The following is a review of the Ethical and Professional Standards principles designed to address the learning outcome statements set forth by CFA Institute®. This topic is also covered in:

CFA Institute Code of Ethics and Standards of Professional Conduct and Guidance Statements for Standards I-VII

Study Session 1

Exam Focus

You should note that for the 2006 exams, a new 9th edition of the *Standards of Practice Handbook* will be in effect[1]. There are significant revisions, restructurings, additions, and deletions in this edition that we will point out in this topic review.

In addition to reading this review of the ethics material, we strongly recommend that all candidates for the CFA® examination *purchase* their own copy of the *Standards of Practice Handbook 9th Edition* (2005) and read it multiple times. As a registered candidate, it is your responsibility to own an original copy of the *Code and Standards* and to comply with the *Code and Standards*.

Brief Summary of Changes

- The Standards have been reorganized to eliminate duplication and improve clarity.
- Some Standards have been revised and expanded to better address current issues in the investment profession. Examples include misrepresentation, duty to employer, suitability, duty of loyalty to clients, disclosure of conflicts, and the use of material nonpublic information.
- A new Standard has been added to address market manipulation and record retention.
- There is no longer a requirement to inform employers of the Code and Standards.
- Previously the Code and Standards were centered around U.S. laws. Now certain Standards are less U.S.-centric. Examples include the use of material nonpublic information and fiduciary duty.
- It has been more clearly stated that all Standards apply to both Members and Candidates.

CFA Institute Code of Ethics and Standards of Professional Conduct

LOS 1: "Code of Ethics and Standards of Professional Conduct."

The Code of Ethics establishes the framework for ethical decision making in the investment profession. The candidate should be able to state the six components of the Code of Ethics.

Code of Ethics

Members of CFA Institute [including Chartered Financial Analyst® (CFA®) charterholders] and candidates for the CFA designation ("Members and Candidates") must:[2]

Professor's Note: Major changes are in italics.

1. The new Code and Standards are effective as of January 1, 2006.
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- Act with integrity, competence, *diligence, respect*, and in an ethical manner with the public, clients, prospective clients, employers, employees, *colleagues in the investment profession, and other participants in the global capital markets*.
- *Place the integrity of the investment profession and the interests of clients above their own personal interests*.
- Use reasonable care and exercise independent professional judgment *when conducting investment analysis, making investment recommendations, taking investment actions, and engaging in other professional activities*.
- Practice and encourage others to practice in a professional and ethical manner that will reflect credit on themselves and the profession.
- *Promote the integrity of, and uphold the rules governing, capital markets*.
- Maintain and improve their professional competence and strive to maintain and improve the competence of other investment professionals.

The Standards of Professional Conduct are organized into seven standards:

I: Professionalism
II: Integrity of Capital Markets
III: Duties to Clients
IV: Duties to Employers
V: Investment Analysis, Recommendations, and Action
VI: Conflicts of Interest
VII: Responsibilities as a CFA Institute Member or CFA Candidate

Each Standard contains multiple provisions for which the candidate is responsible. The candidate should be able to identify the ethical responsibilities required by the Code and Standards.

LOS 2: "Guidance Statements for Standards I–VII."

The Guidance addresses the application of the Code and Standards. For each standard, the Guidance offers application of the standard, presents recommended procedures for compliance, and provides examples of the standard in practice.

The candidate should be able to interpret the Code and Standards in the context of specific situation, explain the application of the Code and Standards in situations that present multiple issues of questionable professional conduct, and identify violations of the Code and Standards.

Standards of Professional Conduct[3]

Professor's Note: Major changes are in italics.

I. PROFESSIONALISM

A. Knowledge of the Law. Members and Candidates must understand and comply with all applicable laws, rules, and regulations (including the CFA Institute *Code of Ethics* and *Standards of Professional Conduct*) of any government, regulatory organization, licensing agency, or professional association

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governing their professional activities. In the event of conflict, Members and Candidates must comply with the more strict law, rule, or regulation. Members and Candidates must not knowingly participate or assist in any violation of laws, rules, or regulations and *must disassociate themselves from any such violation*.

B. Independence and Objectivity. Members and Candidates must use reasonable care and judgment to achieve and maintain independence and objectivity in their professional activities. Members and Candidates must not offer, solicit, or accept any gift, benefit, compensation, or consideration that reasonably could be expected to compromise their own or another's independence and objectivity.

C. Misrepresentation. Members and Candidates must not knowingly make any misrepresentations relating to investment analysis, recommendations, actions, or other professional activities.

D. Misconduct. *Members and Candidates must not engage in any professional conduct involving dishonesty, fraud, or deceit or commit any act that reflects adversely on their professional reputation, integrity, or competence*.

II. INTEGRITY OF CAPITAL MARKETS

A. Material Nonpublic Information. Members and Candidates who possess material nonpublic information that could affect the value of an investment must not act or cause others to act on the information.

B. Market Manipulation. *Members and Candidates must not engage in practices that distort prices or artificially inflate trading volume with the intent to mislead market participants*.

III. DUTIES TO CLIENTS

A. Loyalty, Prudence, and Care. Members and Candidates have a duty of loyalty to their clients and must act with reasonable care and exercise prudent judgment. Members and Candidates must act for the benefit of their clients and place their clients' interests before their employer's or their own interests. In relationships with clients, Members and Candidates must determine applicable fiduciary duty and must comply with such duty to persons and interests to whom it is owed.

B. Fair Dealing. Members and Candidates must deal fairly and objectively with all clients when providing investment analysis, making investment recommendations, taking investment action, or engaging in other professional activities.

C. Suitability.

1. When Members and Candidates are in an advisory relationship with a client, they must:

   a. Make a reasonable inquiry into a client's or prospective clients' investment experience, risk and return objectives, and financial constraints prior to making any investment recommendation or taking investment action and must reassess and update this information regularly.

   b. Determine that an investment is suitable to the client's financial situation and consistent with the client's written objectives, mandates, and constraints before making an investment recommendation or taking investment action.

   c. Judge the suitability of investments in the context of the client's total portfolio.

2. When Members and Candidates are responsible for managing a portfolio to a specific mandate, strategy, or style, they must make only investment recommendations or take investment actions that are consistent with the stated objectives and constraints of the portfolio.

D. Performance Presentation. When communicating investment performance information, Members or Candidates must make reasonable efforts to ensure that it is fair, accurate, and complete.

E. Preservation of Confidentiality. Members and Candidates must keep information about current, former, and prospective clients confidential unless:

1. The information concerns illegal activities on the part of the client or prospective client,

2. Disclosure is required by law, or

3. The client or prospective client permits disclosure of the information.

IV. DUTIES TO EMPLOYERS

A. Loyalty. In matters related to their employment, Members and Candidates must act for the benefit of their employer and *not deprive their employer of the advantage of their skills and abilities, divulge confidential information*, or otherwise cause harm to their employer.

B. Additional Compensation Arrangements. Members and Candidates *must not accept gifts, benefits, compensation, or consideration that competes with, or might reasonably be expected to create a conflict of interest with, their employer's interest unless they obtain written consent from all parties involved.*

C. Responsibilities of Supervisors. Members and Candidates must make reasonable efforts to detect and prevent violations of applicable laws, rules, regulations, and the Code and Standards by anyone subject to their supervision or authority.

V. INVESTMENT ANALYSIS, RECOMMENDATIONS, AND ACTION

A. Diligence and Reasonable Basis. Members and Candidates must:

1. Exercise diligence, independence, and thoroughness in analyzing investments, making investment recommendations, and taking investment actions.

2. Have a reasonable and adequate basis, supported by appropriate research and investigation, for any investment analysis, recommendation, or action.

B. Communication with Clients and Prospective Clients. Members and Candidates must:

1. Disclose to clients and prospective clients the basic format and general principles of the investment processes used to analyze investments, select securities, and construct portfolios and must promptly disclose any changes that might materially affect those processes.

2. Use reasonable judgment in identifying which factors are important to their investment analyses, recommendations, or actions and include those factors in communications with clients and prospective clients.

3. Distinguish between fact and opinion in the presentation of investment analysis and recommendations.

C. **Record Retention.** Members and Candidates must develop and maintain appropriate records to support their investment analysis, recommendations, actions, and other investment-related communications with clients and prospective clients.

VI. CONFLICTS OF INTEREST

A. **Disclosure of Conflicts.** Members and Candidates must make full and fair disclosure of all matters that could reasonably be expected to impair their independence and objectivity or interfere with respective duties to their clients, prospective clients, and employer. Members and Candidates must ensure that such disclosures are prominent, are delivered in plain language, and communicate the relevant information effectively.

B. **Priority of Transactions.** Investment transactions for clients and employers must have priority over investment transactions in which a Member or Candidate is the beneficial owner.

C. **Referral Fees.** Members and Candidates must disclose to their employer, clients, and prospective clients, as appropriate, any compensation, consideration, or benefit received by, or paid to, others for the recommendation of products or services.

VII. RESPONSIBILITIES AS A CFA INSTITUTE MEMBER OR CFA CANDIDATE

A. **Conduct as Members and Candidates in the CFA Program.** *Members and Candidates must not engage in any conduct that compromises the reputation or integrity of CFA Institute or the CFA designation or the integrity, validity, or security of the CFA examinations.*

B. **Reference to CFA Institute, the CFA designation, and the CFA Program.** When referring to CFA Institute, CFA Institute membership, the CFA designation, or candidacy in the CFA Program, Members and Candidates must not misrepresent or exaggerate the meaning or implications of membership in CFA Institute, holding the CFA designation, or candidacy in the CFA Program.

STANDARDS OF PROFESSIONAL CONDUCT: GUIDANCE, COMPLIANCE, AND EXAMPLES

LOS 2: Guidance for Standards I–VII.

The guidance in the *Standards of Practice Handbook* addresses the application of the Standards of Professional Conduct. For each standard, the *Handbook* offers guidance for the standard, presents recommended procedures for compliance, and provides examples of the standard in practice. The candidate should be able to:

LOS 2.a: Demonstrate a thorough knowledge of the Standards of Professional Conduct by recognizing and applying the standards to specific situations.

LOS 2.b: Distinguish between conduct that conforms to the Code and Standards and conduct that violates the Code and the Standards.

I Professionalism

Professor's Note: While we use the term "members" in the following, note that all of the standards apply to candidates as well.

I(A) Knowledge of the Law. Members must understand and comply with laws, rules, regulations, and Code and Standards of any authority governing their activities. In the event of a conflict, follow the more strict law, rule, or regulation. Do not knowingly participate or assist in violations, and *dissociate from any known violation.*

Guidance—Code and Standards vs. Local Law

Members must know the laws and regulations relating to their professional activities in all countries in which they conduct business. Members must comply with applicable laws and regulations relating to their professional activity. Do not violate Code or Standards even if the activity is otherwise legal. Always adhere to the most strict rules and requirements (law or CFA Institute Standards) that apply.

Guidance—Participation or Association With Violations by Others

Members should dissociate, or separate themselves, from any ongoing client or employee activity that is illegal or unethical, even if it involves leaving an employer (an extreme case). While a member may confront the involved individual first, he must approach his supervisor or compliance department. Inaction with continued association may be construed as knowing participation.

Recommended Procedures for Compliance—Members

- Members should have procedures to keep up with changes in applicable laws, rules, and regulations.
- Compliance procedures should be reviewed on an ongoing basis to assure that they address current law, CFAI Standards, and regulations.
- Members should maintain current reference materials for employees to access in order to keep up to date on laws, rules, and regulations.
- Members should seek advice of counsel or their compliance department when in doubt.
- Members should document any violations when they disassociate themselves from prohibited activity and encourage their employers to bring an end to such activity.
- There is no requirement under the Standards to report violations to governmental authorities, but this may be advisable in some circumstances and required by law in others.

Recommended Procedures for Compliance—Firms

Members should encourage their firms to:

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

Application of Standard I(A) Knowledge of the Law[4]

Example 1:

Michael Allen works for a brokerage firm and is responsible for an underwriting of securities. A company official gives Allen information indicating that the financial statements Allen filed with the regulator overstate the issuer's earnings. Allen seeks the advice of the brokerage firm's general counsel, who states that it would be difficult for the regulator to prove that Allen has been involved in any wrongdoing.

Comment:

Although it is recommended that members and candidates seek the advice of legal counsel, the reliance on such advice does not absolve a member or candidate from the requirement to comply with the law or regulation. Allen should report this situation to his supervisor, seek an independent legal opinion, and determine whether the regulator should be notified of the error.

4. Selected Examples and Comments. Copyright 2005, CFA Institute. Reproduced and republished from "Standards of Practice Handbook," 9th ed., 2005, with permission from CFA Institute. All Rights Reserved.

Example 2:

Kamisha Washington's firm advertises its past performance record by showing the 10-year return of a composite of its client accounts. However, Washington discovers that the composite omits the performance of accounts that have left the firm during the 10-year period and that this omission has led to an inflated performance figure. Washington is asked to use promotional material that includes the erroneous performance number when soliciting business for the firm.

Comment:

Misrepresenting performance is a violation of the Code and Standards. Although she did not calculate the performance herself, Washington would be assisting in violating this standard if she were to use the inflated performance number when soliciting clients. She must dissociate herself from the activity. She can bring the misleading number to the attention of the person responsible for calculating performance, her supervisor, or the compliance department at her firm. If her firm is unwilling to recalculate performance, she must refrain from using the misleading promotional material and should notify the firm of her reasons. If the firm insists that she use the material, she should consider whether her obligation to dissociate from the activity would require her to seek other employment.

I(B) Independence and Objectivity. Use reasonable care to exercise independence and objectivity in professional activities. Members and Candidates are not to offer, solicit, or accept any gift, benefit, compensation, or consideration that would compromise either their own or someone else's independence and objectivity.

Professor's Note: It is made clearer than it was under the old Standards that gifts, benefits, and other consideration are prohibited if given in an attempt to influence Members or Candidates.

Guidance

Do not let the investment process be influenced by any external sources. Modest gifts are permitted. Allocation of shares in oversubscribed IPOs to personal accounts is NOT permitted. Distinguish between gifts from clients and gifts from entities seeking influence to the detriment of the client. Gifts must be disclosed to the member's employer in any case.

Guidance—Investment-Banking Relationships

Do not be pressured by sell-side firms to issue favorable research on current or prospective investment-banking clients. It is appropriate to have analysts work with investment bankers in "road shows" only when the conflicts are adequately and effectively managed and disclosed. Be sure there are effective "firewalls" between research/ investment management and investment banking activities.

Guidance—Public Companies

Analysts should not be pressured to issue favorable research by the companies they follow. Do not confine research to discussions with company management, but rather use a variety of sources, including suppliers, customers, and competitors.

Guidance—Buy-Side Clients

Buy-side clients may try to pressure sell-side analysts. Portfolio managers may have large positions in a particular security, and a rating downgrade may have an effect on the portfolio performance. As a portfolio manager, there is a responsibility to respect and foster intellectual honesty of sell-side research.

Guidance—Issuer-Paid Research

Remember that this type of research is fraught with potential conflicts. Analysts' compensation for preparing such research should be limited, and the preference is for a flat fee, without regard to conclusions or the report's recommendations.

Recommended Procedures for Compliance

- Protect the integrity of opinions—make sure they are unbiased.
- Create a restricted list and distribute only factual information about companies on the list.
- Restrict special cost arrangements—pay for one's own commercial transportation and hotel; limit use of corporate aircraft to cases in which commercial transportation is not available.
- Limit gifts—token items only. Customary, business-related entertainment is okay as long as its purpose is not to influence a member's professional independence or objectivity.
- Restrict employee investments in equity IPOs and private placements.
- Review procedures—have effective supervisory and review procedures.
- Firms should have formal written policies on independence and objectivity of research.

Application of Standard I(B) Independence and Objectivity

Example 1:

Steven Taylor, a mining analyst with Bronson Brokers, is invited by Precision Metals to join a group of his peers in a tour of mining facilities in several western U.S. states. The company arranges for chartered group flights from site to site and for accommodations in Spartan Motels, the only chain with accommodations near the mines, for three nights. Taylor allows Precision Metals to pick up his tab, as do the other analysts, with one exception—John Adams, an employee of a large trust company who insists on following his company's policy and paying for his hotel room himself.

Comment:

The policy of Adams' company complies closely with Standard I(B) by avoiding even the appearance of a conflict of interest, but Taylor and the other analysts were not necessarily violating Standard I(B). In general, when allowing companies to pay for travel and/or accommodations under these circumstances, members and candidates must use their judgment, keeping in mind that such arrangements must not impinge on a member or candidate's independence and objectivity. In this example, the trip was strictly for business and Taylor was not accepting irrelevant or lavish hospitality. The itinerary required chartered flights, for which analysts were not expected to pay. The accommodations were modest. These arrangements are not unusual and did not violate Standard I(B) so long as Taylor's independence and objectivity were not compromised. In the final analysis, members and candidates should consider both whether they can remain objective and whether their integrity might be perceived by their clients to have been compromised.

Example 2:

Walter Fritz is an equity analyst with Hilton Brokerage who covers the mining industry. He has concluded that the stock of Metals & Mining is overpriced at its current level, but he is concerned that a negative research report will hurt the good relationship between Metals & Mining and the investment-banking division of his firm. In fact, a senior manager of Hilton Brokerage has just sent him a copy of a proposal his firm has made to Metals & Mining to underwrite a debt offering. Fritz needs to produce a report right away and is concerned about issuing a less-than-favorable rating.

Comment:

Fritz's analysis of Metals & Mining must be objective and based solely on consideration of company fundamentals. Any pressure from other divisions of his firm is inappropriate. This conflict could have been eliminated if, in anticipation of the offering, Hilton Brokerage had placed Metals & Mining on a restricted list for its sales force.

Example 3:

Tom Wayne is the investment manager of the Franklin City Employees Pension Plan. He recently completed a successful search for firms to manage the foreign equity allocation of the plan's diversified portfolio. He followed the plan's standard procedure of seeking presentations from a number of qualified firms and recommended that his board select Penguin Advisors because of its experience, well-defined investment strategy, and performance record, which was compiled and verified in accordance with the CFA Institute Global Investment Performance Standards. Following the plan selection of Penguin, a reporter from the Franklin City Record called to ask if there was any connection between the action and the fact that Penguin was one of the sponsors of an "investment fact-finding trip to Asia" that Wayne made earlier in the year. The trip was one of several conducted by the Pension Investment Academy, which had arranged the itinerary of meetings with economic, government, and corporate officials in major cities in several Asian countries. The Pension Investment Academy obtains support for the cost of these trips from a number of investment managers including Penguin Advisors; the Academy then pays the travel expenses of the various pension plan managers on the trip and provides all meals and accommodations. The president of Penguin Advisors was one of the travelers on the trip.

Comment:

Although Wayne can probably put to good use the knowledge he gained from the trip in selecting portfolio managers and in other areas of managing the pension plan, his recommendation of Penguin Advisors may be tainted by the possible conflict incurred when he participated in a trip paid partly for by Penguin Advisors and when he was in the daily company of the president of Penguin Advisors. To avoid violating Standard I(B), Wayne's basic expenses for travel and accommodations should have been paid by his employer or the pension plan; contact with the president of Penguin Advisors should have been limited to informational or educational events only; and the trip, the organizer, and the sponsor should have been made a matter of public record. Even if his actions were not in violation of Standard I(B), Wayne should have been sensitive to the public perception of the trip when reported in the newspaper and the extent to which the subjective elements of his decision might have been affected by the familiarity that the daily contact of such a trip would encourage. This advantage would probably not be shared by competing firms.

I(C) Misrepresentation. Do not misrepresent facts regarding investment analysis, recommendations, actions, or other professional activities.

Professor's Note: There is stronger language concerning misrepresentation—prohibition of false and misleading statements in all aspects of Members' and Candidates' professional activities and a prohibition against plagiarism.

Guidance

Trust is a foundation in the investment profession. Do not make any misrepresentations or give false impressions. This includes oral and electronic communications. Misrepresentations include guaranteeing investment performance and plagiarism. Plagiarism encompasses using someone else's work (reports, forecasts, charts, graphs, and spreadsheet models) without giving them credit.

Recommended Procedures for Compliance

A good way to avoid misrepresentation is for firms to provide employees who deal with clients or prospects a written list of the firm's available services and a description of the firm's qualifications. Employee qualifications should be accurately presented as well. To avoid plagiarism, maintain records of all materials used to generate reports or other firm products and properly cite sources (quotes and summaries) in work products. Information from recognized financial and statistical reporting services need not be cited.

Application of Standard I(C) Misrepresentations

Example 1:

Allison Rogers is a partner in the firm of Rogers and Black, a small firm offering investment advisory services. She assures a prospective client who has just inherited $1 million that "we can perform all the financial and investment services you need." Rogers and Black is well equipped to provide investment advice but, in fact, cannot provide asset allocation assistance or a full array of financial and investment services.

Comment:

Rogers has violated Standard I(C) by orally misrepresenting the services her firm can perform for the prospective client. She must limit herself to describing the range of investment advisory services Rogers and Black can provide and offer to help the client obtain elsewhere the financial and investment services that her firm cannot provide.

Example 2:

Anthony McGuire is an issuer-paid analyst hired by publicly traded companies to electronically promote their stocks. McGuire creates a website that promotes his research efforts as a seemingly independent analyst. McGuire posts a profile and a strong buy recommendation for each company on the website indicating that the stock is expected to increase in value. He does not disclose the contractual relationships with the companies he covers on his website, in the research reports he issues, or in the statements he makes about the companies on Internet chat rooms.

Comment:

McGuire has violated Standard I(C) because the Internet site and e-mails are misleading to potential investors. Even if the recommendations are valid and supported with thorough research, his omissions regarding the true relationship between himself and the companies he covers constitute a misrepresentation. McGuire has also violated Standard VI(C) by not disclosing the existence of an arrangement with the companies through which he receives compensation in exchange for his services.

Example 3:

Claude Browning, a quantitative analyst for Double Alpha, Inc., returns in great excitement from a seminar. In that seminar, Jack Jorrely, a well-publicized quantitative analyst at a national brokerage firm, discussed one of his new models in great detail, and Browning is intrigued by the new concepts. He proceeds to test this model, making some minor mechanical changes but retaining the concept, until he produces some very positive results. Browning quickly announces to his supervisors at Double Alpha that he has discovered a new model and that clients and prospective clients alike should be informed of this positive finding as ongoing proof of Double Alpha's continuing innovation and ability to add value.

Comment:

Although Browning tested Jorrely's model on his own and even slightly modified it, he must still acknowledge the original source of the idea. Browning can certainly take credit for the final, practical results; he can also support his conclusions with his own test. The credit for the innovative thinking, however, must be awarded to Jorrely.

Example 4:

Gary Ostrowski runs a small, two-person investment management firm. Ostrowski's firm subscribes to a service from a large investment research firm that provides research reports that can be repackaged as in-house research from smaller firms. Ostrowski's firm distributes these reports to clients as its own work.

Comment:

Gary Ostrowski can rely on third-party research that has a reasonable and adequate basis, but he cannot imply that he is the author of the report. Otherwise, Ostrowski would misrepresent the extent of his work in a way that would mislead the firm's clients or prospective clients.

I(D) Misconduct. Do not engage in any professional conduct which involves dishonesty, fraud, or deceit. Do not do anything that reflects poorly on one's integrity, good reputation, trustworthiness, or professional competence.

Professor's Note: There is a subtle change here versus the old Standard. The new focus is on professional rather than personal conduct. There is no longer an attempt to overreach or regulate one's personal behavior.

Guidance

CFA Institute discourages unethical behavior in all aspects of members' and candidates' lives. Do not abuse CFA Institute's Professional Conduct Program by seeking enforcement of this Standard to settle personal, political, or other disputes that are not related to professional ethics.

Recommended Procedures for Compliance

Firms are encouraged to adopt these policies and procedures:

- Develop and adopt a code of ethics and make clear that unethical behavior will not be tolerated.
- Give employees a list of potential violations and sanctions, including dismissal.
- Check references of potential employees.

Application of Standard I(D) Misconduct

Example 1:

Simon Sasserman is a trust investment officer at a bank in a small affluent town. He enjoys lunching every day with friends at the country club, where his clients have observed him having numerous drinks. Back at work after lunch, he clearly is intoxicated while making investment decisions. His colleagues make a point of handling any business with Sasserman in the morning because they distrust his judgment after lunch.

Comment:

Sasserman's excessive drinking at lunch and subsequent intoxication at work constitute a violation of Standard I(D) because this conduct has raised questions about his professionalism and competence. His behavior thus reflects poorly on him, his employer, and the investment industry.

Example 2:

Carmen Garcia manages a mutual fund dedicated to socially responsible investing. She is also an environmental activist. As the result of her participation at nonviolent protests, Garcia has been arrested on numerous occasions for trespassing on the property of a large petrochemical plant that is accused of damaging the environment.

Comment:

Generally, Standard I(D) is not meant to cover legal transgressions resulting from acts of civil disobedience in support of personal beliefs because such conduct does not reflect poorly on the member or candidate's professional reputation, integrity, or competence.

II Integrity of Capital Markets

II(A) Material Nonpublic Information. Members and Candidates in possession of nonpublic information that could affect an investment's value must not act or induce someone else to act on the information.

Professor's Note: This Standard attempts to prohibit any conduct that will damage the integrity of the markets. The new Standard is more straightforward—it states that Members and Candidates must not act or cause others to act on material nonpublic information until that same information is made public. It no longer matters whether the information is obtained in breach of a duty, is misappropriated, or relates to a tender offer.

Guidance

Information is "material" if its disclosure would impact the price of a security or if reasonable investors would want the information before making an investment decision. Ambiguous information, as far as its likely effect on price, may not be considered material. Information is "nonpublic" until it has been made available to the marketplace. An analyst conference call is not public disclosure. Selectively disclosing information by corporations creates the potential for insider-trading violations.

Guidance—Mosaic Theory

There is no violation when a perceptive analyst reaches an investment conclusion about a corporate action or event through an analysis of public information together with items of non-material nonpublic information.

Recommended Procedures for Compliance

Make reasonable efforts to achieve public dissemination of the information. Encourage firms to adopt procedures to prevent misuse of material nonpublic information. Use a "firewall" within the firm, with elements including:

- Substantial control of relevant interdepartmental communications, through a clearance area such as the compliance or legal department.
- Review employee trades—maintain "watch," "restricted," and "rumor" lists.
- Monitor and restrict proprietary trading while a firm is in possession of material nonpublic information.

Prohibition of all proprietary trading while a firm is in possession of material nonpublic information may be inappropriate because it may send a signal to the market. In these cases, firms should take the contra side of only unsolicited customer trades.

Application of Standard II(A) Material Nonpublic Information

Example 1:

Josephine Walsh is riding an elevator up to her office when she overhears the chief financial officer (CFO) for the Swan Furniture Company tell the president of Swan that he has just calculated the company's earnings for the past quarter and they have unexpectedly and significantly dropped. The CFO adds that this drop will not be released to the public until next week. Walsh immediately calls her broker and tells him to sell her Swan stock.

Comment:

Walsh has sufficient information to determine that the information is both material and nonpublic. By trading on the inside information, she has violated Standard II(A).

Example 2:

Samuel Peter, an analyst with Scotland and Pierce Incorporated, is assisting his firm with a secondary offering for Bright Ideas Lamp Company. Peter participates, via telephone conference call, in a meeting with Scotland and Pierce investment-banking employees and Bright Ideas' CEO. Peter is advised that the company's earnings projections for the next year have significantly dropped. Throughout the telephone conference call, several Scotland and Pierce salespeople and portfolio managers walk in and out of Peter's office, where the telephone call is taking place. As a result, they are aware of the drop in projected earnings for Bright Ideas. Before the conference call is concluded, the salespeople trade the stock of the company on behalf of the firm's clients and other firm personnel trade the stock in a firm proprietary account and in employee personal accounts.

Comment:

Peter violated Standard II(A) because he failed to prevent the transfer and misuse of material nonpublic information to others in his firm. Peter's firm should have adopted information barriers to prevent the communication of nonpublic information between departments of the firm. The salespeople and portfolio managers who traded on the information have also violated Standard II(A) by trading on inside information.

Example 3:

Elizabeth Levenson is based in Taipei and covers the Taiwanese market for her firm, which is based in Singapore. She is invited to meet the finance director of a manufacturing company along with the other 10 largest shareholders of the company. During the meeting, the finance director states that the company expects its workforce to strike next Friday, which will cripple productivity and distribution. Can Levenson use this information as a basis to change her rating on the company from "buy" to "sell"?

Comment:

Levenson must first determine whether the material information is public. If the company has not made this information public (a small-group forum does not qualify as a method of public dissemination), she cannot use the information according to Standard II(A).

Example 4:

Jagdish Teja is a buy-side analyst covering the furniture industry. Looking for an attractive company to recommend as a buy, he analyzed several furniture makers by studying their financial reports and visiting their operations. He also talked to some designers and retailers to find out which furniture styles are trendy and popular. Although none of the companies that he analyzed turned out to be a clear buy, he discovered

that one of them, Swan Furniture Company (SFC), might be in trouble. Swan's extravagant new designs were introduced at substantial costs. Even though these designs initially attracted attention, in the long run, the public is buying more conservative furniture from other makers. Based on that and on P&L analysis, Teja believes that Swan's next-quarter earnings will drop substantially. He then issues a sell recommendation for SFC. Immediately after receiving that recommendation, investment managers start reducing the stock in their portfolios.

Comment:

Information on quarterly earnings figures is material and nonpublic. However, Teja arrived at his conclusion about the earnings drop based on public information and on pieces of nonmaterial nonpublic information (such as opinions of designers and retailers). Therefore, trading based on Teja's correct conclusion is not prohibited by Standard II(A).

II(B) Market Manipulation. Do not engage in any practices intended to mislead market participants through distorted prices or artificially inflated trading volume.

Professor's Note: This new Standard requires Members and Candidates to uphold market integrity by banning practices that distort security prices or trading volume with the intent to deceive.

Guidance

This Standard applies to transactions that deceive the market by distorting the price-setting mechanism of financial instruments or by securing a controlling position to manipulate the price of a related derivative and/or the asset itself. Spreading false rumors is also prohibited.

Application of Standard II(B) Market Manipulation

Example 1:

Matthew Murphy is an analyst at Divisadero Securities & Co., which has a significant number of hedge funds among its most important brokerage clients. Two trading days before the publication of the quarter-end report, Murphy alerts his sales force that he is about to issue a research report on Wirewolf Semiconductor, which will include his opinion that

- quarterly revenues are likely to fall short of management's guidance,
- earnings will be as much as 5 cents per share (or more than 10 percent) below consensus, and
- Wirewolf's highly respected chief financial officer may be about to join another company.

Knowing that Wirewolf had already entered its declared quarter-end "quiet period" before reporting earnings (and thus would be reluctant to respond to rumors, etc.), Murphy times the release of his research report specifically to sensationalize the negative aspects of the message to create significant downward pressure on Wirewolf's stock to the distinct advantage of Divisadero's hedge fund clients. The report's conclusions are based on speculation, not on fact. The next day, the research report is broadcast to all of Divisadero's clients and to the usual newswire services.

Before Wirewolf's investor relations department can assess its damage on the final trading day of the quarter and refute Murphy's report, its stock opens trading sharply lower, allowing Divisadero's clients to cover their short positions at substantial gains.

Comment:

Murphy violated Standard II(B) by trying to create artificial price volatility designed to have material impact on the price of an issuer's stock. Moreover, by lacking an adequate basis for the recommendation, Murphy also violated Standard V(A).

Example 2:

Sergei Gonchar is the chairman of the ACME Futures Exchange, which seeks to launch a new bond futures contract. In order to convince investors, traders, arbitragers, hedgers, and so on, to use its contract, the exchange attempts to demonstrate that it has the best liquidity. To do so, it enters into agreements with members so that they commit to a substantial minimum trading volume on the new contract over a specific period in exchange for substantial reductions on their regular commissions.

Comment:

Formal liquidity on a market is determined by the obligations set on market makers, but the actual liquidity of a market is better estimated by the actual trading volume and bid-ask spreads. Attempts to mislead participants on the actual liquidity of the market constitute a violation of Standard II(B). In this example, investors have been intentionally misled to believe they chose the most liquid instrument for some specific purpose and could eventually see the actual liquidity of the contract dry up suddenly after the term of the agreement if the "pump-priming" strategy fails. If ACME fully discloses its agreement with members to boost transactions over some initial launch period, it does not violate Standard II(B). ACME's intent is not to harm investors but on the contrary to give them a better service. For that purpose, it may engage in a liquidity-pumping strategy, but it must be disclosed.

III Duties to Clients and Prospective Clients

III(A) Loyalty, Prudence, and Care. Members must always act for the benefit of clients and place clients' interests before their employer's or their own interests. Members must be loyal to clients, use reasonable care, exercise prudent judgment, and determine and comply with their applicable fiduciary duty to clients.

Professor's Note: This Standard continues to require that members and candidates understand and comply with their actual fiduciary duty; however, there is now a minimum level of conduct—reasonable care and prudent judgment must be exercised in all circumstances.

Guidance

Client interests always come first.

- Exercise the prudence, care, skill, and diligence under the circumstances that a person acting in a like capacity and familiar with such matters would use.
- Manage pools of client assets in accordance with the terms of the governing documents, such as trust documents or investment management agreements.
- Make investment decisions in the context of the total portfolio.
- Vote proxies in an informed and responsible manner. Due to cost benefit considerations, it may not be necessary to vote all proxies.
- Client brokerage, or "soft dollars" or "soft commissions" must be used to benefit the client.

Recommended Procedures of Compliance

Submit to clients, at least quarterly, itemized statements showing all securities in custody and all debits, credits, and transactions.

Encourage firms to address these topics when drafting policies and procedures regarding fiduciary duty:

- Follow applicable rules and laws.
- Establish investment objectives of client. Consider suitability of portfolio relative to client's needs and circumstances, the investment's basic characteristics, or the basic characteristics of the total portfolio.
- Diversify.
- Deal fairly with all clients in regards to investment actions.
- Disclose conflicts.
- Disclose compensation arrangements.
- Vote proxies in the best interest of clients and ultimate beneficiaries.
- Maintain confidentiality.
- Seek best execution.
- Place client interests first.

Application of Standard III(A) Loyalty, Prudence, and Care

Example 1:

First Country Bank serves as trustee for the Miller Company's pension plan. Miller is the target of a hostile takeover attempt by Newton, Inc. In attempting to ward off Newton, Miller's managers persuade Julian Wiley, an investment manager at First Country Bank, to purchase Miller common stock in the open market for the employee pension plan. Miller's officials indicate that such action would be favorably received and would probably result in other accounts being placed with the bank. Although Wiley believes the stock to be overvalued and would not ordinarily buy it, he purchases the stock to support Miller's managers, to maintain the company's good favor, and to realize additional new business. The heavy stock purchases cause Miller's market price to rise to such a level that Newton retracts its takeover bid.

Comment:

Standard III(A) requires that a member or candidate, in evaluating a takeover bid, act prudently and solely in the interests of plan participants and beneficiaries. To meet this requirement, a member or candidate must carefully evaluate the long-term prospects of the company against the short-term prospects presented by the takeover offer and by the ability to invest elsewhere. In this instance, Wiley, acting on behalf of his employer, the trustee, clearly violated Standard III(A) by using the profit-sharing plan to perpetuate existing management, perhaps to the detriment of plan participants and the company's shareholders, and to benefit himself. Wiley's responsibilities to the plan participants and beneficiaries should take precedence over any ties to corporate managers and self-interest. A duty exists to examine such a takeover offer on its own merits and to make an independent decision. The guiding principle is the appropriateness of the investment decision to the pension plan, not whether the decision benefits Wiley or the company that hired him.

Example 2:

Emilie Rome is a trust officer for Paget Trust Company. Rome's supervisor is responsible for reviewing Rome's trust account transactions and her monthly reports of personal stock transactions. Rome has been using Nathan Gray, a broker, almost exclusively for trust account brokerage transactions. Where Gray makes a market in stocks, he has been giving Rome a lower price for personal purchases and a higher price for sales than he gives to Rome's trust accounts and other investors.

Comment:

Rome is violating her duty of loyalty to the bank's trust accounts by using Gray for brokerage transactions simply because Gray trades Rome's personal account on favorable terms.

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, or in other professional activities.

Professor's Note: This Standard is largely unchanged but is slightly broadened.

Guidance

Do not discriminate against any clients when disseminating recommendations or taking investment action. Fairly does not mean equally. In the normal course of business, there will be differences in the time emails, faxes, etc. are received by different clients. Different service levels are okay, but they must not negatively affect or disadvantage any clients. Disclose the different service levels to all clients and prospects, and make premium levels of service available to all who wish to pay for them.

Guidance—Investment Recommendations

Give all clients a fair opportunity to act upon every recommendation. Clients who are unaware of a change in a recommendation should be advised before the order is accepted.

Guidance—Investment Actions

Treat clients fairly in light of their investment objectives and circumstances. Treat both individual and institutional clients in a fair and impartial manner. Members and Candidates should not take advantage of their position in the industry to disadvantage clients (e.g., in the context of IPOs).

Recommended Procedures for Compliance

Encourage firms to establish compliance procedures requiring proper dissemination of investment recommendations and fair treatment of all customers and clients. Consider these points when establishing fair dealing compliance procedures:

- 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 personnel guidelines for pre-dissemination—have in place guidelines prohibiting personnel who have prior knowledge of a recommendation from discussing it or taking action on the pending recommendation.
- Simultaneous dissemination.
- Maintain list of clients and holdings—use to ensure that all holders are treated fairly.
- Develop written trade allocation procedures—ensure fairness to clients, timely and efficient order execution, and accuracy of client positions.
- Disclose trade allocation procedures.
- Establish systematic account review—to ensure that no client is given preferred treatment and that investment actions are consistent with the account's objectives.
- Disclose available levels of service.

Application of Standard III(B) Fair Dealing

Example 1:

Bradley Ames, a well-known and respected analyst, follows the computer industry. In the course of his research, he finds that a small, relatively unknown company whose shares are traded over the counter has just signed significant contracts with some of the companies he follows. After a considerable amount of investigation, Ames decides to write a research report on the company and recommend purchase. While the report is being reviewed by the company for factual accuracy, Ames schedules a luncheon with several of his

best clients to discuss the company. At the luncheon, he mentions the purchase recommendation scheduled to be sent early the following week to all the firm's clients.

Comment:

Ames violated Standard III(B) by disseminating the purchase recommendation to the clients with whom he had lunch a week before the recommendation was sent to all clients.

Example 2:

Spencer Rivers, president of XYZ Corporation, moves his company's growth-oriented pension fund to a particular bank primarily because of the excellent investment performance achieved by the bank's commingled fund for the prior five-year period. A few years later, Rivers compares the results of his pension fund with those of the bank's commingled fund. He is startled to learn that, even though the two accounts have the same investment objectives and similar portfolios, his company's pension fund has significantly underperformed the bank's commingled fund. Questioning this result at his next meeting with the pension fund's manger, Rivers is told that, as a matter of policy, when a new security is placed on the recommended list, Morgan Jackson, the pension fund manger, first purchases the security for the commingled account and then purchases it on a pro rata basis for all other pension fund accounts. Similarly, when a sale is recommended, the security is sold first from the commingled account and then sold on a pro rata basis from all other accounts. Rivers also learns that if the bank cannot get enough shares (especially the hot issues) to be meaningful to all the accounts, its policy is to place the new issues only in the commingled account.

Seeing that Rivers is neither satisfied nor pleased by the explanation, Jackson quickly adds that nondiscretionary pension accounts and personal trust accounts have a lower priority on purchase and sale recommendations than discretionary pension fund accounts. Furthermore, Jackson states, the company's pension fund had the opportunity to invest up to 5 percent in the commingled fund.

Comment:

The bank's policy did not treat all customers fairly, and Jackson violated her duty to her clients by giving priority to the growth-oriented commingled fund over all other funds and to discretionary accounts over nondiscretionary accounts. Jackson must execute orders on a systematic basis that is fair to all clients. In addition, trade allocation procedures should be disclosed to all clients from the beginning. Of course, in this case, disclosure of the bank's policy would not change the fact that the policy is unfair.

III(C) Suitability

1. When in an advisory relationship with client or prospect, Members and Candidates must:

   a. Make reasonable inquiry into clients' investment experience, risk and return objectives, and constraints prior to making any recommendations or taking investment action. Reassess information and update regularly.

   b. Be sure investments are suitable to a client's financial situation and consistent with client objectives before making recommendation or taking investment action.

   c. Make sure investments are suitable in the context of a client's total portfolio.

2. When managing a portfolio, investment recommendations and actions must be consistent with stated portfolio objectives and constraints.

Professor's Note: "Regular updates" to client information should be done at least annually. Suitability is based on a total-portfolio perspective.

Guidance

In advisory relationships, be sure to gather client information at the beginning of the relationship, in the form of an investment policy statement (IPS). Consider client's needs and circumstances and thus the risk tolerance. Consider whether or not the use of leverage is suitable for the client.

If a member is responsible for managing a fund to an index or other stated mandate, be sure investments are consistent with the stated mandate.

Recommended Procedures for Compliance

Members should:

- Put the needs and circumstances of each client and the client's investment objectives into a written IPS for each client.
- Consider the type of client and whether there are separate beneficiaries, investor objectives (return and risk), investor constraints (liquidity needs, expected cash flows, time, tax, and regulatory and legal circumstances), and performance measurement benchmarks.
- Review investor's objectives and constraints at least annually to reflect any changes in client circumstances, as well as prior to material changes in recommendations or decisions.

Application of Standard III(C) Suitability

Example 1:

Ann Walters, an investment advisor, suggests to Brian Crosby, a risk-averse client, that covered call options be used in his equity portfolio. The purpose would be to enhance Crosby's income and partially offset any untimely depreciation in value should the stock market or other circumstances affect his holdings unfavorably. Walters educates Crosby about all possible outcomes, including the risk of incurring an added tax liability if a stock rises in price and is called away and, conversely, the risk of his holdings losing protection on the downside if prices drop sharply.

Comment:

When determining suitability of an investment, the primary focus should be on the characteristics of the client's entire portfolio, not on an issue-by-issue analysis. The basic characteristics of the entire portfolio will largely determine whether the investment recommendations are taking client factors into account. Therefore, the most important aspects of a particular investment will be those that will affect the characteristics of the total portfolio. In this case, Walters properly considered the investment in the context of the entire portfolio and thoroughly explained the investment to the client.

Example 2:

Max Gubler, CIO of a property/casualty insurance subsidiary of a large financial conglomerate, wants to better diversify the company's investment portfolio and increase its returns. The company's investment policy statement (IPS) provides for highly liquid investments, such as large caps, governments, and supra-nationals, as well as corporate bonds with a minimum credit rating of AA—and maturity of no more than five years. In a recent presentation, a venture capital group offered very attractive prospective returns on some of their private equity funds providing seed capital. An exit strategy is already contemplated but investors will first have to observe a minimum 3-year lock-up period, with a subsequent laddered exit option for a maximum of one third of shares per year. Gubler does not want to miss this opportunity and after an extensive analysis and optimization of this asset class with the company's current portfolio, he invests 4 percent in this seed fund, leaving the portfolio's total equity exposure still well below its upper limit.

Comment:

Gubler violates Standards III(A) and III(C). His new investment locks up part of the company's assets for at least three and for up to as many as five years and possibly beyond. Since the IPS requires investments in highly liquid investments and describes accepted asset classes, private equity investments with a lock-up period certainly do not qualify. Even without such lock-up periods, an asset class with only an occasional, and thus implicitly illiquid, market may not be suitable. Although an IPS typically describes objectives and constraints in great detail, the manger must make every effort to understand the client's business and circumstances. Doing so should also enable the manager to recognize, understand, and discuss with the client other factors that may be or may become material in the investment management process.

III(D) Performance Presentation. Presentations of investment performance information must be fair, accurate, and complete.

Guidance

Members must avoid misstating performance or misleading clients/prospects about investment performance of themselves or their firms, should not misrepresent past performance or reasonably expected performance, and should not state or imply the ability to achieve a rate of return similar to that achieved in the past.

Recommended Procedures for Compliance

Encourage firms to adhere to Global Investment Performance Standards. Obligations under this Standard may also be met by:

- Considering the sophistication of the audience to whom a performance presentation is addressed.
- Presenting performance of weighted composite of similar portfolios rather than a single account.
- Including terminated accounts as part of historical performance.
- Including all appropriate disclosures to fully explain results (e.g., model results included, gross or net of fees, etc.).
- Maintaining data and records used to calculate the performance being presented.

Application of Standard III(D) Performance Presentation

Example 1:

Kyle Taylor of Taylor Trust Company, noting the performance of Taylor's common trust fund for the past two years, states in the brochure sent to his potential clients that "You can expect steady 25 percent annual compound growth of the value of your investments over the year." Taylor Trust's common trust fund did increase at the rate of 25 percent per annum for the past year which mirrored the increase of the entire market. The fund, however, never averaged that growth for more than one year, and the average rate of growth of all of its trust accounts for five years was 5 percent per annum.

Comment:

Taylor's brochure is in violation of Standard III(D). Taylor should have disclosed that the 25 percent growth occurred in only one year. Additionally, Taylor did not include client accounts other than those in the firm's common trust fund. A general claim of firm performance should take into account the performance of all categories of accounts. Finally, by stating that clients can expect a steady 25 percent annual compound growth rate, Taylor also violated Standard I(C), which prohibits statements of assurances or guarantees regarding an investment.

Example 2:

Aaron McCoy is vice president and managing partner of the equity investment group of Mastermind Financial Advisors, a new business. Mastermind recruited McCoy because he had a proven 6-year track record with G&P Financial. In developing Mastermind's advertising and marketing campaign, McCoy prepared an advertisement that included the equity investment performance he achieved at G&P Financial. The advertisement for Mastermind did not identify the equity performance as being earned while at G&P. The advertisement was distributed to existing clients and prospective clients of Mastermind.

Comment:

McCoy violated Standard III(D) by distributing an advertisement that contained material misrepresentations regarding the historical performance of Mastermind. Standard III(D) requires that members and candidates make every reasonable effort to ensure that performance information is a fair, accurate, and complete representation of an individual or firm's performance. As a general matter, this standard does not prohibit showing past performance of funds managed at a prior firm as part of a performance track record so long as it is accompanied by appropriate disclosures detailing where the performance comes from and the person's specific role in achieving that performance. If McCoy chooses to use his past performance from G&P in Mastermind's advertising, he should make full disclosure as to the source of the historical performance.

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, or the client or prospect gives permission for the information to be disclosed.

Professor's Note: This Standard is somewhat broader—it covers all client information, not just information "concerning matters within the scope of the relationship." Also note that the language specifically includes not only prospects but former clients. Confidentiality regarding employer information is now covered in Standard IV.

Guidance

If illegal activities by a client are involved, members may have an obligation to report the activities to authorities. The confidentiality Standard extends to former clients as well.

The requirements of this Standard are not intended to prevent Members and Candidates from cooperating with a CFA Institute Professional Conduct Program (PCP) investigation.

Recommended Procedures for Compliance

Members should avoid disclosing information received from a client except to authorized co-workers who are also working for the client.

Application of Standard III(E) Preservation of Confidentiality

Example 1:

Sarah Connor, a financial analyst employed by Johnson Investment Counselors, Inc., provides investment advice to the trustees of City Medical Center. The trustees have given her a number of internal reports concerning City Medical's needs for physical plant renovation and expansion. They have asked Connor to recommend investments that would generate capital appreciation in endowment funds to meet projected capital expenditures. Connor is approached by a local business man, Thomas Kasey, who is considering a substantial contribution either to City Medical Center or to another local hospital. Kasey wants to find out the building plans of both institutions before making a decision, but he does not want to speak to the trustees.

Comment:

The trustees gave Connor the internal reports so she could advise them on how to manage their endowment funds. Because the information in the reports is clearly both confidential and within the scope of the confidential relationship, Standard III(E) requires that Connor refuse to divulge information to Kasey.

Example 2:

David Bradford manages money for a family-owned real estate development corporation. He also manages the individual portfolios of several of the family members and officers of the corporation, including the chief financial officer (CFO). Based on the financial records from the corporation, as well as some questionable practices of the CFO that he has observed, Bradford believes that the CFO is embezzling money from the corporation and putting it into his personal investment account.

Comment:

Bradford should check with his firm's compliance department as well as outside counsel to determine whether applicable securities regulations require reporting the CFO's financial records.

IV Duties to Employers

IV(A) Loyalty. 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*, or otherwise harm their employer.

Professor's Note: Always act in the employer's best interests and do not deprive the employer of any of Member's/Candidate's skills or abilities. Also protect confidential information. There is now a phrase "in matters related to employment," which means that Members/Candidates are not required to subordinate important personal and family obligations to their job.

Guidance

Members must not engage in any activities which would injure the firm, deprive it of profit, or deprive it of the advantage of employees' skills and abilities. Always place client interests above interests of employer. There is no requirement that the employee put employer interests ahead of family and other personal obligations; it is expected that employers and employees will discuss such matters and balance these obligations with work obligations.

Guidance—Independent Practice

Independent practice for compensation is allowed if a notification is provided to the employer fully describing all aspects of the services, including compensation, duration, and the nature of the activities *and* if the employer consents to all terms of the proposed independent practice before it begins.

Guidance—Leaving an Employer

Members must continue to act in their employer's best interests until resignation is effective. Activities which may constitute a violation include:

- Misappropriation of trade secrets.
- Misuse of confidential information.
- Soliciting employer's clients prior to leaving.
- Self-dealing.
- Misappropriation of client lists.

Once an employee has left a firm, simple knowledge of names and existence of former clients is generally not confidential. Also there is no prohibition on the use of experience or knowledge gained while with a former employer.

Guidance—Whistleblowing

There may be isolated cases where a duty to one's employer may be violated in order to protect clients or the integrity of the market, and not for personal gain.

Guidance—Nature of Employment

The applicability of this Standard is based on the nature of the employment—employee versus independent contractor. If Members and Candidates are independent contractors, they still have a duty to abide by the terms of the agreement.

Application of Standard IV(A) Loyalty

Example 1:

James Hightower has been employed by Jason Investment Management Corporation for 15 years. He began as an analyst but assumed increasing responsibilities and is now a senior portfolio manager and a member of the firm's investment policy committee. Hightower has decided to leave Jason Investment and start his own investment management business. He has been careful not to tell any of Jason's clients that he is leaving, because he does not want to be accused of breaching his duty to Jason by soliciting Jason's clients before his departure. Hightower is planning to copy and take with him the following documents and information he developed or worked on while at Jason: (1) the client list, with addresses, telephone numbers, and other pertinent client information; (2) client account statements; (3) sample marketing presentations to prospective clients containing Jason's performance record; (4) Jason's recommended list of securities; (5) computer models to determine asset allocations for accounts with different objectives; (6) computer models for stock selection; and (7) personal computer spreadsheets for Hightower's major corporate recommendations which he developed when he was an analyst.

Comment:

Except with the consent of their employer, departing employees may not take employer property, which includes books, records, reports, and other materials, and may not interfere with their employer's business opportunities. Taking any employer records, even those the member or candidate prepared, violates Standard IV(A).

Example 2:

Dennis Elliot has hired Sam Chisolm who previously worked for a competing firm. Chisolm left his former firm after 18 years of employment. When Chisolm begins working for Elliot, he wants to contact his former clients because he knows them well and is certain that many will follow him to his new employer. Is Chisolm in violation of the Standard IV(A) if he contacts his former clients?

Comment:

Because client records are the property of the firm, contacting former clients for any reason through the use of client lists or other information taken from a former employer without permission would be a violation of Standard IV(A). In addition, the nature and extent of the contact with former clients may be governed by the terms of any non-compete agreement signed by the employee and the former employer that covers contact with former clients after employment.

But, simple knowledge of the name and existence of former clients is not confidential information, just as skills or experience that an employee obtains while employed is not "confidential" or "privileged" information. The Code and Standards do not impose a prohibition on the use of experience or knowledge gained at one employer from being used at another employer. The Code and Standards also do not prohibit former employees from contacting clients of their previous firm, absent a non-compete agreement. Members and candidates are free to use public information about their former firm after departing to contact former clients without violating Standard IV(A).

In the absence of a non-compete agreement, as long as Chisolm maintains his duty of loyalty to his employer before joining Elliot's firm, and does not take steps to solicit clients until he has left his former firm, and does not make use of material from his former employer without its permission after he has left, he would not be in violation of the Code and Standards.

Example 3:

Several employees are planning to depart their current employer within a few weeks and have been careful to not engage in any activities that would conflict with their duty to their current employer. They have just learned that one of their employer's clients has undertaken a request for proposal (RFP) to review and possibly hire a new investment consultant. The RFP has been sent to the employer and all of its competitors. The group believes that the new entity to be formed would be qualified to respond to the RFP and eligible for the business. The RFP submission period is likely to conclude before the employees' resignations are effective. Is it permissible for the group of departing employees to respond to the RFP under their anticipated new firm?

Comment:

A group of employees responding to an RFP that their employer is also responding to would lead to direct competition between the employees and the employer. Such conduct would violate Standard IV(A) unless the group of employees received permission from their employer as well as the entity sending out the RFP.

IV(B) Additional Compensation Arrangements. No gifts, benefits, compensation or consideration are to be accepted which may create a conflict of interest with the employer's interest unless written consent is received from all parties.

Professor's Note: The new language broadens "compensation" to include "gifts, benefits, compensation, or consideration."

Guidance

Compensation includes direct and indirect compensation from a client and other benefits received from third parties. Written consent from a member's employer includes email communication.

Recommended Procedures for Compliance

Make an immediate written report to employer detailing proposed compensation and services, if additional to that provided by employer.

Application of Standard IV(B) Additional Compensation Arrangements

Example 1:

Geoff Whitman, a portfolio analyst for Adams Trust Company, manages the account of Carol Cochran, a client. Whitman is paid a salary by his employer, and Cochran pays the trust company a standard fee based on the market value of assets in her portfolio. Cochran proposes to Whitman that "any year that my portfolio

achieves at least a 15 percent return before taxes, you and your wife can fly to Monaco at my expense and use my condominium during the third week of January. Whitman does not inform his employer of the arrangement and vacations in Monaco the following January as Cochran's guest.

Comment:

Whitman violated Standard IV(B) by failing to inform his employer in writing of this supplemental, contingent compensation arrangement. The nature of the arrangement could have resulted in partiality to Cochran's account, which could have detracted from Whitman's performance with respect to other accounts he handles for Adams Trust. Whitman must obtain the consent of his employer to accept such a supplemental benefit.

IV(C) Responsibilities of Supervisors. All Members and Candidates must make reasonable efforts to detect and prevent violations of laws, rules, regulations, and the Code and Standards by any person under their supervision or authority.

Professor's Note: The focus is on establishing and implementing reasonable compliance procedures in order to meet this Standard.

Guidance

Members must take steps to prevent employees from violating laws, rules, regulations, or the Code and Standards and make reasonable efforts to detect violations.

Guidance—Compliance Procedures

Understand that an adequate compliance system must meet industry standards, regulatory requirements, and the requirements of the Code and Standards. Members with supervisory responsibilities have an obligation to bring an inadequate compliance system to the attention of firm's management and recommend corrective action. While investigating a possible breach of compliance procedures, it is appropriate to limit the suspected employee's activities.

Recommended Procedures for Compliance

A member should recommend that his employer adopt a code of ethics. Employers should not commingle compliance procedures with the firm's code of ethics—this can dilute the goal of reinforcing one's ethical obligations. Members should encourage employers to provide their code of ethics to clients.

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.

Once the compliance program is instituted, the supervisor should:

- Distribute it to the proper personnel.
- Update it as needed.
- Continually educate staff regarding procedures.
- Issue reminders as necessary.

- Require professional conduct evaluations.
- Review employee actions to monitor compliance and identify violations.
- Enforce procedures once a violation occurs.

If there is a violation, respond promptly and conduct a thorough investigation while placing limitations on the wrongdoer's activities.

Application of Standard IV(C) Responsibilities of Supervisors

Example 1:

Jane Mattock, senior vice president and head of the research department of H&V, Inc., a regional brokerage firm, has decided to change her recommendation for Timber Products from buy to sell. In line with H&V's procedures, she orally advises certain other H&V executives of her proposed actions before the report is prepared for publication. As a result of his conversation with Mattock, Dieter Frampton, one of the executives of H&V accountable to Mattock, immediately sells Timber's stock from his own account and from certain discretionary client accounts. In addition, other personnel inform certain institutional customers of the changed recommendation before it is printed and disseminated to all H&V customers who have received previous Timber reports.

Comment:

Mattock failed to supervise reasonably and adequately the actions of those accountable to her. She did not prevent or establish reasonable procedures designed to prevent dissemination of or trading on the information by those who knew of her changed recommendation. She must ensure that her firm has procedures for reviewing or recording trading in the stock of any corporation that has been the subject of an unpublished change in recommendation. Adequate procedures would have informed the subordinates of their duties and detected sales by Frampton and selected customers.

Example 2:

Deion Miller is the research director for Jamestown Investment Programs. The portfolio managers have become critical of Miller and his staff because the Jamestown portfolios do not include any stock that has been the subject of a merger or tender offer. Georgia Ginn, a member of Miller's staff, tells Miller that she has been studying a local company, Excelsior, Inc., and recommends its purchase. Ginn adds that the company has been widely rumored to be the subject of a merger study by a well-known conglomerate and discussions between them are under way. At Miller's request, Ginn prepares a memo recommending the stock. Miller passes along Ginn's memo to the portfolio managers prior to leaving for vacation, noting that he has not reviewed the memo. As a result of the memo, the portfolio managers buy Excelsior stock immediately. The day Miller returns to the office, Miller learns that Ginn's only sources for the report were her brother, who is an acquisitions analyst with Acme Industries and the "well-known conglomerate" and that the merger discussions were planned but not held.

Comment:

Miller violated Standard IV(C) by not exercising reasonable supervision when he disseminated the memo without checking to ensure that Ginn had a reasonable and adequate basis for her recommendations and that Ginn was not relying on material nonpublic information.

V Investment Analysis, Recommendations, and Action

V(A) Diligence and Reasonable Basis

1. When analyzing investments, making recommendations, and taking investment actions use diligence, independence, and thoroughness.

2. Investment analysis, recommendations, and actions should have a reasonable and adequate basis, supported by research and investigation.

Professor's Note: There is no real change to the old Standard—it is now just more clearly stated that Members and Candidates must act with diligence, independence, and thoroughness when performing investment analysis and making a recommendation or taking investment action.

Guidance

The application of this Standard depends on the investment philosophy adhered to, members' and candidates' roles in the investment decision-making process, and the resources and support provided by employers. These factors dictate the degree of diligence, thoroughness of research, and the proper level of investigation required.

Guidance—Using Secondary or Third-Party Research

See that the research is sound. Examples of criteria to use to evaluate:

- Review assumptions used.
- How rigorous was the analysis?
- How timely is the research?
- Evaluate objectivity and independence of the recommendations.

Guidance—Group Research and Decision Making

Even if a member does not agree with the independent and objective view of the group, he does not necessarily have to decline to be identified with the report, as long as there is a reasonable and adequate basis.

Recommended Procedures for Compliance

Members should encourage their firms to consider these policies and procedures supporting this Standard:

- Have a policy requiring that research reports and recommendations have a basis that can be substantiated as reasonable and adequate.
- Have detailed, written guidance for proper research and due diligence.
- Have measurable criteria for judging the quality of research.

Application of Standard V(A) Diligence and Reasonable Basis

Example 1:

Helen Hawke manages the corporate finance department of Sarkozi Securities, Ltd. The firm is anticipating that the government will soon close a tax loophole that currently allows oil and gas exploration companies to pass on drilling expenses to holders of a certain class of shares. Because market demand for this tax-advantaged class of stock is currently high, Sarkozi convinces several companies to undertake new equity financings at once before the loophole closes. Time is of the essence, but Sarkozi lacks sufficient resources to conduct adequate research on all the prospective issuing companies. Hawke decides to estimate the IPO prices based on the relative size of each company and to justify the pricing later when her staff has time.

Comment:

Sarkozi should have taken on only the work that it could adequately handle. By categorizing the issuers as to general size, Hawke has bypassed researching all the other relevant aspects that should be considered when

pricing new issues and thus has not performed sufficient due diligence. Such an omission can result in investors purchasing shares at prices that have no actual basis. Hawke has violated Standard V(A).

Example 2:

Evelyn Mastakis is a junior analyst asked by her firm to write a research report predicting the expected interest rate for residential mortgages over the next six months. Mastakis submits her report to the fixed-income investment committee of her firm for review, as required by firm procedures. Although some committee members support Mastakis's conclusion, the majority of the committee disagrees with her conclusion and the report is significantly changed to indicate that interest rates are likely to increase more than originally predicted by Mastakis.

Comment:

The results of research are not always clear, and different people may have different opinions based on the same factual evidence. In this case, the majority of the committee may have valid reasons for issuing a report that differs from the analyst's original research. The firm can issue a report different from the original report of the analyst as long as there is a reasonable or adequate basis for its conclusions. Generally, analysts must write research reports that reflect their own opinion and can ask the firm not to put their name on reports that ultimately differ from that opinion. When the work is a group effort, however, not all members of the team may agree with all aspects of the report. Ultimately, members and candidates can ask to have their names removed from the report, but if they are satisfied that the process has produced results or conclusions that have a reasonable or adequate basis, members or candidates do not have to dissociate from the report even when they do not agree with its contents. The member or candidate should document the difference of opinion and any request to remove his or her name from the report.

V(B) Communication With Clients and Prospective Clients

1. Disclose to clients and prospects basic format and general principles of investment processes used to analyze and select securities and construct portfolios. Promptly disclose any process changes.
2. Use reasonable judgment in identifying relevant factors important to investment analyses, recommendations, or actions, and include factors when communicating with clients and prospects.
3. Investment analyses and recommendations should clearly differentiate facts from opinions.

Professor's Note: This combines two of the prior Standards. There is no longer a need to distinguish between types of communication, research report versus a recommendation. This Standard covers communication in any form.

Guidance

Proper communication with clients is critical to provide quality financial services. Members must distinguish between opinions and facts and always include the basic characteristics of the security being analyzed in a research report.

Members must illustrate to clients and prospects the investment decision-making process utilized. The suitability of each investment is important in the context of the entire portfolio.

All means of communication are included here, not just research reports.

Recommended Procedures for Compliance

Selection of relevant factors in a report can be a judgment call, so be sure to maintain records indicating the nature of the research, and be able to supply additional information if it is requested by the client or other users of the report.

Application of Standard V(B) Communication with Clients and Prospective Clients

Example 1:

Sarah Williamson, director of marketing for Country Technicians, Inc., is convinced that she has found the perfect formula for increasing Country Technician's income and diversifying its product base. Williamson plans to build on Country Technician's reputation as a leading money manager by marketing an exclusive and expensive investment advice letter to high-net-worth individuals. One hitch in the plan is the complexity of Country Technician's investment system—a combination of technical trading rules (based on historical price and volume fluctuations) and portfolio-construction rules designed to minimize risk. To simplify the newsletter, she decides to include only each week's top-five buy and sell recommendations and to leave out details of the valuation models and the portfolio-structuring scheme.

Comment:

Williamson's plans for the newsletter violate Standard V(B) because she does not intend to include all the relevant factors behind the investment advice. Williamson need not describe the investment system in detail in order to implement the advice effectively, clients must be informed of Country Technician's basic process and logic. Without understanding the basis for a recommendation, clients cannot possibly understand its limitations or its inherent risks.

Example 2:

Richard Dox is a mining analyst for East Bank Securities. He has just finished his report on Boisy Bay Minerals. Included in his report is his own assessment of the geological extent of mineral reserves likely to be found on the company's land. Dox completed this calculation based on the core samples from the company's latest drilling. According to Dox's calculations, the company has in excess of 500,000 ounces of gold on the property. Dox concludes his research report as follows: "Based on the fact that the company has 500,000 ounces of gold to be mined, I recommend a strong BUY."

Comment:

If Dox issues the report as written, he will violate Standard V(B). His calculation of the total gold reserves for the property is an opinion, not a fact. Opinion must be distinguished from fact in research reports.

Example 3:

May & Associates is an aggressive growth manager that has represented itself since its inception as a specialist at investing in small-capitalization domestic stocks. One of May's selection criteria is a maximum capitalization of $250 million for any given company. After a string of successful years of superior relative performance, May expanded its client base significantly, to the point at which assets under management now exceed $3 billion. For liquidity purposes, May's chief investment officer (CIO) decides to lift the maximum permissible market-cap ceiling to $500 million and change the firm's sales and marketing literature accordingly to inform prospective clients and third-party consultants.

Comment:

Although May's CIO is correct about informing potentially interested parties as to the change in investment process, he must also notify May's existing clients. Among the latter group might be a number of clients who not only retained May as a small-cap manager but also retained mid-cap and large-cap specialists in a multiple-manager approach. Such clients could regard May's change of criteria as a style change that could distort their overall asset allocations.

Example 4:

Rather than lifting the ceiling for its universe from $250 million to $500 million, May & Associates extends its small-cap universe to include a number of non-U.S. companies.

Comment:

Standard V(B) requires that May's CIO advise May's clients of this change because the firm may have been retained by some clients specifically for its prowess at investing in domestic small-cap stocks. Other variations requiring client notification include introducing derivatives to emulate a certain market sector or relaxing various other constraints, such as portfolio beta. In all such cases, members and candidates must disclose changes to all interested parties.

V(C) Record Retention. Maintain all records supporting analysis, recommendations, actions, and all other investment-related communications with clients and prospects.

Professor's Note: The issue of record retention is now explicitly broken out into a new Standard, emphasizing its importance.

Guidance

Members must maintain research records that support the reasons for the analyst's conclusions and any investment actions taken. Such records are the property of the firm. If no other regulatory standards are in place, CFA Institute recommends at least a 7-year holding period.

Recommended Procedures for Compliance

This record-keeping requirement generally is the firm's responsibility.

Application of Standard V(C) Record Retention

Example 1:

One of Nikolas Lindstrom's clients is upset by the negative investment returns in his equity portfolio. The investment policy statement for the client requires that the portfolio manager follow a benchmark-oriented approach. The benchmark for the client included a 35 percent investment allocation in the technology sector, which the client acknowledged was appropriate. Over the past three years, the portion put into the segment of technology stocks suffered severe losses. The client complains to the investment manager that so much money was allocated to this sector.

Comment:

For Lindstrom, it is important to have appropriate records to show that over the past three years the percentage of technology stocks in the benchmark index was 35 percent. Therefore, the amount of money invested in the technology sector was appropriate according to the investment policy statement. Lindstrom should also have the investment policy statement for the client stating that the benchmark was appropriate

for the client's investment objectives. He should also have records indicating that the investment had been explained appropriately to the client and that the investment policy statement was updated on a regular basis.

VI Conflicts of Interest

VI(A) Disclosure of Conflicts. Members and Candidates must make full and fair disclosure of all matters which 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.

Professor's Note: Emphasis in the new Standard is on meaningful disclosure—prominent and in plain language.

Guidance

Members must fully disclose to clients, prospects, and their employers all actual and potential conflicts of interest in order to protect investors and employers. These disclosures must be clearly stated.

Guidance—Disclosure to Clients

The requirement that all potential areas of conflict be disclosed allows clients and prospects to judge motives and potential biases for themselves. Disclosure of broker/dealer market-making activities would be included here. Board service is another area of potential conflict.

The most common conflict which requires disclosure is actual ownership of stock in companies that the member recommends or that clients hold.

Guidance—Disclosure of Conflicts to Employers

Members must give the employer enough information to judge the impact of the conflict. Take reasonable steps to avoid conflicts, and report them promptly if they occur.

Recommended Procedures of Compliance

Any special compensation arrangements, bonus programs, commissions, and incentives should be disclosed.

Application of Standard VI(A) Disclosure of Conflicts

Example 1:

Hunter Weiss is a research analyst with Farmington Company, a broker and investment banking firm. Farmington's merger and acquisition department has represented Vimco, a conglomerate, in all of its acquisitions for 20 years. From time to time, Farmington officers sit on the boards of directors of various Vimco subsidiaries. Weiss is writing a research report on Vimco.

Comment:

Weiss must disclose in his research report Farmington's special relationship with Vimco. Broker/dealer management of and participation in public offerings must be disclosed in research reports. Because the position of underwriter to a company presents a special past and potential future relationship with a company that is the subject of investment advice, it threatens the independence and objectivity of the report and must be disclosed.

Example 2:

Samantha Dyson, a portfolio manager for Thomas Investment Counsel, Inc., specializes in managing defined-benefit pension plan accounts, all of which are in the accumulative phase and have long-term

investment objectives. A year ago, Dyson's employer, in an attempt to motivate and retain key investment professionals, introduced a bonus compensation system that rewards portfolio managers on the basis of quarterly performance relative to their peers and certain benchmark indexes. Dyson changes her investment strategy and purchases several high-beta stocks for client portfolios in an attempt to improve short-term performance. These purchases are seemingly contrary to the client investment policy statement. Now, an officer of Griffin Corporation, one of Dyson's pension fund clients, asks why Griffin Corporation's portfolio seems to be dominated by high-beta stocks of companies that often appear among the most actively traded issues. No change in objective or strategy has been recommended by Dyson during the year.

Comment:

Dyson violated Standard VI(A) by failing to inform her clients of the changes in her compensation arrangement with her employer that created a conflict of interest. Firms may pay employees on the basis of performance, but pressure by Thomas Investment Counsel to achieve short-term performance goals is in basic conflict with the objectives of Dyson's accounts.

Example 3:

Bruce Smith covers East European equities for Marlborough investments, an investment management firm with a strong presence in emerging markets. While on a business trip to Russia, Smith learns that investing in Russian equity directly is difficult but that equity-linked notes that replicate the performance of the underlying Russian equity can be purchased from a New York-based investment bank. Believing that his firm would not be interested in such a security, Smith purchases a note linked to a Russian telecommunications company for his own account without informing Marlborough. A month later, Smith decides that the firm should consider investing in Russian equities using equity-linked notes, and he prepares a write-up on the market that concludes with a recommendation to purchase several of the notes. One note recommended is linked to the same Russian telecom company that Smith holds in his personal account.

Comment:

Smith violated Standard VI(A) by failing to disclose his ownership of the note linked to the Russian telecom company. Smith is required by the standard to disclose the investment opportunity to his employer and look to his company's policies on personal trading to determine whether it was proper for him to purchase the note for his own account. By purchasing the note, Smith may or may not have impaired his ability to make an unbiased and objective assessment of the appropriateness of the derivative instrument for his firm, but Smith's failure to disclose the purchase to his employer impaired his employer's ability to render an opinion regarding whether the ownership of a security constituted a conflict of interest that might have affected future recommendations. Once he recommended the notes to his firm, Smith compounded his problems by not disclosing that he owned the notes in his personal account—a clear conflict of interest.

VI(B) Priority of Transactions. Investment transactions for clients and employers must have priority over those in which a Member or Candidate is a beneficial owner.

Professor's Note: Language has been simplified in the new Standard—transactions for clients and employers always have priority over personal transactions.

Guidance

Client transactions take priority over personal transactions and over transactions made on behalf of the member's firm. Personal transactions include situations where the member is a "beneficial owner." Personal transactions may be undertaken only after clients and the member's employer have had an adequate opportunity to act on a recommendation. Note that family-member accounts that are client accounts should be treated just like any client account; they should not be disadvantaged.

Recommended Procedures for Compliance

All firms should have in place basic procedures that address conflicts created by personal investing. The following areas should be included:

- Limited participation in equity IPOs. Members can avoid these conflicts by not participating in IPOs.
- Restrictions on private placements. Strict limits should be placed on employee acquisition of these securities and proper supervisory procedures should be in place. Participation in these investments raises conflict of interest issues, similar to IPOs.
- Establish blackout/restricted periods. Employees involved in investment decision-making should have blackout periods prior to trading for clients—no "front running" (i.e., purchase or sale of securities in advance of anticipated client or employer purchases and sales). The size of the firm and the type of security should help dictate how severe the blackout requirement should be.
- Reporting requirements. Supervisors should establish reporting procedures, including duplicate trade confirmations, disclosure of personal holdings/beneficial ownership positions, and pre-clearance procedures.
- Disclosure of policies. When requested, members must fully disclose to investors their firm's personal trading policies.

Application of Standard VI(B) Priority of Transactions

Example 1:

Erin Toffler, a portfolio manager at Esposito Investments, manages the retirement account established with the firm by her parents. Whenever IPOs become available, she first allocates shares to all her other clients for whom the investment is appropriate; only then does she place any remaining portion in her parents' account, if the issue is appropriate for them. She has adopted this procedure so that no one can accuse her of favoring her parents.

Comment:

Toffler has breached her duty to her parents by treating them differently from her other accounts simply because of the family relationship. As fee-paying clients of Esposito Investments, Toffler's parents are entitled to the same treatment as any other client of the firm. If Toffler has beneficial ownership in the account, however, and Esposito Investments has preclearance and reporting requirements for personal transactions, she may have to preclear the trades and report the transactions to Esposito.

Example 2:

A brokerage's insurance analyst, Denise Wilson, makes a closed-circuit report to her firm's branches around the country. During the broadcast, she includes negative comments about a major company within the industry. The following day, Wilson's report is printed and distributed to the sales force and public customers. The report recommends that both short-term traders and intermediate investors take profits by selling that company's stocks. Several minutes after the broadcast, Ellen Riley, head of the firm's trading department, closes out a long call position in the stock. Shortly thereafter, Riley establishes a sizable "put" position in the stock. Riley claims she took this action to facilitate anticipated sales by institutional clients.

Comment:

Riley expected that both the stock and option markets would respond to the "sell" recommendation, but she did not give customers an opportunity to buy or sell in the options market before the firm itself did. By taking action before the report was disseminated, Riley's firm could have depressed the price of the "calls" and increased the price of the "puts." The firm could have avoided a conflict of interest if it had waited to trade for its own account until its clients had an opportunity to receive and assimilate Wilson's recommendations. As it is, Riley's actions violated Standard VI(B).

VI(C) Referral Fees. Members and Candidates must disclose to their employers, clients, and prospects any compensation consideration or benefit received by, or paid to, others for recommendations of products and services.

Guidance

Members must inform employers, clients, and prospects of any benefit received for referrals of customers and clients, allowing them to evaluate the full cost of the service as well as any potential impartiality. All types of consideration must be disclosed.

Application of Standard VI(C) Referral Fees

Example 1:

Brady Securities, Inc., a broker/dealer, has established a referral arrangement with Lewis Brothers, Ltd., an investment counseling firm. Under this arrangement, Brady Securities refers all prospective tax-exempt accounts, including pension, profit-sharing, and endowment accounts, to Lewis Brothers. In return, Lewis Brothers makes available to Brady Securities on a regular basis the security recommendations and reports of its research staff, which registered representatives of Brady Securities use in serving customers. In addition, Lewis Brothers conducts monthly economic and market reviews for Brady Securities personnel and directs all stock commission business generated by referral account to Brady Securities. Willard White, a partner in Lewis Brothers, calculates that the incremental costs involved in functioning as the research department of Brady Securities amount to $20,000 annually. Referrals from Brady Securities last year resulted in fee income of $200,000, and directing all stock trades through Brady Securities resulted in additional costs to Lewis Brothers' clients of $10,000.

Diane Branch, the chief financial officer of Maxwell Inc., contacts White and says that she is seeking an investment manager for Maxwell's profit-sharing plan. She adds, "My friend Harold Hill at Brady Securities recommended your firm without qualification, and that's good enough for me. Do we have a deal?" White accepts the new account but does not disclose his firm's referral arrangement with Brady Securities.

Comment:

White violated Standard VI(C) by failing to inform the prospective customer of the referral fee payable in services and commissions for an indefinite period to Brady Securities. Such disclosure could have caused Branch to reassess Hill's recommendation and make a more critical evaluation of Lewis Brothers' services.

Example 2:

James Handley works for the Trust Department of Central Trust Bank. He receives compensation for each referral he makes to Central Trust's brokerage and personal financial management department that results in a sale. He refers several of his clients to the personal financial management department but does not disclose the arrangement within Central trust to his clients.

Comment:

Handley has violated Standard V(C) by not disclosing the referral arrangement at Central Trust Bank to his clients. The Standard does not distinguish between referral fees paid by a third party for referring clients to the third party and internal compensation arrangements paid within the firm to attract new business to a subsidiary. Members and candidates must disclose all such referral fees. Therefore, Handley would be required to disclose, at the time of referral, any referral fee agreement in place between Central Trust Bank's departments. The disclosure should include the nature and the value of the benefit and should be made in writing.

Example 3:

Yeshao Wen is a portfolio manager for a bank. He receives additional monetary compensation from his employer when he is successful in assisting in the sales process and generation of assets under management. The assets in question will be invested in proprietary product offerings such as affiliate company mutual funds.

Comment:

Standard VI(C) is meant to address instances where the investment advice provided by a member or candidate appears to be objective and independent but in fact is influenced by an unseen referral arrangement. It is not meant to cover compensation by employers to employees for generating new business when it would be obvious to potential clients that the employees are "referring" potential clients to the services of their employers.

If Wen is selling the bank's investment management services in general, he does not need to disclose to potential clients that he will receive a bonus for finding new clients and acquiring new assets under management for the bank. Potential clients are likely aware that it would be financially beneficial both to the portfolio manager and the manager's firm for the portfolio manager to sell the services of the firm and attract new clients. Therefore, sales efforts attempting to attract new investment management clients need not disclose this fact.

However, in this example, the assets will be managed in "proprietary product offerings" of the manager's company (for example, an in-house mutual fund) and Wen will receive additional compensation for selling firm products. Some sophisticated investors may realize that it would be financially beneficial to the portfolio manager and the manager's firm if the investor buys the product offerings of the firm.

Best practice, however, dictates that the portfolio manager must disclose to clients that they are compensated for referring clients to firm products. Such discloser will meet the purpose of Standard VI(C), which is to allow investors to determine whether there is any partiality on the part of the portfolio manager when making investment advice.

VII Responsibilities as a CFA Institute Member or CFA Candidate

VII(A) Conduct as Members and Candidates in the CFA Program. Members and Candidates must not engage in conduct that compromises the reputation or integrity of CFA Institute or the CFA designation or the integrity, validity, or security of the CFA exams.

Professor's Note: The Standard is intended to cover conduct such as cheating on the CFA exam or otherwise violating rules of CFA Institute or the CFA program. It is not intended to prevent anyone from expressing any opinions or beliefs concerning CFA Institute or the CFA program.

Members must not engage in any activity that undermines the integrity of the CFA charter. This Standard applies to conduct which includes:

- Cheating on the CFA exam or any exam.
- Not following rules and policies of the CFA program.
- Giving confidential information on the CFA program to Candidates or the public.
- Improperly using the designation to further personal and professional goals.
- Misrepresenting information on the Professional Conduct Statement (PCS) or the CFA Institute Professional Development Program.

Members and candidates are not precluded from expressing their opinions regarding the exam program or CFA Institute.

Application of Standard VII(A) Conduct as Members and Candidates in the CFA Program

Example 1:

Ashlie Hocking is writing Level 2 of the CFA examination in London. After completing the exam, she immediately attempts to contact her friend in Sydney, Australia, to tip him off to specific questions on the exam.

Comment:

Hocking has violated Standard VII(A) by attempting to give her friend an unfair advantage, thereby compromising the integrity of the CFA examination process.

Example 2:

Jose Ramirez is an investment-relations consultant for several small companies that are seeking greater exposure to investors. He is also the program chair for the CFA Institute society in the city where he works. To the exclusion of other companies, Ramirez only schedules companies that are his clients to make presentations to the society.

Comment:

Ramirez, by using his volunteer position at CFA Institute to benefit himself and his clients, compromises the reputation and integrity of CFA Institute, and, thus, violates Standard VII(A).

VII(B) Reference to CFA Institute, the CFA designation, and the CFA Program. Members and Candidates must not misrepresent or exaggerate the meaning or implications of membership in CFA Institute, holding the CFA designation, or candidacy in the program.

Professor's Note: Replacing the vague language "dignified and judicious…" this new Standard is clearer as it prohibits Candidates from engaging in any conduct that may "misrepresent or exaggerate the meaning or implications of membership in CFA Institute, holding the CFA designation, or candidacy in the CFA program." The requirement that Candidates still not reference any "partial" designation remains since this also misrepresents or exaggerates credentials.

Guidance

Members must not make promotional promises or guarantees tied to the CFA designation. Do not:

- Over-promise individual competence.
- Over-promise investment results in the future (i.e., higher performance, less risk, etc.).

Guidance—CFA Institute Membership

Members must satisfy these requirements to maintain membership:

- Sign PCS annually.
- Pay annual CFA Institute membership dues.

If they fail to do this, they are no longer active members.

Guidance—Using the CFA Designation

Do not misrepresent or exaggerate the meaning of the designation.

Guidance—Referencing Candidacy in the CFA Program

There is no partial designation. It is acceptable to state that a Candidate successfully completed the program in three years, if in fact they did, but claiming superior ability because of this is not permitted.

Guidance—Proper Usage of the CFA Marks

The Chartered Financial Analyst and CFA marks must always be used either after a charterholder's name or as adjectives, but not as nouns, in written and oral communications.

Recommended Procedures for Compliance

Make sure that members' and candidates' firms are aware of the proper references to a member's CFA designation or candidacy, as this is a common error.

Application of Standard VII(B) Reference to CFA Institute, the CFA Designation, and the CFA Program

Example 1:

An advertisement for AZ Investment Advisors states that all the firm's principals are CFA charterholders and all passed the three examinations on their first attempt. The advertisement prominently links this fact to the notion that AZ's mutual funds have achieved superior performance.

Comment:

AZ may state that all principals passed the three examinations on the first try as long as this statement is true and is not linked to performance or does not imply superior ability. Implying that (1) CFA charterholders achieve better investment results and (2) those who pass the exams on the first try may be more successful than those who do not violates Standard VII(B).

Example 2:

Five years after receiving his CFA charter, Louis Vasseur resigns his position as an investment analyst and spends the next two years traveling abroad. Because he is not actively engaged in the investment profession, he does not file a completed Professional Conduct Statement with CFA Institute and does not pay his CFA Institute membership dues. At the conclusion of his travels, Vasseur becomes a self-employed analyst, accepting assignments as an independent contractor. Without reinstating his CFA Institute membership by filing his Professional Conduct Statement and paying his dues, he prints business cards that display "CFA" after his name.

Comment:

Vasseur has violated Standard VII(B) because Vasseur's right to use the CFA designation was suspended when he failed to file his Professional Conduct Statement and stopped paying dues. Therefore, he no longer is able to state or imply that he is an active CFA charterholder. When Vasseur files his Professional Conduct Statement and resumes paying CFA Institute dues to activate his membership, he will be eligible to use the CFA designation upon satisfactory completion of CFA Institute reinstatement procedures.

The following is a review of the Ethical and Professional Standards principles designed to address the learning outcome statements set forth by CFA Institute. This topic is also covered in:

CFA Institute Soft Dollar Standards: Guidance for Ethical Practices Involving Client Brokerage

Study Session 1

Exam Focus

"Soft dollars" (or "client brokerage") refers to investment research, products and services, and cash credits given to the investment manager by brokers in return for client business. The soft dollar credit is the client's asset because he pays the commission. Fiduciaries owe their clients two basic duties: to act in the clients' best interest and to disclose conflicts of interest. The cardinal rule is that soft dollars are an asset of the client, and soft dollars may not be used for any purpose that does not benefit that client.

LOS 3: State the general principles of the Soft Dollar Standards, distinguish between the requirements and the recommendations of the Soft Dollar Standards, explain how to determine if a product or service is permissible research, and identify practices or transactions that violate the Soft Dollar Standards.

Some Definitions

- *Soft dollars* refer to commissions generated on both agency and principal trade executions.
- *Soft dollar practices* involve the use of client brokerage by an investment manager to obtain certain products and services to aid the manager in the investment decision-making process.
- *Soft dollar arrangement* refers to the research and benefits reimbursed to the client or the client's manager by the broker for directing the trade to the broker.
- *Brokerage* refers to the amount given to a broker as payment for execution services.
- *Research* includes both *proprietary* (generated by the broker) and *third-party* research (purchased by the broker). Research must directly assist the investment manager in the investment decision-making process and not in the management of the firm itself. Research that can be used for both the investment management process and management is called *mixed-use* research.
- An *agency trade* is a transaction that involves the payment of a commission.
- A *principal trade* is a transaction that involves a discount or a spread.

General Principles of the Soft Dollar Standards

The two key principles of the soft dollar standards are:

- Brokerage is the property of the client.
- Investment managers have a duty to obtain best execution, minimize transactions costs, and use client brokerage to benefit clients.

CFA Institute's Soft Dollar Standards are intended to ensure:

- Complete disclosure of the investment manager's use of soft dollars and client brokerage.
- Consistent presentation of data so all parties can clearly understand brokerage practices.
- Uniform disclosure and record keeping so the client clearly understands how the investment manager is using client brokerage.

- Consistently high ethical industry standards.

The investment manager should consider that:

- The manager is a fiduciary and as such must disclose all details relating to benefits received through a client's brokerage.
- Third-party and proprietary research are to be treated similarly when examining soft dollar arrangements since the research received is paid for with client brokerage.
- Any research purchased with client brokerage must directly assist the investment manager in the investment process and not in the overall management of the firm.
- If there is ever any question as to whether the research assists in the investment process, it should be paid for with investment manager assets.

CFA Institute Soft Dollar Standards—Requirements and Recommendations

I. General

Required:

- Soft dollar practices must benefit the client and must place the clients' interests above the investment manager's interests.
- Allocation of client brokerage should not be based on the amount of client referrals the investment manager receives from a broker.
- Regarding mutual funds, the investment manager's client is the fund. The fund's board should set policies regarding broker selection.

II. Relationships With Clients

Required:

- Disclose to the client that the manager may participate in soft dollar arrangements involving the client's account prior to participating in such arrangements.

Recommended:

- It is permissible to use client brokerage from agency trades to obtain research which may not directly benefit the client. Over time, however, the client should receive a benefit from the research.
- It is okay to use client brokerage obtained from principal trades to benefit other client accounts, as long as this is disclosed to the client and prior consent is received.

III. Selection of Brokers

Proper broker selection is a key area where the investment manager can add value for the client. Failure to obtain best execution will hurt performance.

Required:

- Consider trade execution capabilities when selecting brokers.

Recommended:

- When evaluating best execution, consider the broker's financial responsibility, responsiveness, brokerage rate or spread involved, and range of services provided.

IV. Evaluation of Research

Required:

To be able to use client brokerage to pay for research, these criteria must be followed:

- Research must meet the definition. Research is defined as services and products provided by a broker whose primary use directly assists the investment manager in the investment decision making process, and not in the management of the firm.
- Research must benefit the client.
- The basis for the determination must be documented.
- In the case of principal trades not subject to other fiduciary regulations, the research may benefit other client accounts, as long as disclosure is made to the client and prior permission is received.
- If the criteria regarding client brokerage associated with principal trades is not met, the investment manager must pay for the research.
- In the case of mixed-use research, make a reasonable allocation of the cost of the research based on its expected usage. Only portions that are used by the investment manager in the investment decision making process can be paid with client brokerage. Mixed-use research allocation must be re-evaluated annually.

V. Client-Directed Brokerage

Brokerage is an asset of the client, so this practice does not violate the investment manager's duty.

Required:

- Do not use brokerage from another client to pay for products or services purchased under any client-directed brokerage agreement.

Recommended:

- The investment manager should disclose the duty to seek best execution.
- Disclose to the client that the arrangement may adversely affect the manager's ability to obtain best execution and receive adequate research for the client.
- The investment manager should structure the arrangements so that they do not require the commitment of a certain portion of client brokerage to a single broker. The arrangement should ensure that commissions are negotiated and that there is an emphasis on best execution.

VI. Disclosure

Required:

- Investment managers must disclose in plain language their soft dollar policies. Principal trades must be addressed.
- Investment managers must disclose the types of research received through proprietary or third-party research, the extent of its use, and whether an affiliated broker is involved.
- To claim compliance with Soft Dollar Standards, the client must receive a statement that soft dollar practices conform to these Standards, and the statement must be provided at least annually.
- Investment managers must disclose in writing that more information concerning soft dollar arrangements is available on request.
- Additional information provided upon request may include a description of what the firm obtained through its soft dollar arrangements, the brokers who provided services, and total commissions generated for the client's account.

Recommended:

- As requested by the client, provide a description of the product or service obtained through client brokerage generated by the client's account.
- Provide the total amount of brokerage paid from all accounts over which the investment manager has discretion.

VII. Record Keeping

Required:

The investment manager must maintain records that:

- Meet legal and regulatory requirements.
- Are needed to supply timely information to clients consistent with the disclosure requirements.
- Document any arrangements that obligate the investment manager to generate a specific amount of brokerage.
- Document arrangements with clients regarding soft dollar or client-directed brokerage.
- Document any broker arrangements.
- Document the basis for allocations when using client brokerage for mixed-use services and products.
- Show how services and products obtained via soft dollars assist the investment manager in the investment decision-making process.
- Show compliance with the CFA Institute Soft Dollar Standards, and identify the personnel responsible.
- Include copies of client disclosures and authorizations.

PERMISSIBLE RESEARCH GUIDANCE

CFA Institute Soft Dollar Standards set forth a three-level analysis to assist the investment manager in the determination of whether a product or service is "research."

Level 1 – Define the Product/Service: Define it in detail, including multiple components. *For example, a computer work station may be classified as a qualifying product, but the electricity to run the equipment would not.*

Level 2 – Determine Usage: Determine the primary use of the product or service. *For example, does the Bloomberg service received directly assist in the investment decision-making process, or is it there just to provide an "overall benefit to the firm"?*

Level 3 – Mixed-Use Analysis: This step must be completed only if the product or service is classified as "research" based on the Level 1 and Level 2 analysis above. This Level 3 analysis is the investment manager's allocation of the portion of the product or service which directly assists in the investment decision-making process. *For example, if the Bloomberg service is used 50 percent of the time to "determine market and industry trends as part of the investment manager's investment decision-making process," then half of the expense can be paid from client brokerage.*

The following is a review of the Ethical and Professional Standards principles designed to address the learning outcome statements set forth by CFA Institute. This topic is also covered in:

CFA Institute Research Objectivity Standards

Study Session 1

Exam Focus

The objectives of CFA Institute's Research Objectivity Standards are to provide specific, measurable standards for managing and disclosing conflicts of interest that may interfere with an analyst's ability to conduct independent research and make objective recommendations.

These standards are intended to be a universal guide for all investment firms by providing ethical standards and practices regarding full and fair disclosure of any conflicts or potential conflicts relating to the firm's research. The goal is objectivity and independence.

The Research Objectivity Standards are new to the Level 2 curriculum in 2006.

LOS 4: The candidate should be able to state the objectives of the Research Objectivity Standards, explain the recommended procedures for compliance, and identify practices or procedures that violate the Research Objectivity Standards.

Objectives of Research Objectivity Standards

When designing policies and procedures for a firm, strive to achieve these objectives while implementing the CFA Institute Research Objectivity Standards:

A. Prepare research, make recommendations, take investment actions, and develop policies, procedures, and disclosures that put client interests before employees' and the firm's interests.

B. Facilitate full, fair, meaningful, and specific disclosures to clients and prospects of possible and actual conflicts of interest of the firm and its employees.

C. Promote the use of effective policies and procedures that minimize possible conflicts that may adversely affect independence and objectivity of research.

D. Support self-regulation by adhering to specific, measurable standards to promote objective and independent research.

E. Provide a work environment conducive to ethical behavior and adherence to the *Code and Standards*.

Important Definitions

Covered employee: a firm employee who:

- Conducts research, writes research reports, and/or makes investment recommendations.
- Takes investment action on the client's behalf or is involved in the decision-making process.
- May benefit, either personally or professionally, from her ability to influence research reports or investment recommendations.

Immediate family: anyone who lives with (i.e., has the same principal residence as) the analyst or manager.

Investment manager: any employee who conducts investment research and/or takes investment action for client accounts or the firm's accounts, *whether or not the person has the title of "investment manager."*

Public appearance: any forum in which the analyst or manager makes investment recommendations or offers opinions, including seminars, public speaking engagements, interactive electronic forums, and any kind of media interview.

Research analyst: any employee who is primarily responsible for any part of the process of developing a research report, *whether or not the person has the title of "research analyst."*

Subject company: Company whose securities are covered by a research report or recommendation.

Requirements and Recommended Compliance Procedures

1.0 Research Objectivity Policy

The firm must have:

(a) A formal written independence and objectivity of research policy that it distributes to clients, prospective clients, and employees.
(b) Supervisory procedures in place to make sure employees comply with the policy.
(c) A senior officer who attests annually to clients and prospective clients that the firm has complied with the policy.

Compliance Procedures

- Identify and describe covered employees—those conducting and writing research and making recommendations, including anyone who would benefit from his ability to influence the recommendations.
- Specify whether covered employees are subject to a code of ethics and standards of professional conduct. Fully disclose any conflicts of interest.
- Any policy should clearly identify the factors on which research analysts' compensation is based.
- Policy should also include terms regarding how research reports may be purchased by clients.

2.0 Public Appearances

Covered employees who make public appearances to discuss research or investment recommendations must disclose any personal and firm conflicts of interest.

Compliance Procedures

- Be sure that the audience can make informed judgments and that they consider the investment in the context of their entire portfolio.
- Covered employees making public appearances should always be prepared to disclose all conflicts.
- Firms should require covered employees to disclose all investment banking relationships or whether the analyst has participated in marketing activities for the subject company.
- All supporting research reports should be provided at a reasonable cost. (Note: The Standards don't define "reasonable.")

3.0 Reasonable and Adequate Basis

Research reports and investment recommendations must have a reasonable and adequate basis. Either a single employee or a committee must be charged with reviewing and approving all research reports and investment recommendations.

Compliance Procedures

- Firms must provide guidance on what constitutes reasonable and adequate basis for a specific recommendation.
- Offer to provide supporting data to clients, and disclose the current market price of the security.

4.0 Investment Banking

Firms with investment banking operations must have in place policies and procedures that:

(a) Separate research analysts from the investment banking department.
(b) Make sure analysts don't report to, and are not supervised by, investment banking personnel.
(c) Prevent the investment banking department from reviewing, revising, or approving research reports and investment recommendations.

Compliance Procedures

- Firms must prohibit any communication between research and investment banking or corporate finance prior to the publication of a research report.
- Investment banking/corporate finance personnel may review reports only to verify factual information or to identify possible conflicts.
- Firms should have quiet periods for IPOs and secondary offerings of sufficient length to ensure that research reports and recommendations are not based on inside information obtained by the analyst through investment banking/corporate finance sources.
- It is recommended that analysts not be allowed to participate in marketing "road shows."

5.0 Research Analyst Compensation

Compensation for research analysts should be directly related to the quality of the research and recommendations provided by the analyst and not directly linked to investment banking or corporate finance activities.

Compliance Procedures

- Compensation systems should be based on measurable criteria consistently applied to all research analysts.
- Ideally there should be no link between analyst compensation and investment banking and corporate finance activities, but firms should disclose to what extent analyst compensation depends upon investment banking revenues.

6.0 Relationships With Subject Companies

Analysts must not allow the subject company, prior to publication, to see any part of the research report that might signal the analyst's recommendation or rating, or make any promises concerning a specific recommendation or rating.

Compliance Procedures

- Firms should have policies and procedures governing analysts' relationship with subject companies, specifically relating to material gifts, company-sponsored trips, etc.
- There should be efforts made to check facts contained in the research report before publication.
- The compliance and legal departments should receive a report draft before it is shared with the subject company. Any subsequent changes should be carefully documented.

7.0 Personal Investments and Trading

The firm must institute policies and procedures that:

(a) Address the personal trading of covered employees.
(b) Ensure covered employees do not share information with anyone who could use that information to trade ahead (i.e., front running) of client trades.
(c) Ensure covered employees and immediate family members can't trade ahead of client trades.
(d) Prohibit covered employees and immediate family members from trading contrary to the firm's recommendations, except under cases of extreme financial hardship.
(e) Prohibit covered employees and immediate family members from participating in IPOs of subject companies or companies in the industry the employee covers.

Compliance Procedures

- Always place interests of clients ahead of personal and firm interests.
- Obtain approval from the compliance and legal departments in advance of trading on any securities of subject companies in the industries assigned to the analyst.
- Firms should have procedures in place to prevent employees from trading ahead of investing client trades. Restricted periods should be in place at least 30 calendar days before and 5 calendar days after recommendations are made via research reports.
- It is permissible to allow the analyst to sell contrary to their recommendation in the case of extreme financial hardship.
- Firms should require covered employees to provide the compliance and legal departments with a complete list of personal holdings, including securities in which they have a beneficial interest.

8.0 Timeliness of Research Reports and Recommendations

Regularly issue research reports on subject companies on a timely basis.

Compliance Procedures

- Firms should require regular updates to research and recommendations. Quarterly updates are preferred.
- If coverage of a company is discontinued, the analyst should issue a "final" research report.

9.0 Compliance and Enforcement

Firms must enforce their policies and compliance procedures, assess disciplinary sanctions on employees who violate the policies, monitor the effectiveness of the compliance procedures, and maintain records of any internal audits of the policies.

Compliance Procedures

- Firms should distribute to clients a list of activities which are violations and include disciplinary sanctions for such violations.

10.0 Disclosure

The firm must disclose conflicts of interests related to covered employees or the firm as a whole.

Compliance Procedures

- Disclosures should be complete, prominent, and easy to understand.
- Investment banking/corporate finance relationships should be disclosed.

- All conflicts of interest must be disclosed, including whether the firm makes a market in the subject company's security, whether it has managed a recent IPO or secondary offering, and whether any ownership position or covered employee's family is affiliated in any way with the subject company. Any material gifts from the subject company should also be disclosed.
- Disclose any statistical or quantitative basis for recommendations and ratings.
- Disclose valuation methods used to determine specific price targets and include any risk factors.

11.0 Rating System

The firm must have a rating system that investors find useful for investment decisions and provides investors with information they can use to determine the suitability of specific investments for their own portfolio.

Compliance Procedures

- Firms should avoid one-dimensional rating systems since they do not give investors enough information to make informed decisions.
- Rating systems should include the recommendation and rating categories, time horizon categories, and risk categories.
- Absolute (buy, hold, sell, etc.) or relative (market outperform, underperform, etc.) recommendation categories are permitted.
- A complete description of the firm's rating system should be provided to clients upon request.

The following is a review of the Ethical and Professional Standards principles designed to address the learning outcome statements set forth by CFA Institute. This topic is also covered in:

THE GLENARM COMPANY

Study Session 2

EXAM FOCUS

The Glenarm case introduces you to the obligations CFA Institute members and CFA® charterholders and candidates have to their employers. This ethics case will give you a sense of the types of scenarios you are likely to encounter on the Level 2 exam. The particulars of this case are not important in terms of test questions. However, understanding how to analyze a case and having the ability to recommend procedures to bring an illustrative firm into compliance are crucial to your success on the ethics portion of the exam.

LOS 1.A.a: Evaluate the conduct described in each reading with respect to the Code and Standards.

LOS 1.A.b: Distinguish between conduct that complies with the Code and Standards and conduct that violates the Code and Standards, demonstrate the appropriate actions to take in response to conduct that violates the Code and Standards, and draft compliance procedures to implement the principles and requirements of the Code and Standards.

CASE OUTLINE

The main facts of the Glenarm case are as follows:

- Peter Sherman, CFA, was employed for five years with Pearl Investment Management as an emerging markets analyst. While he was at Pearl, he developed outside consulting positions with several Latin American companies. This outside consulting activity was disclosed to Pearl. Sherman recently switched firms and is now employed by the Glenarm Company.
- Glenarm is a small investment management firm that has been investigated, censured, and fined by the SEC for securities violations. Glenarm's partners are eager to repair the firm's reputation and hoped that hiring a CFA charterholder would help retain current clients and bring in new business.
- Prior to joining the firm, Glenarm asked Sherman to solicit current and prospective Pearl clients. Glenarm offered Sherman a large stake in the first-year investment management fees of any Pearl clients that Sherman could bring to Glenarm.
- While still employed at Pearl, Sherman visited socially with several Pearl clients in an attempt to woo them away from Pearl. He also contacted potential Pearl clients that Pearl has been actively soliciting. He even contacted some clients that Pearl had rejected.
- As he left Pearl, Sherman took the following items with him to his new job:
  - Pearl marketing presentations.
  - Computer stock selection models that he developed.
  - Research materials.
  - News articles on firms that he had been following.
  - A list of research ideas that were rejected by Pearl.

CASE RESULTS

Standard IV(A) – Duties to Employers: Loyalty

Violations of Standard IV(A) include:

- Members and Candidates must always act for benefit of the employer. By taking confidential information, and soliciting clients and prospects to benefit Glenarm, Sherman has harmed his old employer, Pearl, and is in violation of his duty of loyalty. Sherman must act in the "old" employer's best interest while still employed there.
- It is acceptable for Sherman to contact prospects that Pearl decided not to pursue, because of a particular size or investment objective, while he is still employed at Pearl.
- Unless the employer consents, departing employees may not misappropriate property. All of the items Sherman took are the property of Pearl, and there is a violation.

Actions required to prevent these violations include:

- Sherman should not solicit Pearl's clients or prospects until he leaves Pearl's employment.
- Sherman should not have taken Pearl property.

Standard IV(B) – Duties to Employers: Additional Compensation Arrangements.

Violations of Standard IV(B) include:

- Sherman did not disclose his consulting arrangements to Glenarm.

Actions required to prevent these violations include:

- Sherman should disclose his consulting arrangements to Glenarm.

Standard VI(A) – Disclosure of Conflicts, and Standard I(B) – Independence and Objectivity

Violations of Standards VI(A) and I(B) include:

- The consulting arrangements had the potential to affect Sherman's independence and objectivity.
- Disclosures must be prominent and delivered in plain language.

Actions required to prevent these violations include:

- Sherman must disclose all details about outside compensation to Glenarm and obtain written permission from Glenarm in advance of entering into any such arrangements.

The following is a review of the Ethical and Professional Standards principles designed to address the learning outcome statements set forth by CFA Institute. This topic is also covered in:

PRESTON PARTNERS

Study Session 2

EXAM FOCUS

The Preston Partners case emphasizes the violations that can occur when allocating block trades to clients. This ethics case will give you a sense of the types of scenarios you are likely to encounter on the Level 2 exam. The particulars of this case are not important in terms of test questions. However, understanding how to analyze a case and having the ability to recommend procedures to bring an illustrative firm into compliance are crucial to your success on the ethics portion of the exam.

LOS 1.B.a: Evaluate the conduct described in each reading with respect to the Code and Standards.

LOS 1.B.b: Distinguish between conduct that complies with the Code and Standards and conduct that violates the Code and Standards, demonstrate the appropriate actions to take in response to conduct that violates the Code and Standards, and draft compliance procedures to implement the principles and requirements of the Code and Standards.

CASE OUTLINE

The following statements summarize the main facts of the Preston Partners case:

- Sheldon Preston, CFA, is president of Preston Partners. Preston Partners is a mid-size investment management firm that specializes in managing large-cap portfolios for individuals and pension funds. CFA Institute's Code and Standards have been adopted as part of Preston's compliance manual.
- Preston wrote the firm's compliance manual but did a cursory job because he was in a hurry. A copy of the manual was provided to all employees upon joining the firm.
- During his daily review of Preston Partner trades, Preston found that Gerald Smithson, CFA, had added the stocks of Utah BioChemical Co. and Norgood PLC to all his clients' portfolios.
- Preston Partners manages Utah BioChemical's pension fund. In addition, the president and CEO of Utah BioChemical, Arne Okapuu, has Smithson manage his personal portfolio. Smithson and Okapuu have had a long-term business relationship.
- Smithson was vacationing in London and had seen Okapuu and the chairman of Norgood talking at a restaurant. Smithson contacted an analyst that he knew in London, Andrew Jones, and requested information on Norgood. Jones's latest research report had placed a "hold" recommendation on Norgood stock.
- Norgood is an aggressive investment and Utah BioChemical is a conservative investment.
- Smithson performed a complete analysis of the biotech industry, Norgood, and Utah BioChemical. Based on his analysis and the fact that he saw Okapuu and Norgood's chairman talking, he deduced that a merger between the two firms was possible.
- Smithson ordered block trades of 50,000 shares for each firm. The firm's compliance manual was vague on the proper allocation of shares from a block trade. Smithson decided to allocate shares based on the size of the client's account, with the largest clients receiving their shares first at the most favorable prices. Also, the needs and constraints of Smithson's clients vary widely.
- Utah BioChemical and Norgood announced that they were merging. The share price of both firms increased by 40 percent.

CASE RESULTS

In researching and making client investment decisions, Smithson complied with Standard V(A) – Diligence and Reasonable Basis. Furthermore, Smithson did not possess or act on insider information. What he learned was assembled through the "mosaic" theory.

However, Smithson did not comply with portions of the Standards relating to suitability of investments for clients and trade allocations. He also failed to properly exercise his supervisory responsibility.

Standard III(C) – Duties to Clients: Suitability

Violations of Standard III(C) include:

- Smithson should have considered clients' individual risk tolerances, needs, circumstances, and goals; he should have also better matched clients with investments. Utah BioChemical is too volatile for many clients' accounts.

Actions required to prevent this violation include:

- Be sure that Smithson's clients have written investment objectives and policy statements.
- For accounts which contain unsuitable investments, the shares should be sold, and Preston Partners should reimburse any loss.

Standard III(B) – Duties to Clients: Fair Dealing

Violations of Standard III(B) include:

- The firm had no clear procedures for allocating block trades to client accounts. Large accounts were favored, disadvantaging smaller accounts.

Actions required to prevent this violation include:

- Detailed guidelines covering block trades must be prepared, emphasizing fairness to clients, timely executions, and accuracy.

Standard IV(C) – Duties to Employers: Responsibilities of Supervisors

Violations of Standard IV(C) include:

- The senior management at Preston Partners should have made reasonable efforts to identify and prevent violations of applicable laws, rules, and regulations. A compliance program should have been in place.
- Supervisors and managers have the responsibility of training, distributing a policies and procedures manual, and providing refresher courses.

Actions required to prevent these violations include:

- Preston must have proper procedures established that would have prevented violations such as those that occurred.
- A compliance officer should be designated.

The following is a review of the Ethical and Professional Standards principles designed to address the learning outcome statements set forth by CFA Institute. This topic is also covered in:

SUPER SELECTION

Study Session 2

EXAM FOCUS

The Super Selection case emphasizes the fiduciary duty that members have to their clients. This ethics case will give you a sense of the types of scenarios you are likely to encounter on the Level 2 exam. The particulars of this case are not important in terms of test questions. However, understanding how to analyze a case and having the ability to recommend procedures to bring an illustrative firm into compliance are crucial to your success on the ethics portion of the exam.

LOS 1.C.a: Evaluate the conduct described in each reading with respect to the Code and Standards.

LOS 1.C.b: Distinguish between conduct that complies with the Code and Standards and conduct that violates the Code and Standards, demonstrate the appropriate actions to take in response to conduct that violates the Code and Standards, and draft compliance procedures to implement the principles and requirements of the Code and Standards.

CASE OUTLINE

The main facts of the Super Selection case are as follows:

- Patricia Cuff is the CFO and compliance officer for Super Selection Investment Advisors. Cuff is also a member of CFA Institute. CFA Institute's Standards of Practice have been incorporated into Super Selection's compliance manual.
- Karen Trader is a portfolio manager with Super Selection. She has recently purchased shares of Atlantis Medical Devices (AMD) for all of her clients' portfolios. AMD is a rapidly growing biotech firm.
- Trader's friend, Josey James, is president of AMD. James has been providing advice to Trader regarding the viability of certain biotech firms over the past few years. Trader has taken advantage of this advice for both her personal account and her client's portfolios. In many cases, she has placed personal trades before trading for her clients. Trader's personal brokerage statements had not been submitted to Cuff until recently.
- Several years ago, James asked Trader to serve as an outside director for AMD. She was paid with AMD stock options that at the time had no value. AMD earnings and sales are up and AMD directors recently voted to take the firm public via an initial public offering. AMD also began paying directors $5,000 per year. Trader stands to gain considerably by exercising her stock options.
- By the time the offering was to go public, the initial public offering (IPO) market had soured considerably. James called Trader to ask if she could commit to the purchase of a block of AMD shares for her client accounts. Trader had previously determined that AMD shares were not a good investment for her clients—but she changed her mind on the recommendation of James and purchased a considerable amount of AMD stock for her clients.

CASE RESULTS

Several Code and Standard violations are evident relating to Karen Trader's involvement with an outside firm. Although she is not a CFA charterholder or member, she is bound by the CFA Institute Code and Standards to the extent that they are a part of her own company's compliance procedures.

Standard IV(C) – Duties to Employers: Responsibilities of Supervisors

The presumption is that Cuff is the "supervisor" and thus must comply with this standard. Cuff has the responsibility to take steps to prevent violations, and as compliance officer she should see that the firm's compliance procedures are adhered to by employees. Any violations must be addressed.

Actions required to prevent these violations include:

- Cuff must take prompt action to correct violations by reporting the violations to senior management.
- Cuff is a compliance officer and must monitor Trader's personal trades and impose sanctions when necessary.
- If the senior management does not back up Cuff, other options include disclosing the incident to the Board, to the regulators, and even resigning from the firm.

Standard VI(A) – Disclosure of Conflicts

Violations of Standard VI(A) include:

- Trader failed to disclose ownership of AMD stock options and also the compensation she received as a director of AMD.

Actions required to prevent this violation include:

- As a supervisor, Cuff must take action by limiting behavior and imposing sanctions.

Standard V(A) – Diligence and Reasonable Basis

Violations of Standard V(A) include:

- Trader determined AMD was not a suitable security for her clients. Trader was pressured by James and reversed positions; thus the AMD stock was purchased.

Actions required to prevent this violation include:

- Trader should have conducted due diligence and thorough research before making an investment decision for clients' accounts. Any change in opinion must have a reasonable basis. Trader must also inform clients of any AMD conflicts such as directorship and stock options.
- The compliance officer, Cuff, should review investment actions taken for clients at least annually.

Standard III(A) – Duties to Clients: Loyalty, Prudence and Care

Violations of Standard III(A) include:

- The fiduciary duty to clients was violated. Remember that client interests always come first.

Actions required to prevent this violation include:

- Trader should have taken any investment action for the sole benefit of her clients. Cuff must completely investigate Trader's activities to determine other fiduciary breaches. Following any fiduciary breaches, wrongdoers must have their activities limited.

Standard III(C) – Duties to Clients: Suitability

Violations of Standard III(C) include:

- AMD stock was purchased for clients without considering client needs and circumstances.

Actions required to prevent this violation include:

- Trader should have considered clients' needs and circumstances instead of taking actions that benefited her personally.
- The compliance officer should establish at least an annual review to compare suitability of investment actions with investment policy statements.

Standard VI(B) – Priority of Transactions

Violations of Standard VI(B) include:

- Trader violated this Standard by trading personally prior to client trades.

Actions required to prevent this violation include:

- By not reporting trades and brokerage accounts, Trader failed to follow her firm's procedures. The compliance officer needs to fully investigate Trader's transactions and recommend proper sanctions.

The following is a review of the Ethical and Professional Standards principles designed to address the learning outcome statements set forth by CFA Institute. This topic is also covered in:

TRADE ALLOCATION: FAIR DEALING AND DISCLOSURE

Study Session 2

EXAM FOCUS

This topic review provides a brief summary of trade allocation procedures as recently updated by CFA Institute. The CFA Institute Code and Standards speak directly to the issue of trade allocation procedures since allocating trades among clients is an example of taking investment action. Under CFA Institute Standard III(B) Duties to Clients – Fair Dealing, "Members and Candidates must deal fairly and objectively with all clients when providing investment analysis, making investment recommendations, taking investment action, or engaging in other professional activities".

LOS 2: Identify and explain the violations of the Code and Standards that occur by entering into trading allocations on an ad hoc basis and describe the steps necessary to ensure that adequate trade allocation practices are followed.

VIOLATIONS THAT OCCUR FROM AD HOC TRADE ALLOCATIONS

The allocation of client trades on an *ad hoc* basis lends itself to two fundamental fairness problems:

- The allocation of trades may be based on *compensation arrangements*.
- The allocation of trades may be based on *client relationships* with the firm.

As far as compensation arrangements are concerned, an *ad hoc* allocation procedure gives rise to the temptation to allocate a disproportionate share of profitable trades to performance-based fee accounts. In addition to violating Standard III(B) – Duties to Clients: Fair Dealing, this is a clear violation of Standard III(A) – Duties to Clients: Loyalty, Prudence, and Care (which covers fiduciary duty) since this has the effect of increasing fees paid to the investment adviser at the expense of asset-based fee accounts.

As far as the client relationship with the firm is concerned, an *ad hoc* allocation procedure gives rise to the temptation to allocate a disproportionate share of profitable trades to favored clients. In addition to violating the fair dealing standard, this is again a clear violation of Standard III(A) – Duties to Clients: Loyalty, Prudence, and Care, which states that members owe a duty of loyalty to clients and requires them to put clients' interests above their own. Conflicts of interest should be avoided. Giving certain clients special access to attractive IPOs with the intent to receive future investment banking business or more fees creates a conflict and breaches the duty to clients.

PROPER TRADE ALLOCATION PROCEDURES

- Get advanced indication of client interest regarding any new issues.
- Distribute new issues by client, not by portfolio manager.
- Have in place a fair and objective method for trade allocation, such as pro rata or a similar system.
- Be fair to clients regarding both execution of trades and price.
- Execute orders in a timely and efficient manner.
- Keep records and periodically review them to ensure that all clients are being treated equitably.

The following is a review of the Ethical and Professional Standards principles designed to address the learning outcome statements set forth by CFA Institute. This topic is also covered in:

CASE STUDY: CHANGING INVESTMENT OBJECTIVES

Study Session 2

EXAM FOCUS

This topic review provides a brief summary of CFA Institute Standard III(C) – Duties to Clients: Suitability. When entering into an advisory relationship with a client, the investment manager must inquire about the client's investing experience and investment objectives and constraints before taking any investment actions or making any recommendations. The actions and recommendations must be suitable to the client's situation and must be judged in the context of the entire portfolio. If the investment manager is managing a portfolio according to a specific style or mandate, the recommendations and investment actions must be consistent with the stated objectives and constraints of the specific portfolio.

LOS 3: Demonstrate the violations of the Code and Standards that occur through improper disclosure of investment product or style and describe the steps necessary to ensure adequate disclosure of the investment process.

VIOLATIONS FROM IMPROPER DISCLOSURE

In the case of pooled client funds such as mutual funds, it is particularly important that the portfolio manager's recommendations and investment actions be consistent with the stated objectives and constraints of the fund. The security selection and portfolio construction processes are typically described in the fund's prospectus. *This is the key element upon which the determination of appropriateness and suitability may be determined.* A material deviation from these processes, in the absence of approval from clients, constitutes a violation of CFA Institute Standard III(C) – Duties to Clients: Suitability. *The investment must fit within the mandate or within the realm of investments that are allowed according to the fund's disclosures.*

ENSURING ADEQUATE DISCLOSURE

In order to remain in compliance with CFA Institute Standards, a portfolio manager must:

- Adequately disclose the basic security selection and portfolio construction processes.
- Conduct regular internal checks for compliance with these processes.
- Stick to the stated investment strategy if managing to a specific mandate or strategy.
- Notify investors and potential investors of any potential change in the security selection and portfolio construction processes and secure documentation of authorization for proposed changes.

The following is a review of the Ethical and Professional Standards principles designed to address the learning outcome statements set forth by CFA Institute. This topic is also covered in:

PRUDENCE IN PERSPECTIVE

Study Session 2

EXAM FOCUS

The new Prudent Investor Rule incorporates the principles of portfolio theory (think "diversification"), total return analysis (versus the *old* school of thought that capital preservation was the only concern), and management's ability to delegate investment duties. The new Rule also carries over from the old Prudent Man Rule general fiduciary standards that are still deemed important. Be prepared for a question or two on the new Rule, particularly on how the new Rule is different from the old Rule. As you read this topic review, note the many similarities between the new Rule and the CFA Institute Standards of Professional Conduct—you'll find the two sets of principles to be quite consistent. You may see this material tested in conjunction with the portfolio management process material in Study Session 18.

WARM-UP: THE OLD PRUDENT MAN RULE

Until recently, the old *Prudent Man Rule* was the accepted legal statute that applied to fiduciary trust law in the U.S. The Prudent Man Rule originated from Justice Putnam's ruling in the *Harvard College v. Amory* case in 1830. Despite its appealing flexibility, the Prudent Man Rule failed to attain wide acceptance outside of Massachusetts until the 1940s. Prior to that time, most states had adopted "legal list" statutes that described appropriate investments for trustees. After the collapse of the bond markets during the Depression, there was general disaffection with legal lists and a trend toward the Prudent Man Rule.

The Prudent Man Rule states that:

> In acquiring, investing, reinvesting, exchanging, retaining, selling, and managing property for the benefit of another, a fiduciary shall exercise the judgment and care, under the circumstances then prevailing, which men of prudence, discretion, and intelligence exercise in the management of their own affairs, not in regard to speculation but in regard to the permanent disposition of their funds, considering the probable income as well as the probable safety of their capital.

THE NEW PRUDENT INVESTOR RULE

LOS 4: State the five basic principles of the New Prudent Investor Rule, explain the general fiduciary standards to which a trustee must adhere, differentiate between the old Prudent Man Rule and the new Prudent Investor Rule in treatment of individual investments, total portfolio, and delegation of duty, and explain the general fiduciary standards carried over from the old Prudent Man Rule to the new Prudent Investor Rule.

Five Basic Principles

Because the old Rule severely limited trustees' abilities to manage portfolios to the best of their abilities, the American Law Institute in 1992 offered a definitive commentary called the **Prudent Investor Rule**. The substance of the *new* Rule is to change the mindset that certain types of investments are prohibited. There are five basic principles to the new Prudent Investor Rule:

1. Diversification is expected of portfolio managers as a method of reducing risk.

2. Trustees must base an investment's appropriateness on its risk/return profile: how it contributes to the overall risk of the portfolio.

3. Excessive trading (churning) as well as excessive fees and other transactions costs that are not warranted by the portfolio risk/return objectives should be avoided.

4. Current income for the trust must be balanced against the need for growth.

5. Trustees are allowed to delegate investment authority. In fact, this is a duty if the trustee does not have the required level of expertise.

Old Prudent Man Rule vs. New Prudent Investor Rule

The old Rule and the new Rule differ in a number of ways:

- *Individual investments*. Entire classes of securities were deemed imprudent under the *old* Rule, including options, futures, and initial public offerings (IPOs). While the *new* Rule calls for the avoidance of undue speculation and risk, it also encourages trustees to view risk in a portfolio context. For example, stock options are risky when held in isolation but can actually reduce portfolio risk when held as part of a properly structured portfolio. Protective put options are an example of this type of strategy.
- *Total portfolio*. Under the *old* Rule, each investment was considered on its own merit. Even if you had a portfolio of 99 winners and one loser, the fiduciary could be held accountable for the losses of the poorly performing security. Under the *new* Rule, the trustee has a duty to diversify unless it is not prudent under the circumstances.
- *Delegation of duty*. The *old* Rule did not permit trustees to delegate investment authority. In fact, investing in mutual funds or even index funds was deemed improper. The *new* Rule goes so far as to say that it may be the *duty* of a trustee (this is stronger language than just authority) to delegate, just as a prudent investor would.

General Fiduciary Standards

A trustee must exercise *care, skill, caution, loyalty,* and *impartiality* when managing trust assets. The loyalty and impartiality standards are carried over from the old Rule to the new Rule. The definitions of care, skill, and caution have changed significantly.

- *Care* means the trustees must do their homework by gathering pertinent information to use in their investment decisions. This could include seeking advice. A higher level of care is required under the new Rule.
- *Skill* means that if the trustee does not have the relevant investment knowledge, he or she has a duty to seek out such advice. Note the difference in this standard versus the old Rule. The old Rule forbade such delegation. Also, if you have the necessary skill set, you have a duty to use it. Here again, the requirement for skill is higher. Before, you as a trustee needed to have all the answers.
- *Caution* must be used to balance the need for current income with the need to guard against inflation. In addition, a *total return* approach to money management should be employed. Principal growth (not just maintaining purchasing power) could indeed be a goal in certain circumstances. Caution under the old Rule *really* meant caution—don't lose any money, which meant don't even think about growth!
- *Loyalty* requires the trustee to avoid conflicts of interest by always acting exclusively in the best interest of beneficiaries. This standard remains fairly constant under both rules.
- *Impartiality* requires that the trustee act "in a fair and reasonable manner" when handling the conflicting interests of beneficiaries (i.e., remaindermen interests versus current income beneficiaries). Impartiality standards also carry over from the old Rule to the new Rule.

The adherence to these standards is required of the trustee at the time of the investment decision. For example, the trustees of Enron's pension assets may have believed at the time that they acted according to the aforementioned standards. However, it is clear to see today that the decisions they made were not appropriate. We must not judge decisions ex post facto under the new standards.

KEY CONCEPTS

1. The five basic principles of the new Prudent Investor Rule are:
   - Diversification is expected of portfolio managers as a method of reducing risk.
   - Trustees must base an investment's appropriateness on its risk/return profile.
   - Excessive trading (churning), as well as excessive fees and other transactions costs that are not warranted by the portfolio risk/return objectives, should be avoided.
   - Current income for the trust must be balanced against the need for growth.
   - Trustees are allowed (and may be required under certain circumstances) to delegate investment authority.
2. The general fiduciary standards that a trustee must adhere to are care, skill, caution, loyalty, and impartiality. The adherence to these standards is required of the trustee at the time of the investment decision.
3. Under the *old* Rule, certain risky individual investments were deemed imprudent and not allowed in portfolios. The *new* Rule calls for the avoidance of speculation and undue risks, but it does not ban certain investment vehicles (e.g., options and futures) just on the basis that they are perceived as too risky. Diversification is mandated under the *new* Rule, unless under the circumstances it is deemed imprudent. This is in contrast to the *old* Rule that considered an investment in isolation. Also, the *old* Rule forbade the delegation of investment authority. The *new* Rule says that it may be the *duty* of a trustee to delegate if the trustee lacks the necessary skills.
4. The loyalty and impartiality standards have carried over from the old Rule to the new Rule. The definitions of care, skill, and caution have changed significantly.

The following is a review of the Quantitative Methods principles designed to address the learning outcome statements set forth by CFA Institute. This topic is also covered in:

HYPOTHESIS TESTING

Study Session 3

EXAM FOCUS

This topic review covers hypothesis tests of population means (z-test or t-test), population variances (chi-square test), differences in means (t-test), differences in variances (F-test), and mean differences (t-test). You should know when and how to apply each of these tests. This is a review of the material you first encountered at Level 1. However, you should still be ready to apply these very important concepts on the Level 2 exam. You're likely to see hypothesis testing in the context of regression analysis. For example, you may be asked to test whether a regression parameter estimate is statistically significant.

WARM-UP: HYPOTHESIS TESTING CONCEPTS AND PROCEDURES

Hypothesis testing is the statistical assessment of a statement or idea regarding a population. For instance, a statement could be as follows: "The mean return for the U.S. equity market is greater than zero." Given the relevant returns data, we could employ hypothesis testing procedures to test the validity of this statement at a given level of probability.

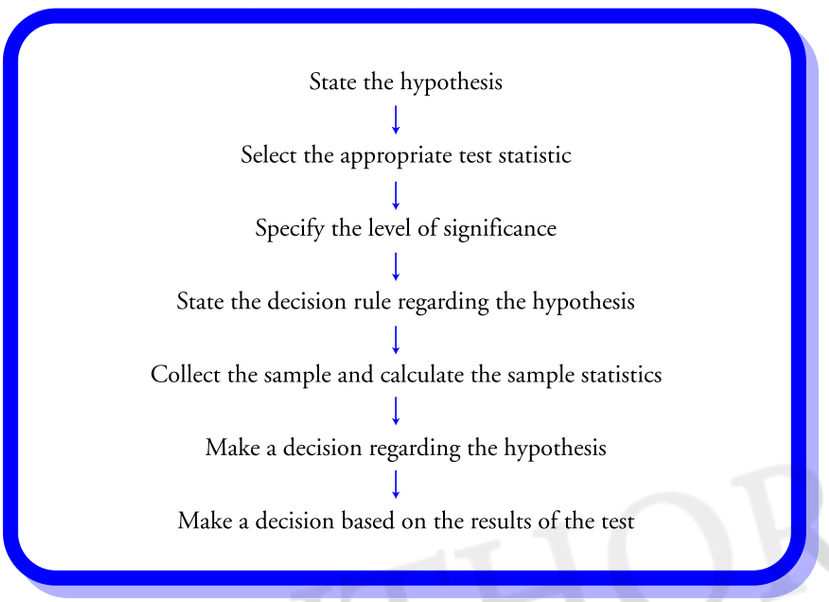
To illustrate the hypothesis testing concepts and procedures presented in this topic review, we will use an example pertaining to stock option returns. The background for this example follows.

Option returns: The storyline. (This example is used throughout this topic review.) There is an investor who believes that options should have a mean daily return greater or less than zero. To empirically assess this belief, he has gathered data on the daily return of a very large portfolio of options. The mean daily return for the sample portfolio is 0.001, or 0.1 percent, and the sample standard deviation of returns is 0.0025, or 0.25 percent. The sample size (number of daily observations) is 250.

Hypotheses. A hypothesis is a statement about the value of a population parameter developed for the purpose of testing a theory or belief. Hypotheses are stated in terms of the population parameter to be tested, such as the population mean, μ. For example, a researcher may be interested in the mean daily return on stock options. Hence the hypothesis may be that the mean daily return on a portfolio of stock options is positive.

Hypothesis testing procedures, based on sample statistics and probability theory, are used to determine whether a hypothesis cannot be rejected because there is insufficient evidence or if it is an unreasonable statement and should be rejected based on the empirical evidence. The process of hypothesis testing consists of the series of steps shown in Figure 1.

Figure 1: Process of Hypothesis Testing



Source: Wayne W. Daniel and James C. Terrell, *Business Statistics, Basic Concepts and Methodology*, Houghton Mifflin, Boston, 1997.

Professor's Note: Hypothesis testing is an important concept at Level 2, so understanding and being able to implement the process is crucial to your success. Even if you remember this material from Level 1, don't get overconfident and overlook it this time around.

The null hypothesis and alternative hypothesis. The null hypothesis, designated H_0, is the hypothesis that the researcher wants to test and is the basis for the selection of the test statistics. The null is generally stated as a simple statement about a population parameter. Typical statements of the null hypothesis for the population mean include $H_0: \mu = \mu_0$, $H_0: \mu \leq \mu_0$ and $H_0: \mu \geq \mu_0$, where μ is the population mean and μ_0 is the hypothesized value of the population mean.

The *alternative hypothesis,* designated H_a, is what we conclude if there is sufficient evidence to reject the null hypothesis. It is usually the alternative hypothesis that we are really trying to assess. Since we can never really prove anything with statistics, when the null hypothesis is discredited, the implication is that the alternative hypothesis is valid.

One- and Two-Tailed Tests

LOS 1.A.a: Distinguish between one-tailed and two-tailed hypothesis tests.

The alternative hypothesis can be one-sided or two-sided. A one-sided test is referred to as a **one-tailed test**, and a two-sided test is referred to as a **two-tailed test**. Whether the test is one- or two-sided depends on the proposition being tested. If we want to test whether the return on stock options is greater than zero, we need a one-tailed test. However, we should use a two-tailed test if the research question is whether the return on options is different from (e.g., greater or less than) zero.

Professor's Note: In the real world, most hypothesis tests are constructed as two-tailed tests. On the exam, however, CFA Institute likes to test your knowledge of one-tailed tests as well, so be prepared for both.

The proposition in our option example is that option returns are positive. This calls for a one-tailed test. The hypotheses for this one-tailed test are structured as:

H_0: $\mu \leq 0$ versus H_a: $\mu > 0$

On the other hand, a two-tailed test should be used if we want to know if option returns are different than zero. The null and alternative hypotheses for this two-tailed tested are structured as:

H_0: $\mu = 0$ versus H_a: $\mu \neq 0$

WARM-UP: TEST STATISTICS

Hypothesis testing involves two values: the test statistic calculated from the sample data and the critical value of the test statistic. Comparing the value of the computed test statistic to the critical value is a key step in assessing the validity of a hypothesis.

A test statistic is calculated by comparing the point estimate of the population parameter with the hypothesized value of the parameter (i.e., the value specified in the null hypothesis). With reference to our option return example, this means we are concerned with the difference between the mean return of the sample (i.e., $\overline{x} = 0.001$) and the hypothesized mean return (i.e., $\mu_0 = 0$). The test statistic is the difference between the sample statistic and the hypothesized value, scaled by the standard error of the sample statistic:

$$\text{test statistic} = \frac{\text{sample statistic} - \text{hypothesized value}}{\text{standard error of the sample statistic}}$$

The standard error of the sample statistic is the adjusted standard deviation of the sample. When the sample statistic is the sample mean, $\overline{x}$, the standard error of the sample statistic for sample size n when the population standard deviation, σ, is *known,* is calculated as:

$$\sigma_{\overline{x}} = \frac{\sigma}{\sqrt{n}}$$

or, when the population standard deviation, σ, *is not known*,

$$s_{\overline{x}} = \frac{s}{\sqrt{n}}$$

In this case, it is estimated using the standard deviation of the sample, s.

Professor's Note: Don't be confused by the notation here. A lot of the literature that you will encounter in your studies simply uses the term $\sigma_{\overline{x}}$ for the standard error of the test statistic, regardless of whether the population standard deviation was used in its computation.

Example: Computing test statistics

Compute the test statistic for our option returns example for the null hypothesis H_0: $\mu = 0$.

Answer:

To compute the test statistic, it is first necessary to calculate the standard error of the sample statistic.

$$s_{\bar{x}} = \frac{s}{\sqrt{n}} = \frac{0.0025}{\sqrt{250}} = 0.000158$$

Now, the test statistic can be computed as follows:

$$\text{test statistic} = \frac{\text{sample statistic} - \text{hypothesized value}}{\text{standard error of the sample statistic}} = \frac{0.001 - 0}{0.000158} = 6.33$$

As you will soon see, a test statistic is a random variable that may follow one of several distributions, depending on the characteristics of the sample and the population. We will look at four distributions for test statistics: the *t*-distribution, the *z*-distribution (standard normal distribution), the chi-square distribution, and the *F*-distribution. The critical value for the appropriate test statistic—the value against which the computed test statistic is compared—is a function of its distribution.

Type I and II Errors

LOS 1.A.b: Define and interpret a Type I and a Type II error and discuss how the choice of significance level affects the probabilities of Type I and Type II errors.

Keep in mind that hypothesis testing is used to make inferences about the parameters of a given population on the basis of statistics computed for a sample that is drawn from that population. There is some probability that the sample, in some way, is not representative of the population, and any conclusion about the population based on the sample may be in error.

When we do hypothesis testing, there are two possible errors we can make:

- **Type I error:** We reject the null hypothesis when it is actually true.
- **Type II error:** We fail to reject the null hypothesis when it is actually false.

The **significance level** is the probability of making a Type I error (rejecting the null when it is true) and is designated by the Greek letter alpha (α). For instance, a significance level of 10 percent ($\alpha = 0.10$) means that there is a 10 percent chance of rejecting a true null hypothesis. When conducting hypothesis tests, we must specify a significance level when selecting the critical values against which we compare test statistics.

The power of a test is the probability of correctly rejecting the null hypothesis when it is false, which is equal to one minus the probability of making a Type II error. When more than one test statistic is available, the power of the test for the competing test statistics may be useful in deciding which test statistic to use. Ordinarily, we would like to use the test statistic that provides the most powerful test among all possible tests.

Figure 2 shows the relationship between the level of significance, the power of the test, and the two types of errors.

Figure 2: Type I and Type II Errors in Hypothesis Testing

	True Condition	
Decision	*H_0 is true*	*H_0 is false*
Do not reject H_0	Correct decision	Incorrect decision **Type II error** Power of the test = 1 – P(Type II error)
Reject H_0	Incorrect decision **Type I error** Significance level = α = P(Type I error)	Correct decision

Decreasing the probability of making a Type I error (i.e., decreasing the level of significance of the test) makes it more difficult to reject the null when it is true. All else being equal, however, the decrease in the chance of making a Type I error comes at the cost of increasing the probability of making a Type II error because the null is rejected less frequently, even when it is actually false. As the probability of a Type II error increases, the power of the test declines because it is defined as one minus the probability of a Type II error. The only way to simultaneously reduce the probabilities of both Type I and Type II errors is to increase the size of the sample.

WARM-UP: MORE ON HYPOTHESIS TESTING FROM LEVEL 1

Professor's Note: This material is a review from Level 1 that does not directly address any of the Level 2 LOS. If you feel you have mastered these concepts, you can move on to the Level 2 material that starts with LOS 1.A.c. Otherwise, you should review this material carefully.

The decision rule. The decision for a hypothesis test is to either reject the null hypothesis or fail to reject the null hypothesis. Note that it is statistically incorrect to say "accept" the null hypothesis because it can only be supported or rejected. The decision rule for rejecting or failing to reject the null hypothesis is based on the distribution of the test statistic. For example, if the test statistic follows a normal distribution, the decision rule is based on critical values determined from the standard normal distribution (z-distribution). Regardless of the appropriate distribution, it must be determined if a one-tailed or two-tailed hypothesis test is appropriate before a decision rule (rejection rule) can be stipulated.

Two-tailed test. A two-tailed test for the population mean may be structured as H_0: $\mu = \mu_0$ versus H_a: $\mu \neq \mu_0$. Since the alternative hypothesis allows for values above and below the hypothesized parameter, a two-tailed test requires two critical values.

The general decision rule for a two-tailed test is:

Reject H_0 if: test statistic > upper value, or
test statistic < lower critical value

Let's look at the development of the decision rule for a two-tailed test using a z-distributed test statistic (a z-test) at a 5 percent level of significance, $\alpha = 0.05$.

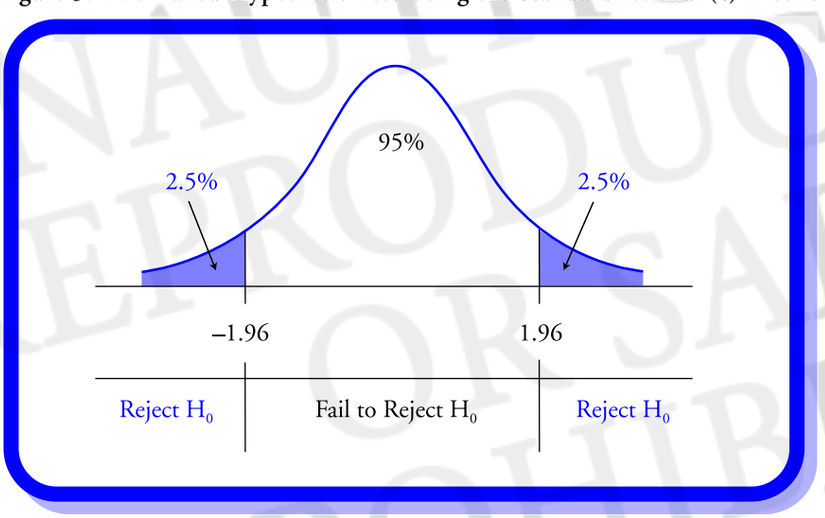
- At $\alpha = 0.05$, the computed test statistic is compared with the critical *z*-values of ±1.96. The values of ±1.96 correspond to $\pm z_{\alpha/2} = \pm z_{0.025}$, the range of *z*-values within which 95 percent of the probability lies. These values are obtained from the cumulative probability table for the standard normal distribution (*z*-table), which is included at the back of this book.
- If the computed test statistic falls outside the range of critical *z*-values (i.e., test statistic > 1.96, or test statistic < –1.96), we conclude that the sample statistic is sufficiently different from the hypothesized value, and we can reject the null hypothesis.
- If the computed test statistic falls within the range ±1.96, we conclude that the sample statistic is not sufficiently different from the hypothesized value ($\mu = \mu_0$ in this case), and we fail to reject the null hypothesis.

The decision rule (rejection rule) for a two-tailed z-test at $\alpha = 5\%$ is:

Reject H_0 if test statistic < –1.96, or if test statistic > 1.96

Figure 3 shows the standard normal distribution for a two-tailed hypothesis test using the *z*-distribution. Notice that the significance level of 5 percent depicted here means that there is 2.5 percent probability (area) under each tail of the distribution beyond ±1.96.

Figure 3: Two-Tailed Hypothesis Test Using the Standard Normal (*z*) Distribution



Example: Two-tailed test

Test the hypothesis that the mean return for our option portfolio is not equal to zero at the 5 percent significance level. Recall that we previously calculated the test statistic to be 6.33.

Answer:

Finally, we can perform a hypothesis test for our option return data. Let's start by specifying the null and alternative hypotheses using a two-tailed structure as follows:

H_0: $\mu = 0$ versus H_a: $\mu \neq 0$

At a 5 percent significance level, the critical *z*-values for a two-tailed test are ±1.96, so the decision rule can be stated as:

Reject H_0 if test statistic < –1.96 or if test statistic > 1.96

Our test statistic was previously calculated to be 6.33. Since 6.33 > 1.96, we reject the null hypothesis that the mean daily option return is equal to zero. Note that when we reject the null, we conclude that the sample value is significantly different from the hypothesized value. We are saying that the two values are different from one another *after considering the variation in the sample*. That is, the sample mean of 0.001 is statistically different from zero given the sample's standard deviation and size.

One-tailed test. For a one-tailed hypothesis test of the population mean, the null and alternative hypotheses are either:

Upper tail: $H_0: \mu \leq \mu_0$ versus $H_a: \mu > \mu_0$, or
Lower tail: $H_0: \mu \geq \mu_0$ versus $H_a: \mu < \mu_0$

The appropriate set of hypotheses depends on whether we believe the population mean, μ, to be greater than (in the upper tail of the distribution) or less than (in the lower tail of the distribution) the hypothesized value μ_0. Using a *z*-test at the 5 percent significance level, the computed test statistic is compared with the critical values of 1.65 for the upper tail tests (i.e., $H_a: \mu > \mu_0$) or –1.65 for lower tail tests (i.e., $H_a: \mu < \mu_0$). These critical values are obtained from a *z*-table, where $-z_{0.05} = -1.65$ corresponds to a cumulative probability equal to 5 percent and the $z_{0.05} = 1.65$ corresponds to a cumulative probability of 95 percent (1 – 0.05).

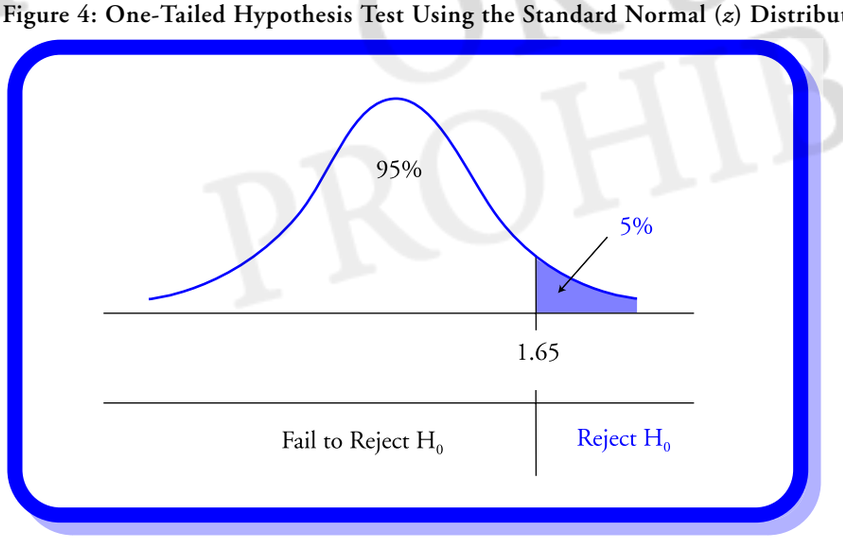
Let's use the upper tail test structure where $H_0: \mu \leq \mu_0$ versus $H_a: \mu > \mu_0$. If the calculated test statistic is greater than 1.65, we conclude that the sample statistic is sufficiently greater than the hypothesized value. In other words, we reject the null hypothesis. If the calculated test statistic is less than 1.65, we conclude that the sample statistic is not sufficiently different from the hypothesized value, and we fail to reject the null hypothesis.

The decision rule (rejection rule) for this test can be stated as:

Reject H_0 if test statistic > 1.65

Figure 4 shows the standard normal distribution and the rejection region for a one-tailed test (upper tail) at the 5 percent level of significance.

Figure 4: One-Tailed Hypothesis Test Using the Standard Normal (*z*) Distribution



Example: One-tailed test

Test the proposition that option returns are positive.

Answer:

In this case, we use a one-tailed test with the following structure:

H_0: $\mu \leq 0$ versus H_a: $\mu > 0$

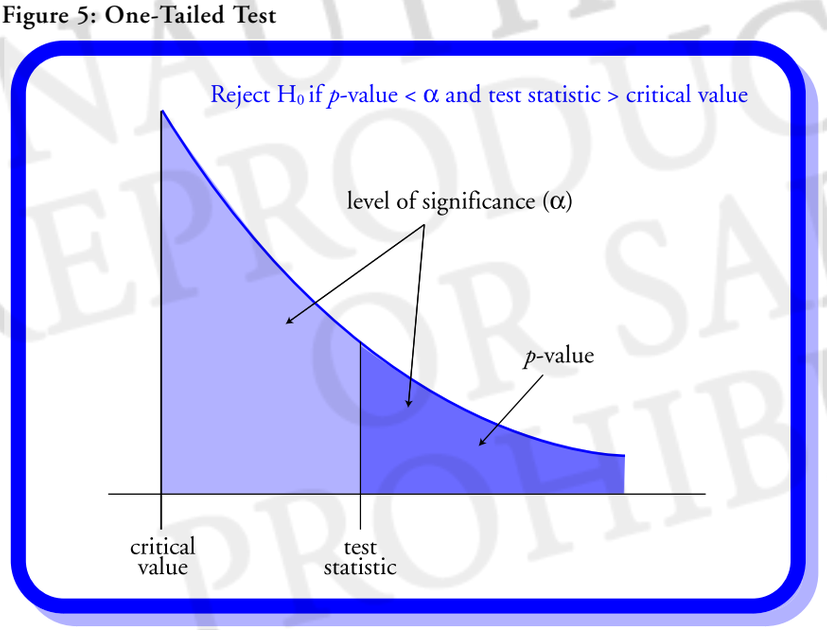
Recalling that $z_{0.05} = 1.65$, the appropriate decision rule for our one-tailed *z*-test at a significance level of 5 percent is:

Reject H_0 if test statistic > 1.65

The test statistic is computed the same way regardless of whether we are using a one-tailed or two-tailed test. From the previous example, we know that the test statistic for the option return sample is 6.33. Since 6.33 > 1.65, we reject the null hypothesis and conclude that mean returns are statistically greater than zero at a 5 percent significance level.

P-values. The *p*-value is the smallest level of significance for which the null hypothesis can be rejected. For one-tailed tests, the *p*-value is the probability that lies above the computed test statistic for upper tail tests or below the computed test statistic for lower tail tests. A one-tailed *p*-value-based decision is illustrated in Figure 5. Since the *p*-value in the figure is less than the level of significance, the null is rejected.

Figure 5: One-Tailed Test



Since the *p*-value is always less than the significance level when the test statistic is greater than the critical value, we always reach the same decision regardless of whether we use the *p*-value approach or compare the computed value of the test statistic to the critical value.

Professor's Note: Most statistical software packages generate p-values along with critical values for test statistics, and most analysts use p-values because the approach is intuitively much more straightforward. However, on exam day be prepared to use the "old-fashioned" critical value approach as well as p-values.

For two-tailed tests, the *p*-value is the probability that lies above the positive value of the computed test statistic *plus* the probability that lies below the negative value of the computed test statistic.

Hypothesis testing and statistical decisions may be made on the basis of the *p*-value instead of the relationship between the critical value and the computed test-statistic. There are two decision rules for the *p*-value approach to hypothesis testing:

- Reject H_0 if the *p*-value is less than the significance level of the hypothesis test.
- Do not reject H_0 if the *p*-value is greater than the significance level.

Professor's Note: On exam day remember that, to reject the null hypothesis, you are looking for big computed test statistics (bigger than the critical value) and small p-values (smaller than the significance level).

Z-TEST AND *T*-TEST

The *z*-test. The *z*-test is the appropriate hypothesis test of the population mean when the *population is normally distributed with known variance* or when the sample size is 30 observations or more. The computed test statistic used with the *z*-test is referred to as the *z*-statistic. The *z*-statistic for a hypothesis test for a population mean is computed as follows:

$$\text{z-statistic} = \frac{\overline{x} - \mu_0}{\sigma / \sqrt{n}}$$

where:
$\overline{x}$ = sample mean
μ_0 = hypothesized population mean
σ = standard deviation of the *population*
n = sample size

To test a hypothesis, compare the *z*-statistic to the critical *z*-value corresponding to the significance of the test. Critical *z*-values for the most common levels of significance are displayed in Figure 6.

Professor's Note: You should have these memorized by now!

Figure 6: Selected Critical *z*-Values

Level of Significance	*Two-Tailed Test*	*One-Tailed Test*
0.10 = 10%	±1.65	+1.28 or –1.28
0.05 = 5%	±1.96	+1.65 or –1.65
0.01 = 1%	±2.58	+2.33 or –2.33

It is also appropriate to use the *z*-test with an unknown variance if the sample size is large enough ($n \geq 30$), regardless of the distribution of the population. This is acceptable because of the *central limit theorem*, which states that for any given distribution, normal or otherwise, with a mean of μ and a variance of σ^2, the sampling distribution of the mean approaches a normal distribution with a mean μ and a variance of σ^2/n as the sample size, *n*, increases. However, since the *t*- and the *z*-distributions converge as sample size increases, this point is moot for large samples.

When the *sample size is large* and the *population variance is unknown*, the *z*-statistic is:

$$z = \frac{\overline{x} - \mu_0}{s / \sqrt{n}}$$

where:
$\overline{x}$ = sample mean
μ_0 = hypothesized sample mean
s = standard deviation of the *sample*
n = sample size

Note the use of the sample standard deviation, *s*, versus the population standard deviation, σ.

The *t*-test is a widely used hypothesis test that employs a test statistic that is distributed according to a *t*-distribution. The computed value for the test statistic based on the *t*-distribution is referred to as the *t*-statistic. For hypothesis tests of a population mean, a *t*-statistic with n – 1 degrees of freedom is computed as:

$$t = \frac{\overline{x} - \mu_0}{s / \sqrt{n}}$$

where:
$\overline{x}$ = sample mean
μ_0 = hypothesized sample mean (i.e., the null)
s = standard deviation of the sample
n = sample size

Professor's Note: Make sure you know the number of degrees of freedom for each test statistic. CFA Institute likes to write questions that test your knowledge of degrees of freedom. The t-statistic for testing the population mean has n – 1 degrees of freedom.

This computation is not new. It is the same test statistic computation that we have been performing all along. Note the use of the sample standard deviation, *s*, in the standard error term in the denominator. To conduct a *t*-test, compare the *t*-statistic to a critical *t*-value at the desired level of significance with the appropriate degrees of freedom.

Here are the rules for when it is appropriate to use the *t*-test for hypothesis tests of the population mean. *Use the t-test if the population variance is unknown* and either of the following conditions exist:

(i) the sample is large ($n \geq 30$) or

(ii) the sample is small ($n < 30$), but the population is normally distributed

Professor's Note: If the sample size is large, the z-statistic is also appropriate.

Example: *z*-test or *t*-test?

Referring to our option return problem once more, **identify** which test statistic (*z* or *t*) should be used, and discuss the difference in the likelihood of rejecting the null with each distribution.

Answer:

This is a trick question: either *t*- or *z*-statistic is appropriate. The population variance for our sample of returns is unknown. Hence, the *t*-distribution is appropriate. With 250 observations, however, the sample is also considered to be large, so the *z*-distribution would also be acceptable.

With regard to the difference in the likelihood of rejecting the null, since our sample is so large, the critical values for the *t* and *z* are almost identical. Hence, there is almost no difference in the likelihood of rejecting the null.

Professor's Note: If you feel you have mastered these concepts, you can move on to the Level 2 material that follows. Otherwise, you should review this material.

Testing the Population Mean

LOS 1.A.c: Formulate a null and an alternative hypothesis about a population mean and determine whether to reject the null hypothesis at a given level of significance.

The choice between using a critical value based on the *t*-distribution or the *z*-distribution depends on sample size, the distribution of the population, and whether or not the variance of the population is known, as shown in Figure 7.

Figure 7: When to Use the *z*-Statistic and the *t*-Statistic

	Small Sample (< 30)	*Large Sample (≥ 30)*
Normal distribution Known variance	z-statistic	z-statistic
Normal distribution Unknown variance	*t*-statistic	*t*-statistic or *z*-statistic

Example: Testing the population mean

When your company's gizmo machine is working properly, the mean length of gizmos is 2.5 inches. However, from time to time the machine gets out of alignment and produces gizmos that are either too long or too short. When this happens, production is stopped and the machine is adjusted. To check the machine, the quality control department takes a gizmo sample each day. Today a random sample of 49 gizmos showed a mean length of 2.49 inches and a sample standard deviation of 0.021 inches. Assume the underlying population is normally distributed. Using a 5 percent significance level, **determine** if the machine should be shut down and adjusted.

Answer:

Let's follow the process for hypothesis testing presented in the table in Figure 1. Let μ be the mean length of all gizmos made by this machine and $\bar{x}$ the corresponding mean for the sample.

State the hypothesis. The null and alternative hypotheses are structured as:

H_0: $\mu = 2.5$ (The machine does not need an adjustment.)
H_a: $\mu \neq 2.5$ (The machine needs an adjustment.)

Note that since this is a two-tailed test, H_a allows for values above and below 2.5.

Select the appropriate test statistic. Since the population is normally distributed and we have a large sample, either the *t* or the *z*-statistic is appropriate. We'll use the *z*-statistic in this case: the *z*-table is easier to interpret because we don't have to worry about degrees of freedom. The *z*-statistic is computed as:

$$z = \frac{\overline{x} - \mu_0}{s/\sqrt{n}}$$

Specify the level of significance. The level of significance is given at 5 percent, implying that we are willing to accept a 5 percent probability of rejecting the null hypothesis when the null is true.

State the decision rule regarding the hypothesis. The ≠ sign in the alternative hypothesis indicates that the test is two-tailed with two rejection regions, one in each tail of the standard normal distribution curve. Because the total area of both rejection regions combined is 0.05 (the significance level), the area of the rejection region in each tail is 0.025. The critical *z*-values for $\pm z_{0.025}$ are ±1.96.

The decision rule can be stated as:

Reject H_0 if *z*-statistic < –1.96 or if *z*-statistic > 1.96

Collect the sample and calculate the sample statistic. The value of $\overline{x}$ from the sample is 2.49 and *s* is 0.021, so:

$$z = \frac{\overline{x} - \mu_0}{s/\sqrt{n}} = \frac{2.49 - 2.50}{0.021/\sqrt{49}} = \frac{-0.01}{0.003} = -3.33$$

Make a decision regarding the hypothesis. The calculated value of the *z*-statistic is = –3.33. Since this value is less that the critical value, $-z_{0.025}$ = –1.96, it falls in the rejection region in the left tail of the *z*-distribution. Hence, there is sufficient evidence to reject H_0.

Make a decision based on the results of the test. Based on the sample information and the results of the test, it is concluded that the machine is out of adjustment and should be shut down for repair.

Professor's Note: The critical t-value for a 5 percent, two-tailed test with 48 degrees of freedom is approximately 2.01, which is very close to the critical z-value of 1.96. That means if we had used the t-statistic we would have reached the same decision as we did using the z-statistic.

LOS 1.A.d: Discuss the choice between tests of differences between means and tests of mean differences (paired comparisons test) in relation to the independence of samples and formulate a null and an alternative hypothesis about two population means (normally distributed populations), select the appropriate test statistic, and determine whether to reject the null hypothesis at a given level of significance.

This LOS addresses two distinct hypothesis tests of means: differences between the means of two populations versus the mean of the paired differences from two populations. Here are rules for when these tests may be applied:

- The **test of differences between means** is used when there are two *independent samples*. For example, we could test whether the difference between the mean P/E ratios in the telecom and utility industries as of September 2004 are statistically significant. The two samples are independent, so the differences between means test is appropriate.

- The **test of mean differences** is used when the samples are *not independent* but in fact allow *paired comparisons*. For example, we could test whether the mean of the difference between the monthly returns on a growth index and a value index during the 1990s was statistically significant. The samples are not independent because value and growth returns are both influenced by the same underlying equity market factors, so a paired comparisons test would be appropriate. In this case, the "pairs" would be the return on each index in each month, and *d* would equal the difference between them. For example, for May 1994:

$$d_{\text{May, 1994}} = \text{value return}_{\text{May, 1994}} - \text{growth return}_{\text{May, 1994}}$$

Tests of Differences Between Means

Up to this point, we have been concerned with tests of a single population mean. In practice, we frequently want to know if there is a difference between the means of two populations. There are two *t*-tests that are used to test differences between the means of two populations. Application of either of these tests requires that we are reasonably certain that our samples are independent and are taken from the two normally distributed populations. Both of these *t*-tests are used when the population variance is unknown. In one case, the two population variances are assumed to be equal, and the sample observations are pooled. In the other case, however, no assumption is made regarding the equality between the two population variances, and the *t*-test uses an approximate value for the degrees of freedom.

When testing differences between the mean of population 1, μ_1, and mean of population 2, μ_2, we may be interested in knowing if the two means are equal (i.e., $\mu_1 = \mu_2$), if the mean of population 1 is greater than that of population 2 (i.e., $\mu_1 > \mu_2$), or if the mean of population 2 exceeds that of population 1 (i.e., $\mu_2 > \mu_1$). These three sets of hypotheses are structured as:

$H_0: \mu_1 - \mu_2 = 0$ versus $H_a: \mu_1 - \mu_2 \neq 0$
$H_0: \mu_1 - \mu_2 \leq 0$ versus $H_a: \mu_1 - \mu_2 > 0$
$H_0: \mu_1 - \mu_2 \geq 0$ versus $H_a: \mu_1 - \mu_2 < 0$

Professor's Note: It is also possible to structure other hypotheses, such as $H_0: \mu_1 - \mu_2 = 50$ versus $H_a: \mu_1 - \mu_2 \neq 50$. Regardless of the specific structure, the hypothesis testing procedure is the same.

Unknown variances: Assumed equal. A pooled variance is used with the *t*-test for testing differences between the means of normally distributed populations with *unknown variances that are assumed to be equal*. Assuming independent samples, the *t*-statistic, with $n_1 + n_2 - 2$ degrees of freedom, is computed as:

$$t = \frac{(\bar{x}_1 - \bar{x}_2) - (\mu_1 - \mu_2)}{\left(\frac{s_p^2}{n_1} + \frac{s_p^2}{n_2}\right)^{1/2}}$$

where:

$s_p^2 = \dfrac{(n_1 - 1)s_1^2 + (n_2 - 1)s_2^2}{n_1 + n_2 - 2}$ = pooled variance

s_1^2 = variance of the first sample

s_2^2 = variance of the second sample

n_1 = number of observations in the first sample

n_2 = number of observations in the second sample

This formula looks intimidating, but notice that the pooled variance is a weighted average of the two sample variances:

$$s_p^2 = \left(\frac{n_1 - 1}{n_1 + n_2 - 2}\right)s_1^2 + \left(\frac{n_2 - 1}{n_1 + n_2 - 2}\right)s_2^2$$

For example, if $n_1 = 40$ and $n_2 = 60$:

$$s_p^2 = \left(\frac{39}{98}\right)s_1^2 + \left(\frac{59}{98}\right)s_2^2$$

Example: Difference between means—equal variances

Sue Smith is investigating whether the abnormal returns that occur to acquiring firms during merger announcement periods differ for horizontal and vertical mergers. She estimated the abnormal returns for a sample of acquiring firms associated with horizontal mergers and a sample of acquiring firms involved in vertical mergers. Her sample findings are reported in Figure 8.

Figure 8: Abnormal Returns During Merger Announcement Periods

	Abnormal Returns Horizontal Mergers	*Abnormal Returns Vertical Mergers*
Mean	$\overline{x}_H = 1.0\%$	$\overline{x}_V = 2.5\%$
Standard deviation	$s_H = 1.0\%$	$s_V = 2.0\%$
Sample size (*n*)	$n_H = 64$	$n_V = 81$

Assuming the samples are independent, the population means are normally distributed, and the population variances are equal, **determine** if there is a statistically significant difference in the announcement period abnormal returns for these two types of mergers.

Answer:

State the hypothesis. Since this is a two-sided test, the structure of the hypotheses takes the following form:

H_0: $\mu_H - \mu_V = 0$ versus H_a: $\mu_H - \mu_V \neq 0$

where μ_H is the mean of the abnormal returns for the horizontal mergers, and μ_V is the mean of the abnormal returns for the vertical mergers.

Select the appropriate test statistic. Since we are assuming equal variances, the test statistic is computed using the following formula:

$$t = \frac{(\overline{x}_H - \overline{x}_V) - (\mu_H - \mu_V)}{\left(\frac{s_p^2}{n_H} + \frac{s_p^2}{n_V}\right)^{1/2}}$$

Specify the level of significance. We will use the common significance level of 5 percent ($\alpha = 0.05$). In order to look up the critical *t*-value, we also need the degrees of freedom, which in this case is $n_H + n_V - 2 = 64 + 81 - 2 = 143$.

State the decision rule regarding the hypothesis. We must identify the critical *t*-value for a 5 percent level of significance and the *closest* degrees of freedom specified in a *t*-table. As you should verify with the partial *t*-table contained in Figure 9, the closest entry for df = 143 is df = 120. At $\alpha / 2 = 0.025$ with df = 120, the critical *t*-value is approximately 1.980.

Figure 9: Partial *t*-Table

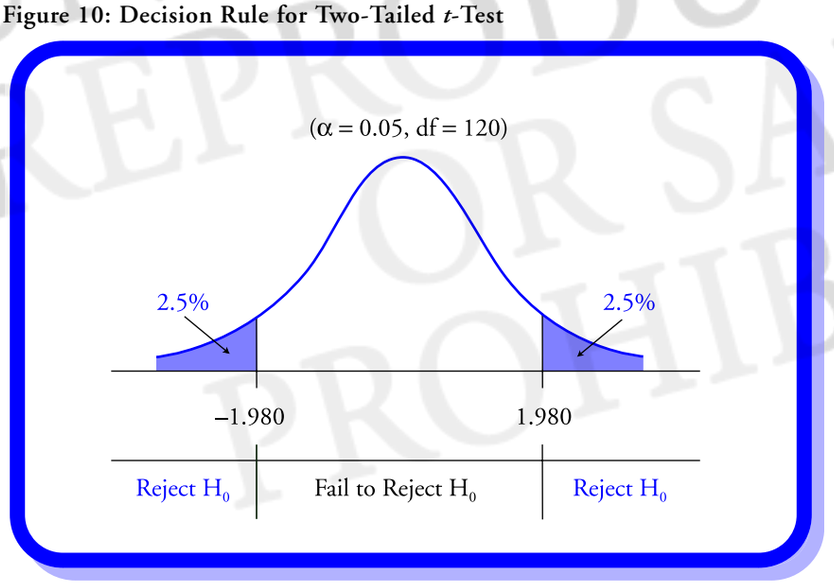
	One-Tailed Probabilities		
df	p = 0.10	p = 0.05	p = 0.025
110	1.289	1.659	1.982
120	1.289	1.658	**1.980**
200	1.286	1.653	1.972

Thus, the decision rule can be stated as:

Reject H_0 if *t*-statistic < –1.980 or *t*-statistic > 1.980

The rejection region for this test is illustrated in Figure 10.

Figure 10: Decision Rule for Two-Tailed *t*-Test



Collect the sample and calculate the sample statistics. Using the information provided, the *t*-statistic can be computed as follows:

$$t = \frac{(0.010 - 0.025) - 0}{\left(\frac{0.000268}{64} + \frac{0.000268}{81}\right)^{1/2}} = \frac{-0.01500}{0.00274} = -5.47$$

$$s_p^2 = \left(\frac{63}{143}\right)0.01^2 + \left(\frac{80}{143}\right)0.02^2 = 0.000268$$

Make a decision regarding the hypothesis. Since the calculated test statistic falls to the left of the lowest critical *t*-value, we reject the null hypothesis and conclude that the announcement period abnormal returns are different for horizontal and vertical mergers.

Unknown variances: Not assumed equal. The *t*-test for differences between population means when the populations are normally distributed having *variances that are unknown and not assumed to be equal* uses the sample variances for both populations. Assuming independent samples, the *t*-statistic in this case is computed as follows:

$$t = \frac{(\bar{x}_1 - \bar{x}_2) - (\mu_1 - \mu_2)}{\left(\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}\right)^{1/2}}$$

where:

$$\text{degrees of freedom} = \frac{\left(\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}\right)^2}{\frac{\left(\frac{s_1^2}{n_1}\right)^2}{n_1} + \frac{\left(\frac{s_2^2}{n_2}\right)^2}{n_2}}$$

and where:

s_1^2 = variance of the first sample
s_2^2 = variance of the second sample
n_1 = number of observations in the first sample
n_2 = number of observations in the second sample

Professor's Note: You need to be familiar with these incredibly ugly formulas. The LOS asks you to "select the appropriate test statistic"; that may mean selecting the appropriate formula from among a set of alternatives. Here's an exam tip: if the t-statistic is large (say more than 5), you know the t-statistic has to be significant no matter what the degrees of freedom are, so you won't have to use the ugly formula to estimate degrees of freedom.

Paired Comparisons Test—Test of Mean Differences

Frequently, we are interested in the difference in the value of paired observations from two *samples that are not independent*. The hypothesis test in this case is called a test of paired differences or a *paired comparisons test*. For a two-tailed paired comparisons test assuming the null hypothesis is that the mean of the paired differences is zero, the hypotheses are structured as:

H_0: $\mu_d = 0$ versus H_a: $\mu_d \neq 0$

where:
μ_d = mean of the population of paired differences

For one-sided tests, the hypotheses are structured as either:

$H_0: \mu_d \leq 0$ versus $H_a: \mu_d > 0$ or $H_0: \mu_d \geq 0$ versus $H_a: \mu_d < 0$

For the paired comparisons test, the *t*-statistic with n – 1 degrees of freedom is computed as:

$$t = \frac{\bar{d}}{s_{\bar{d}}}$$

where:

$\bar{d}$ = sample mean difference = $\frac{1}{n}\sum_{i=1}^{n} d_i$

d_i = difference between the *i*th pair of observations

$s_{\bar{d}}$ = standard error of the mean difference = $\frac{s_d}{\sqrt{n}}$

s_d = sample standard deviation
n = the number of paired observations

Example: Paired comparisons test

Joe Andrews is examining changes in estimated betas for the common stock of companies in the telecommunications industry before and after deregulation. Andrews believes that the betas may decline because of deregulation since companies are no longer subject to the uncertainties of rate regulation or that they may increase because there is more uncertainty regarding competition in the industry. The sample information that he gathered is reported in Figure 11.

Figure 11: Beta Differences After Deregulation

Mean of differences in betas (before minus after)	0.23
Sample standard deviation of differences	0.14
Sample size	39

Test whether the mean difference in the betas is different from zero.

Answer:

Once again, we follow our hypothesis testing procedure.

State the hypothesis. There is reason to believe that the mean differences may be positive or negative, so a two-sided alternative hypothesis is in order here. Thus, the hypotheses are structured as:

$H_0: \mu_d = 0$ versus $H_a: \mu_d \neq 0$

Select the appropriate test statistic. This is a paired comparison test because the two samples aren't independent: we have the same sample of firms before and after deregulation. We can calculate the difference

in the betas for each firm before and after deregulation and then compute the mean and standard deviation of these differences. Therefore, the appropriate test is:

$$t = \frac{\bar{d}}{s_{\bar{d}}}$$

Specify the level of significance. Let's use a 5 percent level of significance.

State the decision rule regarding the hypothesis. There are 39 – 1 = 38 degrees of freedom. Using the *t*-distribution, the two-tailed critical *t*-values for a 5 percent level of significance with df = 38 is ±2.024. As indicated in the table in Figure 12, the critical *t*-value of 2.024 is located at the intersection of the p = 0.025 column and the df = 38 row. The one-tailed probability of 0.025 is used because we need 2.5 percent in each tail for a 5 percent significance level.

Figure 12: Partial *t*-Table with One-Tailed Probabilities

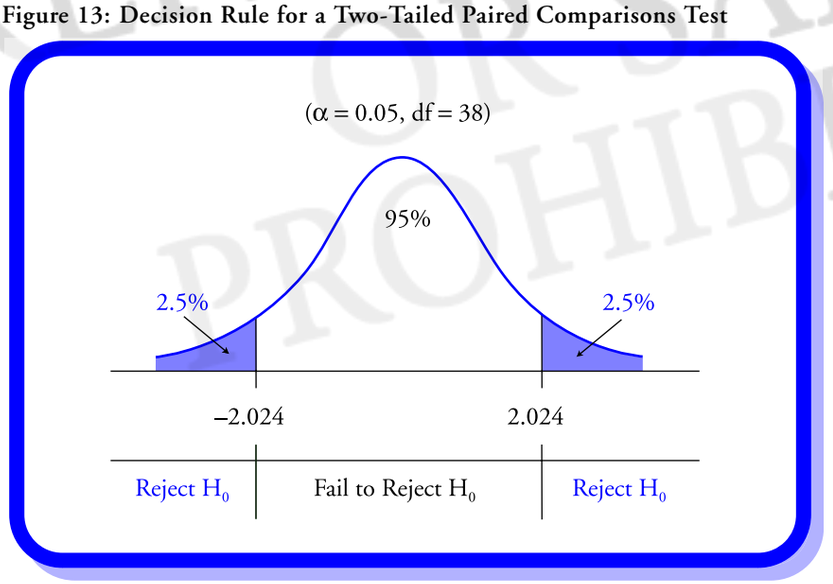
df	*p = 0.10*	*p = 0.05*	*p = 0.025*
38	1.304	1.686	2.024
39	1.304	1.685	2.023
40	1.303	1.684	2.021

Thus, the decision rule is:

Reject H_0 if *t*-statistic < –2.024 or *t*-statistic > 2.024

This decision rule is illustrated in Figure 13.

Figure 13: Decision Rule for a Two-Tailed Paired Comparisons Test



Collect the sample and calculate the sample statistics. Using the sample data provided, the test statistic is computed as follows:

$$t = \frac{\bar{d}}{s_{\bar{d}}} = \frac{0.23}{0.14/\sqrt{39}} = 10.26$$

Make a decision regarding the hypotheses. Since the computed test statistic, 10.26, is greater than the critical *t*-value, 2.024—it falls in the rejection region to the right of 2.024 in Figure 13—we reject the null hypothesis of no difference and conclude that there *is* a statistically significant difference in betas after deregulation.

Make a decision based on the results of the test. We can now make the decision that betas are different as a result of deregulation, providing support for the proposition that deregulation resulted in changed risk.

Variance Hypothesis Testing

LOS 1.A.e: Formulate a null and an alternative hypothesis about the variance of a normally distributed population, select the appropriate test statistic, and determine whether to reject the null hypothesis at a given level of significance.

Given that many financial market observers measure risk in terms of variance of returns, the variance is a common focus of statistical analysis. We will review two hypothesis-testing procedures concerned with the population variance:

- Tests pertaining to the value of a single population variance.
- Tests pertaining to differences between two population variances.

Letting σ^2 represent the true population variance and σ_0^2 represent the hypothesized variance, the hypotheses for a two-tailed test of a single population variance are structured as:

$$H_0: \sigma^2 = \sigma_0^2 \text{ versus } H_a: \sigma^2 \neq \sigma_0^2$$

The hypotheses for one-tailed tests are structured as:

$$H_0: \sigma^2 \leq \sigma_0^2 \text{ versus } H_a: \sigma^2 > \sigma_0^2, \text{ or}$$

$$H_0: \sigma^2 \geq \sigma_0^2 \text{ versus } H_a: \sigma^2 < \sigma_0^2$$

Hypothesis testing of the population variance requires the use of a chi-square distributed test statistic, denoted χ^2. The chi-square distribution is asymmetrical and approaches the normal distribution in shape as the degrees of freedom increase. The chi-square test assumes that the sample is normally distributed, and interpretation of the test is very sensitive to this assumption. If the sample isn't normally distributed, you can't use the chi-square test.

The chi-square test statistic with n – 1 degrees of freedom is computed as:

$$\chi^2 = (n-1)\frac{s^2}{\sigma_0^2}$$

where:
n = sample size
s^2 = sample variance
σ_0^2 = hypothesized value for the population variance

Similar to other hypothesis tests, the chi-square test compares the test statistic, χ^2, to a critical chi-square value at a given level of significance and n – 1 degrees of freedom. Note that since the chi-square distribution is bounded below by zero, chi-square values cannot be negative.

Professor's Note: Notice that if the null hypothesis is true ($s^2 = s_0^2$), the χ^2 statistic will be approximately equal to n – 1; if the sample variance is much larger or much small than the hypothesized value, the χ^2 statistic will be much larger or smaller than n – 1. In other words, you will reject the two-sided null when the test statistic is much more or much less than the number of degrees of freedom.

To illustrate the chi-square distribution, consider a two-tailed test with a 5 percent level of significance and 30 degrees of freedom. As displayed in Figure 14, the critical chi-square values are 16.791 and 46.979 for the lower and upper bounds, respectively. These values are obtained from a chi-square table. A portion of a chi-square table is presented in Figure 15.

Note that the chi-square values in the table in Figure 15 correspond to the probabilities in the right tail of the distribution. As such, the 16.791 in Figure 14 is from the column headed "0.975" because 97.5 percent (95 percent + 2.5 percent) of the probability is to the right of it. The 46.979 is from the column headed "0.025" because 2.5 percent probability is to the right of it.

Figure 14: Chi-Square Distribution: Two-Tailed Critical Values

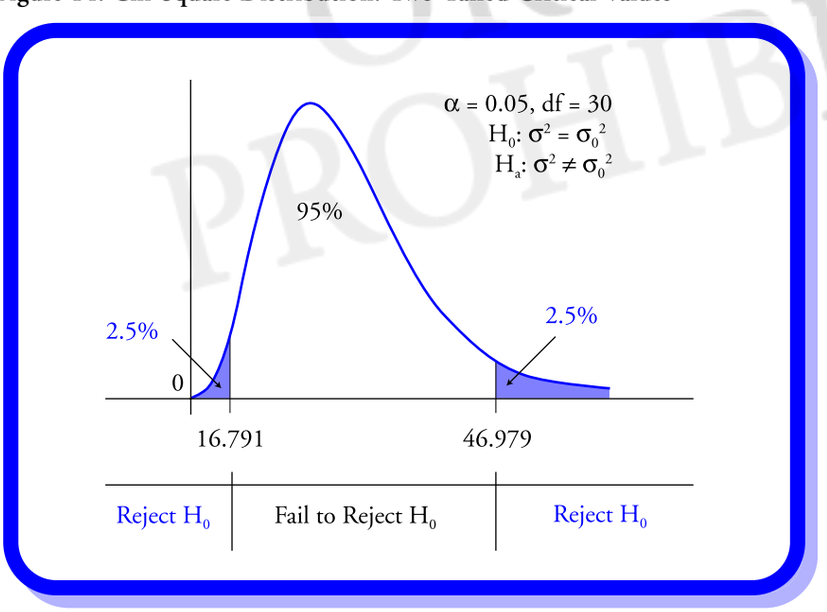
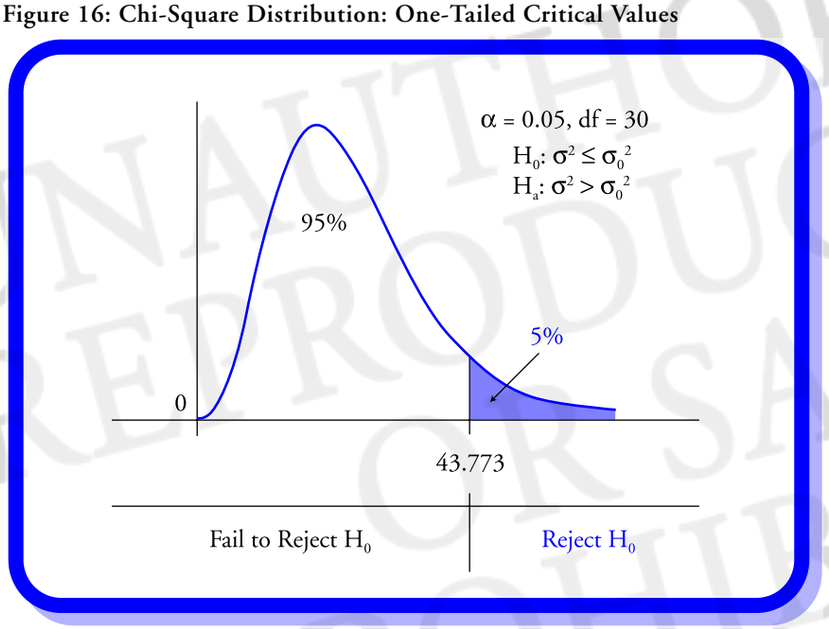


Figure 15: Partial Chi-Square Table

Degrees of Freedom	*Probability in Right Tail*				
	0.975	0.950	0.100	0.050	0.025
9	2.700	3.325	14.684	16.919	19.023
10	3.247	3.940	15.987	18.307	20.483
11	3.816	4.575	17.275	19.675	21.920
23	**11.689**	13.091	32.007	35.172	**38.076**
30	**16.791**	**18.493**	40.256	**43.773**	**46.979**

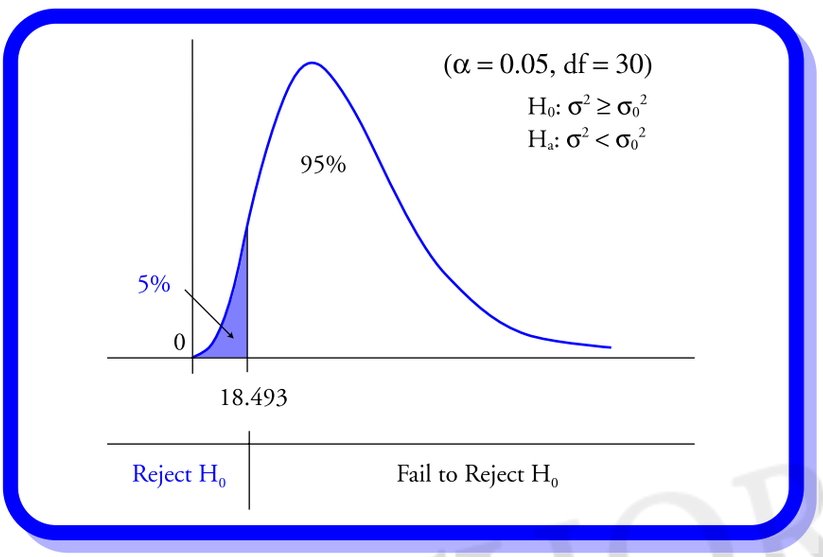
For a 5 percent one-tailed test with 30 degrees of freedom where the alternative hypothesis is H_a: $\sigma^2 > \sigma_0^2$, the null would be rejected if the test statistic were greater than the critical value of 43.773, as shown in Figure 16.

Figure 16: Chi-Square Distribution: One-Tailed Critical Values



For a 5 percent one-tailed test with 30 degrees of freedom where the alternative hypothesis is H_a: $\sigma^2 < \sigma_0^2$, the null would be rejected if the test statistic were less than the critical value of 18.493, as shown in Figure 17.

Figure 17: Chi-Square Distribution: One-Tailed Critical Values



Example: Chi-square test for a single population variance

Historically, High-Return Equity Fund has advertised that its monthly returns have a standard deviation equal to 4 percent. This was based on estimates from the 1992-2002 period. High-Return wants to verify whether this claim still adequately describes the standard deviation of the fund's returns. High-Return collects monthly returns for the 24-month period including 2003 and 2004, and measures a standard deviation of monthly returns of 3.8 percent. **Test** whether the more recent standard deviation is different from the advertised standard deviation.

Answer:

State the hypothesis. The null hypothesis is that the variance of monthly returns for the population is $(0.04)^2 = 0.0016$. Since High-Return wants to test whether the standard deviation is 4 percent, a two-sided test should be used. So the hypothesis test structure takes the form:

$$H_0: \sigma^2 = 0.0016 \text{ versus } H_a: \sigma^2 \neq 0.0016$$

Select the appropriate test statistic. The appropriate test statistic for tests of variance using the chi-square distribution is computed as follows:

$$\chi^2 = (n-1)\frac{s^2}{\sigma_0^2}$$

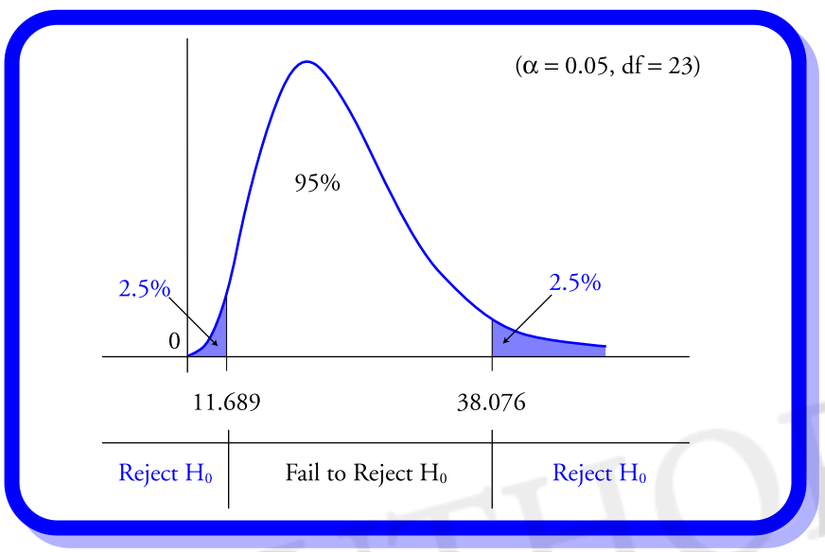
Specify the level of significance. Let's use a 5 percent level of significance, which means that there will be 2.5 percent probability in each tail of the chi-square distribution because this is a two-tailed test.

State the decision rule regarding the hypothesis. With a 24-month sample, there are 23 degrees of freedom. Using the table of chi-square values in Figure 15, for 23 degrees of freedom and probabilities of 0.975 and 0.025, we find two critical values, 11.689 and 38.076. Thus the decision rule is:

Reject H_0 if $\chi^2 < 11.689$, or $\chi^2 > 38.076$

This decision rule is illustrated in Figure 18.

Figure 18: Decision Rule for a Two-Tailed Chi-Square Test of a Single Population Variance



Collect the sample and calculate the sample statistics. Using the information provided, the test statistic is computed as:

$$\chi^2 = 23\left(\frac{0.038^2}{0.04^2}\right) = 20.757$$

Make a decision regarding the hypothesis. Since the computed test statistic (20.757) falls between the two critical values (11.689 and 38.076), we fail to reject the null hypothesis that the variance is equal to 4 percent.

Make a decision based on the results of the test. It can be concluded that the recently measured standard deviation is close enough to the advertised standard deviation of 4 percent that we cannot say that it is different, given the 5 percent level of significance.

Testing Equality of Variances

LOS 1.A.f: Formulate a null and an alternative hypothesis about the equality of the variances of two populations (normally distributed, independent samples), select the appropriate test statistic, and determine whether to reject the null hypothesis at a given level of significance.

The hypotheses concerned with equality of variances of two populations are tested with an *F*-distributed test statistic. Hypothesis testing using a test statistic that follows an *F*-distribution is referred to as the *F*-test. The *F*-test is used under the assumption that the populations from which samples are drawn are normally distributed and that the samples are independent.

If we let σ_1^2 and σ_2^2 represent the variances of population 1 and population 2, respectively, the hypotheses for the two-tailed F-test of differences in the variances can be structured as:

H_0: $\sigma_1^2 = \sigma_2^2$ versus H_a: $\sigma_1^2 \neq \sigma_2^2$

The one-sided test structures can be specified as:

$H_0: \sigma_1^2 \leq \sigma_2^2$ versus $H_a: \sigma_1^2 > \sigma_2^2$, or

$H_0: \sigma_1^2 \geq \sigma_2^2$ versus $H_a: \sigma_1^2 < \sigma_2^2$

The test statistic for the *F*-test with $n_1 - 1$ and $n_2 - 1$ degrees of freedom is the ratio of the sample variances and is computed as:

$$F = \frac{s_1^2}{s_2^2}$$

where:

s_1^2 = variance of the sample of n_1 observations drawn from population 1

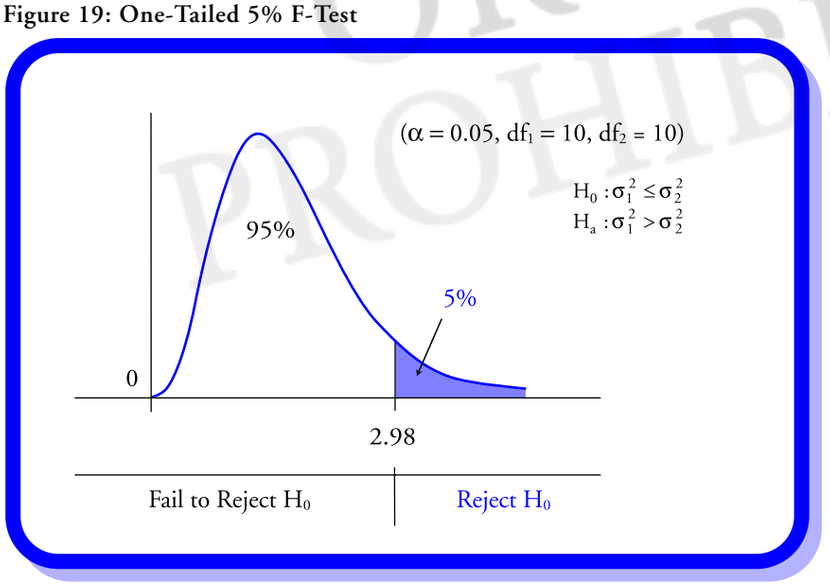
s_2^2 = variance of the sample of n_2 observations drawn from population 2

Professor's Note: Always put the largest variance in the numerator (s_1^2).

An *F*-distribution is presented in Figure 19. As indicated, the *F*-distribution is right-skewed and is truncated at zero on the left-hand side. The shape of the *F*-distribution is determined by *two separate degrees of freedom*, the numerator degrees of freedom, $df_1 = n_1 - 1$, and the denominator degrees of freedom, $df_2 = n_2 - 1$. Also shown in Figure 19 is that the *rejection region is in the right-side tail* of the distribution. This will always be the case as long as the *F*-statistic is computed with the largest sample variance in the numerator. The labeling of 1 and 2 is arbitrary anyway.

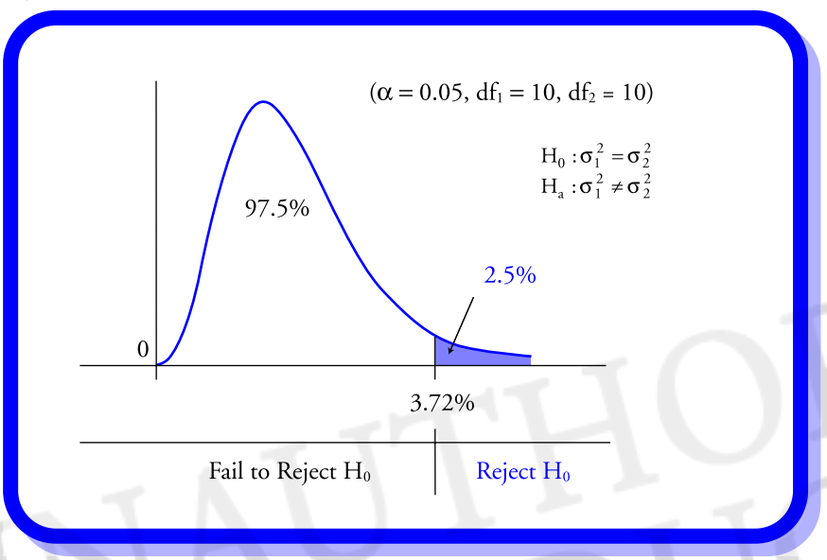
It's important to make the distinction here between one-tailed and two-tailed F-tests because the interpretation and calculation of the critical value is slightly different than for other tests. Figure 19 shows that the critical value for a one-tailed, 5 percent test with $df_1 = 10$ and $df_2 = 10$ is 2.98 because 5 percent of the probability is in the right-hand tail.

Figure 19: One-Tailed 5% F-Test



However, for two-tailed tests, we only want half the total probability in the right-hand tail, but because we always put the larger variance in the numerator, the rejection region will still be just the right-hand tail. For example, Figure 20 shows that the critical value for a 5 percent two-tailed *F*-test is 3.72, with $df_1 = 10$ and $df_2 = 10$ using a 2.5 percent *F*-table.

Figure 20: Two-Tailed 5% F-Test



Professor's Note: F-tables are different from the others we've worked with because we need a separate table for each significance level. You'll find both a 5 percent and 2.5 percent table in the back of this book.

Example: One-tailed *F*-test

Annie Cower is examining the earnings for two different industries. Cower suspects that the earnings of the textile industry are more divergent than those of the paper industry. To confirm this suspicion, Cower has looked at a sample of 31 textile manufacturers and a sample of 41 paper companies. She measured the sample standard deviation of earnings across the textile industry to be $4.30 and that of the paper industry companies to be $3.80. **Test** whether the earnings of the textile industry are more divergent than those of the paper industry.

Answer:

State the hypothesis. In this example, we are concerned with whether the variance of the earnings of the textile industry is greater (more divergent) than the variance of the earnings of the paper industry. As such, the test hypotheses can be structured as:

$H_0: \sigma_T^2 \leq \sigma_P^2$ versus $H_a: \sigma_T^2 > \sigma_P^2$

where:

σ_T^2 = variance of earnings for the textile industry

σ_P^2 = variance of earnings for the paper industry

Note: $\sigma_T^2 > \sigma_P^2$

Select the appropriate test statistic. For tests of difference between variances, the appropriate test statistic is:

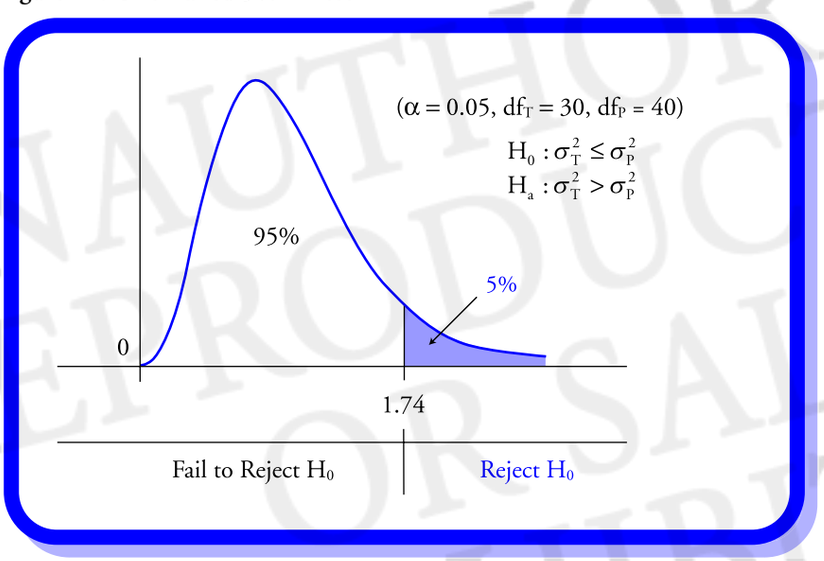
$$F = \frac{s_T^2}{s_P^2}$$

Specify the level of significance. Let's conduct our hypothesis test at the 5 percent level of significance.

State the decision rule regarding the hypothesis. This is a one-tailed, 5 percent *F*-test, so we want 5 percent in the upper tail. Using the sample sizes for the two industries, the critical F-value for our test is 1.74. This value is obtained from the table of the F-distribution at the 5 percent level of significance with $df_T = 30$ and $df_P = 40$. Thus, if the computed F-statistic is greater than the critical value of 1.74, the null hypothesis is rejected. The decision rule, illustrated in Figure 21, can be stated as:

Reject H_0 if $F > 1.74$

Figure 21: One-Tailed 5% F-Test



Collect the sample and calculate the sample statistics. Using the information provided, the *F*-statistic can be computed as:

$$F = \frac{s_T^2}{s_P^2} = \frac{\$4.30^2}{\$3.80^2} = 1.28$$

Professor's Note: Remember to square the standard deviations to get the variances.

Make a decision regarding the hypothesis. Since the calculated *F*-statistic of 1.28 is less than the critical *F*-statistic of 1.74, we fail to reject the null hypothesis.

Make a decision based on the results of the test. Based on the results of the hypothesis test, Cower should conclude that the earnings of the textile industry are not more divergent than those of the paper industry at a 5 percent level of significance.

NONPARAMETRIC TESTS

LOS 1.A.g: Distinguish between parametric and nonparametric tests and describe the situations in which the use of nonparametric tests may be appropriate.

Parametric tests are defined by two characteristics:

- Parametric tests depend on assumptions regarding the distribution of the population. For example, the *z*-test relies upon the existence of a mean and a standard deviation to define the normal distribution. The *t*-test also requires that either the sample is large, relying on the central limit theorem to assure a normal sampling distribution, or the population itself is normally distributed.
- Parametric tests are used to test population parameters that define the distribution. For example, a normal distribution is defined by its mean and variance, and the tests we've discussed up to this point have tested either the mean or the variance of a normally distributed population.

The *z*-statistic, *t*-statistic, chi-square statistic, and the *F*-statistic are all examples of parametric statistics.

Nonparametric tests either do not test a particular population parameter or require few assumptions about the population. Nonparametric tests are used in situations in which:

- *The distributional assumptions are not valid*. For example, if the normality assumption is not valid for a particular sample, we can use nonparametric statistics to test the median instead of using the *z*-test or *t*-test to test the mean. The *median test* is a nonparametric alternative to the *t*-test for differences between means, and the *sign test* is an alternative to the *t*-test for paired comparisons.
- *The data consist of ranked observations* instead of observations based on an ordinal scale. For example, rather than having the actual annual returns on 500 mutual funds, we might only have the rank of each fund from 1 to 500 based on annual returns, so we know that Fund XYZ had the 47th highest return during the year, but we don't know the actual return.
- *Some characteristic other than a parameter is being tested*. For example, we can use a *runs test* to test whether or not a sample is random and the *Kolmogorov-Smirnov* test to test whether the underlying population follows a specific probability distribution. We can also test independence with nonparametric statistics if the data is organized into *contingency tables*. For example, we could classify mutual funds in each of two consecutive years as winners if their return is greater than the benchmark and losers if the return is less than the benchmark. Then we would create a 2 × 2 contingency table by classifying each fund into one of four categories: winner in period 1 and winner in period 2, winner/loser, loser/winner, and loser/loser. If the number of funds in each cell is approximately the same, then we can conclude that mutual fund performance from year to year is independent. The actual test typically involves a chi-square statistic.

Professor's Note: You're not responsible for any more detail than this on any of these nonparametric tests. Notice that the LOS simply says "describe the situations in which the use of nonparametric tests may be appropriate."

KEY CONCEPTS

1. A two-tailed test results from a two-sided alternative hypothesis (e.g., H_a: $\mu \neq \mu_0$), and a one-tailed test results from a one-sided alternative hypothesis (e.g., H_a: $\mu > \mu_0$, or H_a: $\mu < \mu_0$).
2. When hypothesis testing, there are two possible errors:
   - Type I error: rejecting the null hypothesis when it is actually true.
   - Type II error: failing to reject the null hypothesis when it is actually false.
3. The significance level, α, is the probability of a Type I error. As the significance level decreases, the probability of a Type II error increases, and the power of the test (1 – probability of Type II error) decreases.

The following is a review of the Quantitative Methods principles designed to address the learning outcome statements set forth by CFA Institute. This topic is also covered in:

CORRELATION AND REGRESSION

Study Session 3

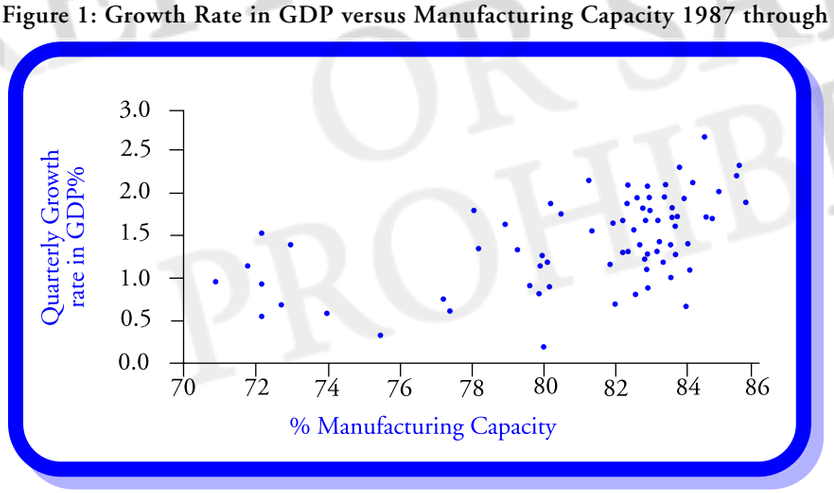
EXAM FOCUS

This topic review is a review of concepts you first encountered at Level 1: correlation analysis and regression analysis with one independent variable, two widely used tools for quantifying the relationship between variables. In addition to calculating and interpreting correlation coefficients and regression estimates, you are expected to be able to test for the statistical significance of these measures. At Level 2, you are most likely to be tested on your understanding of multiple regression with more than one independent variable, which is the subject of the next topic review. However, this topic review provides an excellent introduction to the basic concepts of regression analysis. Mastery of this material will make the multiple regression material much easier to tackle.

WARM-UP: CORRELATION ANALYSIS AND COVARIANCE

A *scatter plot* is a two-dimensional display of the relationship between two variables. In the scatter plot of two random variables, *X* and *Y*, each point on the plot is a pair of *XY* observations. Figure 1 shows a scatter plot of the quarterly growth rate in U.S. gross domestic product (GDP) versus the percentage of manufacturing capacity for the first quarter of 1987 through the first quarter of 2003. It appears that there is a slight tendency for the variables to move together (i.e., as manufacturing capacity increases, GDP growth also increases).

Figure 1: Growth Rate in GDP versus Manufacturing Capacity 1987 through 2003



Source: U.S. Department of Commerce: Bureau of Economic Analysis, FRED II, August 28, 2003, <http://research.stlouisfed.org/fred2/> (September 12, 2005)

The use of a scatter plot provides us with a visual image of the relationship between two variables, regardless of whether the relationship is linear or not. However, correlation analysis is specifically concerned with the linear relationship between two variables. The strength of the linear relationship is measured using a statistic called the correlation coefficient. Before we can discuss the correlation coefficient, however, we must first discuss the covariance.

The *covariance* between two random variables is a statistical measure of the degree to which the two variables move together. The covariance captures the linear relationship between one variable and another. A positive covariance indicates that the variables tend to move together; a negative covariance indicates that the variables tend to move in opposite directions. It appears from Figure 1 that the covariance between manufacturing capacity and GDP growth rate is positive.

The actual value of the covariance is not very meaningful because its measurement is extremely sensitive to the scale of the two variables. Also, the covariance may range from negative to positive infinity and its computation results in squared units (e.g., percent square). For these reasons, we calculate the correlation coefficient, which converts the covariance into something that is more useful and intuitively appealing.

Correlation Coefficient

LOS 1.B.a: Calculate and interpret a correlation coefficient, explain how outliers can affect correlations, define and explain the concept of spurious correlation, and formulate a test of the hypothesis that the population correlation coefficient equals zero and determine whether to reject the hypothesis at a given level of significance.

The **correlation coefficient**, *r*, is a measure of the strength of the linear relationship (correlation) between two variables. The correlation coefficient is unitless; it is a "pure" measure of the tendency of two variables to move together.

The correlation coefficient for two variables, *X* and *Y*, is calculated as:

$$r_{XY} = \frac{\text{covariance of X and Y}}{(\text{standard deviation of X})(\text{standard deviation of Y})} = \frac{\text{cov}(X,Y)}{(\sigma_X)(\sigma_Y)}$$

Example: Calculating the correlation coefficient

Calculate the correlation coefficient between *X* and *Y* if the covariance between the two variables is 49.44, the variance of *X* is 41.611 and the variance of *Y* is 260.67.

Answer:

$$r_{XY} = \frac{49.44}{\sqrt{41.611} \times \sqrt{260.67}} = 0.475$$

The correlation coefficient is bounded by positive and negative one (i.e., $-1 \leq r \leq +1$), where a correlation coefficient of one indicates that there is a one-for-one movement in the variables. However, if the correlation coefficient is negative one, the variables move exactly opposite of each other.

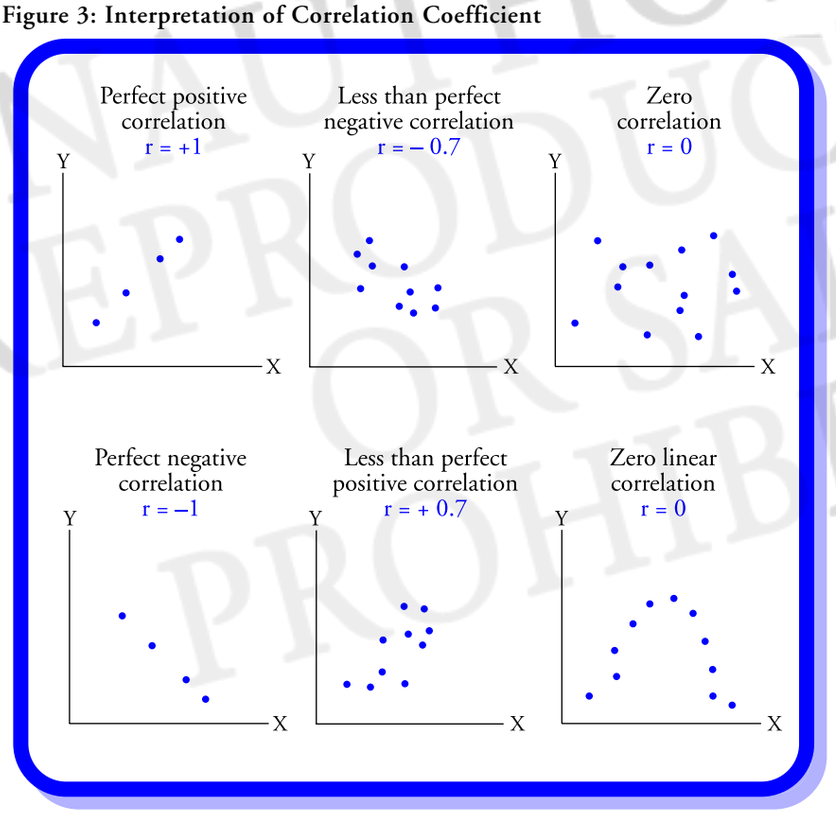
The interpretation of the possible correlation values is summarized in Figure 2.

Figure 2: Interpretation of Correlation Coefficients

Correlation Coefficient (r)	*Interpretation*
r = +1	perfect positive correlation
0 < r < +1	a positive linear relationship
r = 0	no linear relationship
−1 < r < 0	a negative linear relationship
r = −1	perfect negative correlation

It is possible to use these general interpretations of the correlation coefficient to describe the degree of correlation that is apparent in a scatter plot of two variables. For instance, the scatter plot shown previously in Figure 1 appears to be generally upward sloping. In this case, we say that there is positive correlation between GDP growth and manufacturing capacity. If the scatter plot appeared to have a downward trend, we would say that the relationship between *X* and *Y* exhibits a negative correlation. Figure 3 shows several scatter plots and the corresponding interpretation of correlation.

Figure 3: Interpretation of Correlation Coefficient



Outliers and Spurious Correlation

Computed correlation coefficients, as well as other sample statistics, may be affected by outliers. **Outliers** represent *a few extreme values* for sample observations. Relative to the rest of the sample data, the value of an outlier may be extraordinarily large or small. Outliers can provide statistical evidence that a significant relationship exists when, in fact, there is none, or provide evidence that there is no relationship when, in fact, there is.

Spurious correlation refers to the appearance of a linear relationship when, in fact, there is no relation. Certain data items may be highly correlated but not necessarily a result of a causal relationship. A good example of a spurious correlation is if you compute the correlation coefficient for historical stock prices and snowfall totals in Minnesota, you will get a statistically significant relationship—especially for the month of January. Since there is no economic explanation for this relationship, however, this would be considered a spurious correlation.

Testing the Correlation Coefficient

As indicated earlier, the closer the correlation coefficient is to plus or minus one, the stronger the correlation. With the exception of these extremes, we cannot really speak of the strength of the relationship indicated by the correlation coefficient without a statistical test of significance. Thus, a hypothesis test is in order.

For our purposes, we want to test whether the correlation between two variables is not equal to zero. Using the lower case Greek letter rho, ρ, to represent the population correlation coefficient, the appropriate null and alternative hypotheses can be structured as a two-tailed test as follows:

$H_0: \rho = 0$ versus $H_a: \rho \neq 0$

Assuming that the two populations are normally distributed, we can use a *t*-test to determine whether the null hypothesis should be rejected. The test statistic is computed using the sample correlation, *r*, with n – 2 degrees of freedom:

$$t = \frac{r\sqrt{n-2}}{\sqrt{1-r^2}}$$

The decision rule for this two-tailed test is:

Reject H_0 if $t > +t_{critical}$ or $t < -t_{critical}$

Example: Test of significance for the correlation coefficient

The sample correlation between *X* and *Y* is 0.475 for a sample of ten observations. **Determine** if the correlation is significant at the 5 percent level.

Answer:

The test statistic can be computed as:

$$t = \frac{0.475\sqrt{10-2}}{\sqrt{1-0.475^2}} = 1.527$$

The two-tailed critical *t*-values at a 5 percent level of significance with df = 8 (n – 2) are found in the *t*-table to be ±2.306.

Since $-2.306 < 1.527 < 2.306$ (i.e., $-t_{critical} < t < +t_{critical}$), the null cannot be rejected. We conclude that the correlation between variables *X* and *Y* is not significantly different than zero at a 5 percent significance level.

For a given correlation, the larger the sample size (n), the larger the *t*-statistic and the smaller the critical value. Therefore the null hypothesis ($H_0: \rho = 0$) is more likely to be rejected the larger the sample, all else equal. For example, if the sample size in the previous example increases from 10 to 32, the *t*-statistic increases to 3.36 and

the critical *t*-value falls to 2.04. Assuming the sample correlation coefficient is still 0.475, we would now reject the null and conclude that the correlation between X and Y is not equal to zero.

WARM-UP: THE BASICS OF SIMPLE LINEAR REGRESSION

Professor's Note: This material is a review from Level 1. If you feel you have mastered these concepts, you can move on to the Level 2 material beginning with ANOVA. Otherwise, you should review this material.

Regression analysis may be used to summarize and explain the nature of the relationship between one variable (a dependent variable) in terms of one or more other variables (independent variables). In this warm-up, we will learn how to apply regression techniques to the analysis of the linear relationship between one dependent variable and only one independent variable. This type of application of regression analysis is often referred to as *simple linear regression*.

The purpose of simple linear regression is to explain the variation in a dependent variable in terms of the variation in the independent variable. Here, the term variation is interpreted as the degree to which a variable differs from its mean value. Don't confuse variation with variance—they are related, but are not the same.

- The *dependent variable* is the variable whose variation is explained by the independent variable. The dependent variable is also referred to as the *explained variable*, the *endogenous variable*, or the *predicted variable*.
- The *independent variable* is the variable whose variation is used to explain the variation of the dependent variable. The independent variable is also referred to as the *explanatory variable*, the *exogenous variable*, or the *predicting variable.*

Example: Dependent vs. independent variables

Suppose that you want to predict stock returns with GDP growth. **Identify** which variable is the independent variable.

Answer:

Since GDP is going to be used as a predictor of stock returns, stock returns are being *explained* by GDP. Hence, stock returns are the dependent (explained) variable and GDP is the independent (explanatory) variable.

The following linear regression model is used to describe the relationship between two variables, *X* and *Y*:

$$Y_i = b_0 + b_1X_i + \varepsilon_i$$

where:
Y_i = *i*th observation of the dependent variable, Y
X_i = *i*th observation of the independent variable, X
b_0 = intercept with the Y-axis
b_1 = slope coefficient
ε_i = the residual for the *i*th observation (also referred to as the disturbance term or error term)

Based on the regression model stated above, the regression process estimates an equation for a line through a scatter plot of the data that "best" explains the observed values for *Y* in terms of the observed values for *X*. The linear equation, often called the line of best fit, or regression line, takes the following form:

$$\hat{Y}_i = \hat{b}_0 + \hat{b}_1 X_i$$

where:

$\hat{Y}_i$ = the estimated value of Y_i given X_i

$\hat{b}_0$ = the estimated intercept term

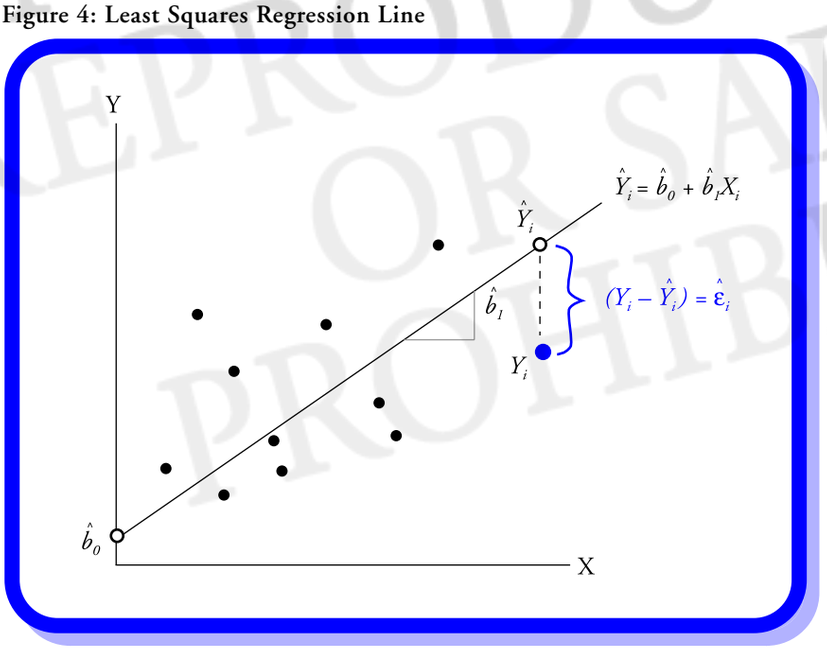
$\hat{b}_1$ = the estimated slope coefficient

Professor's Note: The hat "^" above a variable or parameter indicates an estimated value.

The regression line is just one of the many possible lines that can be drawn through the scatter plot of *X* and *Y*. In fact, the criteria used to estimate this line forms the very essence of linear regression. The regression line is the line for which the estimates of $\hat{b}_0$ and $\hat{b}_1$ are such that the sum of the squared differences (vertical distances) between the *Y*-values predicted by the regression equation $(\hat{Y}_i = \hat{b}_0 + \hat{b}_1 X_i)$ and actual *Y*-values, Y_i, is minimized. The sum of the squared vertical distances between the estimated and actual *Y*-values is referred to as the sum of squared errors (SSE).

Thus, the regression line is the line that minimizes SSE. This explains why simple linear regression is frequently referred to as *ordinary least squares* (OLS) regression, and the values estimated by the estimated regression equation, $\hat{Y}_i$, are called least squares estimates. Figure 4 illustrates the concept behind the OLS regression method.

Figure 4: Least Squares Regression Line



The estimated *slope coefficient*, $\hat{b}_1$, for the regression line describes the change in *Y* for a given change in *X*. It can be positive, negative, or zero, depending on the relationship between the regression variables. The *intercept* term, $\hat{b}_0$, is the line's intersection with the *Y*-axis at X = 0. It can be positive, negative, or zero.

Linear regression requires a number of assumptions. Fortunately, the validity of the model is fairly insensitive to minor violations of these assumptions. As indicated in the following list, most of the major assumptions pertain to the regression model's error term, ε, which is commonly called the residual term, or residual.

- A linear relationship exists between the dependent and independent variables.
- The independent variable is uncorrelated with the error term.
- The expected value of the error term is zero ($E(\varepsilon_i) = 0$).
- The variance of the error term (ε_i) is constant. In other words, the error terms are homoskedastic. (A violation of this is referred to as heteroskedasticity—a good word to throw around at parties! "My, you're looking extremely heteroskedastic this evening.")
- The error term is independently distributed; that is, the error term for one observation is not correlated with that of another observation. (A violation of this is referred to as autocorrelation.)
- The error term is normally distributed.

Professor's Note: If you feel you have mastered the material in this warm-up you can move on to the Level 2 material that follows.

Analysis of Variance

LOS 1.B.f: Describe the use of analysis of variance (ANOVA) in regression analysis and interpret ANOVA results.

Professor's Note: We've changed the original order of the LOS in this topic review to improve the flow of the review and make it easier for you to understand the relationship among the important concepts.

Analysis of variance (ANOVA) is a statistical procedure for analyzing the total variability of a data set. Let's define some terms before we move on to ANOVA tables.

- *Total sum of squares (SST) measures the total variation* in the dependent variable. SST is equal to the sum of the squared differences between the actual *Y*-values and the mean of *Y*:

$$\text{SST} = \sum_{i=1}^{n} (Y_i - \overline{Y})^2$$

- *Regression sum of squares (SSR) measures the variation in the dependent variable explained by the independent variable*. SSR is the sum of the squared distances between the predicted *Y*-values and the mean of *Y*.

$$\text{SSR} = \sum_{i=1}^{n} (\hat{Y}_i - \overline{Y})^2$$

- *Sum of squared errors (SSE) measures the unexplained variation* in the dependent variable. It's also known as the sum of squared residuals. SSE is the sum of the squared vertical distances between the actual *Y*-values and the predicted *Y*-values on the regression line.

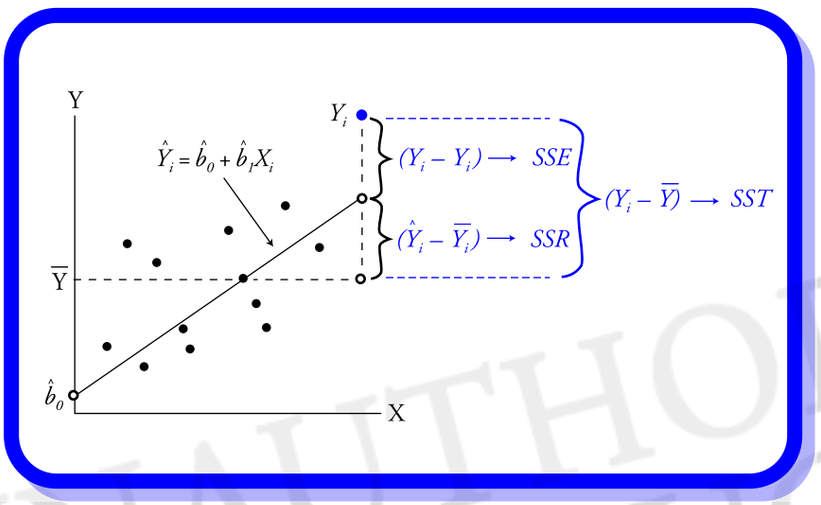
$$\text{SSE} = \sum_{i=1}^{n} (Y_i - \hat{Y}_i)^2$$

Thus, total variation = explained variation + unexplained variation, or

SST = SSR + SSE

Figure 5 illustrates how the total variation in the dependent variable (SST) is made up of SSR and SSE.

Figure 5: Components of the Total Variation



The output of the ANOVA procedure is an ANOVA table, which is a summary of the variation in the dependent variable. ANOVA tables are included in the regression output of many statistical software packages. You can think of the ANOVA table as the source of the data for the computation of many of the regression concepts discussed in this topic review. A generic ANOVA table for a simple linear regression (one independent variable) is presented in Figure 6.

Figure 6: Analysis of Variance (ANOVA) Table

Source of Variation	*Degrees of Freedom*	*Sum of Squares*	*Mean Sum of Squares*
Regression (explained)	k = 1	SSR	$MSR = \frac{SSR}{k}$
Error (unexplained)	n – 2	SSE	$MSE = \frac{SSE}{n-2}$
Total	n – 1	SST	

Professor's Note: k is the number of slope parameters estimated and n is the number of observations. In general, the regression df = k and the error df = (n – k – 1). Since we are limited to simple linear regressions in this topic review (one independent variable) we use k = 1 for the regression df and n – 1 – 1 = n – 2 for the error df.

The mean regression sum of squares (MSR) and mean squared error (MSE) are simply calculated as the appropriate sum of squares divided by its degrees of freedom.

As you'll see shortly, we can calculate the standard error of estimate and the coefficient of determination using an ANOVA table. That makes ANOVA tables very useful on the exam.

Professor's Note: Many of the parameters we discuss in this topic review, such as the R^2 and the SEE, are included in the regression output from most statistical software packages; hence, you usually do not have to calculate these parameters from the data in the ANOVA table. However, the CFA exam is a different story.

LOS 1.B.b: Calculate and interpret the standard error of estimate and the coefficient of determination.

The **standard error of estimate** (SEE) measures the degree of variability of the actual *Y*-values relative to the estimated *Y*-values from a regression equation. The SEE gauges the "fit" of the regression line. *The smaller the standard error, the better the fit*.

In some regressions, the relationship between the independent and dependent variables is very strong (e.g., the relationship between 10-year Treasury bond (T-bond) yields and mortgage rates). In other cases, the relationship is much weaker (e.g., the relationship between stock returns and inflation). SEE will be low (relative to total variability) if the relationship is very strong and high if the relationship is weak.

Formally, SEE is the standard deviation of the predicted values for the dependent variable about the regression line. Equivalently, it is the standard deviation of the error terms in the regression. As such, SEE is also referred to as the standard error of the residual, or standard error of the regression, and often specified as s_e.

The standard error of estimate (SEE) is equal to the square root of the mean squared error, which means we can calculate it from an ANOVA table:

$$\text{Standard error of estimate (SEE)} = \sqrt{\frac{\text{SSE}}{n-2}} = \sqrt{\text{MSE}}$$

Example: Calculating SEE

Calculate the standard error of estimate using the information in the ANOVA table.

Figure 7: ANOVA Table

Source of Variation	*Df*	*Sum of Squares*	*Mean Sum of Squares*
Regression (explained)	1	5,050	5,050
Error (unexplained)	28	600	21.429
Total	29	5,650	

Answer:

$$\text{SEE} = \sqrt{\frac{600}{28}} = \sqrt{21.429} = 4.629$$

Coefficient of Determination

The **coefficient of determination** (R^2) is defined as the percentage of the total variation in the dependent variable explained by the independent variable. For example, an R^2 of 0.63 indicates that the variation of the independent variable explains 63 percent of the variation in the dependent variable.

The coefficient of determination is calculated as:

$$R^2 = \frac{\text{total variation} - \text{unexplained variation}}{\text{total variation}} = \frac{\text{explained variation}}{\text{total variation}}$$

$$= \frac{SST - SSE}{SST} = \frac{SSR}{SST}$$

Example: Calculating R^2

Calculate the R^2 using the information in the ANOVA table.

Figure 8: ANOVA Table

Source of Variation	*Df*	*Sum of Squares*	*Mean Square*
Regression (explained)	1	5,050	5,050
Error (unexplained)	28	600	21.429
Total	29	5,650	

Answer:

$$R^2 = \frac{SSR}{SST} = \frac{5050}{5650} = 0.894 = 89.4\%$$

Professor's Note: For simple linear regression (i.e., one independent variable), the coefficient of determination, R^2, may be computed by simply squaring the correlation coefficient, r. In other words, $R^2 = r^2$, for regression with one independent variable. Unfortunately, this approach is not appropriate when more than one independent variable is used in the regression, as is the case with the multiple regression techniques presented in the next topic review.

Regression Coefficient Confidence Interval

LOS 1.B.c: Calculate and interpret a confidence interval for a regression coefficient.

Hypothesis testing for a regression coefficient may use the confidence interval for the coefficient being tested. For instance, a frequently asked question is whether an estimated slope coefficient is statistically different from zero. In other words, the null hypothesis is H_0: $b_1 = 0$ and the alternative hypothesis is H_a: $b_1 \neq 0$. If the confidence interval at the desired level of significance does not include zero, the null is rejected, and the coefficient is said to be statistically different from zero.

The confidence interval for the regression coefficient, b_1, is calculated as:

$$\hat{b}_1 \pm \left(t_c \times s_{\hat{b}_1}\right), \text{or} \left[\hat{b}_1 - \left(t_c \times s_{\hat{b}_1}\right) < b_1 < \hat{b}_1 + \left(t_c \times s_{\hat{b}_1}\right)\right]$$

In this expression, t_c is the critical *t*-value for the selected confidence level with the appropriate number of degrees of freedom, which is equal to the number of sample observations minus two (i.e., n – 2).

The standard error of the regression coefficient is denoted as $s_{\hat{b}_1}$. It is a function of the standard error of estimate (SEE): as SEE rises, $s_{\hat{b}_1}$ also increases, and the confidence interval widens. This makes sense because SEE measures the variability of the data about the regression line, and the more variable the data, the less confidence there is in the regression model to estimate a coefficient.

Professor's Note: It is highly unlikely you will have to calculate $s_{\hat{b}_1}$ on the exam. It is included in the output of all statistical software packages and should be given to you if you need it.

Although the confidence interval for regression parameters looks slightly different than what you've seen at Level 1, it is precisely the same concept. All confidence intervals take the predicted value, then add and subtract the critical test statistic times the variability of the statistic.

Example: Calculating the confidence interval for a regression coefficient

Suppose a regression line has an estimated slope coefficient of 0.78 with a standard error equal to 0.32. Assuming that the sample had 26 observations, **calculate** the 95 percent confidence interval for b_1.

Answer:

The confidence interval for b_1 is:

$$\hat{b}_1 \pm \left(t_c \times s_{\hat{b}_1}\right), \text{or} \left[\hat{b}_1 - \left(t_c \times s_{\hat{b}_1}\right) < b_1 < \hat{b}_1 + \left(t_c \times s_{\hat{b}_1}\right)\right]$$

The critical t-values are ± 2.064 (from the *t*-table with 24 degrees of freedom). We can compute the 95 percent confidence interval as:

$$0.78 \pm (0.32)(2.064) = 0.78 \pm 0.66 = \{0.12 < b_1 < 1.44\}$$

Since this confidence interval does not include zero, we can conclude that the slope coefficient is significantly different from zero.

REGRESSION COEFFICIENT *T*-TEST

LOS 1.B.d: Formulate a null and an alternative hypothesis about a population value of a regression coefficient, select the appropriate test statistic, and determine whether to reject the null hypothesis at a given level of significance.

A *t*-test may also be used to test the hypothesis that the true slope coefficient, b_1, is equal to some hypothesized value. Letting $\hat{b}_1$ be the point estimate for b_1, the appropriate test statistic with n–2 degrees of freedom is:

$$t_b = \frac{\hat{b}_1 - b_1}{s_{\hat{b}_1}}$$

The decision rule for tests of significance for regression coefficients is:

Reject H_0 if $t > +t_{critical}$ or $t < -t_{critical}$

Rejection of the null means that the slope coefficient is *different* from the hypothesized value of b_1.

To test whether an independent variable explains the variation in the dependent variable, the hypothesis that is tested is whether the true slope is zero ($b_1 = 0$). The appropriate test structure for the null and alternative hypotheses is:

H_0: $b_1 = 0$ versus H_a: $b_1 \neq 0$

Example: Hypothesis test for significance of regression coefficients

Suppose a regression line has an estimated slope coefficient of 0.78 with a standard error equal to 0.32. Assuming that the sample had 26 observations, **determine** if the estimated slope coefficient is significantly different than zero at a 5 percent level of significance.

Answer:

The calculated test statistic is: $t = \frac{\hat{b}_1 - b_1}{s_{\hat{b}_1}} = \frac{0.78 - 0}{0.32} = 2.4375$

The critical *t*-values are ± 2.064 (from the *t*-table with df = 26 – 2 = 24). Since $t > t_{critical}$ (i.e., 2.4375 > 2.064), we reject the null hypothesis and conclude that the slope is different from zero.

Note that the *t*-test and the confidence interval lead to the same conclusion to reject the null hypothesis.

Interpretation of Regression Coefficient

LOS 1.B.e: Interpret a regression coefficient.

As indicated earlier, the *estimated intercept*, $\hat{b}_0$, represents the value of the dependent variable at the point of intersection of the regression line and the axis of the dependent variable (usually the vertical axis). In other words, the intercept is an estimate of the dependent variable when the independent variable takes on a value of zero. We also mentioned earlier that the *estimated slope coefficient*, $\hat{b}_1$, is interpreted as the change in the dependent variable for a one-unit change in the independent variable. For example, an estimated slope coefficient of two would indicate that the dependent variable will change two units for every one-unit change in the independent variable.

Keep in mind, however, that any conclusions regarding the importance of an independent variable in explaining a dependent variable requires determining the statistical significance of the slope coefficient. Simply looking at the magnitude of the slope coefficient does not address the issue of the importance of the variable. A hypothesis test must be conducted, or a confidence interval must be formed, to assess the importance of the variable.

Predicted Value of the Dependent Variable

LOS 1.B.g: Calculate a predicted value for the dependent variable given an estimated regression model and a value for the independent variable and calculate and interpret a confidence interval for the predicted value of a dependent variable.

Predicted values are values of the dependent variable based on the estimated regression coefficients and a prediction about the value of the independent variable. They are the values that are *predicted* by the regression equation, given an estimate of the independent variable.

For a simple regression, the predicted, or forecast, value of *Y* is:

$$\hat{Y} = \hat{b}_0 + \hat{b}_1 X_p$$

where:
$\hat{Y}$ = predicted value of the dependent variable
X_p = predicted value of the independent variable

Example: Forecasting

Suppose you estimate the following regression equation:

$$\hat{Y} = 1.5 + 2.5X_1$$

Calculate the predicted value of the *Y* variable if the predicted value of the independent variable is 20.

Answer:

The predicted value for *Y* is determined as follows:

$$\hat{Y} = 1.5 + 2.5(20) = 51.5$$

Confidence Intervals for Predicted Values

Professor's Note: Just about everything we do in this topic review related to simple linear regression will be repeated in the next topic review on multiple linear regression. However, you are only responsible for being able to calculate a confidence interval for the predicted value in simple linear regression, not multiple regression.

Confidence intervals for the predicted value of a dependent variable are calculated in a manner similar to the confidence interval for the regression coefficients. The equation for the confidence interval for a predicted value of *Y* is:

$$\hat{Y} \pm (t_c \times s_f) \Rightarrow \left[\hat{Y} - (t_c \times s_f) < Y < \hat{Y} + (t_c \times s_f)\right]$$

where:
t_c = the critical *t*-value at the desired level of significance with df = n – 2
s_f = the standard error of the forecast

The challenge with computing a confidence interval for a predicted value is calculating s_f. It's unlikely that you will have to calculate the standard error of the forecast (it will probably be provided if you need to compute a confidence interval for the dependent variable). However, if you do need to calculate s_f, it can be done with the following formula for the variance of the forecast:

$$s_f^2 = SEE^2\left[1 + \frac{1}{n} + \frac{(X - \bar{X})^2}{(n-1)s_x^2}\right]$$

where:

SEE^2 = variance of the regression = the square of the standard error of estimate
s_x^2 = variance of the independent variable
X = value of the independent variable for which the forecast was made

Professor's Note: This equation implies that the standard error of the forecast is larger than the SEE, but the difference between the two decreases as the number of observations increases, all else equal. If you are asked on the exam to calculate a confidence interval for a predicted value and the sample size is large, you'll get pretty close to the correct answer by using SEE^2 *rather than* s_f^2 *.*

Example: Confidence interval for a predicted value

Suppose an analyst uses least squares regression to explain the variation in *Y* in terms of *X*. The regression produced the following output:

$\hat{b}_0 = 0.01$ $\hat{b}_1 = 1.2$ $SEE = 0.23$

$s_x = 0.16$ $n = 32$ $\bar{X} = 0.06$

Calculate the predicted value of the dependent variable given that the forecasted *X*-value is $X = 0.05$. Also, **calculate** a 95 percent prediction interval on the forecasted value of *Y*.

Answer:

Given the estimated parameters, the prediction equation can be stated as:

$$\hat{Y} = 0.01 + 1.2X$$

For a forecasted value of $X = 0.05$, the predicted value of the dependent variable:

$$\hat{Y} = 0.01 + 1.2(0.05) = 0.07$$

The critical *t*-value at the 5 percent level of significance (95 percent confidence level) with $df = 32 - 2 = 30$ is 2.042.

The variance of the forecast is:

$$s_f^2 = 0.23^2\left[1+\frac{1}{32}+\frac{(0.05-0.06)^2}{(32-1)0.16^2}\right] = 0.05456$$

$$s_f = \sqrt{0.05456} = 0.23358$$

Hence, the prediction interval at the 95 percent confidence level is:

$$\hat{Y}-(t_c \times s_f) < Y < \hat{Y}+(t_c \times s_f) \Rightarrow [0.07-(0.23358\times 2.042)] < Y < [0.07+(0.23358\times 2.042)]$$

or

$$-0.41 < Y < 0.55$$

This range can be interpreted such that with 95 percent confidence, the forecast value of *Y* given a forecast value for the independent variable of 0.05 will be between –0.41 and 0.55.

LOS 1.B.h: Discuss the limitations of regression analysis.

Limitations of regression analysis include:

- Regression relations change over time. This means that the estimation equation based on data from a specific time period may not be relevant for forecasts or predictions in another time period. This is referred to as *non-stationarity*.
- If the assumptions of regression analysis are not valid, the interpretation and tests of hypotheses are not valid. For example, if the data is *heteroskedastic* (non-constant variance of the error terms) or exhibits *autocorrelation* (error terms are not independent), then it is very difficult to use the regression to forecast the dependent variable given information about the independent variables.

KEY CONCEPTS

1. The correlation coefficient is a measure of the linear relationship between two variables:

$$r_{x,y} = \frac{\text{cov}(X,Y)}{(\sigma_X)(\sigma_Y)}$$

2. Outliers, or values that are unusually large or small, may influence the results of regression and the estimate of the correlation coefficient.
3. Spurious correlation means that there may appear to be a relationship between two variables when, in fact, there is none.
4. A *t*-test with n – 2 degrees of freedom is used to determine if a correlation coefficient, *r*, is statistically significant:

$$t = \frac{r\sqrt{n-2}}{\sqrt{1-r^2}}$$

The following is a review of the Quantitative Methods principles designed to address the learning outcome statements set forth by CFA Institute. This topic is also covered in:

MULTIPLE REGRESSION AND ISSUES IN REGRESSION ANALYSIS

Study Session 3

EXAM FOCUS

Multiple regression is *the* "must-know" quant topic at Level 2. It's a useful analysis tool that shows up again in Study Sessions 4 (Economics), 12 and 13 (Equity), 15 (Debt), and 18 (Portfolio Management). It *will* appear on the exam: be ready for it and you're on your way to Level 3!

You should know that a *t*-test assesses the significance of the individual regression parameters, and an *F*-test assesses the effectiveness of the model as a whole in explaining the dependent variable. You should understand the effect that heteroskedasticity, serial correlation, and multicollinearity have on regression results, be able to detect the existence of each of these conditions, and recommend corrective actions.

Focus on interpretation of the regression equation and the test statistics. Remember that most of the test/descriptive statistics discussed (e.g., *t*-stat, *F*-stat, and R^2) are provided in the output of statistical software. Hence, application and interpretation of these measurements are more likely than actual computations on the exam.

WARM-UP: MULTIPLE REGRESSION BASICS

Multiple regression is regression analysis with more than one independent variable. It is used to quantify the influence of two or more independent variables on a dependent variable. For instance, simple (or univariate) linear regression explains the variation in stock returns in terms of the variation in systematic risk as measured by beta. With multiple regression, stock returns can be regressed against beta and against additional variables, such as firm size, equity, and industry classification, that might influence returns. Theoretically, there is no upper limit on the number of independent variables that can be included in a multiple regression model.

The multiple linear regression model is:

$$Y_i = b_0 + b_1X_{1i} + b_2X_{2i} + \ldots + b_kX_{ki} + \varepsilon_i$$

where:

Y_i = *i*th observation of the dependent variable Y, i = 1, 2, …, n
X_j = independent variables, j = 1, 2, …, k
X_{ji} = *i*th observation of the *j*th independent variable
b_0 = intercept term
b_j = slope coefficient for each of the independent variables
ε_i = error term for the *i*th observation

As with simple linear regression, the intercept term in the multiple regression equation represents the value of the dependent variable when all independent variables equal zero. The slope coefficients, the betas, estimate the change in the dependent variable for a one-unit change in each independent variable, *holding all other independent variables constant*.

The multiple regression methodology estimates the intercept and slope coefficients such that the sum of the squared error terms, $\sum_{i=1}^{n} \varepsilon_i^2$, is minimized. The result of this procedure is the following regression equation:

$$\hat{Y}_i = \hat{b}_0 + \hat{b}_1 X_{1i} + \hat{b}_2 X_{2i} + \ldots + \hat{b}_k X_{ki}$$

where the "^" indicates an estimate for the corresponding model parameter.

The error of the estimate (also known as the residual or disturbance term), $\hat{\varepsilon}_i$, is the difference between the observed value, Y_i, and the estimated parameter value, $\hat{Y}_i$:

$$\hat{\varepsilon}_i = Y_i - \hat{Y}_i = Y_i - \left(\hat{b}_0 + \hat{b}_1 X_{1i} + \hat{b}_2 X_{2i} + \ldots + \hat{b}_k X_{ki}\right)$$

Tests for significance in multiple regression involve testing whether each independent variable *individually* contributes to explaining the variation in the dependent variable using the *t*-statistic, and whether some or all of the independent variables contribute to explaining the variation in the dependent variable using the *F*-statistic or the R^2.

MULTIPLE REGRESSION

LOS 1.C.a: Formulate a multiple regression equation to describe the relationship between a dependent variable and several independent variables, interpret the slope coefficients, determine the statistical significance of each independent variable, and interpret the estimated coefficients.

Example: Interpreting a regression equation

A multiple regression was performed to estimate the relationship between the sales of the V-Ball Company (in millions of dollars) and three independent (explanatory) variables:

ADV = the number of dollars spent on advertising in millions
SP = the number of salespersons
MKT = the number of competing companies in the market

The regression model for this relationship may be expressed as:

$$\text{Sales} = b_0 + b_1\text{ADV} + b_2\text{SP} + b_3\text{MKT} + \varepsilon$$

Based on the model, the estimated regression equation is:

$$\widehat{\text{Sales}} = 8.0 + 1.7(\text{ADV}) + 2.8(\text{SP}) - 0.6(\text{MKT})$$

Interpret the relationships between the independent variables and the dependent variable in the regression equation.

Answer:

The coefficient estimates are interpreted as follows:

- Sales will equal \$8 million if each of the independent variables equals zero.
- Spending an additional \$1 million on advertising results in an additional \$1.7 million of sales, *holding number of salespersons and competing companies constant*.
- The addition of another sales person results in \$2.8 million of additional sales, *holding advertising dollars and number of competing companies constant*.
- An increase in the number of competing firms by one results in a decline in sales of \$600,000, *holding advertising dollars and number of salespersons constant*.

Be careful with the units of measurement. A slope coefficient of one indicates a one-unit change in Y (\$1 million in this example) for a one-unit change in the independent variable. It is also important that you note that the effect of each individual coefficient on the dependent variable is interpreted while holding all other independent variables constant.

Hypothesis Testing for Statistical Significance

As with simple linear regression, the magnitude of the coefficient in a multiple regression tells us nothing about the importance of the independent variable in explaining the dependent variable. Thus, we must conduct hypothesis testing on the estimated slope coefficients to determine if the independent variables make a significant contribution to explaining the variation in the dependent variable. The *t*-statistic used to test the significance of the coefficient in a multiple regression is calculated using the same formula as that used with simple linear regression. The calculated test statistic for the *j*th independent variable is:

$$t = \frac{\hat{b}_j - b_j}{s_{\hat{b}_j}}$$

where :
$\hat{b}_j$ = estimated regression parameter
b_j = hypothesized value
$s_{\hat{b}_j}$ = estimated standard error of $\hat{b}_j$

The *t*-statistic has n – k – 1 degrees of freedom, where *n* is the number of sample observations and *k* is the number of independent variables. To test for statistical significance we conduct a two-tailed test where the null hypothesis is that the regression coefficient is equal to zero versus the alternative that it is not.

Example: Test of significance for a slope coefficient

Recall that the estimated regression equation from a preceding example was:

$$\widehat{\text{Sales}} = 8.0 + 1.7(\text{ADV}) + 2.8(\text{SP}) - 0.6(\text{MKT})$$

Now consider the additional results of the estimation on a sample of 34 observations provided in Figure 1. **Calculate** the *t*-statistic for each coefficient, **determine** whether each coefficient is statistically different from zero (at a 5 percent significance level), and **interpret** each result.

Figure 1: Regression Estimates for V-Ball Sales

Variable	*Coefficient*	*Standard Error*
Intercept	8.0	2.080
ADV	1.7	0.756
SP	2.8	1.033
MKT	–0.6	0.146

Answer:

To test whether a coefficient is statistically significant means to test whether it is significantly different from zero. Thus, the null hypothesis is that the slope coefficient for the j^{th} independent variable equals zero. The appropriate two-tailed test structure is:

$H_0: b_j = 0$ versus $H_a: b_j \neq 0$

The decision rule is to reject if the calculated test statistic is larger than the upper tail critical value ($+t_c$) or less than the lower tail critical value ($-t_c$):

Reject H_0 if: $t_{b_j} > +t_c$ or $t_{bj} < -t_c$

The *t*-statistics for each coefficient are:

$$t_{b_0} = \frac{8.0 - 0.0}{2.080} = 3.85$$

$$t_{b_{ADV}} = \frac{1.7 - 0.0}{0.756} = 2.25$$

$$t_{b_{SP}} = \frac{2.8 - 0.0}{1.033} = 2.71$$

$$t_{b_{MKT}} = \frac{-0.6 - 0.0}{0.146} = -4.11$$

At a 5 percent significance level with df = 30 = 34 – 3 – 1, the two-tailed critical *t*-values are $t_c = \pm 2.042$. Applying the decision rule to the calculated *t*-statistics in the table in Figure 1 indicates that all three variables have slope coefficients that are significantly different from zero at the 5 percent significance level, indicating that all three independent variables contribute to explaining sales for V-Ball Company. In addition, the intercept term is statistically significant.

LOS 1.C.b: Formulate a null and an alternative hypothesis about the population value of a regression coefficient, calculate the value of the test statistic, determine whether to reject the null hypothesis at a given level of significance, using a one-tailed or two-tailed test, and interpret the result of the test and interpret p-values for regression coefficients.

As we discussed in the previous LOS, testing for statistical significance means testing the null that the regression coefficient is equal to zero. We can also test the hypothesis that the coefficient is equal to some other value. For example, we might want to test the null that one of the regression coefficients is less than or equal to one (H_0: $b_j \leq 1$) or that it is equal to 25 (H_0: $b_j = 25$).

Example: Testing regression coefficients (two-tailed test)

Suppose we want to test the null hypothesis that $1.00 spent on advertising results in $1.50 of sales using the previous regression equation. **Identify** the appropriate hypotheses, **calculate** the appropriate *t*-statistic, and **interpret** the results.

Answer:

The hypotheses for this two-tailed test (used when testing alternative hypothesis of inequality) can be structured as:

H_0: $b_1 = 1.50$ versus H_a: $b_1 \neq 1.50$

The calculated *t*-statistic is:

$$t = \frac{\hat{b}_1 - 1.5}{s_{\hat{b}_1}} = \frac{1.7 - 1.5}{0.756} = 0.265$$

The decision rule is:

Reject H_0 if $t_{b_j} > +t_c$ or $t_{b_j} < -t_c$

The two-tailed critical *t*-value at a 5 percent level of significance with df = 30 is ±2.042.

Since ($t = 0.265$) < ($+t_c = 2.042$) and ($t = 0.265$) > ($-t_c = -2.042$), we fail to reject the null hypothesis and conclude that $1.00 in advertising generates $1.50 dollars of sales.

Professor's Note: You should be able to look up the critical t-value. Please refer to the tables supplied at the back of this book.

Example: Testing regression coefficients (one-tailed test)

Suppose now we want to test the null hypothesis that $1.00 spent on advertising results in $1.50 of sales or less. **Identify** the appropriate hypotheses, **calculate** the appropriate *t*-statistic, and **interpret** the results.

Answer:

This example calls for a one-tailed test (used when testing alternative hypotheses involving "greater than" or "less than"). The hypotheses for this test can be structured as:

H_0: $b_1 \leq 1.5$ versus H_a: $b_1 > 1.5$

The calculated *t*-statistic is:

$$t = \frac{\hat{b}_1 - 1.5}{s_{\hat{b}_1}} = \frac{1.7 - 1.5}{0.756} = 0.265$$

The decision rule is:

Reject H_0 if $t > t_c$

The one-tailed critical *t*-value at a 5 percent level of significance with df = 30 is +1.697.

Since ($t = 0.265$) < ($t_c = 1.697$), we fail to reject the null hypothesis and conclude that $1.00 in advertising does not generate more than $1.50 of sales.

The p-value is the smallest level of significance for which the null hypothesis can be rejected. An alternative method of doing hypothesis testing of the coefficients is to compare the p-value to the significance level:

- If the p-value is less than significance level, the null hypothesis can be rejected.
- If the p-value is greater than the significance level, the null hypothesis cannot be rejected.

Example: Interpreting p-values

Given the following regression results, determine which regression parameters for the independent variables are statistically significantly different from zero at the 1 percent significance level, assuming the sample size is 60.

Variable	*Coefficient*	*Standard error*	*t-statistic*	*p-value*
Intercept	0.40	0.40	1.0	0.3215
X1	8.20	2.05	4.0	0.0002
X2	0.40	0.18	2.2	0.0319
X3	–1.80	0.56	–3.2	0.0022

Answer:

The independent variable is statistically significant if the p-value is less than 1 percent, or 0.01. Therefore X1 and X3 are statistically significantly different from zero.

Confidence Intervals in Multiple Regression

The confidence interval for a regression coefficient in a multiple regression is calculated and interpreted exactly the same as with a simple linear regression. That is, if zero is in the confidence interval constructed for a coefficient at a desired significance level, we conclude that the slope is not statistically different from zero.

The calculation for the confidence interval for the *j*th population slope coefficient is:

$$\hat{b}_j \pm \left(t_c \times s_{\hat{b}_j} \right) \text{ or } \left[\hat{b}_j - \left(t_c \times s_{\hat{b}_j} \right) < b_j < \hat{b}_j + \left(t_c \times s_{\hat{b}_j} \right) \right]$$

Example: Calculating a confidence interval

Using the regression results in Figure 2, **calculate** and **interpret** a 95 percent confidence interval for b_{MKT}.

Figure 2: Regression Estimates for V-Ball Sales

Variable	*Coefficient*	*Standard Error*
Intercept	8.0	2.080
ADV	1.7	0.756
SP	2.8	1.033
MKT	–0.6	0.146

Answer:

At a 5 percent significance level with df = 30 = 34 – 3 – 1, the two-tailed critical t-values are $t_c = \pm 2.042$. The 95 percent confidence interval is:

$$\hat{b}_{MKT} \pm \left(t_c \times s_{\hat{b}_{MKT}} \right) = -0.6 \pm (2.042 \times 0.146) = -0.90 < b_{MKT} < -0.30$$

Since this confidence interval does not contain zero, we conclude that the slope coefficient for MKT is statistically different from zero at the 95 percent level of confidence. This indicates that at a 5 percent significance level, we can estimate that the addition of one competing company in the market, holding all other variables constant, will result in a \$600,000 (\$0.6 million) decrease in the sales of V-Ball.

WARM-UP: SST, SSR, AND SSE

There are some rather ugly-looking formulas with rather intimidating names that appear often in multiple regression analysis. Let's review them here, but keep in mind that these sums of squares will always be calculated for you on the exam, usually as part of an ANOVA table (discussion of an ANOVA table is in LOS 1.C.d). Don't memorize the formulas! Instead, understand the interpretation of each.

Total sum of squares (SST) is the total variation of *Y* about its mean or average value:

$$SST = \sum_{i=1}^{n} (Y_i - \overline{Y})^2$$

where:
$\overline{Y}$ = the mean of Y

Sum of squared errors (SSE) is the portion of the total variation in *Y* that is not explained by the regression:

$$SSE = \sum_{i=1}^{n} (Y_i - \hat{Y}_i)^2 = \sum_{i=1}^{n} \hat{\varepsilon}_i^2$$

where $\hat{Y}_i$ is the estimated value of the *i*th observation for *Y* using the regression equation (i.e., $\hat{Y}_i$ is located on the regression line).

Regression sum of squares (SSR) is the variation that is explained by the regression equation:

$$SSR = \sum_{i=1}^{n}(\hat{Y}_i - \overline{Y})^2$$

Note the following relationships:

$$SST = SSR + SSE$$

total variation = explained variation + unexplained variation

$$\sum_{i=1}^{n}(Y_i - \overline{Y})^2 = \sum_{i=1}^{n}(\hat{Y}_i - \overline{Y})^2 + \sum_{i=1}^{n}(Y_i - \hat{Y}_i)^2$$

$$\sum_{i=1}^{n}(Y_i - \overline{Y})^2 = \sum_{i=1}^{n}(\hat{Y}_i - \overline{Y})^2 + \sum_{i=1}^{n}\hat{\varepsilon}_i^2$$

Mean squared error (MSE) is computed as:

$$MSE = \frac{SSE}{n - k - 1}$$

where:
n = number of observations
k = number of independent variables

Mean regression sum of squares (MSR) is computed as:

$$MSR = \frac{SSR}{k}$$

Professor's Note: All of these variables are reported in a typical ANOVA table, which we will discuss in LOS 1.C.d.

LOS 1.C.c: Explain the assumptions of a multiple regression model and calculate a predicted value for the dependent variable given an estimated regression model and assumed values for the independent variables.

MULTIPLE REGRESSION ASSUMPTIONS

As with simple linear regression, most of the assumptions made with the multiple regression pertain to the model's error term, ε_i. The assumptions of the multiple regression model are as follows:

- A linear relationship exists between the dependent and independent variables.
- The independent variables are not random. Also, there is no exact linear relation between any two or more independent variables.
- The expected value of the error term is zero [i.e., $E(\varepsilon) = 0$].

- The variance of the error terms is constant (i.e., the errors are homoskedastic).
- The error term for one observation is not correlated with that of another observation (i.e., the errors are not serially correlated).
- The error term is normally distributed.

PREDICTING THE DEPENDENT VARIABLE

We can use the regression equation to make predictions about the dependent variable *based on predicted values of the independent variables*. The process is similar to forecasting with simple linear regression, only now we need predicted values for more than one independent variable. The value of dependent variable *Y* is predicted as:

$$\hat{Y}_i = \hat{b}_0 + \hat{b}_1\hat{X}_{1i} + \hat{b}_2\hat{X}_{2i} + ... + \hat{b}_k\hat{X}_{ki}$$

where:

$\hat{Y}_i$ = the predicted value of the dependent variable

$\hat{b}_j$ = the estimated slope coefficient for the *j*th independent variable

$\hat{X}_{ji}$ = the predicted value of the *j*th independent variable, j = 1, 2, …, *k*

The prediction of the dependent variable uses the estimated intercept and all of the estimated slope coefficients, regardless of whether the independent variables are significant.

Example: Calculating a predicted value

Given the following estimated regression model and assumed values for the independent variables *ADV*, *SP*, and *MKT*, **calculate** the predicted value for sales.

The estimated regression equation is:

$$\widehat{\text{Sales}} \text{ (in millions)} = 8.0 + 1.7(\text{ADV}) + 2.8(\text{SP}) - 0.6(\text{MKT})$$

where:
ADV = the number of dollars spent on advertising in millions
SP = the number of salespersons
MKT = the number of competing companies in the market

Independent variable forecasts:

ADV = $20,000,000
SP = 42
MKT = 3

Answer:

$$\widehat{\text{Sales}} = 8.0 + (1.7 \times 20) + (2.8 \times 42) - (0.6 \times 3) = \$157.8 \text{ million}$$

The predicted sales figure, given the forecasts of the independent variables, is $157.8 million.

LOS 1.C.d: Define, calculate, and interpret the *F*-statistic and discuss how it is used in regression analysis, define, distinguish between, and interpret the R^2 and adjusted R^2 in multiple regression, and infer how well a regression model explains the dependent variable by analyzing the output of the regression equation and an ANOVA table.

THE F-STATISTIC

An *F*-test assesses how well a set of independent variables, as a group, explains the variation in the dependent variable. That is, the *F*-statistic is used to test whether *at least one* independent variable in a set of independent variables explains a significant portion of the variation of the dependent variable.

The *F*-statistic is calculated as:

$$F = \frac{MSR}{MSE} = \frac{SSR/k}{SSE/(n-k-1)}$$

where:
SSR = regression sum of squares
SSE = sum of squared errors
MSR = mean regression sum of squares
MSE = mean squared error

The *F*-statistic is almost always formulated to test *all* independent variables as a group. For example, if there are four independent variables in the model, the hypotheses are structured as:

$H_0: b_1 = b_2 = b_3 = b_4 = 0$ versus H_a: at least one $b_j \neq 0$

Important Note: When testing the hypothesis that all the regression coefficients are simultaneously equal to zero, *the F-test is always a one-tailed test.*

To determine whether at least one of the coefficients is statistically significant, the calculated *F*-statistic is compared with the critical *F*-value, F_c, at the appropriate level of significance. The degrees of freedom for the numerator and denominator are:

$df_{numerator} = k$

$df_{denominator} = n - k - 1$

where:
n = number of observations
k = number of independent variables

The decision rule for the *F*-test is:

Decision rule: reject H_0 if $F > F_c$

Rejection of the null hypothesis at a stated level of significance indicates that at least one of the coefficients is significantly different than zero, which is interpreted to mean that at least one of the independent variables in the regression model makes a significant contribution to the explanation of the dependent variable.

Professor's Note: The output of most statistical packages provides the F-statistic and the lowest level of significance at which the null can be rejected, which is essentially a p-value. However, if you need to look up critical F-values, F-tables are included at the back of this book (as well as in most statistics texts). Using an F-table is similar to using a t-table. However, you need to keep track of the degrees of freedom in both the numerator and denominator.

Example: Calculating and interpreting the F-statistic

An analyst runs a regression of monthly value-stock returns on five independent variables over 60 months. The total sum of squares is 460, and the sum of squared errors is 170. **Test** the null hypothesis at the 5 percent significance level that all five of the independent variables are equal to zero.

Answer:

The null and alternative hypotheses are:

$H_0: b_1 = b_2 = b_3 = b_4 = b_5 = 0$ versus H_a: at least one $b_j \neq 0$

$$SSR = SST - SSE = 460 - 170 = 290$$

$$MSR = \frac{290}{5} = 58.0$$

$$MSE = \frac{170}{60 - 5 - 1} = 3.15$$

$$F = \frac{58.0}{3.15} = 18.41$$

The critical *F*-value for 5 and 54 degrees of freedom at a 5 percent significance level is approximately 2.40. Remember, it's a one-tailed test, so we use the 5 percent F-table! Therefore we can reject the null hypothesis and conclude that at least one of the five independent variables is significantly different than zero.

Coefficient of Determination

In addition to an *F*-test, the multiple coefficient of determination, R^2, can be used to test the overall effectiveness of the entire set of independent variables in explaining the dependent variable. In other words, R^2 (or multiple-R^2), is the percentage of variation in the dependent variable *collectively* explained by all of the independent variables. For example, an R^2 of 0.63 indicates that the model, as a whole, explains 63 percent of the variation in the dependent variable.

R^2 is calculated as:

$$R^2 = \frac{\text{total variation} - \text{unexplained variation}}{\text{total variation}} = \frac{SST - SSE}{SST}$$

Unfortunately, R^2 by itself *may not be a reliable measure of how well a multiple regression model fits* (i.e., how well it is specified). This is because R^2 almost always increases as variables are added to the model, even if the contribution of the new variables is not statistically significant. Consequently, a relatively high R^2 value may reflect the impact of a large set of independent variables rather than how well the set explains the dependent variable. This problem is often referred to as overestimating the regression.

To overcome the problem of overestimating the impact of additional variables on the explanatory power of a regression model, many researchers recommend adjusting R^2 for the number of independent variables. The *adjusted* R^2 value is expressed as:

$$R_a^2 = 1 - \left[\left(\frac{n-1}{n-k-1}\right) \times (1 - R^2)\right]$$

where:
n = number of observations
k = number of independent variables
R^2 = *unadjusted* R^2

Whenever there is more than one independent variable, R_a^2 is less than or equal to R^2. So while adding a new independent variable to the model will increase R^2, it may either *increase or decrease* the R_a^2 . If the new variable has only a small effect on R^2, the value of R_a^2 may decrease. In addition, R_a^2 may be less than zero.

Example: Calculating R^2 and adjusted R^2

An analyst runs a regression of monthly value-stock returns on five independent variables over 60 months. The total sum of squares for the regression is 460, and the sum of squared errors is 170. **Calculate** and **interpret** the R^2 and adjusted R^2.

Answer:

$$R^2 = \frac{460 - 170}{460} = 0.630 = 63.0\%$$

$$R_a^2 = 1 - \left[\left(\frac{60-1}{60-5-1}\right) \times (1 - 0.63)\right] = 0.596 = 59.6\%$$

The R^2 of 63 percent suggests that the five independent variables together explain 63 percent of the variation in monthly value-stock returns.

Example: Interpreting adjusted R^2

Suppose the analyst now adds four more independent variables to the regression, and the R^2 increases to 65.0 percent. **Identify** which model the analyst would most likely prefer.

Answer:

With nine independent variables, even though the R^2 has increased, the adjusted R^2 has decreased to 58.7 percent:

$$R_a^2 = 1 - \left[\left(\frac{60-1}{60-9-1}\right) \times (1 - 0.65)\right] = 0.587 = 58.7\%$$

The analyst would prefer the first model because the adjusted R^2 is higher and the model is more parsimonious: it has five independent variables as opposed to nine.

ANOVA Tables

Analysis of variance (ANOVA) is a statistical procedure that provides information on the explanatory power of a regression. ANOVA also provides the inputs for the *F*-test for testing the significance of the set of explanatory (independent) variables. The results of the ANOVA procedure are presented in an ANOVA table, which accompanies the output of a multiple regression program. An example of a generic ANOVA table is presented in Figure 3.

Figure 3: Analysis of Variance (ANOVA) Table

Source	*df (Degrees of Freedom)*	*SS (Sum of Squares)*	*MS (Mean Square= SS/df)*
Regression	k	SSR	MSR
Error	n – k – 1	SSE	MSE
Total	n – 1	SST	

The information in an ANOVA table is used to attribute the total variation of the dependent variable to one of two sources: the regression model and the residuals. This is indicated in the first column in Figure 3, where the "source" of the variation is listed.

The information in an ANOVA table can be used to calculate R^2, the *F*-statistic, and the standard error of estimate (SEE). That is:

$$R^2 = \frac{SSR}{SST}$$

$$F = \frac{MSR}{MSE} \text{ with k and n – k – 1 degrees of freedom}$$

$$SEE = \sqrt{MSE}$$

Professor's Note: R^2, F, and SEE are provided along with the standard ANOVA table produced by most statistical software packages. On the exam, be prepared to fill in "missing data" from an ANOVA output.

Let's look at an example to tie all of this together.

Example: Using an ANOVA table with regression output

In an attempt to estimate a regression equation that can be used to forecast BuildCo's future sales, 22 years of BuildCo's annual sales were regressed against two independent variables:

GDP = the level of gross domestic product
ΔI = changes in 30-year mortgage interest rates (expressed in percentage terms)

The output from a statistical software package is contained Figure 4.

Figure 4: Regression Results for BuildCo Sales Data

		Coefficient	*Standard Error*	*t-Statistic*	*p-Value*
Intercept		6.000	4.520	1.327	0.20
Level of gross domestic product (GDP)		0.004	0.003	?	0.20
Changes in 30-year mortgage rates (ΔI)		-20.500	3.560	?	< 0.001
ANOVA	*df*	*SS*	*MS*	*F*	*Significance F*
Regression	?	236.30	?	?	p < 0.005
Error	?	116.11	?		
Total	?	?			
R^2	?				
R_a^2	?				

Based on the output in Figure 4, the regression equation can be stated as:

$$\widehat{\text{BuildCo Sales}} = 6.000 + 0.004(\text{GDP}) - 20.500(\Delta I)$$

Fill in the missing data and **interpret** the results of the regression at a 5 percent level of significance with respect to:

- The significance of the individual independent variables.
- The utility of the model as a whole.

Answer:

Step 1: Fill in the missing data.

The computed test statistics for the regression coefficients are:

$$t_{GDP} = \frac{0.004}{0.003} = 1.333$$

$$t_{\Delta I} = \frac{-20.500}{3.560} = -5.758$$

Degrees of freedom are:

$$df_{regression} = k = 2$$
$$df_{error} = n - k - 1 = 22 - 2 - 1 = 19$$
$$df_{total} = n - 1 = 22 - 1 = 21$$

Other calculations:

$$SST = SSR + SSE = 236.30 + 116.11 = 352.41$$

$$MSR = \frac{SSR}{k} = \frac{236.30}{2} = 118.15$$

$$MSE = \frac{SSE}{n-k-1} = \frac{116.11}{19} = 6.11$$

$$F = \frac{MSR}{MSE} = \frac{118.15}{6.11} = 19.34$$

$$R^2 = \frac{SSR}{SST} = \frac{236.30}{352.41} = 67.05\%$$

$$R_a^2 = 1 - \left(\frac{n-1}{n-k-1}\right)(1-R^2) = 1 - \left(\frac{21}{19}\right)(1 - 0.6705) = 63.58\%$$

Figure 5 shows what the complete ANOVA table looks like:

Figure 5: Regression Results for BuildCo Sales Data

	Coefficient	*Standard Error*	*t-Statistic*	*p-Value*
Intercept	6.000	4.520	1.327	0.20
Level of gross domestic product	0.004	0.003	1.333	0.20
Changes in 30-year mortgage rates	–20.500	3.560	–5.758	< 0.001

ANOVA	*df*	*SS*	*MS*	*F*	*Significance F*
Regression	2	236.30	118.15	19.34	p < 0.005
Error	19	116.11	6.11		
Total	21	352.41			
R^2	67.05%				
R^2_a	63.58%				

Step 2: Determine the significance of the individual independent variables.

The contribution of the individual variables, as indicated by the significance of their slope coefficients, can be tested using *t*-tests. However, since the *p*-values are included with the regression output, as is usually the case, the level of significance can be observed directly. Just for practice, let's test for significance of the individual coefficients using *t*-tests *and* *p*-values.

- Using *p*-values. Only the *p*-value of coefficient for ΔI is less than the 5 percent level of significance, so we conclude that only ΔI contributes significantly to the level of BuildCo's annual sales.
- Using *t*-statistics. The hypothesis test structure is:

  H_0: b = 0 versus H_a: b ≠ 0

The decision rule is:

Reject H_0 if $t_{b_j} > +t_c$ or $t_{b_j} < -t_c$

The critical two-tailed *t*-values with df = 19 are ±2.093.

Since $t_{GDP} = 1.33$ does not fall in the rejection region, we cannot reject the null for GDP, and we conclude that the level of GDP does not make a statistically significant contribution to the explanation of sales at the 5 percent level.

Since ($t_{\Delta I} = -5.758$) < ($t_c = -2.093$), we conclude that changes in mortgage rates make a significant contribution to the explanation of BuildCo's annual sales.

Professor's Note: The use of p-values or t-tests will always result in the same conclusions about the statistical significance of the slope estimate (i.e., coefficients on the independent variables). On the exam, use the p-value if it is provided!

Step 3: Determine the utility of the model as a whole.

The overall utility of the model can be generally assessed with the coefficient of determination, R^2. The R^2 value indicates that *GDP* and ΔI explain 67.05 percent of the variation in BuildCo's annual sales.

Tests of significance for the set of independent variables should be performed using the *F*-test. The hypotheses for the one-sided *F*-test can be structured as:

$H_0: b_{\Delta I} = b_{GDP} = 0$ versus $H_a: b_{\Delta I} \neq 0$, or $b_{GDP} \neq 0$

The decision rule is:

Reject H_0 if $F > F_c$

F_c at the 5 percent significance level with $df_{numerator} = 2$ and $df_{denominator} = 19$ is 3.52. Remember, this is a one-tailed test. Since $F = 19.34 > F_c$, the null hypothesis can be rejected and we can conclude that at least one of the independent variables significantly contributes to the dependent variable. That is, changes in mortgage rates *and* the level of GDP explain a significant amount of the variation in BuildCo's annual sales at the 5 percent significance level. Notice that we could have reached this conclusion by observing that the ANOVA table reports that *F* is significant at a level less than 5 percent.

DUMMY VARIABLES

LOS 1.C.e: Formulate a multiple regression equation using dummy variables to represent qualitative factors and interpret the coefficients.

Observations for most independent variables (e.g., firm size, level of GDP, and interest rates) can take on a wide range of values. However, there are occasions when the independent variable is binary in nature—it is either "on" or "off." Independent variables that fall into this category are called **dummy variables** and are often used to quantify the impact of qualitative events.

Dummy variables are assigned a value of "0" or "1." For example, in a time series regression of monthly stock returns you could employ a "January" dummy variable that would take on the value of "1" if a stock return occurred in January and "0" if it occurred in any other month. The purpose of including the January dummy

variable would be to see if stock returns in January were significantly different than stock returns in all other months of the year. Many "January Effect" anomaly studies employ this type of regression methodology.

The estimated regression coefficient for dummy variables indicates the difference in the dependent variable for the category represented by the dummy variable and the average value of the dependent variable for all classes except the dummy variable class. For example, the slope coefficient for the January dummy variable just mentioned would indicate whether security returns are different in January than the other months.

An *important consideration* when performing multiple regression with dummy variables is the choice of the number of dummy variables to include in the model. Whenever we want to distinguish between *n* classes, we must use n – 1 dummy variables. Otherwise, the regression assumption of no exact linear relationship between independent variables would be violated. This condition is referred to as perfect collinearity, a close cousin to multicollinearity, which will be discussed in the next section.

Consider the following regression equation for explaining quarterly EPS in terms of the quarter of their occurrence:

$$EPS_t = b_0 + b_1Q_{1t} + b_2Q_{2t} + b_3Q_{3t}$$

where:
EPS_t = a quarterly observation of earnings per share
Q_{1t} = 1 if period t is the first quarter, Q_{1t} = 0 otherwise
Q_{2t} = 1 if period t is the second quarter, Q_{2t} = 0 otherwise
Q_{3t} = 1 if period t is the third quarter, Q_{3t} = 0 otherwise

The intercept term, b_0 represents the average value of *EPS* for the fourth quarter. The slope coefficient on each dummy variable tells us about the *difference* in earnings per share (on average) between the respective quarter (i.e., quarter 1, 2, or 3) and the omitted quarter (the fourth quarter in this case). *Think of the omitted class as the reference point*.

In this example, the slope coefficient, b_1, represents the difference between the first-quarter EPS and the fourth-quarter EPS (b_0). So if $b_0 = 1.25$ and $b_1 = 0.75$, the prediction for the first-quarter EPS is 1.25 + 0.75 = 2.00.

As with all multiple regression results, the *t*-statistics for the individual coefficients, the *F*-statistic for the set of coefficients, and R^2 should be evaluated to determine if the quarters, individually or collectively, contribute to the explanation of total quarterly EPS.

Mazumdar and Sengupta (2005)[1] provide a recent example of an investment application of multiple regression using dummy variables. They determined that loan spreads relative to LIBOR on private debt contracts are negatively associated with measures of the quality of the company's financial disclosures. The dependent variable (SPREAD) is the quoted spread in basis points over LIBOR on the first year of the loan. The independent variables include a number of quantitative variables, including, for example, average total disclosure score (DISC), standard deviation of daily stock returns (STDRETN), current ratio (CRATIO), and market to book ratio (MKBK). They also include three dummy variables in their regression:

- SECURE, which is equal to one if the loan is collateralized, and equal to zero otherwise.
- BID, which is equal to one if the loan contained the option to price the loan relative to a different index, and equal to zero otherwise.
- RESTRUC, which is equal to one if the loan was for corporate restructuring, and equal to zero otherwise.

1. Mazumdar, S. and P. Sengupta. 2005. "Disclosure of the Loan Spread on Private Debt." *Financial Analysts Journal*, vol. 61, no. 3 (May/June): 83-95.

In their model both SECURE and RESTRUC are positive and statistically significantly different from zero. The proper interpretation is that the loan spreads on private debt contracts are higher for collateralized loans than for uncollateralized loans, and higher for loans used for corporate restructuring than for loans used for other purposes, *given the other independent variables in the model*.

WARM-UP: WHY MULTIPLE REGRESSION ISN'T AS EASY AS IT LOOKS

Regression analysis relies on the assumptions listed in LOS 1.C.c. When these assumptions are violated, the inferences drawn from the model are questionable. There are three primary assumption violations that you will encounter: (1) heteroskedasticity, (2) serial correlation (i.e., autocorrelation), and (3) multicollinearity.

On exam day, you must be able to answer the following three questions about each of the three assumption violations:

- What is it?
- How do we detect it?
- How do we correct for it?

Recall that the calculated test statistic for the estimated regression coefficient on the j^{th} independent variable is:

$$t = \frac{\hat{b}_j - b_j}{s_{\hat{b}_j}}$$

Note that the denominator in the test statistic equation above, $s_{\hat{b}_j}$, is the standard error for coefficient *j*. Without getting into the math, suffice it to say that the coefficient standard error is calculated using the standard error of estimate (SEE) which is the standard deviation of the error term. Any violation of the assumptions that affects the error term will ultimately affect the coefficient standard error. Consequently, this will affect the test statistic and any conclusions drawn from hypothesis tests involving the test statistic.

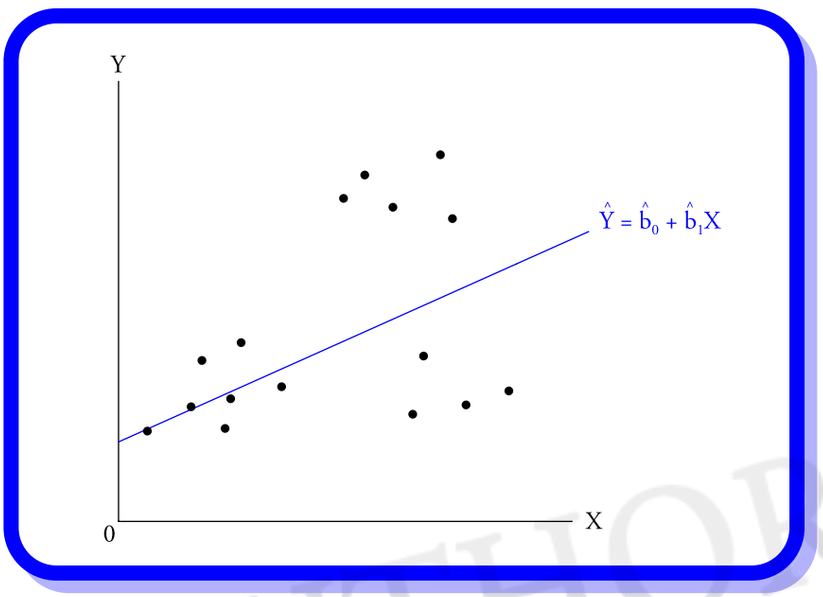
LOS 1.C.f: Describe conditional heteroskedasticity, and unconditional heteroskedasticity, and serial correlation and discuss their effects on statistical inference, explain how to test and correct for heteroskedasticity and serial correlation, and calculate and interpret a Durbin-Watson statistic.

HETEROSKEDASTICITY

One of the assumptions of a multiple regression model is that the residuals are homoskedastic: their variance is constant across observations.

Heteroskedasticity occurs when the variance of the residuals is not the same across all observations in the sample. This happens when there are subsamples that are more spread-out than the rest of the sample. This situation is illustrated in the scatter plot and simple linear regression line shown in Figure 6. Notice in this figure that the errors associated with the larger values of the independent variable, *X,* are larger than the errors associated with the smaller values of *X*.

Figure 6: Heteroskedastic Errors



Heteroskedasticity is a problem because the estimated slope coefficients will not have the smallest possible variance, which means that the standard errors of the coefficients will not be the same for different values of the independent variable(s). This can significantly influence the conclusions drawn from *t*-tests about a regression equation.

Unconditional heteroskedasticity occurs when the heteroskedasticity is not related to the level of the independent variables, which means that it doesn't systematically increase or decrease with changes in the value of the independent variable(s). While this is a violation of the equal variance assumption, *it usually causes no major problems with the regression*.

Conditional heteroskedasticity is heteroskedasticity that is related to the level of (i.e., conditional on) the independent variables. For example, conditional heteroskedasticity exists if the variance of the residual term increases as the value of the independent variable increases, as shown in Figure 6. Conditional heteroskedasticity *does create significant problems for statistical inference*.

Detecting Heteroskedasticity

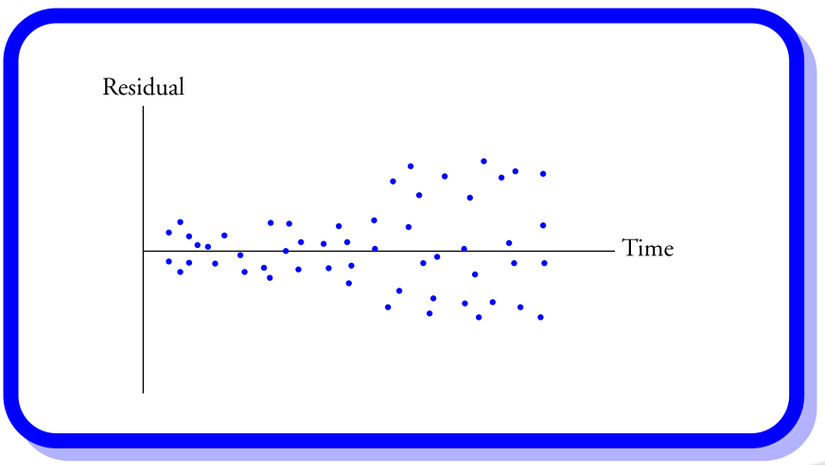
There are two methods that can be used to detect heteroskedasticity: examining scatter plots of the residuals and using the Breusch-Pagan test.

A scatter plot of the residuals versus one or more of the independent variables can reveal patterns among observations.

Example: Detecting heteroskedasticity with a residual plot

You have been studying the weekly returns of a mutual fund over the past ten years, hoping to draw conclusions about the fund's average performance. You calculate the mean return, the standard deviation, and the portfolio's beta using regression analysis. The standard deviation of returns and the fund's beta don't seem to fit the firm's stated risk profile. For your analysis, you have prepared a scatter plot of the error terms (actual return – predicted return) for the regression using ten years of returns, as shown in Figure 7. **Determine** whether the residual plot indicates that there may be a problem with the data.

Figure 7: Residual Plot



Answer:

The residual plot in Figure 7 indicates the presence of heteroskedasticity. Notice how the variation in the regression residuals increases over time. This indicates that the variance of the fund's returns about the mean has changed over time. It appears as though the fund was relatively low-risk in the first few years of the study, and now it is a high-risk fund.

Conditional heteroskedasticity can also be detected using the *Breusch-Pagan test*, which calls for the regression of the squared residuals on the independent variables. If conditional heteroskedasticity is present, the independent variables will significantly contribute to the explanation of the squared residuals. The number of observations times the R^2 of the regression follows a chi-squared distribution with k degrees of freedom (k is the number of independent variables) under the null hypothesis of no heteroskedasticity. This is a one-tailed test because heteroskedasticity is only a problem if the R^2 and the test statistic are too large. The test statistic for the Breusch-Pagan test is calculated as:

$$BP = n \times R^2 \text{ with k degrees of freedom}$$

where:
n = the number of observations
R^2 = R^2 from regression of squared residuals on independent variables
k = the number of independent variables

Example: The Breusch-Pagan test

The residual plot of mutual fund returns over time shows evidence of heteroskedasticity. To confirm your suspicions, you regress the squared residuals from the original regression on the set of six independent variables. The R^2 from that regression is 8 percent. Use the Breusch-Pagan test to determine whether heteroskedasticity is present at the 5 percent significance level.

Answer:

With 10 years of weekly observations, n is equal to 520. The test statistic is:

$$n \times R^2 = 520 \times 0.08 = 41.6$$

The one-tailed critical value for a chi-squared distribution with 6 degrees of freedom and α equal to 5 percent is 12.592. Therefore you should reject the null hypothesis and conclude that you have a problem with heteroskedasticity.

Correcting Heteroskedasticity

Heteroskedasticity is not easy to correct, and the details of the available techniques are beyond the scope of the CFA curriculum (which means you don't need to know the details for the exam!). Two possible remedies for heteroskedasticity include:

- Calculating *robust standard errors* (called White-corrected standard errors) which correct for the heteroskedasticity in the model. These robust standard errors are then used to recalculate the *t*-statistics using the original regression coefficients. This is the preferred method. On the exam, use robust standard errors to calculate *t*-statistics if there is evidence of heteroskedasticity.
- Using a technique called *generalized least squares*, in which the original regression equation is altered by modeling the heteroskedasticity in the error term and then re-estimating the model.

Example: Using White-corrected standard errors

An analyst runs a regression of annualized Treasury bill rates (the dependent variable) on annual inflation rates (the independent variable) using monthly data for 10 years. The results of the regression are shown in Figure 8.

Figure 8: Regression of T-Bill Rates on Inflation Rates

Variable	*Coefficient*	*Standard error*	*t-statistic*	*p-value*
Intercept	4.82	0.85	5.67	< 0.0001
Inflation	0.60	0.28	2.14	0.0340

He determines using the Breusch-Pagan test that heteroskedasticity is present, so he also estimates the White-corrected standard error for the coefficient on inflation to be 0.31. The critical 2-tailed 5% *t*-value for 119 degrees of freedom is 1.98. Is inflation statistically significant at the 5% level?

Answer:

The t-statistic should be recalculated using the White-corrected standard error as:

$$t = \frac{0.60}{0.31} = 1.94$$

This is less than the critical t-value of 1.98, which means after correcting for heteroskedasticity, the null hypothesis that the inflation coefficient is zero cannot be rejected. Therefore inflation is not statistically significant.

Serial Correlation

Serial correlation, also known as autocorrelation, refers to the situation in which the residual terms are correlated with one another. Serial correlation occurs most often with time series data.

Positive serial correlation exists whenever a positive regression error in one time period increases the probability of observing a positive regression error for the next time period. Positive serial correlation is a problem because it will lead to coefficient standard errors that are too small, even though the estimated coefficients are accurate.

These small standard error terms will cause the computed *t*-statistics to be larger than they should be, which will cause too many Type I errors: the rejection of the null hypothesis when it is actually true.

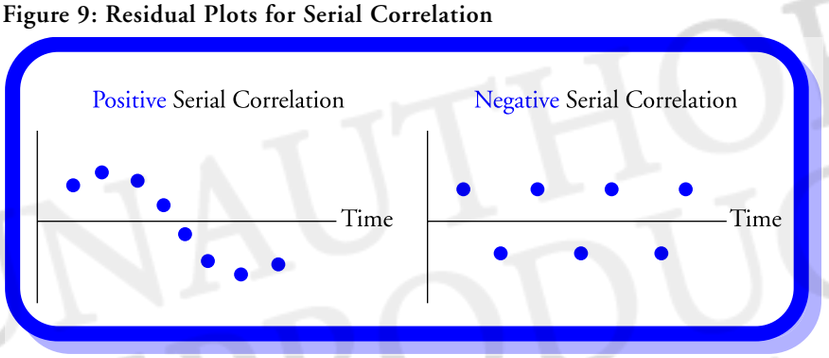
Negative serial correlation occurs whenever a positive error in one period increases the probability of observing a negative error in the next period. Negative serial correlation causes the standard errors to be too large, which leads to *t*-statistics that are too small. This will cause us to fail to reject the null hypothesis when it is actually false, a Type II error.

Detecting Serial Correlation

There are two methods that are commonly used to detect the presence of serial correlation: residual plots and the Durbin-Watson statistic.

A scatter plot of residuals versus time, like those shown in Figure 9, can reveal the presence of serial correlation. Figure 9 illustrates examples of positive and negative serial correlation.

Figure 9: Residual Plots for Serial Correlation



The **Durbin-Watson statistic** is a statistical test that is used to detect the presence of serial correlation. It is calculated as:

$$DW = \frac{\sum_{t=2}^{T}(\hat{\varepsilon}_t - \hat{\varepsilon}_{t-1})^2}{\sum_{t=1}^{T}\hat{\varepsilon}_t^2}$$

where:
$\hat{\varepsilon}_t$ = residual for period t

If the sample size is large:

$$DW \approx 2(1-r)$$

where:
r = correlation coefficient between residuals from one period and those from the previous period

Professor's Note: This LOS actually says to "calculate" the DW statistic. However, the exact calculation of the DW is obviously too lengthy to do on the exam, but the approximation is straightforward. Be prepared to calculate the DW statistic given the correlation coefficient between residuals.

You can see from the approximation that the Durbin-Watson test statistic is approximately equal to 2 if the error terms are homoskedastic and not serially correlated (r = 0). DW < 2 if the error terms are positively serially correlated (r > 0), and DW > 2 if the error terms are negatively serially correlated (r < 0). But how much above or below the magic number 2 is statistically significant enough to reject the null hypothesis of no serial correlation?

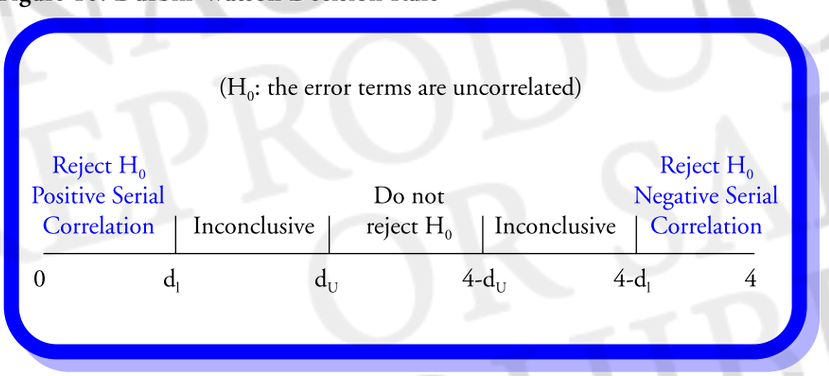
There are tables of DW statistics that provide upper and lower critical DW-values (d_u and d_l, respectively) for various sample sizes, levels of significance, and numbers of degrees of freedom against which the computed DW test statistic can be compared. The DW-test procedure for serial correlation is as follows:

H_0: The regression has *no* serial correlation.

The decision rules are rather complicated because they allow for rejecting the null in favor of either positive or negative correlation. The test can also be inconclusive, which means we don't accept or reject (See Figure 10).

- If DW < d_l, the error terms are *positively* serially correlated (i.e., reject the null hypothesis of no serial correlation).
- If d_l < DW < d_u, the test is inconclusive.
- If d_u < DW < 4 – d_u, there is no serial correlation (i.e., do not reject the null).
- If 4 –d_u < DW < 4 – d_l, the test is inconclusive.
- If 4 – d_l < DW < 4, the error terms are *negatively* serially correlated (i.e., reject the null hypothesis of no serial correlation).

Figure 10: Durbin-Watson Decision Rule



Example: The Durbin-Watson test for serial correlation

Suppose you have a regression output which includes three independent variables that provide you with a DW statistic of 1.23. Also suppose that the sample size is 40. At a 5 percent significance level, **determine** if the error terms are serially correlated.

Answer:

From a 5 percent DW table with n = 40 and k = 3, the upper and lower critical DW values are found to be d_l = 1.34 and d_u = 1.66, respectively. Since DW < d_l (i.e., 1.23 < 1.34), you should reject the null hypothesis and conclude that the regression has positive serial correlation among the error terms.

Correcting Serial Correlation

Possible remedies for serial correlation include:

- *Adjust the coefficient standard errors* (recommended method). The Hansen method is the preferred method for adjusting coefficient standard errors. The Hansen method, a standard component in many stats packages, also corrects for conditional heteroskedasticity. These adjusted standard errors are then used in hypothesis testing of the regression coefficients. Only use the Hanson method if serial correlation is a problem. The White-corrected standard errors are preferred if only heteroskedasticity is a problem.
- *Improve the specification of the model.* The best way to do this is to explicitly incorporate the time-series nature of the data (e.g., include a seasonal term). This can be tricky.

MULTICOLLINEARITY

LOS 1.C.g: Describe multicollinearity, and discuss its causes and effects in regression analysis.

Multicollinearity refers to the condition under which a high correlation exists among two or more of the independent variables in a multiple regression. This condition distorts the standard error of estimate, which distorts the coefficient standard errors, leading to problems when conducting *t*-tests for statistical significance of parameters. As a result of multicollinearity, there is a *greater probability that we will incorrectly conclude that a variable is not statistically significant* (e.g., a Type II error). Multicollinearity is likely to be present to some extent in most economic models. The issue is really one of degree.

The most common way to detect multicollinearity is the situation where *t*-tests indicate that none of the individual coefficients is significantly different than zero, while the *F*-test statistically significant and the R^2 is high. This suggests that the variables together explain much of the variation in the dependent variable, but the individual independent variables don't. The only way this can happen is if the independent variables are highly correlated with each other, so while their common source of variation is explaining the dependent variable, the high degree of correlation also "washes out" the individual effects.

High correlation among independent variables is sometimes suggested as a sign of multicollinearity. In fact, answers to some old CFA questions suggest the following general rule of thumb: If the absolute value of the sample correlation between any two independent variables in the regression is greater than 0.7, multicollinearity is a potential problem. However, this only works if there are exactly two independent variables. If there are more than two independent variables, while individual variables may not be highly correlated, linear combinations might be, leading to multicollinearity. High correlation among the independent variables suggests the possibility of multicollinearity, but low correlation among the independent variables *does not necessarily* indicate multicollinearity is *not* present.

Example: Detecting multicollinearity

Bob Watson, CFA, runs a regression of mutual fund returns on average P/B, average P/E, and average market capitalization, with the following results:

Variable	*Coefficient*	*p-value*
Average P/B	3.52	0.15
Average P/E	2.78	0.21
Market Cap	4.03	0.11
F-test	34.6	< 0.001
R^2	89.6%	

Determine whether or not multicollinearity is a problem in this regression.

Answer:

The R^2 is high and the *F*-test is statistically significant, which suggest that the three variables as a group do an excellent job of explaining the variation in mutual fund returns. However, none of the independent variables individually is statistically significant to any reasonable degree, since the *p*-values are larger than 10 percent. This is a classic indication of multicollinearity.

The most common method to correct for multicollinearity is to omit one or more of the correlated independent variables. Unfortunately, it is not always an easy task to identify the variable(s) that are the source of the multicollinearity. There are statistical procedures that may help in this effort, like stepwise regression, which systematically remove variables from the regression until multicollinearity is minimized.

Figure 11: Summary of What You Need to Know Regarding Violations of the Assumptions of Multiple Regression

Violation	*What is it?*	*Detection?*	*Correction?*
Conditional Heteroskedasticity	Residual variance related to level of independent variables	Breusch-Pagan chi-square test	Use White-corrected standard errors
Serial Correlation	Residuals are correlated	Durbin-Watson test	Use Hanson method to adjust standard errors
Multicollinearity	Two or more independent variables are correlated.	Conflicting *t* and *F* statistics; correlations among independent variables if k = 2	Drop one of the correlated variables

Qualitative Dependent Variables

LOS 1.C.h: Discuss models for qualitative dependent variables.

Financial analysis often calls for the use of a model that has a **qualitative dependent variable**, a dummy variable that takes on a value of either zero or one. An example of an application requiring the use of a qualitative dependent variable is a model that attempts to predict when a bond issuer will default. In this case, the dependent variable may take on a value of one in the event of default and zero in the event of no default. An

ordinary regression model is not appropriate for situations that require a qualitative dependent variable. However, there are several different types of models that use a qualitative dependent variable.

Probit and logit models. A probit model is based on the normal distribution, while a logit model is based on the logistic distribution. Application of these models results in estimates of the probability that the event occurs (e.g., probability of default). The maximum likelihood methodology is used to estimate coefficients for probit and logit models. These coefficients relate the independent variables to the likelihood of an event occurring, such as a merger, bankruptcy, or default.

Discriminant models. Discriminant models are similar to probit and logit models but make different assumptions regarding the independent variables. Discriminant analysis results in a linear function similar to an ordinary regression which generates an overall score, or ranking, for an observation. The scores can then be used to rank or classify observations. A popular application of a discriminant model makes use of financial ratios as the independent variables to predict the qualitative dependent variable bankruptcy. A linear relationship among the independent variables produces a value for the dependent variable that places a company in a bankrupt or not bankrupt class.

The analysis of regression models with qualitative dependent variables is the same as we have been discussing all through this topic review. Examine the individual coefficients using t-tests, determine the validity of the model with the *F*-test and the R^2, and look out for heteroskedasticity, serial correlation, and multi-collinearity.

Interpreting Regression Results

LOS 1.C.i: Interpret the economic meaning of the results of multiple regression analysis and critique a regression model and its results.

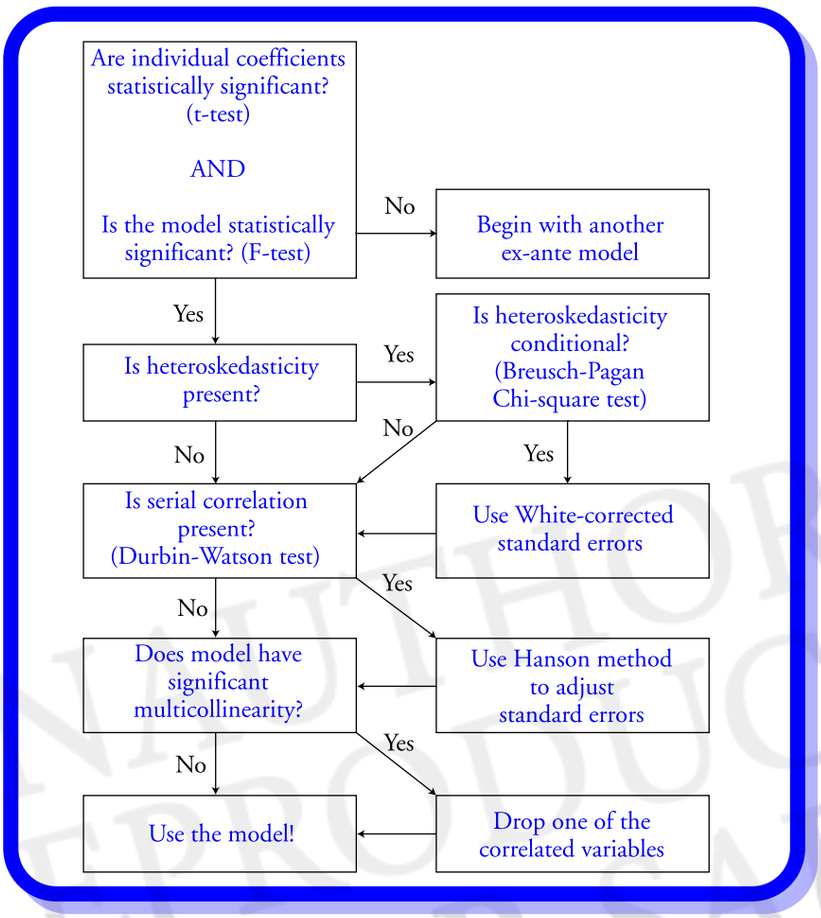
The economic meaning of the results of a regression estimation focuses primarily on the slope coefficients. The slope coefficients indicate the change in the dependent variable for a one-unit change in the independent variable. The individual slope coefficients can then be interpreted as an elasticity measure (i.e., the change in one variable corresponding to a change in another variable).

As is always the case with statistical inferences, it is possible to identify a relationship that has statistical significance without having any economic significance. For instance, a study of dividend announcements may identify a statistically significant abnormal return associated with the announcement, but these returns may not be sufficient to cover transactions costs.

Warm-Up: Assessing a Multiple Regression Model—Putting It All Together

The flow chart in Figure 12 will help you evaluate a multiple regression model and grasp the "big picture" in preparation for the exam.

Figure 12: Assessment of a Multiple Regression Model



KEY CONCEPTS

1. The multiple regression equation specifies a dependent variable as a linear function of two or more independent variables: $Y_i = b_0 + b_1X_{1i} + b_2X_{2i} + \ldots + b_kX_{ki} + \varepsilon_i$
2. If an independent variable contributes to the explanation of the dependent variable, the coefficient on that variable is significantly different from zero. The hypotheses are structured as H_0: $b_j = 0$ versus H_a: $b_j \neq 0$, and the t-statistic is $t = \frac{\hat{b}_j}{s_{\hat{b}_j}}$, with n – k – 1 degrees of freedom.
3. A *t*-test is used for hypothesis testing of regression parameter estimates: $t_{bj} = \frac{\hat{b}_j - b_j}{s_{\hat{b}_j}}$, with n–k–1 degrees of freedom.
4. The confidence interval for slope coefficient is $\hat{b}_j - \left(t_c \times s_{\hat{b}_j}\right) < b_j < \hat{b}_j + \left(t_c \times s_{\hat{b}_j}\right)$.
5. Assumptions of multiple regression mostly pertain to the error term, ε_i.
   - A linear relationship exists between the dependent and independent variables.
   - The independent variables are not random. Also, there is no exact linear relation between any two or more independent variables.