each class of claimant
Blocking position	One-third of any class of claimant
Absolute priority	Order of claims
Cramdown	Judge implements plan over objections of claimants
Debtor-in-possession financing	Additional secured lending extended to distressed firm

Distressed Debt Investing

Distressed debt: issuer in or near default

Three broad categories of investment

Intent to take control

- Board representation
- Debt/equity swap

Active, no control

- Possible debt/equity swap

Passive/opportunistic

5 Observations on Vultures

- Distressed debt investors clean up bad debts through their actions in the restructuring process
- Credit cycles are largely caused by poor central bank policy rather than by vulture investors
- Most important skill is the identification of the fulcrum security
- Due to increasing debt loads at corporations, the fulcrum security has moved from subordinated debt up to senior secured loans
- Negative perception of vultures comes from the origination of loan-to-own investments designed to profit from the bankruptcy of the borrower

Venture Debt

Debt financing provided to VC-backed companies by specialized banks and venture debt funds

Size	\$1m - \$20m
Tenor	1–3 years
Interest Rate	9%–15%
Fees (1%–2%)	Arrangement, Prepayment, Backend/Success
Dilution	Warrant coverage of 5%–15% of loan amount, typically <2% equity dilution
Covenants	None
Repayment	Typically repaid at next equity financing round

Typical target IRR: 12%–18%

Venture Debt Lowers Dilution

Example:

A start-up company is raising \$20m Series B finance. Details are:

- Pre-money valuation = \$35m
- Warrant coverage = 5% of loan value
- Existing owners: 80% founders, 20% Series A VC firm

Calculate by how much equity dilution is reduced for the founder if the finance is raised as 40% equity and 60% debt vs. if the funds were 100% equity.

Venture Debt Lowers Dilution

Solution:

100% equity fund raising:

Post-money valuation = Pre-money valuation + equity raised

= \$35m + \$20m = \$55m

Ownership:

- Series B VC share = \$20m / \$55m = 36.4%
- Founder's share = 0.80 × (1 – 0.364) = 50.9%
- Series A VC share = 0.20 × (1 – 0.364) = 12.7%

Dilution to founder = 80% – 50.9% = 29.1%

Venture Debt Lowers Dilution

Solution:

40% equity, 60% debt fund raising:

Equity raised = \$20m × 0.40 = \$8m, Debt raised = \$20m × 0.60 = \$12m

Equity amount from warrants = 0.05 × \$12m = \$0.6m

Post-money equity valuation = \$35m + \$8m + \$0.6m = \$43.6m

Venture Debt Lowers Dilution

Ownership:

- Warrants = $0.6m / $43.6m = 1.4%
- Series B VC share = $8m / $43.6m = 18.3%
- Founder's share = 0.80 × (1 – 0.183 – 0.014) = 64.2%
- Series A VC share = 0.20 × (1 – 0.183 – 0.014) = 16.1%

Dilution to founder = 80% – 64.2% = 15.8%

Venture Debt: Other Points

Reasons for demand for venture debt

- Reduction of equity dilution
- Debt finance cheaper than equity finance
- Debt is quicker and easier to issue than equity
- Additional capital to achieve valuation milestones without equity finance

Risks

- Ensuring low loss rates is more important than focusing on the potential upside of warrants
- Venture debt portfolio default rates remarkably low due to high likelihood VC will follow on with equity funding

Private Credit Performance 2004–2016

- Low price volatility (potentially due to smoothing)
- Relatively high correlations between distressed debt, BDCs, high-yield bonds, and leveraged loans; much lower correlations for mezzanine investing
- Direct lending had the best returns, leveraged loans had the worst returns
- Less liquid, more complex strategies with longer holding periods performed better than more liquid fixed income strategies

Select Keyword Review

Define these keywords and describe their role in the reading:

- **PIK toggle**
- **Stretch financing**
- **Unitranche debt**

Select Keyword Review

- **PIK toggle:** allows firm to issue coupons in cash or additional debt
- **Stretch financing:** refers to lending amounts that exceed traditional lending limits; amount of financing provided above traditional limit is subject to higher interest rate and may require equity kicker
- **Unitranche debt:** a large debt issue that is a package of both junior and senior debt in a single security

Discussion Questions

1. A company is financed 60% by bank loans at an interest rate of 4% and 40% by equity. The beta of the equity of the company is 1.5, the risk-free rate is 1%, and the expected return on the market portfolio is 6%. The corporate tax rate is 0. Calculate the weighted average cost of capital of ABC.
2. Assume now that 50% of the equity financing is replaced with mezzanine debt with a coupon of 6%, which causes the beta of the company stock to rise to 2. Calculate the postmezzanine WACC of the company.

Discussion Questions Answers

1. Using CAPM, cost of equity equals:
   $E(R) = 1\% + 1.5(6\% - 1\%) = 8.5\%$

   WACC of ABC:
   $(0.6 \times 4\%) + (0.4 \times 8.5\%) = 5.8\%$

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Discussion Questions Answers

2. Postmezzanine financing, company will be financed 60% by debt, 20% equity, and 20% mezzanine:
   - Using CAPM, cost of equity postmezzanine financing equals:
     $1\% + 2(6\% - 1\%) = 11\%$
   - Postmezzanine WACC:
     $(0.6 \times 4\%) + (0.2 \times 11\%) + (0.2 \times 6\%) = 5.8\%$
   - WACC has stayed the same because the lower cost of new mezzanine financing is exactly offset by a higher cost of equity.

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Hedge Funds

Overview

Hedge Funds

- Structure of the Hedge Fund Industry
- Macro and Managed Futures Funds
- Event-Driven and Relative Value Hedge Funds
- Equity Hedge Funds
- Funds of Hedge Funds

Structure of the Hedge Fund Industry

Need to Know Concepts

- **3 primary elements** of a hedge fund
- Reasons for industry growth and concentration
- CAIA classification of hedge fund strategies
- Hedge fund fees:
  - Calculate total annual fee
  - Apply the annuity view (calculation)
  - Apply the option view (calculation)
  - Effect on manager behavior
- Hedge fund indices:
  - Data issues and biases

Primary Elements of Hedge Funds

Structure	Characteristics
Regulatory	Private, unlisted, less regulated
Compensation	Performance fees
Trading	Flexibility to use leverage, derivatives, unlisted securities, structured products, and short positions; usually involves active management and complex strategies

Growth and Concentration

Growth due to:

- Low correlations with traditional assets (**diversifying**)
- Ability to take of advantage of both long and **short** ideas
- Potential **high returns** in low yield environment

Concentration

Post-crisis (2008) investor flows towards larger funds due to:

- Large funds perceived as **less risky**—better risk management systems and controls
- High costs of facilitating **due diligence** by allocators

Hedge Fund Fee Structure

Management fee = 1.5% of NAV

"1.5/17.5"

Performance/incentive fee
= 17.5% × (gross return above HWM – management fee – HR)

HWM = high watermark of fund
HR = hurdle rate

Example: Hedge Fund Fees

FMO Hedge Fund has a 2-and-25 fee arrangement with a hurdle rate of 5% and an NAV of $300 million at the beginning of the year. The NAV increased to $395 million at the end of the year, before fees. If management fees are distributed annually based on the start-of-the year NAV, **calculate** the following:

- Annual management fee
- Incentive fee
- Total annual fee
- Ending NAV after fees
- Percentage return, net-of-fees

Solution: Hedge Fund Fees

- Annual management fee = 2% × \$300 = \$6 million
- Return required to meet hurdle rate = 5% × \$300 = \$15 million
- Incentive fee = 25% × (\$395 – \$300 – \$6 – \$15) = \$18.5 million
- Total annual fees = \$6 + \$18.5 = \$24.5 million
- Ending net NAV after fees = \$395 – \$24.5 = \$370.5 million
- Net return after fees = (\$370.5 – \$300) / \$300 = 23.5%

Example: Annuity View of Hedge Fund Fees

A 2/20 hedge fund has the following:

- Beginning NAV of \$500 million
- Constant 15% rate of return
- Zero hurdle rate

Apply the annuity view model to determine the NAV as well as the management and incentive fees at the end of the first two years (assume the fund is liquidated at the end of Year 2).

Solution: Annuity View of Hedge Fund Fees

At the end of Year 1:

- NAV is $575 million before fees (= $500 × 1.15)
- Management fee is $10 million (= 2% × $500)
- Incentive fee is $13 million [= 20% × ($75 – $10)]
- NAV is $552 million after fees (= $575 – $10 – $13)

Solution: Annuity View of Hedge Fund Fees

At the end of Year 2:

- NAV is $634.8 million before fees (= $552 × 1.15)
- Management fee is $11.04 million (= 2% × $552)
- Incentive fee is $14.35 million [= 20% × ($82.8 – $11.04)]
- NAV after fees is $609.41 million (= $634.8 – $11.04 – $14.35)

Solution: Annuity View of Hedge Fund Fees

- Using a 15% discount rate, the present value of the ending NAV is $460.80 million

  [= $609.41 / $(1.15)^2$]

- The total present value of fees is $39.20 million
  (= $500 beginning NAV – $460.80)

Option View of Hedge Fund Fees

- Incentive fees can be considered a call option on performance of fund, granted to the manager
  - Underlying asset = NAV
  - Strike = HWM
  - Time to expiry = performance period
  - Price of option = time and effort of manager
- Holders of options benefit from increased volatility
  - *Perverse incentive* for manager to increase volatility of the fund when the option is "out-the-money" (NAV < HWM)

At-the-Money Incentive Free Approximation

$$\text{incentive fee call option value} \approx i \times 40\% \times \text{NAV} \times \sigma_1$$

- Increasing the volatility of the fund increases the present value of future management fees

Example: Suppose a $500 million hedge fund has a 20% incentive fee. In addition, assume there is no hurdle rate and that a performance fee has just been paid.

Estimate the incentive fee call option value:

- If the annual volatility of the NAV is 15%
- If the annual volatility of the NAV is 25%

Solution: Option View

- Incentive fee call option value =
  20% × 40% × $500 million × 15% = $6 million
- Incentive fee call option value =
  20% × 40% × $500 million × 25% = $10 million
- Clearly, volatility levels substantially impact the value of the manager's incentive fee

Evidence on Option View

- **Lock-in effect:** managers take less risk to preserve their incentive fees when the incentive option is far in-the-money
- Factors that limit a manager's desire to increase volatility:
  - Manager invests **own money** in the fund
  - Potential further losses **further below the high-water mark**
  - Reduction of **assets under management** and management fee
  - **Reputation** damage

CAIA Hedge Fund Classifications

- Macro & Managed Futures
  - Macro
  - Managed Futures
- Event-Driven Hedge Funds
  - Activist
  - Merger Arbitrage
  - Distressed
  - Event-Driven Multistrategy
- Relative Value **(Arbitrage)** Hedge Funds
  - Convertible
  - Volatility
  - Fixed Income
  - Relative Value Multistrategy
- Equity Hedge Funds
  - Long-Short
  - Market Neutral
  - Short Selling
- Funds of Hedge Funds

Hedge Fund Strategy Risk Exposures

1. **Equity strategies**
   - Market risk
2. **Event-driven and relative value strategies**
   - Convergence risk
3. **Absolute return strategies**
   - Seek to minimize risk
4. **Diversified strategies**
   - Diversify across different investment themes

Hedge Fund Strategy Distributions

Equity	Event-Driven and Relative Value (ED & RV)	Absolute Return	Diversified
• Equity long/short • Short bias	• Event driven: distressed securities, merger arbitrage, multistrategy • Relative value: convertible bond, volatility, fixed income, and multistrategy	• Equity market neutral • Market defensive FoFs	• Global macro, systematic diversified (managed futures) • Multistrategy • Funds of funds

Hedge Fund Strategy Distributions

Equity	ED & RV	Absolute Return	Diversified
• Market risk (systematic risk) • High standard deviation	• Primary risk—event risk (off-balance sheet risk) • Large negative skew • High kurtosis	• Low standard deviation • Very small skew • Low kurtosis	• High returns, reasonable risks, and low drawdowns • Low skew (systematic diversified positive)

Hedge Fund Strategy Distributions

Equity	ED & RV	Absolute Return	Diversified
• High correlation with equity market	• Profits similar to the insurance industry, small profits, and occasional large losses (short volatility) • Similar to high yield credit risk	• Skill based strategy—skill at selecting specific securities	• High Sharpe ratios • Diversification benefits • Close to normal

Hedge Fund Investment Program

- Rationale:
  - Return enhancement or risk management?
- *Caveats* to performance data:
  - Shocks to hedge fund system
  - Past no guide to future
  - Index bias: survivorship and selection
  - Sharpe ratio a flawed measure

Opportunistic Hedge Fund Investing

- **Opportunistic hedge fund programs:** taking advantage of short-term conditions
  1. Adding value through specialization in sector or strategy
  2. Filling gaps in existing portfolios' investment universe

Headline Risk

- Dispersion in economic value from important, unexpected, or controversial events deters some investors from allocating to hedge funds
- Famous examples exist of hedge funds profiting from events perceived as negative (e.g., currency crises)
  - Limited evidence that hedge funds *cause* such crises, but they may magnify market decline

Hedge Fund Indices

- **Asset-weighted indices:**
  - Biased towards larger funds
  - Better reflect universe performance; incorporates market impact costs
  - Consistent with traditional indices
- **Equal-weighted indices:**
  - Does not give preference to larger funds
  - Most index providers prefer equal-weighted indices (reflects all strategies)

Hedge Fund Index Issues

Representativeness	Extent to which the sample matches HF universe
Data Biases	(1) survivorship, (2) selection, (3) instant history/backfill, (4) liquidation, (5) participation
Fee Bias	Successful HF managers often raise fees; new investors are unable to attain same net performance as original investors
Style Drift	HF manager not using stated strategy
Investability	Better performing funds are likely to be closed to new investment, hence not represented in investable indices

Select Keyword Review

Define these keywords and describe their role in the readings:

- **Closet indexer**
- **Lock-in effect**
- **Optimal contracting**
- **Off-balance sheet risk**
- **Synthetic hedge funds**

Select Keyword Review

- **Closet indexer:** managers who charge high fees, but returns follow index
- **Lock-in effect:** occurs when managers take less risk to ensure incentive fees
- **Optimal contracting:** designing incentive fees with intent to align interests of managers and investors
- **Off-balance sheet risk:** type of investment risk not reflected in financial statements
- **Synthetic hedge funds:** attempt to earn hedge fund-like returns with lower fees using listed securities and quantitative models

Discussion Questions

1. Using option theory, explain two potential courses of action by a manager of a fund with a NAV significantly below its high watermark to increase the probability of earning incentive fees.

Discussion Questions Answers

1. The manager could either:
   - increase volatility of fund in an attempt to move NAV above the high watermark; or
   - liquidate fund and start another one which would reset the moneyness of the incentive fee option.

- Neither action is in the best interests of current fund investors.

Macro and Managed Futures Funds

Need to Know Concepts

- **Discretionary vs. systematic** traders
- **Technical vs. fundamental** analysis
- Systematic trading strategies
  - Moving averages (SMA, WMA, and EMA), channel breakouts, and Relative Strength Index (RSI)
- Position sizing: volatility targeting
- 8 core benefits of CTAs
- How to structure a managed futures investment:
  - Single CTAs, multi-manager fund, in-house team, managed account, and platforms

Traders and Types of Analysis

Traders

Discretionary (subjective)
opinion-based

Systematic (objective)
rules-based

Black Box

Analysis

Fundamental
(underlying supply/demand factors)

Technical
(charts and indicators)

Global Macro vs. Managed Futures Funds

	Macro	Managed Futures
Style	Opportunistic, top-down analysis of global events; investing anywhere based on macroeconomic forecast.	Active trading of futures and forwards on commodities, financial assets, and exchange rates
Examples	• Currency devaluation bets (GBP, THB) • Sovereign bond bets (EU) • Monetary policy bets (Abenomics) • Thematic investing (China)	Usually systematic (rules based) trading models
Risks	Market, event, leverage	Transparency, model, capacity, liquidity, regulatory, lack of trends

Structure of the Managed Futures Industry

Regulation	• *Commodities Exchange Act 1974:* requires reporting, disclosure, and recordkeeping • Main U.S. regulator: **CFTC** (Commodity Futures Trading Commission) • Self-regulatory body: **NFA** (National Futures Association) • Regulate **CPOs** (commodity pool operators) and **CTAs** (commodity trading advisers) • Post 2008 crisis: move to centrally clear OTC Forwards (*futurization*) through Dodd-Frank Act in U.S. and EMIR in EU
Market Segments	• Public commodity pools • Private commodity pools • Individually managed accounts
Benchmark	• Mount Lucas Management Index (MLMI)

Core Dimensions of Managed Futures

- Managed Futures Strategies
  - Data Sources
    - Fundamental
    - Technical
  - Implementation Style
    - Systematic
    - Discretionary
  - Strategy Focus
    - Momentum
    - Mean Reversion
    - Global Macro
    - Relative Value
    - Multistrategy
  - Time Horizon
    - High Frequency
    - Short Term
    - Medium Term
    - Long Term

Time Horizon

	High Frequency	Short Term	Medium Term	Long Term
Holding period	Not traditionally classified as managed futures	Intraday to 1 month	1–6 months	6 months+

Core issues:

- **Transaction costs**: increase with shorter time horizons
- **Trading capacity**: important for CTAs taking large positions
- **Slippage**: occurs when actual performance slips away from expected performance due to transaction costs/capacity constraints

Systematic Model Assessment

- *What* is it?
- *Why* and *when* does it work?
- *How* is it implemented?

- **Validation:** proving trading rule works on different data
- **Robustness:** how well model works in different time periods, datasets, or applications
  - Must perform well *out-of-sample*
- **Degradation:** trading rules becoming less effective over time

Systematic Trading Strategies

- **Trend-following strategies (momentum)**
  - Moving average and breakout strategies
- **Non-trend-following strategies (mean reverting)**
  - Relative Strength Index
- **Relative value strategies**
  - Exploit price inefficiencies between two related contracts

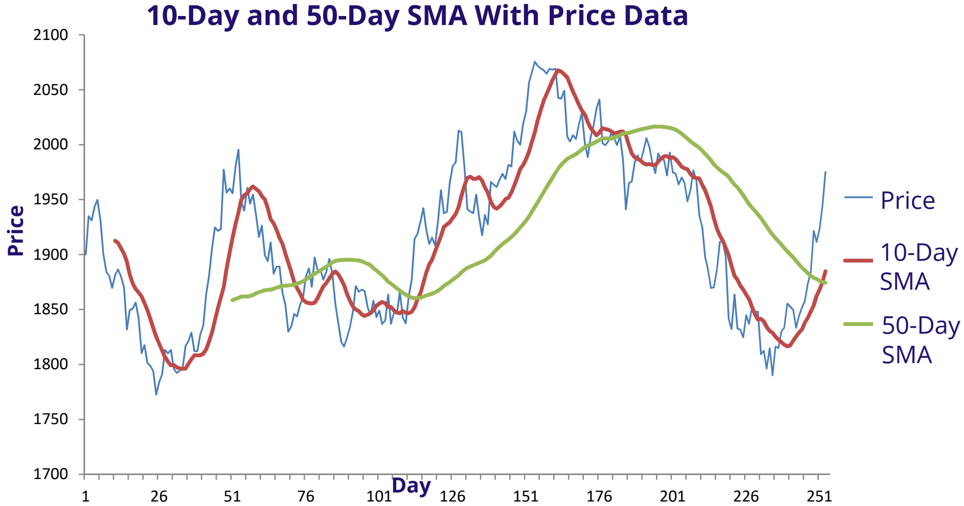
Trend Following: Moving Averages

- **Moving average (MA) strategy rule:**
  - Buy when current price crosses above the *n*-day MA
  - Sell when current price crosses below the *n*-day MA

  or
  - Buy when short-term MA crosses above long-term MA
  - Sell when short-term MA crosses below long-term MA
- MA strategies do well in trending markets and poorly in volatile, trendless markets (reversals hurt MA).

Trend Following: Moving Averages

10-Day and 50-Day SMA With Price Data



Trend Following: Moving Averages

- *Simple (SMA):* equally weighted average

$$SMA_t(n) = \frac{1}{n}P_{t-1} + \frac{1}{n}P_{t-2} + \ldots + \frac{1}{n}P_{t-n}$$

- *Weighted (WMA):* recent observations weighted higher

$$WMA_t(n) = \frac{n}{N}P_{t-1} + \frac{n-1}{N}P_{t-2} + \ldots + \frac{1}{N}P_{t-n} \qquad N = \sum_{i=1}^{n} i$$

- *Exponential (EMA):* multiplicative rule giving higher weight to most recent observations

$$EMA_t = (\lambda)P_{t-1} + (1-\lambda)EMA_{t-1}$$

Equation exception list

Example: Moving Averages

Given the following data, **calculate** the following for Friday:

- Three-day SMA
- Three-day WMA
- EMA with a weighting parameter λ = 0.25, given that the EMA on Thursday was 503

Day	Price
Monday	425
Tuesday	495
Wednesday	511
Thursday	611

Solution: Moving Averages

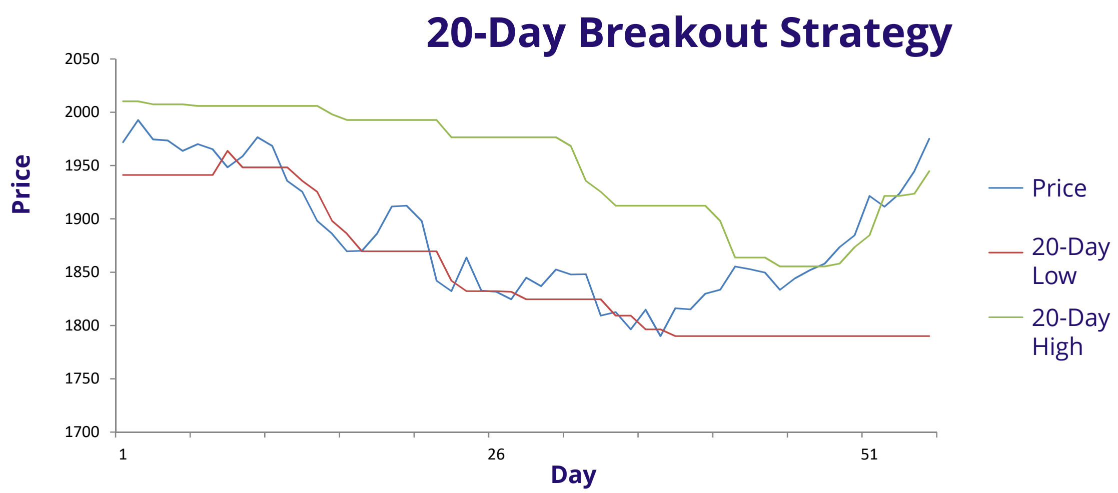
Day	Price
Monday	425
Tuesday	495
Wednesday	511
Thursday	611

- Three-day SMA = (611 + 511 + 495) / 3 = 539
- Three-day WMA = (3 × 611 + 2 × 511 + 1 × 495) / 6 = 558.33
- EMA = 0.25 × 611 + (1 − 0.25) × 503 = 530

Trend-Following Strategies: Channel Breakout

- Create a channel of prices with an upper and lower bound:
  - **Upper bound**—the highest high price over the last *n* days (most commonly a 20-day look-back period)
  - **Lower bound**—the lowest low price over the last *n* days
- Buy and sell signals
  - Buy when the price moves above the upper bound
  - Sell when the price moves below the lower bound

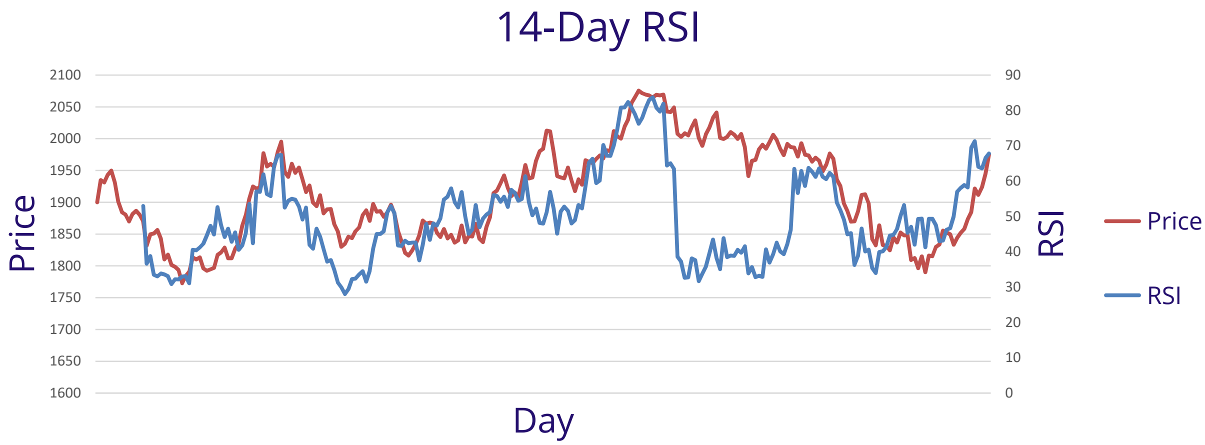
Trend-Following Strategies: Channel Breakout



Countertrend Strategies

- Designed to profit by trading against the current trend
  - Long positions are taken when the market is deemed oversold.
  - Short futures positions are taken when the market is deemed overbought.
- Use Relative Strength Index to identify buy and sell signals

Relative Strength Index



Relative Strength Index

$$RSI = 100 - \frac{100}{1 + \frac{U}{D}}$$

U = average increase during up days
D = average decrease during down days

Market is overbought if RSI > 70 → **SELL**

Market is oversold if RSI < 30 → **BUY**

Example: RSI

Trading Day	Index Closing Price
Day 1	1,600
Day 2	1,650
Day 3	1,700
Day 4	1,690
Day 5	1,725

Calculate the RSI and **recommend** appropriate action.

Solution: RSI

Trading Day	Index Closing Price
Day 1	1,600
Day 2	1,650
Day 3	1,700
Day 4	1,690
Day 5	1,725

Average up movement = (50 + 50 + 35) / 3 = 45
Average down movement = 10

$$RSI = 100 - \frac{100}{1 + \frac{45}{10}} = 81.82$$

RSI > 70: Market is overbought. Short futures positions should be taken.

Relative Value Strategies Using RSI

- Calculate the price difference between two contracts (A and B) over the last *n days:*

$$\textit{Price difference} = \textit{price of } A_t - \textit{price of } B_t$$

- Calculate the RSI *on the price differences.*
- When the RSI (price difference) < 30, buy Contract A and sell Contract B; A is oversold relative to B.
- When the RSI (price difference) > 70, sell Contract A and buy Contract B; B is oversold relative to A.

Futures Trading Systems

Four Core Decisions

1. Entry
2. Sizing
3. Exit
4. Market allocation

Portfolio Construction

1. Data processing
2. Position sizing
3. Market allocation
4. Trading execution

Position Sizing

Volatility Targeting

$$\text{number of futures contracts} = \text{sizing function} \times \frac{(\text{risk loading} \times \text{equity})}{\text{notional value}} \times \frac{\text{RVol}_T}{\text{RVol}_R}$$

sizing function = direction and confidence in the signal
risk loading = amount of exposure desired in a particular market
notional value = exposure of one futures contract
RVol_T = realized volatility target
RVol_R = estimate of future volatility

Example: Volatility Targeting

A CTA has $50 million and has determined that 8% of this capital should be allocated to trading the gold market. The sizing function is estimated to be −0.25; the current price of gold futures is $1,200 per ounce with a contract size of 100 ounces. The annualized volatility target is 30%, and the annualized volatility of the near-term contract has recently been 22%.

Calculate the number of futures contracts required.

Solution: Volatility Targeting

$$\text{number of futures contracts} = -0.25 \times \frac{(0.08 \times \$50{,}000{,}000)}{(100 \times \$1{,}200)} \times \frac{30\%}{22\%} = -11.36$$

The CTA should sell 11 contracts.

Position Sizing

Volatility Targeting: Alternative Approach

$$\text{number of futures contracts} = \text{sizing function} \times \frac{\text{risk loading} \times \text{equity}}{PVol_R \times \text{contract size}}$$

sizing function = direction and confidence in the signal
risk loading = reflects both desired exposure and volatility target
$PVol_R$ = daily price volatility of the futures contract

Example: Volatility Targeting Alternative Approach

A CTA has $50m, and risk loading is estimated to be 0.2%. The sizing function is estimated to be −0.25, and the daily price volatility of gold is estimated to be $30 per ounce; each contract is for 100 ounces.

Calculate the number of futures contracts required.

Solution: Volatility Targeting Alternative Approach

$$\text{number of futures contracts} = -0.25 \times \frac{(0.002 \times \$50{,}000{,}000)}{(\$30 \times 100)} = -8.33$$

The CTA should sell eight contracts.

Market Allocation and Trading Execution

Market allocation:

- Combines capital allocation and risk allocation
- Simplest capital allocation: equal weight
- Risk allocation methods:
  - Equal dollar risk allocation
  - Equal risk contribution
  - Market capacity weighting (market size)

Trading execution:

- Short-term strategies sensitive to *alpha decay*—cost of delayed execution
- Long-term strategies more sensitive to transaction cost

Eight Core Benefits of CTAs

1. **Diversification:** risk reduction due to low correlation with traditional assets
2. **Performance:** higher Sharpe ratios than long-only commodities
3. **Access to multiple markets**
4. **Transparency:** futures have daily mark-to-market valuation, more reliable limit order books, no liquidity dark pools, no models used for valuation

Eight Core Benefits of CTAs

5. **Liquidity:** low transaction costs
6. **Size:** estimated $320 billion in 2018
7. **No withholding taxes:** domestic investors can pass on tax benefits to investors in futures via cash/futures arbitrage
8. **Very low foreign exchange risk:** no liquidating values, so foreign exchange exposure is limited to posted margin

Managed Futures Returns

- **Research findings:**
  - Combining managed futures with stocks and bonds improve risk/return profile.
  - Managed futures appear to be more efficient diversifiers than hedge funds.
  - Systematic funds tend to outperform discretionary funds in times of crisis/falling markets.
  - Systematic funds are generally better market timers than discretionary funds.

Benefits of CTAs

- **Sources of return:**
  - Futures markets are in aggregate zero-sum games
    - CTAs may be earning a premium through:
      - Allowing those with underlying exposure to hedge
      - Providing liquidity
      - Taking offsetting positions for rebalancing demand
    - May also benefit due to market distortions caused by central bank policy
    - Evidence for premium: higher Sharpe ratios for trend following in futures markets than for spot markets

Creating a CTA Investment Program

Step 1: Determine the number of CTAs desired for the portfolio.

- One diversified CTA may be appropriate for small investors

Step 2: Identify how portfolio diversification can be achieved.

- Managed accounts
- Multi-manager fund vs. in-house team?
- Platforms

Managed Accounts

Advantages:
- Control
- Transparency
- Liquidity
- No lock-up provisions, little risk of fraud or unwanted leverage

Disadvantages:
- Limited number of managers
- Large required initial investment
- Investor must comply with each broker's legal, administrative, risk, and investment requirements
- Managed accounts do not always have a limited liability structure

Macro/Managed Futures Performance

Asset Class	Average Return	Standard Deviation	Sharpe Ratio	Skew	Excess Kurtosis
Macro systematic diversified	5.0%	7.6%	0.3	0.2	0.1
Macro	4.5%	5.1%	0.4	0.3	0.6
World equities	4.3%	15.5%	0.1	–0.6	1.5

Maximum drawdowns of macro funds were very low (i.e., good!) relative to that of equities

Period: Jan. 2000–Dec. 2020

Select Keyword Review

Define these keywords and describe their role in the reading:

- **Momentum**
- **Pattern recognition systems**
- **Random walk**
- **Slippage**
- **Whipsawing**

Select Keyword Review

- **Momentum:** degree to which price movements occur in same direction as last movement
- **Pattern recognition systems:** look for market anomalies in market price patterns or volatility patterns
- **Random walk:** price changes are independent from past prices
- **Slippage:** difference between expected entry and exit prices and actual entry and exit prices
- **Whipsawing:** when a trader establishes a long position immediately prior to a price decline, or a short position immediately prior to price increase

Discussion Questions

A stock's price history is as follows:

Day	–8	–7	–6	–5	–4	–3	–2	–1
Price	499	501	504	507	502	500	498	503

1. What is the three-day WMA on Day 0?
2. What is the EMA on Day 0 given a weighting parameter of 0.4 and an EMA on Day –1 of 500?
3. If an analyst is using a five-day breakout strategy, what price would generate a buy signal on Day 0?
4. What signal (if any) is being given by the current RSI?

Discussion Questions Answers

1. 3-day WMA on Day 0 = (3 × 503 + 2 × 498 + 1 × 500) / 6 = 500.83
2. EMA on Day 0 = 0.4 × 503 + (1 – 0.4) × 500 = 501.20
3. Buy signal generated if the stock trades above the five-day high. On Day 0, this signal is generated for any number above 507.

Discussion Questions Answers

4.

Day	–8	–7	–6	–5	–4	–3	–2	–1
Price	499	501	504	507	502	500	498	503
Price Move		2	3	3	–5	–2	–2	5

- Average UP: 3.25
- Average DOWN: 3

$$RSI = 100 - \frac{100}{1 + \frac{3.25}{3}} = 52$$

- **No signal** because RSI is above 30 and below 70

Event-Driven and Relative Value Hedge Funds

Need to Know Concepts

- **Event-Driven Strategy Returns**
  - Insurance view
  - Binary option view (calculation)
- **Activist Investing**
  - Corporate governance and agency costs
  - Five types of shareholder activists
  - Three activist agendas
- **Merger Arbitrage Investing**
  - Two risks to merger arbitrage
- **Distressed Securities Funds**
  - Liquidation events—viewing short sales as naked call options
  - Distressed activists—capital structure arbitrage

Need to Know Concepts

- **Convertible Bond Arbitrage**
  - Traditional convertible arbitrage strategy
  - Unbundled approach to convertible bond valuation (calculation)
- Delta and gamma
- Four reasons for attractively-priced convertible bonds
- Six convertible bond risks
- Five fixed-income arbitrage risks

Need to Know Concepts

- **Volatility Arbitrage**
  - Volatility swaps and variance swaps (calculation of payoff)
  - Long volatility funds vs. market-neutral volatility funds
  - Dispersion trade
- **Fixed-Income Arbitrage**
  - Inter-curve vs. intra-curve positions
  - Two sovereign debt strategies, MBS risks
  - Five fixed-income arbitrage risks

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Event-Driven Payoffs

Event Risk
Dispersion in economic outcomes due to uncertainty regarding corporate events (e.g., merger)

Similar to ***selling insurance*** against event not happening:
High chance of small gain on event, small chance of large loss if event fails to happen

Binary option view:
Can view investment as exposure to a binary option (an option that pays a fixed amount on exercise)

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Example: Binary Option

Purch Corp. has offered to buy Sub Corp. for $30/share. Before the announcement, Sub was trading at $22/share. After the announcement, Sub trades at $28/share. Assume that the share price of Sub would fall to $20 if the deal fails and the risk-free rate is 0%.

Deal successful:
Profit to merger arb
= $30 – $28 = $2

Deal fails:
Loss to merger arb
= $20 – $28 = –$8

Explain how this payoff could be expressed as a combination of a risk-free bond and a binary option.

Solution: Binary Option

- Payoff could be viewed as the following:
  - Risk-free bond with par value of $20
  - Long binary call with $10 payoff
  - Current value of call option is $28 – $20 = $8

- Alternatively, payoff could be viewed as the following:
  - Risk-free bond with $30 par value
  - Short binary put option $10 payoff
  - Value of the put option is $30 – $28 = $2

Activist Investing

1. Identify corporations with management that does not maximize shareholder wealth.
2. Establish positions that will benefit from changes in *corporate governance*.
3. Execute favorable corporate governance changes to benefit the position.

Corporate Governance

Company Management (Executives)
Make operational decisions of company

Agency Conflict

Shareholders (Owners)
Face consequences of management decisions

Corporate Governance

- Processes and controls established to ensure management decisions maximize shareholder value
  - Includes establishment of *board of directors*

Categories of Activists

Financial: aim to increase stock prices	vs.	**Social:** aim to change corporate behavior to benefit society
Activists: seek major changes or replacement of management	vs.	**Pacifists:** oppose activist changes
Initiators: pay search and initiation costs of activism process	vs.	**Followers:** support the plans of the initiators
Friendly: work with management to improve conditions	vs.	**Hostile:** threaten management with adverse consequences
Active: establish stock positions for the purpose of activism	vs.	**Passive:** existing shareholders who participate in activism

Categories of Activists

Active followers—wolf pack
(free riders)

Active Initiators **vs.** **Pacifists**

Passive followers

Proxy Battle

Activist positions disclosed in Forms 13D, 13F, 13G

Agendas for Activists

1. Exorbitant management compensation and ineffective board of directors
2. Capital structure and dividend policy
3. Mergers and divestitures

Merger Arbitrage Strategy

- **Traditional merger arbitrage (stock-for-stock merger)**
  - Leverage used to buy stock of the target firm and short sell stock in the acquiring firm
  - Similar to insurance underwriting, bearing the event risk of a failed merger

Example: Stock-for-Stock

- Acquirer’s stock currently trading at $105
- Offers two shares for one share of the target firm
- Target stock rises from $150 to $180 and acquirer’s stock falls to $100
- Merger arbitrage fund buys $180 target firm and short sells two shares of acquiring firm’s stock for $200
- Short position is covered once deal goes through
- Merger offer (i.e., two shares of the acquirer per share of the target) determines the *hedge ratio*

Merger Arbitrage Bidding

- **Bidding contest:** when firms compete to acquire same target firm
- **Benefits:**
  - Traditional merger arbitrage benefits as price of the target increases
- **Concerns:**
  - Potential scenarios become much more numerous and complex
  - Both bidders may decide to abandon deal

Merger Arbitrage Risks

- **Regulatory risk:** uncertainty regarding the decisions made by regulators who may not approve a merger
  - Greatest concerns: reduction of competition, nationalistic, or tax-related reasons
- **Financing risk:** uncertainty regarding ability of the acquiring firm to obtain funding needed to consummate a merger
  - Greatest concerns: employee buyout deals and leveraged buyouts

Distressed Debt Hedge Funds

Short securities of firms expected to file for ***Chapter 7 liquidation***

Similar risk profile to writing *naked call options*

Buy undervalued securities and estimate ***recovery values*** after bankruptcy proceedings

Activist strategies based on enhancing value through the ***Chapter 11 reorganization*** process

Capital Structure Arbitrage

- Long senior claim
- Short junior claim

Event-Driven Performance

Period: Jan. 2000–Dec. 2020

Asset Class	Average Return	Standard Deviation	Sharpe Ratio	Skew	Excess Kurtosis
Merger arbitrage	5.0%	**4.0%**	**0.6**	–2.5	**23.4**
Distressed	**7.0%**	**6.6%**	**0.7**	–1.4	6.9
World equities	4.3%	15.5%	0.1	–0.6	1.5

Period: Jan. 2005–Dec. 2020

Asset Class	Average Return	Standard Deviation	Sharpe Ratio	Skew	Excess Kurtosis
Activist	8.0%	13.8%	0.4	-0.8	2.6
World equities	8.4%	15.5%	0.4	–0.7	2.2

Relative Value: Convertible Bond Arbitrage

- **Convertible bond:** hybrid corporate security that includes an embedded call option that allows bond to be exchanged for common stock
- Classic convertible bond arbitrage trade:
  - Long convertible bond, short company stock
  - **Objective:** benefit from mispricing of option component embedded in bond
  - By short selling stock, seek to eliminate equity exposure while receiving coupon interest paid on bond

Convertible Bond Characteristics

- **Conversion ratio:** number of common shares for which convertible bond can be exchanged
- **Option strike price:** convertible bond face value divided by conversion ratio
- **Conversion value:** conversion ratio multiplied by market price of issuer's stock
- **Conversion premium:** premium of convertible bond's price over conversion value of bond

Unbundled Approach to Convertible Bond Valuation

Convertible Bond = Option-Free Bond + Equity Call Option

Use TVM buttons on calculator
N = number of periods
I/Y = yield of bond
PMT = coupon
FV = par value
CPT PV gives value of bond

Use output of option valuation model (usually given in question)

Example: Unbundled Approach

- A firm has unsecured debt with a yield to maturity of 10%, and the firm's stock currently trades at $60.
- The firm can issue five-year convertible bonds at an annual coupon rate of 5% and a conversion ratio of 15 shares per $1,000 of par.
- Assume that a five-year European style call option with similar parameters to the option embedded in the bond is valued at $10.50 per share.
- **Calculate** the convertible bond value using the unbundled approach and **determine** the conversion premium of the bond.

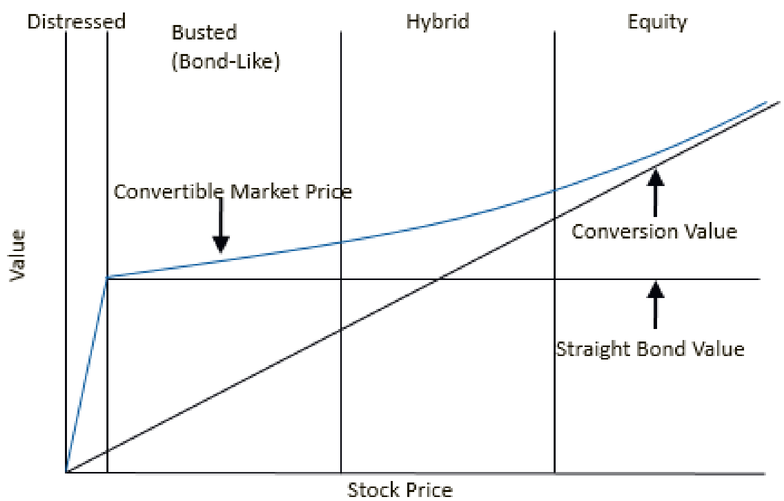
Solution: Unbundled Approach

- The option-free bond value is found using the TVM keys:

2nd FV
5 N
10 I/Y
50 (5% × 1,000) PMT
1000 FV
CPT PV: –810.46

- Option is worth $10.50 × 15 = $157.50
- Value of convertible = $810.46 + $157.50 = $967.96
- Conversion value of the bond = 15 × $60 = $900
- Conversion premium = (967.96 – 900) / 900 = 7.55%

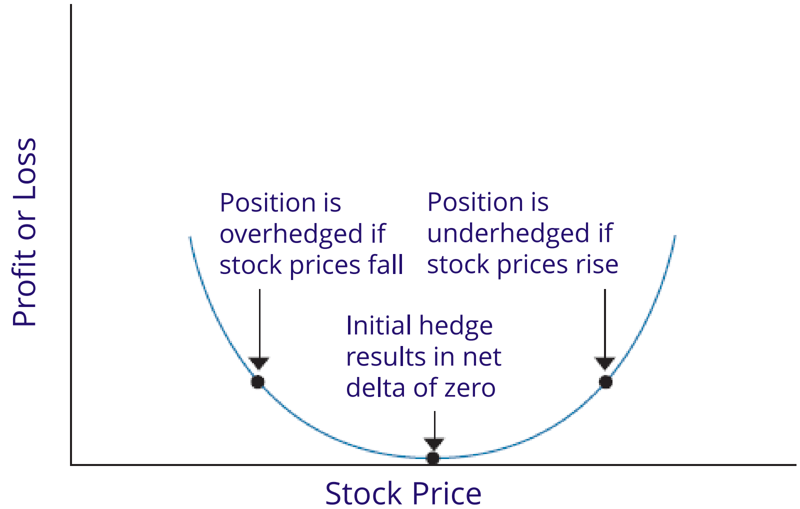
Moneyness



Delta Hedging

- **Delta:** change in option vs. change in underlying
  - Delta values for calls range from 0 to +1
- **Delta hedging:** long convertible position hedged with short position in the underlying stock (net delta = 0)
  - Number of shares to short:
    number of bonds long × conversion ratio × delta

Delta Hedging



Gamma and Theta

- **Gamma:** second derivative of an option's price with respect to underlying price of asset
  - Higher gamma → more convex movement in convertible bond option
- **Theta:** first derivative of option price with respect to option's expiration date
  - Higher theta → more time decay in convertible bond option
- Profits occur when moves in underlying stock generate *convex* moves in convertible bond through gamma, which outweigh negative impact of theta.

Reasons for Convertible Bond Underpricing

1. Agents (corporate managers) may underestimate true costs of issuing convertible bonds
2. Agents of small firms may not have any other options than to issue convertible bonds at attractive prices
3. Potential for substantial conflict of interest between straight bond investors and shareholders regarding the volatility of corporate assets
4. Indirect equity issuance costs

Convertible Arbitrage Total Return

- The **total return** of a convertible arbitrage strategy comes from the following components:
  - **Arbitrage income component =** bond interest – dividends + short stock rebate – financing costs
  - **Capital gains/losses on stock and convertible bond trading =** capital gains on stock and bond – capital losses on stock and bond

Convertible Arbitrage Risks

- Interest rate risk
- Equity and volatility
- Correlation
- Credit
- Legal
- Liquidity and crisis

Volatility Arbitrage

- **Volatility arbitrage strategies:** capitalize on differences in implied volatility between options
- **Vega:** impact of change in volatility of underlying asset
  - Long option when anticipated volatility > implied volatility

Instruments Used by Volatility Arbitrage Funds

- **Variance swap**
  - Variance buyer:
    - Pays the fixed swap strike in exchange for realized variance
    - Profits when variance is higher than expected

$$\text{variance swap payoff} = \text{variance notional value} \times (\text{realized variance} - \text{strike variance})$$

$$\text{variance swap payoff} = \frac{\text{vega notional value} \times (\text{realized variance} - \text{strike variance})}{2 \times \sqrt{\text{strike variance}}}$$

Equation exception list

Instruments Used by Volatility Arbitrage Funds

- **Volatility swaps:** use volatility rather than variance

volatility swap payoff =
vega notional value × (realized volatility − strike volatility)

Example: Variance Swap

- Two parties enter into a 30-day variance swap on the returns of the S&P 500 Index.
  - Vega notional value = $200,000
  - Strike price = 7.0
- After 30 days, the realized annualized variance of the S&P 500 Index is 6.0.
- **Calculate** the cash payoff at maturity.

Solution: Variance Swap

$$\text{payoff} = \frac{\$200{,}000 \times (6.0 - 7.0)}{2 \times \sqrt{7}} = -\$37{,}796$$

Volatility Arbitrage Strategies

1. **Long volatility funds**
   - Aim to profit from an increase in volatility
   - Can provide *tail risk* protection (*portfolio protection*) in times of crisis

2. **Market-neutral volatility funds**
   - Aim to earn profits from writing overvalued options (selling vol) and buying more reasonably priced options

The Dispersion Trade

- **Classic dispersion trade** (or *short correlation trade*): long options of individual equities and short a related index option
  - Profits are associated with low levels of realized correlations
  - Losses are associated with high levels of realized correlations

Fixed-Income Arbitrage Strategy

- **Fixed-income arbitrage strategies:**
  - Long/short similar fixed-income securities
    - *Profit from small pricing discrepancies* as prices converge over time
    - Pricing discrepancies are small → *significant leverage* often required
    - *Duration-neutral strategy:*
      - Zero sensitivity to changes in market interest rates

Types of Fixed-Income Arbitrage Trades

- **Spread trades** *(intercurve arbitrage positions)*
  - Long/short two bonds of *similar maturity*
  - Examples: swap spread strategies and carry trades
- **Yield curve trades** *(intracurve arbitrage positions)*
  - Long/short two bonds with *different maturities*
  - Profit from predicting changes in *yield curve* shape

Sovereign Debt Market

- **Sovereign debt risk:**
  - Unique credit risks since governments can print money to service debts but can also *choose* to default
- Strategies include:
  - **Buying off-the-run/selling on-the-run treasuries** to take advantage of yield differences
  - **Riding the yield curve:** *rolling down* an upward sloping yield curve

Asset-Backed Securities Market

- **Asset-backed securities (ABS):**
  - Major risk: **prepayment risk**
    - Borrower's right to repay principal early (discussed in *Real Estate Assets and Debt*)
  - Valued using **option-adjusted spread (OAS)**

MBS Yield = R_f + OAS + spread due to prepayment option

- Complexities of prepayment modeling give rise to fixed-income arbitrage opportunities involving ABS and MBS

Risks of Fixed-Income Arbitrage Funds

Risk Factor	Description
Prepayment risk	Option to prepay loans and mortgages acts like a short call option in MBS
Credit spread	Risk of defaults on fixed-income instruments or on the loans in the collateral of MBS
Liquidity and crisis	In times of crisis, a flight to quality will cause the value of MBS and credit risky securities to fall as OASs increase

Risks of Fixed-Income Arbitrage Funds

Risk Factor	Description
Interest rate	Measured by **duration** (recall Foundations of Financial Economics) • For option-free bonds, use **modified** duration. • For bonds with embedded options and MBS, use **effective** duration.
Convexity	• The price/yield relationship is *convex*, not linear, as assumed by duration. • Convexity can be *negative* for callable bonds and MBS at low interest rates.

Relative Value Performance

Period: Jan. 2000–Dec. 2020

Asset Class	Average Return	Standard Deviation	Sharpe Ratio	Skew	Excess Kurtosis
Convertible arb.	6.2%	**7.0%**	**0.5**	–2.7	**24.2**
Fixed-income arb.	5.5%	**5.8%**	**0.5**	**–2.7**	**15.8**
World equities	4.3%	15.5%	0.1	–0.6	1.5

Period: Jan. 2005–Dec. 2020

Asset Class	Average Return	Standard Deviation	Sharpe Ratio	Skew	Excess Kurtosis
Volatility arb.	**4.1%**	**5.5%**	0.3	**–2.3**	**8.0**
World equities	8.4%	15.5%	0.4	–0.7	2.2

Select Keyword Review

Define these keywords and describe their role in the reading:

- **Financial market segmentation**
- **Free rider**
- **Interlocking boards**
- **Proxy battle**
- **Parallel shift**
- **Portfolio insurance**

Select Keyword Review

- **Financial market segmentation:** occurs when two or more markets use different valuations for similar assets due to the lack of participants who trade in both markets
- **Free rider:** follows the activist ideas of others (*active follower*)
- **Interlocking boards:** when board members or managers serve on multiple firms and boards simultaneously
- **Proxy battle:** conflict between corporation's management and one or more shareholders to influence proxy votes
- **Parallel shift:** when all maturities shift up or down in equal amounts on a yield curve
- **Portfolio insurance:** strategies designed to limit portfolio tail risk

Discussion Questions

1. *Stella Corp.* has offered to purchase *JJ Corp.* for $29 per share. Immediately after the announcement, *JJ Corp.* trades at $27/share, having traded at $20 immediately before the merger proposal announcement. An analyst estimates the share price of *JJ* would fall to $18 if the deal failed. Assuming that the risk-free rate is 0%, do the following:
   a) Describe a long position in *JJ Corp.* as a combination of positions in a risk-free bond and a binary call option and the potential payoffs.
   b) Describe a long position in *JJ Corp.* as a combination of positions in a risk-free bond and a binary put option and the potential payoffs.

Discussion Questions

2. A convertible bond has a face value of $1,000, a coupon rate of 7%, and a conversion ratio of 25. The common stock of the issuer is trading at $33 per share, and the convertible bond price is currently $1,050. Calculate the conversion value and conversion premium of the bond.

3. In which zone is the conversion premium of a convertible bond most likely to be lowest: busted zone, hybrid zone, or equity zone?

Discussion Questions

4. A 90-day variance swap on the returns of a stock index with a variance notional value of $10 million has a strike price of 10. After the 90-day reference period is observed, the realized annualized variance in the index is 8.5. Calculate the final payoff of the variance buyer.

Discussion Questions Answers

1.a) *Long binary call option*

- A long position in a risk-free bond with a face value of $18 and a long binary call option costing $9 with a payoff of $11 if the merger is successful; $0 if it is unsuccessful
- Initial cost is $27, with potential payoffs of $18 or $29

1.b) *Short binary put option*

- A long position in a risk-free bond with a face value of $29 and a short binary put option valued at $2 with a potential payoff of –$11 for the fund if the merger is not successful
- Initial cost is $27 (= $29 + –$2), with potential payoffs of $18 or $29

Discussion Questions Answers

2. Conversion value = $33 × 25 = $825

   Conversion premium = (1,050 − 825) / 825 = 27.3%

3. Conversion premium is lowest when convertible bond price is closest to conversion value. This will be in the equity zone.

4. Variance buyer payoff:

   $10,000,000 × (8.5 − 10) = −$15,000,000

Equity Hedge Funds

Need to Know Concepts

- Three major types of equity hedge funds
- Three sources of excess return to equity hedge funds
- Five examples of market anomalies
- Applying CAPM to short bias funds and equity long/short funds (calculation)

Equity Hedge Funds

- **Equity long/short funds:** bias towards being net long (positive beta)
- **Equity market-neutral funds:** eliminate market risk, maintain a portfolio beta of 0
- **Short-bias funds:** higher percentage of short positions relative to long positions

Sources of Excess Returns

- **Liquidity returns**
  - Provide liquidity on both sides of the transaction when needed by the market
- **Information efficiency returns**
  - Temporary inefficiencies in prices, for example, due to *asynchronous trading* or market *overreactions and underreactions*
- **Factor-based returns**
  - Factor models explain stock price changes and predict future returns (e.g., Fama-French model)

Market Anomalies: Accounting Accruals

Company Earnings (Net Income)

Cash | *Accruals* (Noncash)

- Net income > operating cash flows
  - **Future negative earnings surprises** are more likely
- **Buy stocks with negative accruals and sell stocks with positive accruals.**

Market Anomalies: Price Momentum

- **Price momentum:**
  - Upward trend → higher future prices
  - Downward trend → lower future prices
  - Based on prices having *positive serial correlation/autocorrelation*

Market Anomalies: Earnings Momentum

- Positive earnings surprises → positive price performance

- A **post-earnings-announcement drift**
  - Buying after a positive earnings surprise.
    - Standardized unexpected earnings (SUE):

SUE = (actual – expected) / standard deviation of surprises

Market Anomalies: Net Stock Issuance

- **Strategy:** long firms with share buyback programs, short firms issuing large amounts of new stock

  - **Share buyback program:**
    - Fewer shares outstanding → higher future EPS
    - Sign of manager confidence

Market Anomalies: Insider Trading

- **Legal insider trading**
  - Bases trades on the action of senior executives

  - **Strategy**
    - Buy when insiders are buying, sell when insiders are selling
    - Insider buying signals are much clearer signals

Implementing Market Anomaly Strategies

- **Multiple-factor scoring models:** generate single trading signal based on combining scores from numerous anomalies

- **Pairs trading:** match stocks based on systematic risk; long undervalued stock and short overpriced stock

- **Ability to short sell:** implies higher expected alphas for every level of tracking error than long-only portfolios due to the greater breadth

Example: Applying CAPM to Short Bias Funds

- Assume:
  - Expected market return is 9%
  - Risk-free rate is 2%
  - Long-only equity fund beta is 1.2 with 10% expected return
  - Short-bias fund has beta of –1.2 with –4% expected return
- Should an investor allocate to the short-bias fund?

Solution: Applying CAPM to Short Bias Funds

- R_{long} = 0.02 + 1.2(0.09 – 0.02) = 0.104 or 10.4%
- ex ante alpha_{long} = 10.0% – 10.4% = –0.4%
- R_{short} = 0.02 + (–1.2)(0.09 – 0.02) = –0.064 or –6.4%
- ex ante alpha_{short} = –4.0% – (–6.4%) = 2.4%

→ Performance improved by allocating to short portfolio because of positive ex-ante alpha

Allocating 50% to long portfolio and 50% to short portfolio:
- Portfolio expected return = 0.5 × 10 + 0.5 × –4 = 3%
- Portfolio beta = 0.5 × 1.2 + 0.5 × –1.2 = 0
- Portfolio ex-ante alpha = 0.5 × –0.4% + 0.5 × 2.4 = 1.0%

Example: Applying CAPM to Long/Short Funds

Construct a 130/30 portfolio and **calculate** the portfolio return and weighted average beta assuming the following:

- Long energy ETF (beta = 1.12)
- Short materials ETF (beta = 0.95)
- Realized return for energy ETF = 15%
- Realized return for materials ETF = 5%
- Expected market return = 8%

Compare results to market portfolio.

Solution: Applying CAPM to Long/Short Funds

- Portfolio: 130% in energy ETF and short 30% of materials ETF
- Portfolio return: $1.3 \times 15\% - 0.3 \times 5\% = 18\%$
- Portfolio beta: $1.3 \times 1.12 - 0.3 \times 0.95 = 1.17$

→ Expected return much higher than market return 8%, even though portfolio beta near 1

Equity Hedge Performance

Period: Jan. 2000–Dec. 2020

Asset Class	Average Return	Standard Deviation	Sharpe Ratio	Skew	Excess Kurtosis
Long/short	5.7%	**7.9%**	**0.4**	–0.3	3.0
Market neutral	3.2%	**2.8%**	0.2	–0.5	2.9
World equities	4.3%	15.5%	0.1	–0.6	1.5

Period: Jan. 2005–Dec. 2020

Asset Class	Average Return	Standard Deviation	Sharpe Ratio	Skew	Excess Kurtosis
Short bias	**–8.8%**	**15.3%**	**–0.7**	–0.7	**6.1**
World equities	8.4%	15.5%	0.4	–0.7	2.2

Select Keyword Review

Define these keywords and describe their role in the reading:

- **Mean neutrality**
- **Taking liquidity**
- **Uptick rule**
- **Variance neutrality**

Select Keyword Review

- **Mean neutrality:** zero beta exposure to market risk
- **Taking liquidity:** large investor decreases the supply of limit orders near the current bid-ask spread when executing a trade
- **Uptick rule:** permits short sellers to enter a short sale only at a price that is equal to or higher than the previous transaction price of the stock
- **Variance neutrality:** objective of funds that try to produce returns that are uncorrelated with changes in market risk including crisis situations

Discussion Questions

Give two examples of market anomaly-based ***sell*** signals that could be used by equity long/short hedge fund managers to generate excess returns.

Discussion Questions Answers

Bearish anomaly signals include the following:

- High earnings accruals
- Negative price momentum
- Negative earnings surprises
- Large share issuances
- Insider sellers

Funds of Hedge Funds

Need to Know Concepts

- Four functions of FoF management
- Eleven benefits of FoFs
- Six disadvantages of FoFs
- Three ways for FoF managers to add value
- Risk of a portfolio of hedge funds (calculation)
- Advantages and disadvantages of FOFs vs. multistrategy hedge funds
- Four FOF categories
- Key features of liquid alternatives (UCITS/’40 Act funds)

Four Functions of FoF Management

- Strategy and manager selection
- Portfolio construction
- Risk management and monitoring
- Manager due diligence

Eleven Benefits of FoFs

- Diversification
- Accessibility
- Economies of scale
- Information advantage
- Liquidity
- Access to certain managers
- Negotiated fees
- Regulation
- Currency hedging
- Leverage
- Education

Six Disadvantages of FoFs

- Double layer of fees
- Performance fees not netted
- Taxation
- Lack of transparency
- Exposure to other investor’s cash flows
- Lack of control

Three Ways for FoF Managers to Add Value

- Long-term strategic style allocation
- Short-term tactical style allocation
- Individual manager selection

Diversification in Hedge Funds

- Well-diversified portfolio: 15–20 hedge funds
- Theoretical approach:

$$\sigma_{\text{portfolio}} = \frac{\sigma}{\sqrt{N}}$$

where:

σ = standard deviation of funds in the portfolio (assumed all equal)
N = number of funds in the portfolio

Hedge Fund Risk

Example:

Assuming all of the individual funds in a hedge fund program have a standard deviation of 30%, **calculate** the estimated standard deviation of an equally weighted portfolio of 20 hedge funds.

Solution:

$$\sigma_{\text{portfolio}} = \frac{0.30}{\sqrt{20}} = 0.067 = 6.7\%$$

Multistrat Funds vs. FoFs

Multistrat Advantages:

- Avoids second level of fees
- Fee netting
- Greater transparency
- Greater tactical flexibility
- Superior risk management

FoF Advantages:

- Manager selection skills
- Reduced operational risk
- Broader diversification
- Liquidity facilities
- Superior managers (?)
- Access to closed managers

Empirical Evidence on FoFs

- FoFs underperform broad hedge fund indices
- Reasons that FoFs may be less biased than indices:
  - Index performance may be inaccurate
    - Survivorship bias
    - Instant history bias
  - FoFs use actual weights that are more reflective of investments in practice

Liquid Hedge Fund Alternatives

UCITS (Europe) Regulations:

- Reporting frequency: two weeks, maximum leverage: 200%
- Holdings limits:
  - 35% European sovereign
  - 20% investment fund
  - 10% illiquid holdings
  - 20% deposit at single institution
  - Max position 10% (20% with derivatives)

Liquid Hedge Fund Alternatives

'40 Act (U.S.) Regulations:

- Regular liquidity: redemptions paid within seven days
- *Symmetric* performance fees can exist
- Maximum leverage: minimum 300% asset coverage (A/D) → borrowing limited to 33% of assets
- Holding limits (apply to 75% of fund):
  - Max position size: 5% in single security, 25% in one industry
  - 15% illiquid holdings
  - Max stake in issuer: 10%

Availability of Liquid Alternatives

Available	Not Available
Macro and managed futures, long/short equity, and equity market neutral	Merger arbitrage, distressed debt, private equity, and relative value

- *Multialternative* structures can bypass limits on concentration/ leverage at fund level
- Performance-wise, liquid alternatives have lower risk, slightly lower or equivalent returns to similar hedge funds

FOF Investment Objectives

- **Composite** and **diversified indices:** equity, event-driven, macro, and relative value strategies
  - *Objective:* earn diversified returns
- **Conservative index:** equity market-neutral, fixed income arb, and convertible arb
  - *Objective:* obtain consistent returns with low risk
- **Market defensive index:** macro, systematic, and short strategies
  - *Objective:* hedge market risk
- **Strategic index:** equity hedge and emerging market strategies
  - *Objective:* earn high returns

FoFs Performance

Period: Jan. 2000–Dec. 2020

Asset Class	Average return	Standard Deviation	Sharpe Ratio	Skew	Excess Kurtosis
Diversified	3.8%	**5.1%**	0.2	–1.2	4.9
Conservative	3.3%	**3.9%**	0.2	–2.5	**11.9**
Market defensive	4.1%	**4.8%**	0.3	**0.2**	**0.4**
Strategic	4.1%	7.2%	0.2	–0.8	3.8
World equities	4.3%	15.5%	0.1	–0.6	1.5

Select Keyword Review

Define these keywords and describe their role in the reading:

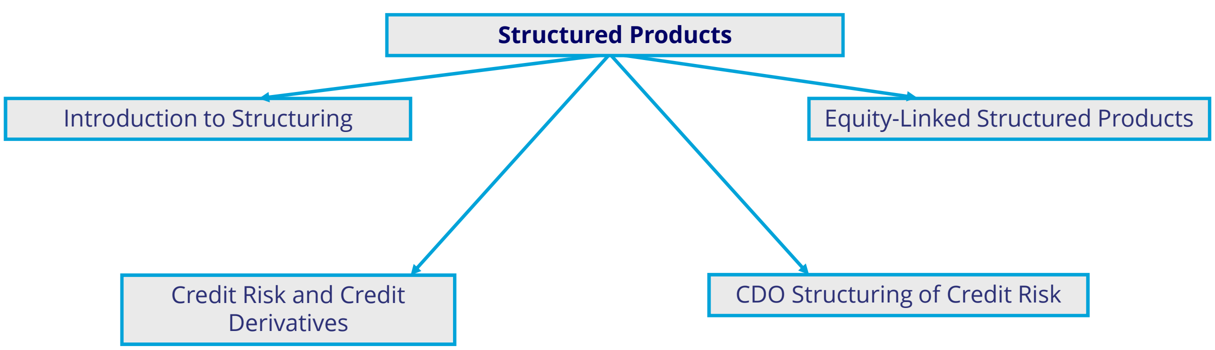
- **Access**
- **Fee netting**
- **Seeding funds**
- **Unconstrained bond funds**

Select Keyword Review

- **Access:** ability to place new or increase investment in a hedge fund
- **Fee netting:** in a multistrategy fund, investor pays incentive fees based only on net profits of the combined strategies, rather than on all profitable strategies
- **Seeding funds:** fund of funds that invest in newly formed hedge funds, acting in an advisory venture-capital like capacity
- **Unconstrained bond funds:** invest in investment-grade, high-yield or emerging-markets debt, often including leverage and short positions

Structured Products

Overview



Introduction to Structuring

Need to Know Concepts

- Economic role of structuring: completing the market
- Collateralized Mortgage Obligations (CMOs):
  - Sequential pay (calculation)
  - PAC/TAC/PO/IO tranche definitions
- Structural approach to pricing credit risk
  - Merton's structural model
  - Valuing risky debt
    - De-levering volatility (calculation)
- Interest rate caps/floors

Structuring

Creates claims with different risk/tax/liquidity attributes

Credit Derivatives

CDO Tranching

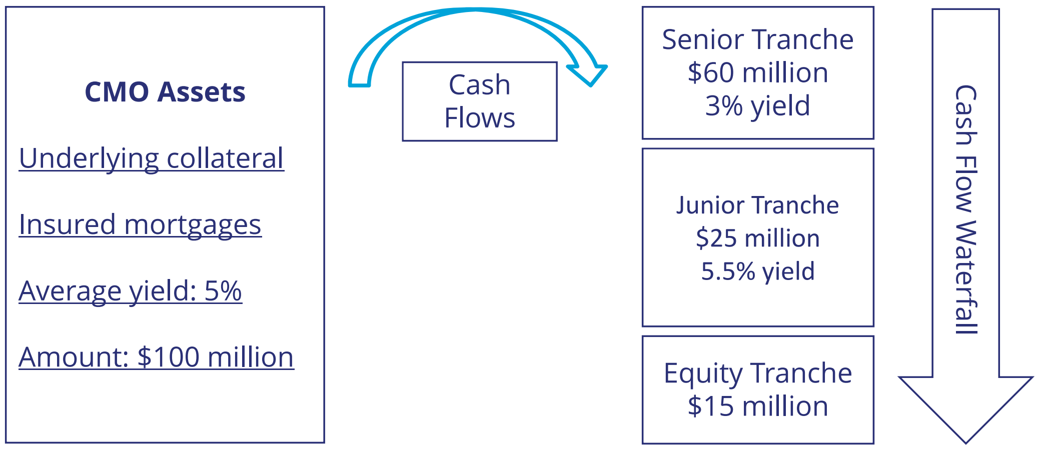
Tailored Securities (e.g., equity-linked)

Completing the market: Securities structured to meet all *different needs*. Helps investors prepare for ***states of the world***

Mortgage-Backed Securities

- **Mortgage-backed security** (MBS)
  - Security secured by pool of mortgages (collateral)
- **Residential MBS** (Agency RMBS)
  - Low credit risk: backed by the U.S. government
  - **Prepayment risk:** borrower's right to repay mortgage early a key risk
    - **Contraction risk:** average life decreases when rates fall and prepayments *increase*
    - **Extension risk:** average life increases as rates rise and prepayments *fall*

Collateralized Mortgage Obligations (CMOs)



Sequential-Pay CMOs

- **Sequential-pay tranches:** tranches retired sequentially
  - Senior tranche receives *all principal* until paid off
  - All tranches receive interest
    - ***Z*-tranche** or **accrual tranche** receives no payments until sequential-pay tranches serviced

Collateralized Mortgage Obligations

- Each **sequential-pay CMO** tranche has a mix of contraction and extension risk:

Tranche	*Contraction Risk*	*Extension Risk*
A (sequential pay)	HIGH	LOW
B (sequential pay)		
C (sequential pay)		
D (sequential pay)	LOW	
Z (accrual)		HIGH

Example: Sequential-Pay CMO

Tranche	Outstanding Par Value	Coupon Rate
A (Senior)	$350,000,000	4.5%
B (Junior)	$150,000,000	5.5%

Total principal repayments are $300,000 in month 1

Calculate the cash flow allocation in month 1.

Solution: Sequential-Pay Tranche

Month 1, Tranche A

Principal repayments:	$300,000
Interest payments:	$1,312,500
Total payments	$1,612,500

Month 1, Tranche B

Principal repayments:	$0
Interest payments:	$687,500
Total payments	$687,500

Other CMO Structures

PAC CMO structure

- **PAC tranches:** principal payments guaranteed, if prepayment rates are within **prescribed range**
- **Support tranche:** provides prepayment protection to PAC tranches

Other CMO Structures

- **Targeted Amortization Class (TAC)**
  - Like a PAC structure, but with more narrow and complex range of prepayment speeds
- **Principal-only (PO) and interest-only (IO) strips**
  - PO faces extension risk; IO faces contraction risk
- **Floating/inverse floater rate tranches**
  - Linked to index such as LIBOR

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Systemic Risk and Structured Mortgage Products

U.S. CMO crisis, 1994

- Interest rates rose dramatically, prepayments fell
- Extension risk → CMO values plummeted
- Liquidity dried up
- TAC tranches & inverse floaters were most affected

Global Financial Crisis, 2007

- Financial losses in nonagency MBS from default risk
- Major cause/exacerbation of financial crisis

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CMOs and Default Risk

- ***Agency RMBS:***
  - Prepayment risk and interest rate risk
  - Low credit risk since insured by government
- ***CMBS/subprime MBSs, especially junior tranches:***
  - Focus on credit risks, default correlation, and expected default rates

Credit Risk: Merton's Structural Model

Company issues zero coupon debt with par = K

Assets, $A < K$ at maturity	Assets, $A \geq K$ at maturity
Default	*No default*
Bondholders receive A	Bondholders receive K

This payoff can be modeled using options.

Merton's Structural Model

Credit-risky bond = risk-free bond – put on company assets

strike price = K, par value of debt

Example: Structural Model

Consider two discount bonds with face values of $1,000 and one year to maturity—one risk-free and the other risky. The risk-free bond is priced at $950.25 with a yield of 5.2%, and the risky bond is priced at $920.25 with a yield of 8.6%.

Calculate the value of the implied put option on the firm's assets.

Solution: Structural Model

The value of the implied put option is the difference between the prices of the risky and risk-free bonds.

$950.25 – $920.25 = $30

Put-Call Parity

No-arbitrage relationship linking option prices to underlying

Call + Risk-Free Bond = Underlying Asset + Put

1. Given this relationship, how else could the payoff from credit risky debt be considered?
2. Given that assets must equal debt plus equity, how could an equity investment be considered?

Put-Call Parity: Solutions

1. Credit-risky debt = risk-free debt – put
   = (underlying asset + put – call) – put
   = underlying asset – call

   Hence, risky debt can also be viewed as a long position in the assets of the company and a short call on the assets.

2. Equity = underlying assets – risky debt = underlying assets – (underlying assets – call) = call

   Hence, an equity position can be viewed as a long call on company assets.

Conflict of Interest

Volatility of Assets UP

↓

Option Values UP

Shareholders *win* (long call)

Bondholders *lose* (short put)

Valuing Risky Debt

Black-Scholes option pricing model can be used

1. Estimate volatility of firm's equity
2. De-lever firm's volatility:

   $\sigma_{assets} \approx \sigma_{equity} \times (\text{equity / assets})$

3. Use BSM to solve for value of call & put on assets
4. Use option values in Merton's structural model

Structural Models

Advantages:

- Uses liquid equity market data
- Prices securities that differ in seniority and with features such as conversion options

Disadvantages:

- Potential irrational equity prices
- Inaccurate pricing of very short-term and very high-quality bonds
- Current data on liabilities may be unreliable (unworkable for sovereigns)

Interest Rate Derivatives

Interest Rate Cap	**Interest Rate Floor**
Series of calls on interest rates (caplets)	Series of puts on interest rates (floorlets)
↓	↓
Holder receives payment when LIBOR *rises* above the strike rate	Holder receives payment when LIBOR *falls* below the strike rate

Example: Interest Rate Derivatives

HDR Investments buys an interest rate cap from IB Bank. The cap is for 3 years, has a strike rate of 3%, has a notional value of $100m, and is settled quarterly.

What is the payment to HDR if LIBOR in a particular quarter is:

a) 2%?

b) 4%?

Solution: Interest Rate Derivatives

a) If LIBOR is 2%, there is no payout to the cap holder because the reference rate is below the strike rate (3%)

b) If LIBOR is 4%, the payout to HDR is:

$$(0.04 - 0.03) \times (3/12) \times \$100{,}000{,}000 = \$250{,}000$$

Deannualize quoted rates for quarterly periods

Select Keyword Review

Define these keywords and describe their role in the reading:

- **Complete market**
- **Inverse floater tranche**
- **PAC tranches**

Select Keyword Review

- **Complete market:** a financial market in which enough different types of distinct securities exist to meet the needs and preferences of all participants
- **Inverse floater tranche:** offers a coupon that increases when interest rates fall and decreases when interest rates rise
- **PAC tranches:** receive guaranteed principal payments as long as prepayment speeds remain within a predetermined range

Discussion Questions

1. Using Merton's structural approach, explain how the following changes would affect the fair value of a firm's credit-risky debt relative to similar risk-free debt:
   - Increased borrowing
   - Increased volatility of the firm's assets
   - Longer maturity of borrowings
   - A fall in firm asset value

Discussion Questions

2. Explain how an unexpected rise in interest rates will likely impact the following MBS structures:
   A. IO strip
   B. Senior tranche of sequential-pay CMO
   C. Support tranche of PAC structure

Discussion Questions Answers

1.

- *Increased borrowings will increase the strike price of the put option:* increase put value and decrease value of credit-risky debt relative to risk-free debt
- *Increasing asset volatility:* increase put value and decrease value of credit-risky debt relative to risk-free debt
- *Increasing maturity will increase time to expiry:* increase put value and decrease value of credit-risky debt relative to risk-free debt
- *Underlying asset value falls:* increase put value and decrease value of credit-risky debt relative to risk-free debt

Discussion Questions Answers

2.

A. **IO strip:** rise in interest rates will likely lead to slower prepayment speeds; principal underlying strips will be outstanding for longer, meaning more interest payments

B. **Senior tranche of sequential-pay CMO:** protected from extension risk by the junior tranches in a slower prepayment speed environment

C. **Support tranche of PAC structure:** will have to absorb lower prepayment speeds by sacrificing some cash flows originally scheduled and providing them to the PAC tranche, thereby protecting the PAC tranche from extension risk

Credit Risk and Credit Derivatives

Need to Know Concepts

- Pricing bonds using the reduced-form model (calculation)
  - Advantages and disadvantages of approach
- Three groupings of credit derivatives
- Four stages of credit derivatives activity
- Mechanics of interest rate swaps
- Mechanics of total return swaps
- Mechanics of **credit default swaps**
  - CDS terms
  - Methods of unwinding CDS positions
  - Motivations and risks of CDS contracts
- Other contracts:
  - Credit options, options on CDS contracts, and credit-linked notes

Credit Risk Models

- **Structural models:** incorporate characteristics of firm including structure of cash flows and underlying asset behavior (discussed in previous Reading)
- **Reduced-form models:** focus on default probabilities based on observations of market data of similar risk securities

Expected Loss Due To Credit Risk

Expected Credit Loss

probability of default×exposure at default×loss given default

or

PD×EAD×LGD

LGD = 1 – recovery rate (RR)

Example: Reduced-Form Model

A bank has made a one-year loan of $10 million at an interest rate of 12%. Bonds with a similar credit rating have a probability of default of 4%, and recovery rates are 12 cents on the dollar. What is the expected credit loss?

Solution: Reduced-Form Model

PD = 4%

EAD = $10 million × (1.12) = $11.2 million

LGD = 1 – 0.12 = 0.88

Expected credit loss = 0.04 × $11.2 million × 0.88 = $394,240

Reduced-Form Model

Infers market's expectation of default from the prices of liquid securities

For a credit spread, s (expression 1):

$$B(0,1) = \frac{K}{1 + r + s}$$

For a risk-neutral probability of default, λ, applying a binomial approach (expression 2):

$$B(0,1) = \lambda \frac{K \times RR}{1 + r} + (1 - \lambda)\frac{K}{1 + r}$$

Reduced-Form Model

- Expressions 1 and 2 must be equal, which implies:

$$\lambda = \frac{1}{1 - RR}\left(\frac{s}{1 + r + s}\right)$$

- If the short-term rate and credit spread are not large, the denominator expression can be *approximated* by:

$$\lambda \approx \frac{s}{1 - RR}$$

Example: Reduced-Form Model

Given the following information, **calculate** the risk-neutral probability of default.

- One-year risk-free rate = 6%
- One-year, zero-coupon bond yield = 8%
- Historical recovery rate = 50%

Solution: Reduced-Form Model

$$\lambda = \frac{1}{1 - RR}\left(\frac{s}{1 + r + s}\right) = \frac{1}{1 - 0.50}\left(\frac{0.02}{1 + 0.06 + 0.02}\right) = 3.70\%$$

$$\lambda \approx \frac{s}{1 - RR} = \frac{0.02}{1 - 0.5} = 4\%$$

Example: Approximate Credit Spread

Assume there is a credit-risky, one-year, zero-coupon bond and the one-year risk-free rate is 5%. The historical recovery rate for credit-risky bonds with the same credit rating is 60%, and the estimated risk-neutral probability of default is 8%.

Calculate the approximate credit spread for the risky bond.

Solution: Approximate Credit Spread

Using the approximation:

$S \approx \lambda \times (1 - RR) = 8\% \times (1 - 60\%) = 3.2\%$

Reduced-Form Model

Advantages:

- Can be calibrated using CDS spreads
- Flexibility
  - Can easily price derivatives and portfolios
  - Can adjust for credit rating changes
  - Does not require balance sheet information

Disadvantages:

- Potential lack of adequate market data needed to calibrate model
- Sensitivity to key assumptions
- Limited historical default rates
- No guarantee that historical default rates represent future default rates

Credit Derivatives

Uses:
Transferring credit risk, providing liquidity and price revelation

- Single-name vs. multiname
- Funded vs. unfunded
- Sovereign vs. nonsovereign

Stages of Market Development

1. **Defensive Stage (late 1980s–early 1990s)**
   - Attempts to develop methods to reduce credit exposures of banks
2. **Emergence of Intermediaries (1991–late 1990s)**
   - Total return swaps and synthetic credit products created
3. **Development of Regulations (late 1990s–2002)**
   - ISDA created the Master Agreement of 1999; market matures
4. **Liquid Market (2003–present)**
   - Index trading; hedge funds enter market
   - Push for exchange trading and clearing

Interest Rate Swaps

Fixed rate *swap rate*

Pay fixed → **Receive fixed**

Pay fixed ← **Receive fixed**

Floating rate

Rationale:

- **Comparative advantage:** borrow where funds are cheapest, enter swap to get desired interest rate exposure
- **Hedge** interest rate exposure (fixed liabilities → receive fixed)
- **Speculate** on interest rates moving (rates↑ → pay fixed wins)

Interest Rate Swaps

- **Swap mechanics:**
  - Fixed/floating payments netted off
  - Rate differential applied to pre-agreed *notional* principal (does not change hands)
  - Floating rates are known in advance, *paid in arrears*
  - Don’t forget to deannualize quoted rates for periodicity

Example: Interest Rate Swaps

- PFX Fund enters into a $10m four-year semi-annual pay fixed swap with a swap rate of 3% on January 1, 2020. Selected six-month LIBOR rates are displayed below:

Date	6-Month LIBOR
Jan. 1, 2020	2.50%
July 1, 2020	3.25%
Jan. 1, 2021	3.00%

- What are the net payments made on the dates in the table above?

Solution: Interest Rate Swaps

Date	6-Month LIBOR	Payment to PFX (Pay 3% Fixed)
Jan. 1, 2020	2.50%	No payment necessary to enter swap
July 1, 2020	3.25%	[0.025 − 0.03] × (1/2) × $10m = −$25,000
Jan. 1, 2021	3.0%	[0.0325 − 0.03] × (1/2) × $10m = $12,500

Valuing a Swap

V_{swap} (pay fixed) = PV(floating payments) – PV(fixed payments)

- Value of swap is *zero* at initiation if swap is fairly priced
- **Example:** PSN fund enters into $10m one-year semiannual receive fixed swap priced at 1.5%. Current term structure of interest rates is displayed below. What is the value of the swap?

Six-Month Period	Future LIBOR at Start of Period	Deannualized Future LIBOR at Start of Period
1	1.000%	0.5000%
2	2.005%	1.0025%

Valuing a Swap

Period	Future LIBOR at Start of Period	Deannualized Future LIBOR at Start of Period	Floating Payment End of Period	Fixed Payment End of Period (Based on 1.5%)	Net Payment to Receive Fixed Side	Discount Factor*	PV of Net Payment (Receive Fixed)
1	1.000%	0.5000%	$50,000	$75,000	+$25,000	0.99502	+$24,875.62
2	2.005%	1.0025%	$100,250	$75,000	−$25,250	0.98515	−$24,875.00

Net value of swap is close to **zero** → swap is priced fairly

*Time 1 Discount Factor = 1/(1.005) = 0.99502
Time 2 Discount Factor = 1/(1.005)(1.010025) = 0.98515

Valuing a Swap

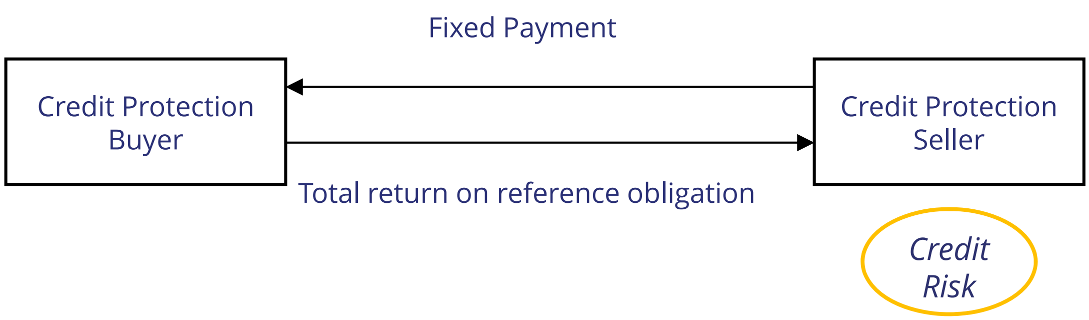
V_{swap} (pay fixed) = PV(floating payments) – PV(fixed payments)

- Value of swap *after* initiation is **nonzero**
- Rates UP → Pay fixed profits, receive fixed loses

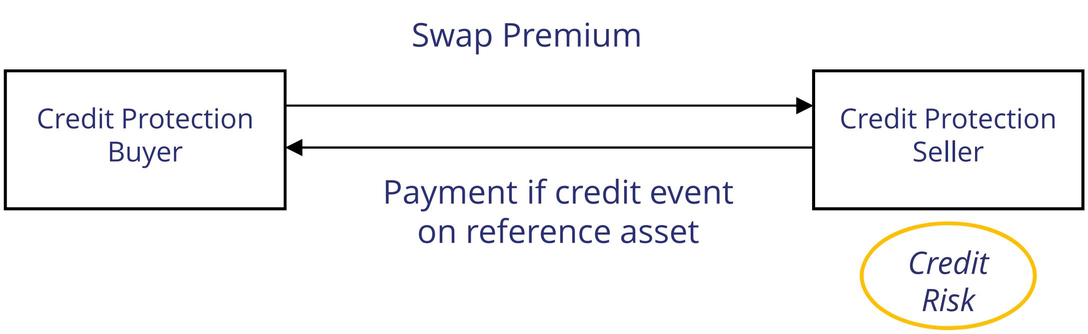
Interest Rate Swaps: Risks

- **Credit risk:** party making money faces risk of default by the other side; managed through collateral provisions and diversification
- **Interest rate risk:** unexpected movements in rates can cause large mark-to-market losses
- **Post 2008 crisis:**
    - LIBOR no longer considered a risk-free rate for collateralized swap position
    - Overnight indexed swap rates now considered more appropriate for valuing collateralized contracts

Total Return Swaps (TRS)



Credit Default Swaps (CDS)



CDS Terms

- Referenced asset
- CDS spread (premium)
- Contract size and maturity
- Payment trigger events:
  - Bankruptcy, failure to pay, restructuring, obligation acceleration, obligation default (technical default), repudiation/moratorium by sovereign, government intervention
- Method of settlement: cash vs. physical
- Choice of assets to deliver

Example: Credit Default Swap

In reviewing its credit exposures, an investment bank has decided that it has too much exposure to client X. The bank decides to transfer the risk via a CDS. The bank chooses one of X's senior unsecured bonds as a reference and sets the notional amount at $8 million. The bank finds a hedge fund to serve as a counterparty for a five-year swap with a 125 bps credit spread.

- What is the amount of the quarterly payment to be made by the credit protection buyer?
- In the event of a default, what payments will occur?

Solution: Credit Default Swap

Quarterly payment made by the credit protection buyer (i.e., the investment bank) = \$8 million × (1.25% / 4) = \$25,000

In the event of a default:

- Credit protection buyer delivers \$8 million in face value of a qualifying bond issued by client X.
- Credit protection seller (i.e., the hedge fund) pays the credit protection buyer \$8 million in cash.

CDS Positions: Other Issues

Market Participants

- Banks
- Hedge funds
- Asset managers
- Insurance companies
- Corporations

Valuing a CDS

- Protection buyer wins if CDS spread increases
- MTM = PV (difference in fixed payments adjusted for probability contract is terminated early due to trigger event)

CDS Indices

- Baskets of single-name CDSs
- CDX (U.S.) and iTraxx (Europe & Asia)

Unwinding a CDS

- Offsetting position
- Novation (assignment)
- Contract termination

CDS Positions: Other Issues

Motivation for CDS
- Isolate credit risk
- Easy to short credit positions
- Synthetic exposure
- Link bond, loan, and equity markets
- Provide liquidity

Risks of Credit Derivatives
- Excessive leverage
- Pricing/model risk
- Liquidity risk
- Counterparty risk
- Basis risk

Other Credit Derivatives

- Credit call options (underlying = spread)
- Credit put options (underlying = bond)

Potentially pays out on credit *event*

- Call option on a CDS
  - Holder can enter CDS contract at strike rate

- Credit-linked notes
  - Bonds issued with embedded derivative selling protection

Select Keyword Review

Define these keywords and describe their role in the reading:

- **Assignment**
- **Hazard rate**
- **Standard ISDA agreement**
- **Unfunded credit derivatives**

Select Keyword Review

- **Assignment:** when one party to a contract reaches an agreement with a third party to take over all rights and obligations to a contract (also called novation)
- **Hazard rate:** term often used in the context of reduced form models to denote the default rate
- **Standard ISDA agreement:** a template to negotiated credit agreements that contains commonly used provisions used by market participants
- **Unfunded credit derivatives:** involve exchanges of payments that are tied to a notional amount, but the notional amount does not change hands until a default occurs (e.g., CDS)

Discussion Questions

1. The senior debt of GLA Corporation currently trades at a credit spread of 0.50% over similar risk-free bonds. The expected recovery rate of the senior debt is 80%.

   If the company issues junior debt with an expected recovery rate of 40%, what arbitrage-free credit spread should be expected on this debt issue?

Discussion Questions

2. The receiver of the fixed leg in a CDS is the party facing credit risk. True or false?
3. The payer of the fixed leg in a TRS is the party facing credit risk. True or false?
4. When credit conditions improve, the party paying the premium in the CDS will profit. True or false?

Discussion Questions Answers

1.

- Using approximate reduced-form model formula: probability of default = credit spread / (1 – recovery rate)
- Senior debt implies probability of default equals: 0.005 / (1 – 0.8) = 0.025 or 2.5%
- Hence, for the junior debt, credit spread equals: 0.025 × (1 – 0.4) = 0.015 or 1.5%

Discussion Questions Answers

2. *True*. The fixed leg is the regular premium. This is received by the protection seller.
3. *True*. The payer of the fixed leg in a TRS in return receives the total return of the reference asset and, therefore, faces the credit risk.
4. *False*. When credit conditions improve, CDS premiums fall and the party paying the fixed premium will suffer losses should the position be marked to market.

CDO Structuring of Credit Risk

Need to Know Concepts

- CDO terminology and option view
- Structure of CDO cash flows (calculation)
- Motivation: balance sheet vs. arbitrage
- Structure: cash-funded vs. synthetic
- Management: cash flow vs. market value
- Leverage: funded vs. unfunded

Collateralized Debt Obligations

Structuring cash flows from collateral into tranches.

CDO Assets

Underlying collateral

High-yield bonds

Average coupon: 8%

Amount: $100 million

Cash Flows

Senior Tranche
$60 million
AAA rated
4% coupon

Mezzanine Tranche
$25 million
BBB rated
9% coupon

Equity Tranche
$15 million
Unrated

Cash Flow Waterfall

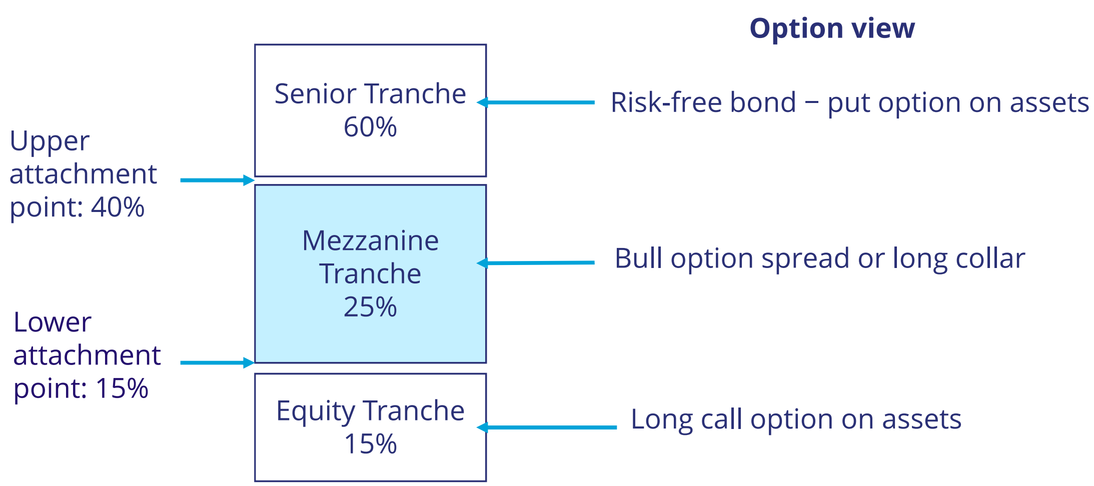
Example: CDOs

Calculate the following:

- Coupon income from collateral
- Cash flow to senior tranche
- Cash flow to mezzanine tranche
- Cash flow to equity tranche

If collateral defaults equal $20 million with no recovery, what is the impact on the CDO tranches?

CDO Terminology



CDO Motivations

1. Risk management
2. Return enhancement
3. Diversification
4. Relaxing regulatory constraints
5. Access to superior management
6. Liquidity enhancement

CDO Terminology

CDO Lifecycle

1. Ramp-up period
2. Revolving period
3. Amortization period

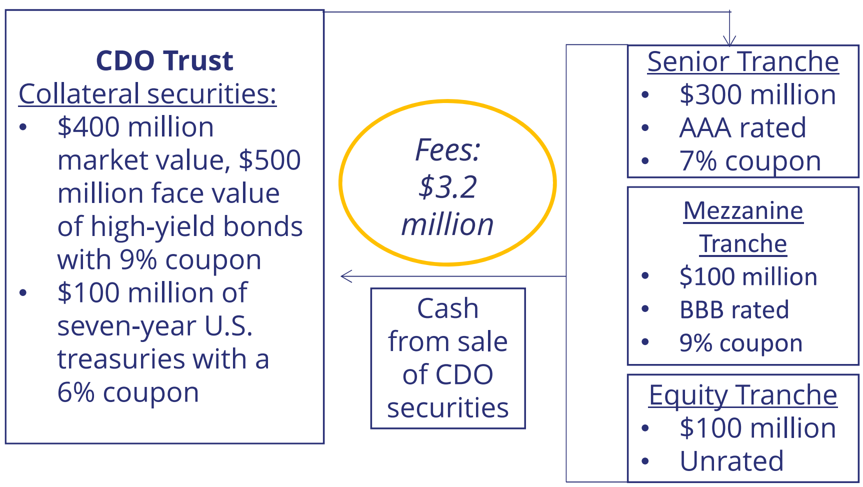
Pool Features

- Weighted average rating factor (WARF)
- Weighted average spread (WAS)
- Diversity score

Types of CDOs

- Balance sheet CDOs
  - Cash-funded CDOs
  - Synthetic CDOs
    - Funded CDOs
    - Unfunded CDOs
- Arbitrage CDOs
  - Cash flow CDOs
  - Market value CDOs
  - Synthetic CDOs
    - Funded CDOs
    - Unfunded CDOs

Example: Arbitrage CDO



Solution: Arbitrage CDO

- Annual income from the collateral securities:
  $500 million × 9% + $100 million × 6% = $51 million
- After paying the $3.2 million in fees, assuming there are no defaults, there is $47.8 million to distribute to the investors.
  - Senior tranche will receive $21 million (= $300 million × 7%)
  - Mezzanine tranche will receive $9 million (= $100 million × 9%)
  - Equity tranche will receive remaining $17.8 million, representing a 17.8% return.
- Note that a small default rate of 5% in the high-yield collateral securities would wipe out 20% of the equity tranche.

Example: Cash-Funded CDO

A bank has $300 million in commercial loans.

1. If the regulatory capital requirement is 8% of the loan balance, how much regulatory capital would the bank free up by securitizing the loans?
2. If the bank retains a $5 million equity tranche and is required to hold regulatory capital one-for-one on this tranche, how much regulatory capital would the bank free up?

Solution: Cash-Funded CDO

1. The bank would free up $24 million (= $300 million × 8%) by removing the loans from its balance sheet.
2. The requirement to hold the equity tranche would result in the bank being able to free up $19 million (= $300 million × 8% – $5 million) in regulatory capital.

Cash-Funded vs. Synthetic CDOs

1. Ownership
   - Cash-funded—ownership of assets transferred to SPV
   - Synthetic—bank transfers assets' risks through credit derivatives, but retains legal ownership
2. If CDO is funded, use of proceeds from sale of tranche securities:
   - Cash-funded—purchases loans and bonds, which are used as collateral
   - Synthetic—purchase U.S. Treasury securities, which are used to fund swap payments to bank

Credit Enhancement

Internal

- Subordination
- Overcollateralization
- Spread enhancement
- Reserve account

External

- Insurance
- Credit protection
  - CDS
  - Credit put option

Other CDO Issues

New developments in CDOs:
- Distressed debt CDOs
- Hedge fund CDOs
- Single-tranche CDOs

Risk shifting:
Collateral risk increased → wealth transfer from senior to junior tranches

Risks of CDOs:
- Underlying collateral
- Financial engineering
- Correlation risk
- Basis
- Credit spread compression
- Yield curve shape

Select Keyword Review

Define these keywords and describe their role in the reading:
- **Bankruptcy remote**
- **Copula approach**
- **Sponsor of the trust**
- **Tranche width**

Select Keyword Review

- **Bankruptcy remote:** assets held by the SPV are secure from any financial difficulties suffered by the bank or brokerage firm sponsoring the CDO
- **Copula approach:** incorporated the interdependency between the underlying portfolio securities when modeling defaults
- **Sponsor of the trust:** forms the CDO and must bear the burden of the administrative and legal costs of the trust; typically a bank
- **Tranche width:** percentage of the CDO's capital structure that is attributable to a particular tranche

Discussion Questions

1. A CDO trust with assets of $200 million issues three tranches: (1) senior tranche, which consists of $135 million of securities, (2) tranche B, which consists of $50 million of subordinated fixed-income securities, and a (3) $15 million equity tranche. **Calculate** the overcollateralization rate for the senior tranche.
2. What is the difference between a cash-funded CDO and a synthetic CDO?
3. Explain how a CDO trust would use a CDS contract in a synthetic CDO structure.

Discussion Questions Answers

1. The overcollateralization of the senior tranche is the total amount of collateral versus the par amount outstanding for the senior tranche. This is \$200 million / \$135 million = 148%.
2. Under a cash-funded CDO, the CDO trust physically purchases collateral from the originating bank. Under a synthetic CDO, the originating bank retains legal ownership of the collateral and credit risk is transferred to the CDO trust using credit derivatives.
3. A CDO trust would sell protection under a CDS contract in order to gain exposure to the credit risk of the collateral.

Equity-Linked Structured Products

Need to Know Concepts

- Six types of wrapper, four potential tax effects of wrappers (calculations)
- Exotic option types: Asian, binary, and barrier option payoffs
- EUSIPA structured product classifications
  - 4x capital protection products
  - 2x yield enhancement products
  - 2x participation products
  - 4x leverage products
- Examples of structured products:
  - Multiple kinks, sprint, absolute return, and power reverse dual currency notes

Equity-Linked Structured Products

- Meet preferences of investors, generate fees for issuers
- Generally not collateralized
- Rarely serve as simply a pass-through security

Example:

Certificate of deposit issued by a bank offering a low guaranteed minimum interest rate, plus 33% participation in any positive performance of the S&P 500 over the next five years

Six Types of Wrappers

1. OTC contracts
2. Medium-term notes/certificates/warrants
3. Funds
4. Life insurance policies
5. Structured deposits
6. Islamic wrappers

Four Potential Tax Effects of Wrappers

- **Tax-free**
  - After-tax return = pretax return
- **Fully taxed**
  - After-tax return = pretax return × (1 – tax rate)
- **Tax deferral**
  - Contribute post-tax, grow tax free, taxed on profits at end
- **Tax deferral and deduction**
  - Contribute tax free, grow tax free, taxed on whole amount at end

Example: Tax Effects of Wrappers

An investor places $1,000 in an investment account for 10 years. The pretax return of the account is 6%. What is the final post-tax value of the portfolio and after-tax rate of return under the following tax wrappers?

- Tax free
- Fully taxed (80% of return is income taxed at 40%; 20% is capital gain taxed at 60% of income tax rate)
- Tax deferral at a rate of 40%
- Tax deferral and tax deduction (current tax rate 40%; anticipated tax rate 20%)

Solution: Tax Effects of Wrappers

- **Tax-free**
  - Investment will grow to $\$1{,}000(1.06)^{10} = \$1{,}790.85$
  - After-tax return = pre-tax return = 6%
- **Fully taxed (80% of return is income taxed at 40%; 20% is capital gain taxed at 60% of income tax rate)**
  - Post-tax income return = 6% × 0.8 × (1 – 0.4) = 2.88%
  - Post-tax capital gain return = 6% × 0.2 × (1 – (0.6 × 0.4)) = 0.912%
  - Total post-tax return = 2.88% + 0.912% = 3.792%
  - Investment will grow to after-tax value of $\$1{,}000(1.03792)^{10} = \$1{,}450.90$

Solution: Tax Effects of Wrappers

- **Tax-deferral at a rate of 40%**
  - Investment grows tax-free to $\$1{,}000(1.06)^{10} = \$1{,}790.85$
  - Pretax gain: $1,790.85 – $1,000 = $790.85
  - Post-tax gain: $790.85 × (1 – 0.4) = $474.51
  - After-tax value = $1,000 + $474.51 = $1,474.51
  - After-tax return = $(\$1{,}474.51 / \$1{,}000)^{(1/10)} - 1 = 3.96\%$

Solution: Tax Effects of Wrappers

- **Tax-deferral and tax deduction (current tax rate 40%; anticipated tax rate 20%)**
  - Investment of $1,000 is made tax-free, therefore is grossed up to $1,000 / (1 – 0.4) = $1,666.67
  - This will grow tax free to $\$1{,}666.67(1.06)^{10} = \$2{,}984.75$
  - Post-tax future value = $2,984.75(1 – 0.2) = $2,387.80
  - After-tax return = $(\$2{,}387.80 / \$1{,}000)^{(1/10)} - 1 = 9.09\%$

Exotic Options

- **Asian Options**
  - Payoff based on *average price* vs. strike
- **Binary Options**
  - Pay fixed amount if price > strike (call) or < strike (put)
- **Spread Options**
  - Payoff depends on difference between two prices or rates
- **Look-Back Options**
  - Payoff based on min./max. over life of option (expensive)
- **Quanto Options**
  - Payoff in different currency to underlying asset

Exotic Options

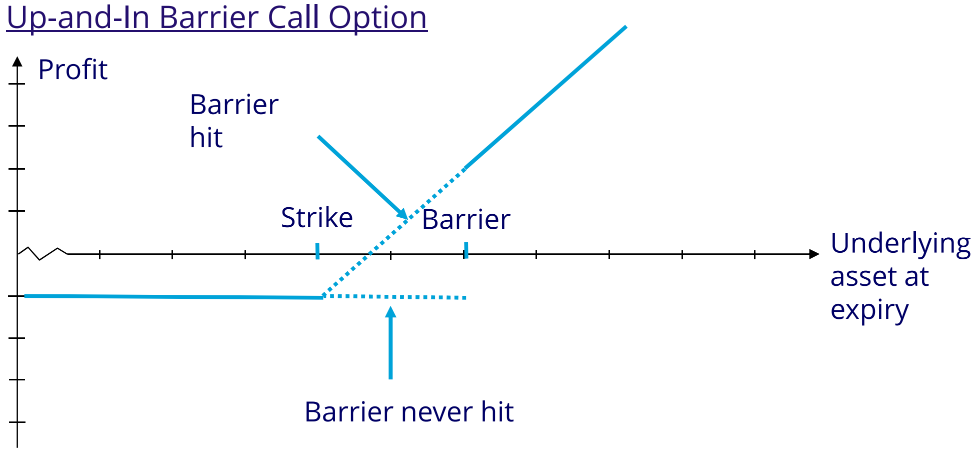
Barrier Options

- Knock-in: becomes active if underlying hits barrier
- Knock-out: becomes inactive if underlying hits barrier

	Barrier > Underlying	Barrier < Underlying
Knock-in	Up-and-in call or put	Down-and-in call or put
Knock-out	Up-and-out call or out	Down-and-out call or put

Option Exposures

Up-and-In Barrier Call Option



Example: Exotic Options

- Asset Price: $50
- European knock-in call option:
  - Strike $60
  - Barrier $40

Describe the payoff under the following scenarios:

1. The asset increases to $70.
2. The asset declines to $39, then rises to $60.

Solution: Exotic Options

1. **The asset increases to $70.**

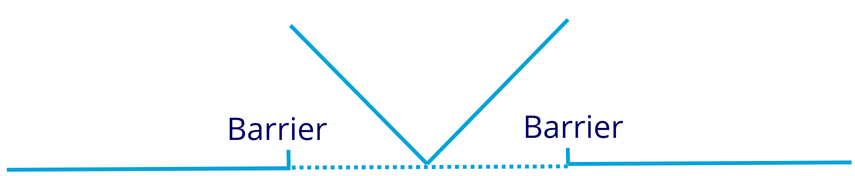
   The option never hits the barrier, so it never becomes active and expires worthless.

2. **The asset declines to $39, then rises to $60.**

   The option becomes active since the barrier is hit; however, the option expires worthless since it is not in the money at expiration.

Equity-Linked Structured Products

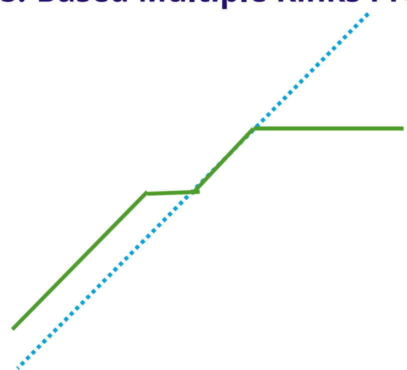
Absolute Return Product



ATM Up-and-Out Call + ATM Down-and-Out Put

Equity-Linked Structured Products

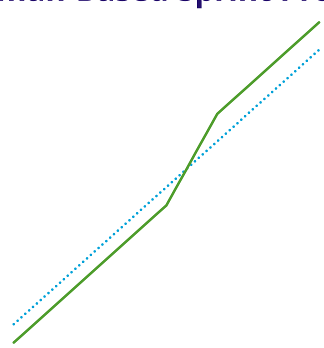
U.S.-Based Multiple Kinks Product



Underlying Asset + Bear Put Spread – OTM Call

Equity-Linked Structured Products

German-Based Sprint Product



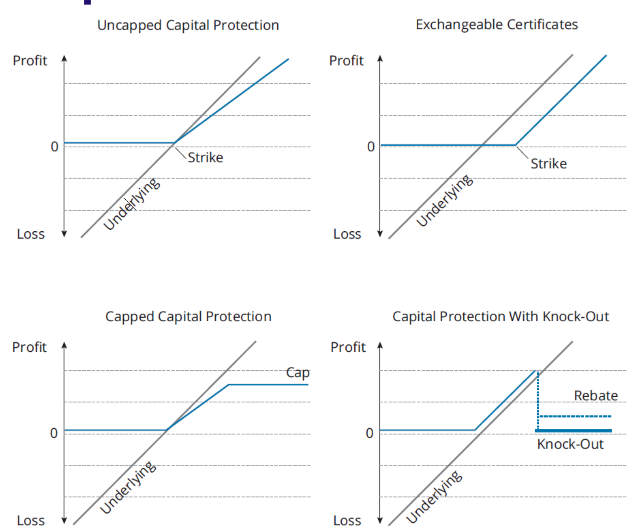
Underlying Asset + Bull Spread

Equity-Linked Structured Products

Japan-Based Power Reverse Dual Currency Note Product

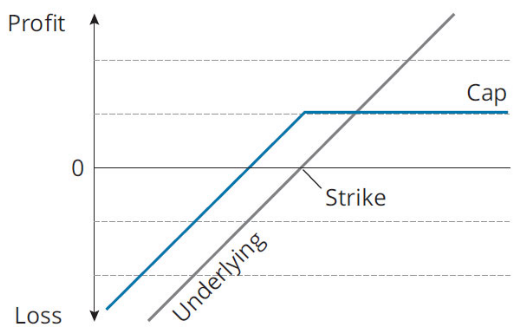
- Investor *pays* interest based on domestic interest rate, *receives* interest based on foreign interest rate
- If foreign currency strengthens, coupon rate received increases
- *Leveraged carry trade*

EUSIPA: Capital Protection Products

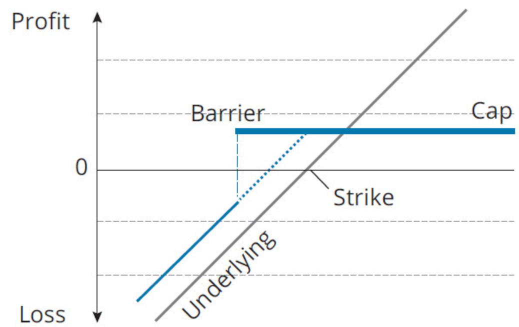


EUSIPA: Yield Enhancement Products

Discount Certificates

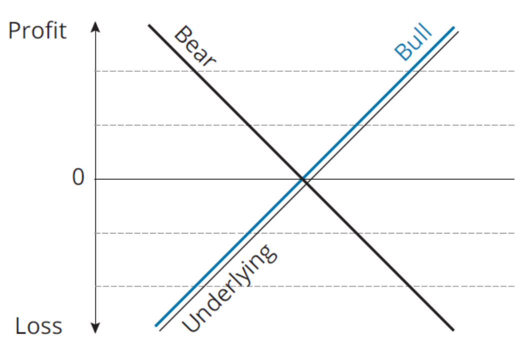


Barrier Discount Certificates

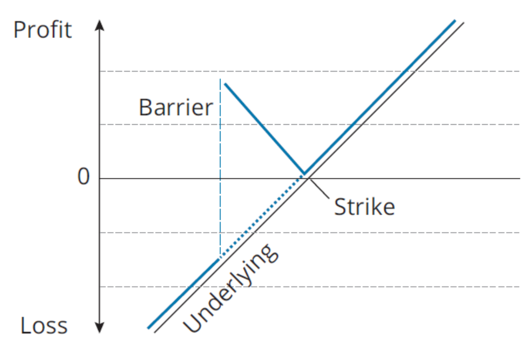


EUSIPA: Participation Products

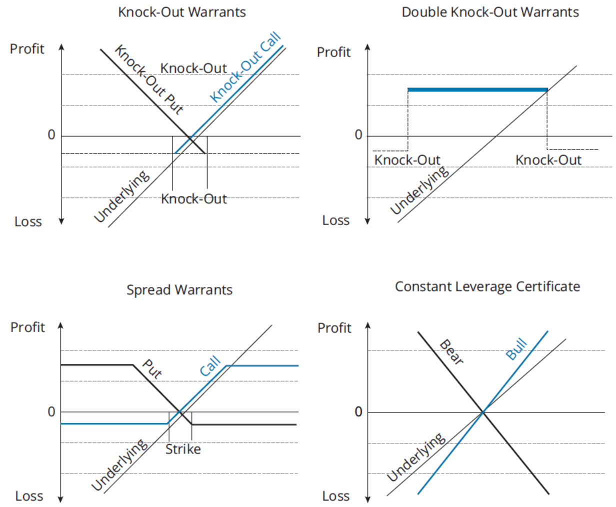
Tracker Certificates



Twin-Win Certificates



EUSIPA: Leverage Products



Structured Products Pricing

1. **Partial differential equations (PDEs)**
   - Establish solutions based on *boundary conditions*
   - Solved *analytically* (Black Scholes) or *numerically*
2. **Monte Carlo simulation**
   - Simulate paths of underlying asset
3. **Building blocks approach**
   - Replication using underlying asset and simple options

Principles of Payoffs

1. Any payoff diagram *shape* can be constructed given a sufficient availability of options.
   - Slopes mimicked using simple options
   - Jumps mimicked using binary option
2. The payoff diagram *level* dictates whether product is attractive.

Select Keyword Review

Define these keywords and describe their role in the reading:

- **Cash-and-call strategy**
- **Dynamic hedging**
- **Overconfidence bias**
- **Participation rate**

Select Keyword Review

- **Cash-and-call strategy:** long position in cash, or a zero coupon bond combined with a long position in a call option
- **Dynamic hedging:** when the portfolio weights must be altered through time to maintain a desired risk exposure, such as zero risk
- **Overconfidence bias:** a tendency to overestimate the true accuracy of one's beliefs and predictions
- **Participation rate:** indicates the ratio of the product's payout to the value of the underlying asset

Discussion Questions

1. Under a tax wrapper with tax deferral and tax deduction, the after-tax return can exceed the pre-tax return. True or false?

2. A cash-and-call strategy offers principal protection after five years plus participation in the upside of the U.K. FTSE 100 index. If five-year zero coupon rates are 3%, what is the value of the call option embedded in the strategy?

Discussion Questions Answers

1. True. Under a tax wrapper with tax deferral and tax deduction, the after-tax return can exceed the pretax return, when tax rates decline between contribution and withdrawal ($T_N < T_0$).

2. Value of zero coupon bonds = $1,000 / $(1.03)^5$ = $862.61
   Value invested in call option = $1,000 − $862.61 = $137.39