CFA Institute

PORTFOLIO MANAGEMENT PATHWAY

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CONTENTS

How to Use the CFA Program Curriculum

The CFA® Program exams measure your mastery of the core knowledge, skills, and abilities required to succeed as an investment professional. These core competencies are the basis for the Candidate Body of Knowledge (CBOK™). The CBOK consists of four components:

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- The CFA Program curriculum that candidates receive access to upon exam registration.

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The curriculum development process is rigorous and involves multiple rounds of reviews by content experts. Despite our efforts to produce a curriculum that is free of errors, we must make corrections in some instances. Curriculum errata are periodically updated and posted by exam level and test date on the Curriculum Errata webpage (www.cfainstitute.org/en/programs/submit-errata). If you believe you have found an error in the curriculum, you can submit your concerns through our curriculum errata reporting process found at the bottom of the Curriculum Errata webpage.

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Portfolio Management Pathway

LEARNING MODULE

1

Index-Based Equity Strategies

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LEARNING OUTCOMES

Mastery	*The candidate should be able to:*
☐	compare factor-based strategies to market-capitalization-weighted indexing
☐	compare different approaches to index-based equity strategies
☐	compare different approaches to index-based equity investing
☐	compare the full replication, stratified sampling, and optimization approaches for the construction of index-based equity portfolios
☐	discuss potential causes of tracking error and methods to control tracking error for index-based equity portfolios
☐	explain sources of return and risk to an index-based equity portfolio

INTRODUCTION

This learning module provides a broad overview of index-based equity investing, including index selection, portfolio management techniques, and the analysis of investment results.

Index-based strategies are rule-based, transparent strategies that do not involve identifying mispriced individual securities but instead seek to replicate the performance of an index. Indexes include broad market indexes, such as the S&P 500 Index, Nikkei 225, and FTSE 100, as well as those tailored more to a factor exposure, such as the Russell 1000 Growth and Russell 1000 Value Indexes. The main advantages of index-based investing are low costs, diversification, and tax efficiency.

In the next section, we will compare factor-based strategies to broad indexing strategies. Then, we will look at how to gain exposure to an index, whether through a pooled investment, a derivative-based approach, or a separately managed account. We will also cover portfolio construction techniques for index-based strategies and discuss how a portfolio manager can control tracking error against the benchmark,

including the sources of tracking error. In addition, we will introduce methods a portfolio manager can use to attribute the sources of return in the portfolio, including country returns, currency returns, sector returns, and security returns. We will also describe the sources of portfolio risk. A summary of key points concludes the module.

2 FACTOR-BASED STRATEGIES

☐ compare factor-based strategies to market-capitalization-weighted indexing

Investors in index-based strategies may seek market return, otherwise known as beta exposure, and do not seek outperformance, known as alpha. A focus on beta is based on a single-factor model: the capital asset pricing model (CAPM). Index-based strategies based on more than a single factor (and a single factor other than beta) are becoming more popular as investors gain an understanding of what drives investment returns. These strategies maintain the low-cost advantage of index funds but provide an expected return based on exposure to various factors, such as the five discussed in Fama and French (2015) that explain US equity market returns: the market risk premium from the CAPM, size, book-to-market ratio (value or growth style classification), operating profitability, and investment intensity (total asset growth).

Although the concepts underlying factor investing, sometimes marketed as "smart beta," have been known for a long time, investors' use of the technique increased dramatically over time. There are many indexes and index-based investment vehicles that allow access to such factors as Value, Size, Momentum, Volatility, and Quality, which are described in Exhibit 1. Many investors apply factor tilts—intentionally overweighting and underweighting certain risk factors—to their portfolios based on their judgment of market conditions. Index-based factor strategies can be used in place of or to complement a more traditional market-cap-weighted indexed portfolio.

Exhibit 1: Common Equity Risk Factors

Factor	Description
Growth	Growth stocks are generally associated with companies with an above-average net income growth rate and high P/Es.
Value	Value stocks are generally associated with mature companies that have stable net incomes or are experiencing a cyclical downturn. Value stocks frequently have low price-to-book and price-to-earnings ratios as well as high dividend yields.
Size	A tilt toward smaller size involves buying stocks with low float-adjusted market capitalization.
Yield	Yield is identified as dividend yield relative to other stocks. High dividend-yielding stocks may provide excess returns in low interest rate environments.
Momentum	Momentum attempts to capture further returns from stocks that have experienced an above-average increase in price during the prior period.

Factor	Description
Quality	Quality stocks might include those with consistent earnings and dividend growth, high cash flow to earnings, and low debt-to-equity ratios.
Volatility	Low volatility is generally desired by investors seeking to lower their downside risk. Volatility is often measured as the standard deviation of stock returns.

While index-based factor strategies may be labeled "passive," they frequently involve active decision making: Decisions on the timing and degree of factor exposure are being made. As Jacobs and Levy (2014) note, the difference between index-based factor investing and conventional active management is that with the former, active management takes place up front rather than continuously. Relative to broad-market-cap weighting, factor-based strategies tend to concentrate risk exposures, leaving investors exposed during periods when a chosen risk factor is out of favor. The observation that even strong risk factors experience periods of underperformance has led many investors toward multi-factor approaches. Index-based factor strategies tend to be transparent in terms of factor selection, weighting, and rebalancing. Possible risks include ease of replication by other investors, which can produce overcrowding and reduce the realized advantages of a strategy.

FUNDAMENTAL FACTOR INDEXING

Capitalization weighting of indexes and index-tracking portfolios involve treating each constituent stock as if investors were buying all the available shares. Arnott, Hsu, and Moore (2005) developed an alternative weighting method based on the notion that if stock market prices deviate from their intrinsic value, larger-cap stocks will exhibit this tendency more than smaller-cap stocks. Thus, traditional cap weighting is likely to overweight overpriced stocks and underweight underpriced stocks. The combination is intended to make cap-weighting inferior to a method that does not use market prices as a basis for weighting.

The idea advanced by Arnott, Hsu, and Moore is to use a cluster of company fundamentals—book value, cash flow, revenue, sales, dividends, and employee count—as a basis for weighting each company. A separate weighting is developed for each fundamental measure. In the case of a large company, its sales might be 1.3% of the total sales for all companies in the index, so its weight for this criterion would be 0.013. For each company, the weightings are averaged across all of the fundamental measures, and those average values represent the weight of each stock in a "composite fundamentals" index.

The authors show that over a 43-year period, a fundamental index would have outperformed a related cap-weighted index by an average of almost 200 basis points per year. They hasten to add that the result should not necessarily be considered alpha, because the fundamental portfolio provides heightened exposure to the Value and Size factors.

Since the time of the seminal article's publication, fundamental-weighted indexing strategies for country markets as well as market segments have gained in popularity and attracted a large amount of investor funds.

No matter the style of a factor-based strategy, its ultimate goal is to improve upon the risk or return performance of the market-cap-weighted strategy. Factor-based approaches gain exposure to many of the same risk factors that active managers seek to exploit. The strategies can be return oriented, risk oriented, or diversification oriented.

Return-oriented factor-based strategies include dividend yield strategies, momentum strategies, and fundamentally weighted strategies. Dividend yield strategies can include dividend growth as well as absolute dividend yield. The low interest rate environment, which followed the 2008–2009 global financial crisis, led to an increase in dividend yield strategies as investors sought reliable income streams. An example index is the S&P 1500 High Yield Dividend Aristocrats Index. This index selects securities within the S&P 1500 that increased dividends in each of the past 20 years and then weights those securities by their dividend yield, with the highest dividend-yielding stocks receiving the highest weight.

Another return-oriented strategy is momentum, which is generally defined by the amount of a stock's excess price return relative to the market over a specified time period. Momentum can be determined in various ways. One example is MSCI's Momentum Index family, in which a stock's most recent 12-month and 6-month price performance are determined and then used to weight the securities in the index.

Risk-oriented strategies take several forms, seeking to reduce downside volatility and overall portfolio risk. For example, risk-oriented factor strategies include volatility weighting, where all of an index's constituents are held and then weighted by the inverse of their relative price volatility. Price volatility is defined differently by each index provider, but two common methods include using standard deviation of price returns for the past 252 trading days (approximately one calendar year) or the weekly standard deviation of price returns for the past 156 weeks (approximately three calendar years).

Volatility weighting can take other forms as well. Minimum variance investing is another risk reducing strategy, and it requires access to a mean–variance optimizer. Minimum variance weights are those that minimize the volatility of the portfolio's returns based on historical price returns, subject to certain constraints on the index's construction. Constraints can include limitations on sector over/under weights, country selection limits, and limits on single stock concentration levels. Mean–variance optimizer programs can be accessed from such vendors as Axioma, BARRA, and Northfield.

Risk weighting has the advantages of being simple to understand and providing a way to reduce absolute volatility and downside returns. However, the development of these strategies is based on past return data, which may not reflect future returns. Thus, investors will not always achieve their objectives despite the strategy's stated goal.

Diversification-oriented strategies include equally weighted indexes and maximum-diversification strategies. Equal weighting is intuitive and has a low amount of single-stock risk. The low single-stock risk comes by way of the weighting structure of $1/n$, where n is equal to the number of securities held. Choueifaty and Coignard (2008) define maximum diversification by calculating a "diversification ratio" as the ratio of the weighted average volatilities divided by the portfolio volatility. Diversification strategies then can attempt to maximize future diversification by determining portfolio weights using past price return volatilities.

Portfolio managers who pursue factor-based strategies often use multiple benchmark indexes, including a factor-based index and a broad market-cap-weighted index. This can result in tracking error from the perspective of the end investor who has modeled a portfolio against a broad market-cap-weighted index. Tracking error indicates how closely the portfolio behaves like its benchmark and is measured as the standard deviation of the differences between a portfolio's returns and its benchmark returns. The concept of tracking error is discussed in detail later.

Finally, factor-based strategies can involve higher management fees and trading commissions than broad-market indexing. Factor-based index providers and managers demand a premium price for the creation and management of these strategies, and

those fees decrease performance. Also, commission costs can be higher in factor-based strategies than they are in market-cap-weighted strategies. All else equal, higher costs will lead to lower net performance.

Factor-based approaches may offer an advantage for those investors who believe it is prudent to seek out groups of stocks that are poised to have desirable return patterns. Active managers also believe in seeking those stocks, but active management brings the burden of higher fees that can eat into any outperformance. Active managers may also own stocks that are outside the benchmark and are, thus, incompatible with the investment strategy. In contrast, factor-based strategies can provide nearly pure exposure to specific market segments, and there are numerous benchmarks against which to measure performance. Fees are generally modest because factor-based strategies are rules-based and thus do not require constant monitoring. An investor's process of changing exposures to specific risk factors as market conditions change is known as factor rotation. With factor rotation, investors can use index-based vehicles to make active bets on future market conditions.

POOLED INVESTMENTS

3

☐ compare different approaches to index-based equity strategies

Index-based equity investment strategies may be implemented using several approaches, from the do-it-yourself method of buying stocks to hiring a subadviser to create and maintain the investment strategy. Index-based investment strategies can be replicated by any internal or external portfolio manager who has the index data, trading tools, and necessary skills. In contrast, every actively managed fund, in theory, has a unique investment strategy developed by the active portfolio manager.

This section discusses different approaches to gain access to an investment strategy's desired performance stream: pooled investments (e.g., mutual funds and exchange-traded funds), derivatives-based portfolios (using options, futures, and swaps contracts), and direct investment in the stocks underlying the strategy.

Some index-based investments are managed to establish a target beta, and managers are judged on how closely they meet that target. Portfolio managers commonly use futures and open-end mutual funds to transform a position (in cash, for example) and obtain the desired equity exposure. This process is known as "equitizing." The choice of which method to use is largely determined by the financing costs of rolling the futures contracts over time.[1] With multinational indexes, it can be expedient to buy a set of complementary exchange-traded funds to replicate market returns for the various countries.

Pooled Investments

Pooled investments are the most convenient approach for the average investor because they are easy to purchase, hold, and sell. This section covers conventional open-end mutual funds and exchange-traded funds (ETFs).

1 The indexes are rebalanced semi-annually. More information can be found at www.msci.com/eqb/methodology/meth_docs/MSCI_Momentum_Indices_Methodology.pdf.

The Qualidex Fund, started in 1970, was the first open-end index mutual fund available to retail investors. It was designed to track the Dow Jones Industrial Average. The Vanguard S&P 500 Index Fund, started in 1975, was the first retail fund to attract investors on a large scale. The primary advantage provided by a mutual fund purchase is its ease of investing and record keeping.

Investors who want to invest in an index-based mutual fund must take the same steps as those investing in actively managed ones. First, a needs analysis must be undertaken to decide on the investor's return and risk objectives as well as investment constraints, and then to find a corresponding strategy. For example, risk-averse equity investors may seek a low volatility strategy, while investors looking to match the broad market may prefer an all-cap market-cap-weighted strategy. Once the need has been identified, it is likely that a mutual fund can be found or built to match that need.

Traditional mutual fund shares can be purchased directly from the adviser who manages the fund, through a fund marketplace, or through an individual financial adviser. The process is the same for any mutual fund whether it is index based or actively managed. Investment companies generally have websites and call centers to help their prospective investors transact shares.

A fund marketplace is a brokerage company that offers funds from different providers. The advantage of buying a mutual fund from a fund marketplace is the ease of purchasing a mutual fund from different providers while maintaining a single account for streamlined record keeping.

A financial adviser can also help in purchasing a fund by offering the guidance needed to identify the strategy, providing the single account to house the fund shares, and gaining access to lower-cost share classes that may not be available to all investors.

No matter how mutual fund shares are purchased, the primary benefits of index-based mutual funds are low costs and the convenience of the fund structure. The investment manager handles all the needed rebalancing, reconstitution, and other changes that are required to keep the investment portfolio in line with the index. Index-based strategies require constant maintenance and care to reinvest cash from dividends and to execute the buys and sells required to match the additions and deletions of securities to the index. The portfolio manager of an index-based mutual fund also has most of the same responsibilities as a direct investor. These include trading securities, managing cash, deciding how to proceed with corporate actions, voting proxies, and reporting performance. Moreover, index-based mutual funds bear costs in such areas as registration, custodial, and audit, which are similar to those for actively managed mutual funds.

Record keeping functions for a mutual fund include maintaining a record of who owns the shares and when and at what price those shares were purchased. Record keepers work closely with both the custodian of the fund shares to ensure that the security is safely held in the name of the investor and the mutual fund sponsor who communicates those trades.

In the United States, mutual funds are governed by provisions of the Investment Company Act of 1940. In Europe, Undertakings for Collective Investment in Transferable Securities (UCITS) is an agreement among countries in the European Union that governs the management and sale of collective investment funds (mutual funds) across European borders.

ETFs are another form of pooled investment vehicle. The first ETF was launched in the Canadian market in 1990 to track the return of 35 large stocks listed on the Toronto Stock Exchange. ETFs were introduced in the US market in 1993. They are registered funds that can be bought and sold throughout the trading day and change hands like stocks. Advantages of the ETF structure include ease of trading, low management fees, and tax efficiency. Unlike with traditional open-end mutual funds, ETF shares can be bought by investors using margin borrowing; moreover, investors can take short positions in an ETF. ETFs offer flexibility in that they track a wide array of indexes.

ETFs have a unique structure that requires a fund manager as well as an authorized participant who can deliver the assets to the manager. The role of the authorized participant is to be the market maker for the ETF and the intermediary between investors and the ETF fund manager when shares are created or redeemed. To create shares of the ETF, the authorized participant delivers a basket of the underlying stocks to the fund manager and, in exchange, receives shares of the ETF that can be sold to the public. When an authorized participant needs to redeem shares, the process is reversed so that the authorized participant delivers shares of the ETF in exchange for a basket of the underlying stocks that can then be sold in the market.

The creation/redemption process is used when the authorized participant is either called upon to deliver new shares of the ETF to meet investor needs or when large redemptions are requested. The redemption process occurs when an authorized participant needs to reduce its exposure to the ETF holding and accepts shares of the underlying securities in exchange for shares of the ETF.

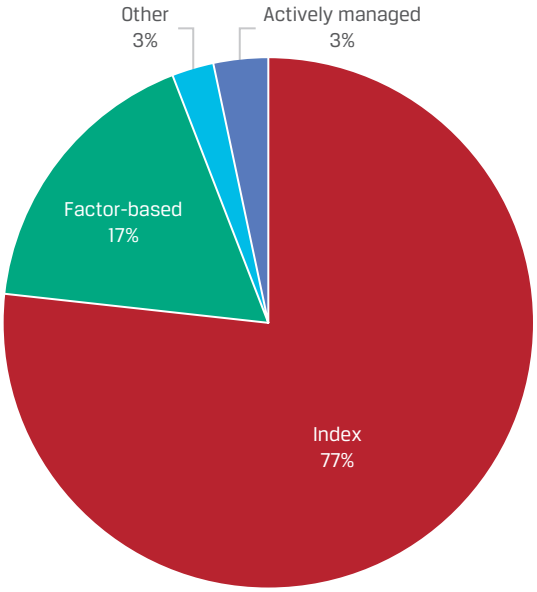
All else equal, for jurisdictions that require capital gains and losses to be passed through to investors like the US, an ETF has greater tax efficiency than a similarly managed mutual fund. Managers of mutual funds must sell their portfolio holdings to fulfill shareholder redemptions, creating a taxable event where gains and losses are realized. ETFs have the advantage of accommodating those redemptions through an in-kind delivery of stock, which is the redemption process. Capital gains are not recorded when a redemption is fulfilled through an in-kind delivery of securities, so the taxable gain/loss passed to the investor becomes smaller.

Disadvantages of the ETF structure include the need to buy at the offer and sell at the bid price, commission costs, and the risk of an illiquid market when the investor needs to buy or sell the actual ETF shares.

ETFs that track indexes are used to an increasing degree by financial advisers to provide targeted exposure to different sectors of the investable market. Large investors find it more cost effective to build their own portfolios through replication, stratified sampling, and optimization, concepts to be introduced later. Other investors find ETFs to be a relatively low-cost method of tracking major indexes. Importantly, like traditional open-end mutual funds, ETFs are an integrated approach in that portfolio management and accounting are conducted by the fund adviser itself. A limitation is that there are far more benchmark indexes than ETFs, so not all indexes have an exchange-traded security that tracks them, although new ETFs are constantly being created.

Exhibit 2 shows that factor-based ETFs have become a large segment of the market, accounting for 17% of the approximately $7 trillion in global equity ETF assets under management as of the fourth quarter 2022. Factor-based ETFs provide exposure to such single factors as Size, Value, Momentum, Quality, Volatility, and Yield. There are also multifactor ETFs, such as the iShares U.S. Equity Factor ETF, which emphasizes exposure to the Size, Value, Momentum, Quality, and Volatility factors. Meanwhile, the ETF attempts to maintain characteristics that are similar to the underlying STOXX U.S. Equity Factor Index, including sector exposures. As of 2023, the fund's expense ratio was 0.08%.

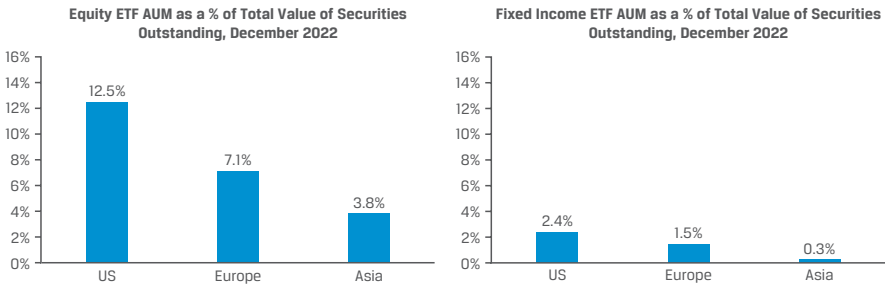
Exhibit 2: Globally Listed Equity ETFs by Investment Approach, Based on Assets under Management



Sources: ETFGI (December 2022); authors' analysis. https://etfgi.com/news/press-releases/2022/12/etfgi-reports-smart-beta-etfs-listed-globally-gathered-us755-billion.

Exhibit 3 shows that while they are large, assets under management in ETFs still represent only a small part of financial markets. ETFs represented just 9% of equity assets across the United States, Europe, and Asia Pacific at the end of 2022. Market share for fixed-income ETFs is much lower. These numbers reflect index ETFs as well as factor-based and other approaches.

Exhibit 3: ETF Market Share by Geography, December 2022



Sources: Blackrock; authors' analysis.

The decision of whether to use a conventional open-end mutual fund versus an ETF often comes down to cost and flexibility. Investors who seek to mimic an index must identify a suitable tracking security. Long-term investors benefit from the slightly lower expense ratios of ETFs than otherwise equivalent conventional open-end mutual funds. However, the brokerage fees associated with frequent investor trades into ETF shares can negate the expense ratio advantage and thus make ETFs less economical.

DERIVATIVES-BASED APPROACHES AND INDEX-BASED PORTFOLIOS

4

☐ compare different approaches to index-based equity investing

Beyond purchasing a third-party-sponsored pooled investment and building it themselves, investors can access index performance through derivatives, such as options, swaps, or futures contracts. Derivative strategies are advantageous in that they can be low cost, easy to implement, and provide leverage. However, they also present a new set of risks, including counterparty default risk for derivatives that are not traded on exchanges or cleared through a clearing house. Derivatives can also be relatively difficult to access for individual investors.

Options, swaps, and futures contracts can be found on many of the major indexes, such as the MSCI EAFE Index and the S&P 500 Index. Options and futures are traded on exchanges and so are processed through a clearing house. This is important because a clearing house eliminates virtually all of the default risk present in having a contract with a single counterparty. Equity swaps, on the other hand, are generally executed with a single counterparty and so add the risk of default by that counterparty.

Derivatives allow for leverage through their notional value amounts. Notional value of the contracts can be many times greater than the initial cash outlay. However, derivatives expire, whereas stocks can be held indefinitely. The risk of an expiring options contract is a complete loss of the relatively small premium paid to acquire the exposure. Futures and swaps can be extended by "rolling" the contract forward, which means selling the expiring contract and buying a longer dated one.

Futures positions must be initiated with a futures commission merchant (FCM), a clearing house member assigned to trade on behalf of the investor. The FCM posts the initial margin required to open the position and then settles on a daily basis to comply with the maintenance margin required by the clearing house. The FCM also helps close the position upon expiration. However, futures accounts are not free of effort on the client's part. Having a futures account requires the management of daily cash flows, sometimes committing additional money and sometimes drawing it down.

It is uncommon for index-based portfolio managers to use derivatives in the long term to synthetically mimic the return from the underlying securities. Derivatives are typically used to adjust a pre-existing portfolio to move closer to meeting its objectives. These derivative positions are often referred to as an **overlay**. A **completion overlay** addresses an indexed portfolio that has diverged from its proper exposure. A common example is a portfolio that has built up a surplus of cash from investor flows or dividends, causing the portfolio's beta to be significantly less than that of the benchmark. Using derivatives can efficiently restore the overall portfolio beta to its target. A **rebalancing overlay** addresses a portfolio's need to sell certain constituent securities and buy others. Particularly in the context of a mixed stock and bond portfolio, using equity index derivatives to rebalance toward investment policy target weights can be efficient and cost-effective. A **currency overlay** assists a portfolio manager in hedging the returns of securities that are held in a foreign currency back to the home country's currency.

Equity index derivatives offer several advantages over cash-based portfolio construction approaches. A portfolio manager can increase or decrease exposure to the entire index portfolio in a single transaction. Managers who want to make tactical adjustments to portfolio exposure often find derivatives to be a more efficient tool

than cash-market transactions for achieving their goals. Many derivatives contracts are highly liquid, sometimes more so than the underlying cash assets. Especially in this case, portfolio exposures can be tactically adjusted quickly and at low cost.

For the longer term, strategic changes to portfolios are usually best made using cash instruments, which have indefinite expirations and do not necessitate rolling over expiring positions. Futures markets, for example, can impose position limits on such instruments that constrain the scale of use. Derivatives usage is also sometimes restricted by regulatory bodies or investment policy statement stipulations, so in this case cash could be a preferred approach. Finally, depending on the index that is being tracked, a suitable exchange-traded futures contract may not be available.

In addition to options, which have nonlinear payoffs, the two primary types of equity index derivatives contracts are futures and swaps. Equity index futures provide exposure to a specific index. Unlike many commodity futures contracts, index futures are cash-settled, which means the counterparties exchange cash rather than the underlying shares.

The buyer of an equity index futures contract obtains the right to buy the underlying (in this case, an index) on the expiration date of the contract at the futures price prevailing at the time the derivative was purchased. For exchange-traded futures, the buyer is required to post margin (collateral) in the account to decrease the **credit risk** to the exchange, which is the effective counterparty. For S&P 500 Index futures contracts as traded on the Chicago Mercantile Exchange, every USD change in the futures price produces a USD250 change in the contract value (thus a "multiplier" of 250). For example, if the September S&P 500 futures contract settled at a price of 2,159.30 after settling at 2,157 the day before, then the change in contract value would be 250 × (USD2,159.30 − USD2,157) = USD575.

Equity index futures contracts for various global markets are shown in Exhibit 4.

Exhibit 4: Representative Equity Index Futures Contracts

Index Futures Contract	Market	Contract Currency and Multiplier
Americas		
Dow Jones mini	United States	USD 5
S&P 500	United States	USD 250
S&P 500 mini	United States	USD 50
NASDAQ 100 mini	United States	USD 20
Mexican IPC	Mexico	MXN 10
S&P/TSX Composite mini	Canada	CAD 5
S&P/TSX 60	Canada	CAD 200
Ibovespa	Brazil	BRL 1
Europe, Middle East, and Africa		
Euro STOXX 50	Europe	EUR 10
FTSE 100	United Kingdom	GBP 10
DAX 30	Germany	EUR 25
CAC 40	France	EUR 10
Swiss Market	Switzerland	CHF 10
IBEX 35	Spain	EUR 10

Europe, Middle East, and Africa		
WIG20	Poland	PLN 20
FTSE/JSE 40	South Africa	ZAR 10
Asia Pacific		
S&P/ASX 200	Australia	AUD 25
CSI 300	Chinese mainland	CNY 300
Hang Seng	Hong Kong SAR	HKD 50
H-Shares	Hong Kong SAR	HKD 50
Nifty 50	India	INR 50
Nikkei 225	Japan	JPY 1,000
Topix	Japan	JPY 10,000
KOSPI 200	Korea	KRW 500,000

Source: Please see www.investing.com/indices/indices-futures, October 2021.

Given that futures can be traded using only a small amount of margin, it is clear that futures provide a significant degree of potential leverage to a portfolio. Leverage can be considered either a positive or negative characteristic, depending on the manner with which the derivative instrument is used. Unlike some institutional investors' short-sale constraints on stock positions, many investors do not face constraints on opening a futures position with a sale of the contracts. Among other benefits of futures is the high degree of liquidity in the market, as evidenced by low bid–ask spreads. Both commission and execution costs also tend to be low relative to the exposure achieved. The low cost of transacting makes it easy for portfolio managers to use futures contracts to modify the equity risk exposure of their portfolios.

Equity index futures do come with some disadvantages. Futures are used by index fund managers because the instruments are expected to move in line with the underlying index. To the extent that the futures and spot prices do not move in concert, the portfolio may not track the benchmark perfectly. The extent to which futures prices do not move with spot prices is known as basis risk. Basis risk results from using a hedging instrument that is imperfectly matched to the investment being hedged. Basis risk can arise when the underlying securities pay dividends, while the futures contract tracks only the price of the underlying index. The difference can be partially mitigated when futures holders combine that position with interest-bearing securities.

As noted, futures account holders also must post margin. The margin amount varies by trading exchange. In the case of an ASX-200 futures contract, the initial margin required by the Sydney Futures Exchange for an overnight position is AUD 6,700. The minimum maintenance margin for one contract is AUD 5,300.

By way of example, assume an investor buys an ASX-200 futures contract priced at AUD 5,700, and the futures contract has a multiplier of 25. The investor controls AUD 142,500 [= 25 × AUD 5,700] in value. This currency amount is known as the contract unit value. With the initial margin of AUD 6,700 and a maintenance margin of AUD 5,300, a margin call will be triggered if the contract unit value decreases by more than AUD 1,400. A decrease of AUD 1,400 in the margin is associated with a contract unit value of AUD 142,500 – AUD 1,400 = AUD 141,100. This corresponds to an ASX-200 futures price of AUD 5,644 [= AUD 141,100/25]. Thus, a futures price decrease of 0.98% [= (AUD 5,644 – AUD 5,700)/AUD 5,700] is associated with a decrease in the margin account balance of 20%. This example demonstrates how even a small change in the index value can result in a margin call once the mark-to-market process occurs.

Another derivatives-based approach is the use of equity index swaps. Equity index swaps are negotiated arrangements in which two counterparties agree to exchange cash flows in the future. For example, consider an investor who has a EUR20 million

notional amount and wants to be paid the return on her benchmark index, the Euro STOXX 50, during the coming year. In exchange, the investor agrees to pay a floating rate of return of Market Reference Rate (MRR) + 0.20% per year, with settlement occurring semi-annually. Assuming a six-month stock index return of 2.3% and annualized MRR of 0.18% per year, the first payment on the swap agreement would be calculated as follows. The investor would receive EUR20 million × 0.023 = EUR460,000. The investor would be liable to the counterparty for EUR20 million × (0.0018 + 0.0020) × (180/360) = EUR38,000; so, when the first settlement occurs the investor would receive EUR460,000 – EUR38,000 = EUR422,000. In this case, the payment received by the portfolio manager is from the first leg of the swap, and the payment made by that manager is from the second leg. MRR is used generically in this example, but the second leg can also involve the return on a different index, stock, or other asset, or even a fixed currency amount per period.

Disadvantages of swaps include counterparty, liquidity, interest rate, and tax policy risks. Relatively frequent settlement decreases counterparty risk and reduces the potential loss from a counterparty's failure to perform. Equity swaps tend to be non-marketable instruments, so once the agreement is made there is not a highly liquid market that allows them to be sold to another party (though it is usually possible to go back to the dealer and enter into an offsetting position). Although the equity index payment recipient is an equity investor, this investor must deliver an amount linked to MRR; the investor bears interest rate risk. One prime motivation for initiating equity swaps is to avoid paying high taxes on the full return amount from an equity investment. This advantage is dependent on tax laws remaining favorable, which means that equity swaps carry tax policy risk.

There are a number of advantages to using an equity swap to gain synthetic exposure to index returns. Exchange-traded futures contracts are available only on a limited number of equity indexes. Yet as long as there is a willing counterparty, a swap can be initiated on virtually any index. So swaps can be customized with respect to the underlying as well as to settlement frequency and maturity. Although most swap agreements are one year or shorter in maturity, they can be negotiated for as long a tenor as the counterparties are willing. If a swap is used, it is not necessary for an investor to pay transaction costs associated with buying all of the index constituents. Like futures, a swap can help a portfolio manager add leverage or hedge a portfolio, which is usually done on a tactical or short-term basis.

Separately Managed Equity Index-Based Portfolios

Building an index-based equity portfolio as a separately managed portfolio requires a certain set of capabilities and tools. An equity investor who builds an indexed portfolio will need to subscribe to certain data on the index and its constituents. The investor also requires a robust trading and accounting system to manage the portfolio, broker relationships to trade efficiently and cheaply, and compliance systems to meet applicable laws and regulations.

The data subscription can generally be acquired directly from the index provider and may be offered on a daily or less-frequent basis. Generally, the data are provided for analysis only and a separate license must be purchased for index replication strategies. The index subscription data should include company and security identifiers, weights, cash dividend, return, and corporate action information. Corporate actions can include stock dividends and splits, mergers and acquisitions, liquidations, and other reasons for index constituent inclusion and exclusion. These data are generally provided in electronic format and can be delivered via file downloads or fed through a portfolio manager's analytical systems, such as Bloomberg or FactSet. The data are then used as the basis for the indexed portfolio.

Certain trading systems, such as those provided by Charles River Investment Management Solution, SS&C Advent (through Moxy), and Eze Castle Integration, allow the manager to see her portfolio and compare it to the chosen benchmark. Common features of trading systems include electronic communication with multiple brokers and exchanges, an ability to record required information on holdings for taxable investors, and modeling tools so that a portfolio can be traded to match its benchmark.

Accounting systems should be able to report daily performance, record historical transactions, and produce statements. Portfolio managers rely heavily on their accounting systems and teams to help them understand the drivers of portfolio performance.

Broker relationships are an often-overlooked advantage of portfolio managers that can negotiate better commission rates. Commissions are a negative drag on a portfolio's returns. The commission rates quoted to a manager can differ on the basis of the type of securities being traded, the size of the trade, and the magnitude of the relationship between the manager and broker.

Finally, compliance tools and teams are necessary. Investors must adhere to a myriad of rules and regulations, which can come from client agreements and regulatory bodies. Sanctions for violating compliance-related rules can range from losing a client to losing the registration to participate in the investment industry; thus, a robust compliance system is essential to the success of an investment manager.

Compliance rules can be company-wide or specific to an investor's account. Company-wide rules take such forms as restricting trades in stocks of affiliated companies. Rules specific to an account involve such matters as dealing with a directed broker or steps to prevent cash overdrafts. Compliance rules should also be written to prohibit manager misconduct, such as front-running in a personal account prior to executing client trades.

To ensure that their portfolios closely match the return stream of the chosen index, indexed portfolio managers must review their holdings and their weightings versus the index each day. Although a perfect match is a near impossibility because of rounding errors and trading costs, the manager must always weigh the benefits and costs of maintaining a close match.

To establish the portfolio, the manager creates a trading file and transmits the file to an executing broker, who buys the securities using a program trade. **Program trading** is a strategy of buying or selling many stocks simultaneously. Index portfolio managers may trade thousands of positions in a single trade file and are required to deliver the orders and execute the trades quickly. The creation of trades may be done on something as rudimentary as an Excel spreadsheet, but it is more likely to be created on an order management system (OMS), such as Charles River.

Portfolio managers use their OMS to model their portfolios against the index, decide which trades to execute, and transmit the orders. Transmitting an order in the United States is generally done on a secure communication line, such as through FIX Protocol. FIX Protocol is an electronic communication protocol to transmit the orders from the portfolio manager to the broker or directly to the executing market place. The orders are first transmitted via FIX Protocol to a broker who executes the trade and then delivers back pricing and settlement instructions to the OMS. International trading is usually communicated using a similar protocol through SWIFT. SWIFT stands for "Society for Worldwide Interbank Financial Telecommunication," and is a service that is used to securely transmit trade instructions.

Index-based strategies seek to replicate an index that is priced at the close of business each day. Therefore, most index-based trade executions take place at the close of the business day using market-on-close (MOC) orders. Matching the trade execution to the benchmark price helps the manager more closely match the performance of the index.

Beyond the portfolio's initial construction, managers maintain the portfolio by trading any index changes, such as adds/deletes, rebalances, and reinvesting cash dividend payments. These responsibilities require the manager to commit time each day to oversee the portfolio and create the necessary trades. Best practice would be to review the portfolio's performance each day and its composition at least once a month.

Dividends paid over time can accumulate to significant amounts that must be reinvested into the securities in the index. Index fund managers must determine when the cash paid out by dividends should be reinvested and then create trades to purchase the required securities.

5 PORTFOLIO CONSTRUCTION

☐ compare the full replication, stratified sampling, and optimization approaches for the construction of index-based equity portfolios

This section discusses the principal approaches that equity portfolio managers use when building an indexed portfolio by transacting in individual securities. The three approaches are full replication, stratified sampling, and optimization. According to Morningstar as of October 2021, among index-tracking equity ETF portfolios globally (the numbers do not sum to 100% because optimization techniques and over-the-counter derivatives can be used with either replication or sampling approaches):

- 74% of funds use full replication,
- 20% of funds use stratified sampling or optimization techniques, and
- 24% of funds use synthetic replication and/or over-the-counter derivatives.

Full Replication

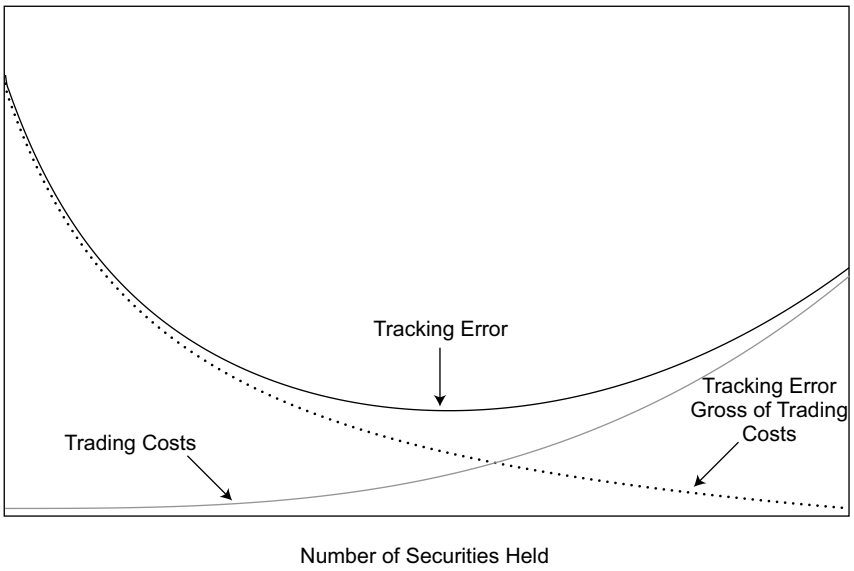
Full replication in index investing occurs when a manager holds all securities represented by the index in weightings that closely match the actual index weightings. Advantages of full replication include the fact that it usually accomplishes the primary goal of matching the index performance and is easy to understand. Full replication, however, requires that the asset size of the mandate is sufficient, that there is sufficient liquidity, and that the index constituents are available for trading.

Not all indexes lend themselves to full replication. For example, the MSCI ACWI Investable Markets Index consists of over 8,000 constituents, but not all securities need be held to closely match the characteristics and performance of that index. Other indexes, such as the S&P 500, have constituents that are readily available for trading and can be applied to portfolios as small as USD10 million.

With respect to the choice between index replication versus sampling, as the number of securities held increases, tracking error decreases because the portfolio gets closer to replicating the index perfectly. Yet as the portfolio manager adds index constituent stocks that are smaller and more thinly traded than average, trading costs increase. The trading costs can take the form of brokerage fees and upward price pressure as a result of the portfolio's purchases. These transaction costs can depress performance and start to impose a small negative effect on tracking effectiveness. As the portfolio manager moves to the least liquid stocks in the index, transaction costs begin to dominate and tracking error increases again. Thus, for an index that

has some constituent securities that are relatively illiquid, the conceptual relationship between tracking error and the number of securities held is U-shaped. The relation can be depicted as shown in Exhibit 5.

Exhibit 5: Relation Between Tracking Error and Transaction Costs versus Number of Benchmark Index Constituent Stocks Held



Source: Author team.

Many managers attempt to match an index's characteristics and performance through a full replication technique, but how does a manager create the portfolio? As mentioned in a prior section, the manager first obtains data from the index provider, including the constituent stocks, their relevant identifiers (ticker, CUSIP, SEDOL, or ISIN), shares outstanding, and price. Additional data, such as constituents' dividends paid and total return, facilitate management of the portfolio.

The manager then uses the index data to create the portfolio by replicating as closely as possible the index constituents and weights. The portfolio construction method may vary by investor, but the most common method is to import the provided data into a data compiler such as Charles River, Moxy, or some other external or internally created OMS. The imported data show the manager the trades that are needed to match the index. Exhibit 6 contains an example for a portfolio that has an initial investment of USD10 million.

Exhibit 6: Sample Index Portfolio Positions and Transactions

Identifier	Security Description	Price	Current Weight	Model Weight	Current Weight – Model Weight = Variance	Current Shares	New Shares	Shares to Trade
Cash	Cash	1	50%	0%	50%	5,000,000	0	–5,000,000
SECA	Security 1	100	50%	50%	0%	50,000	50,000	0
SECB	Security 2	50	0%	50%	–50%	0	100,000	100,000

Exhibit 6 shows a current portfolio made up of one security and a cash holding that needs to be traded to match a two-security index. The index becomes the model for the portfolio, and that model is used to match the portfolio. This type of modeling can easily and cheaply be conducted using spreadsheet and database programs, such as Excel and Access. However, the modeling is only a part of the portfolio management process.

The OMS should also be programmed to provide the investor with pre-trade compliance to check for client-specific restrictions, front-running issues, and other compliance rules. The OMS is also used to deliver the buy and sell orders for execution using FIX or SWIFT Protocol, as described previously.

After initial creation of the indexed portfolio, the manager must maintain the portfolio according to any changes in the index. The changes are announced publicly by the index provider. Index fund managers use those details to update their models in the OMS and to determine the number of shares to buy or sell. A fully replicated portfolio must make those changes in a timely manner to maintain its performance tracking with the index. Again, a perfectly replicated index portfolio must trade at the market-on-close price where available to match the price used by the index provider in calculating the index performance.

Stratified Sampling

Despite their preference to realize the benefits of pure replication of an index, portfolio managers often find it impractical to hold all the constituent securities. Some equity indexes have a large number of constituents, and not all constituents offer high trading liquidity. This can make trading expensive, especially if a portfolio manager needs to scale up the portfolio. Brokerage fees can also become excessive if the number of constituents is large.

Holding a limited sample of the index constituents can produce results that track the index return and risk characteristics closely. But such sampling is not done randomly. Rather, portfolio managers use stratified sampling. To stratify is to arrange a population into distinct strata or subgroupings. Arranged correctly, the various strata will be mutually exclusive and also exhaustive (a complete set), and they should closely match the characteristics and performance of the index. Common stratification approaches include using industry membership and equity style characteristics. Investors who use stratified sampling to track the S&P 500 commonly assign each stock to one of the eleven sectors designated by the Global Industry Classification Standard (GICS). For multinational indexes, stratification is often done first on the basis of country affiliation. Indexes can be stratified along multiple dimensions (e.g., country affiliation and then industry affiliation) within each country. An advantage of stratifying along multiple dimensions is closer index tracking.

In equity indexing, stratified sampling is most frequently used when the portfolio manager wants to track indexes that have many constituents or when dealing with a relatively low level of assets under management. Indexes with many constituents are usually multi-country or multi-cap indexes, such as the S&P Global Broad Market Index that consists of more than 11,000 constituents. Most investors are reluctant to trade and maintain 11,000 securities when a significantly smaller number of constituents would achieve most portfolios' tracking objectives. Regardless of the stratified sampling approach used, index-based equity managers tend to weight portfolio holdings proportionately to each stratum's weight in the index.

KNOWLEDGE CHECK

Stratified Sampling

1. A portfolio manager responsible for accounts of high-net-worth individuals is asked to build an index portfolio that tracks the S&P 500 Value Index, which has more than 300 constituents. The manager and the client agree that the minimum account size will be USD750,000, but the manager explains to the client that full replication is not feasible at a reasonable cost because of the mandate size. How can the manager use stratified sampling to achieve her goal of tracking the S&P 500 Value Index?

   Solution:

   The manager recommends that the client set a maximum number of constituents (for example, 200) to limit the average lot size and to reduce commission costs. Next, the manager seeks to identify the constituents to hold based on their market capitalization. That is, the manager selects the 200 securities with the largest market capitalizations. Then the manager seeks to more closely match the performance of the index by matching the sector weightings of the sampled portfolio to the sector weightings of the index. After comparing sector weights, the manager reweights the sampled portfolio. Using this method of stratified sampling meets the manager's stated goal of closely tracking the performance of the index at a reasonable cost.

Optimization

Optimization approaches for index portfolio construction, such as full replication and stratified sampling, have index-tracking goals. Optimization typically involves maximizing a desirable characteristic or minimizing an undesirable characteristic, subject to one or more constraints. For an indexed portfolio, optimization could involve minimizing index tracking error, subject to the constraint that the portfolio holds 50 constituent securities or fewer. The desired output from the optimization process is identification of the 50 securities and their weights that results in the lowest possible tracking error. The number of security holdings is not the only possible constraint. Other common constraints include limiting portfolio membership to stocks that have a market capitalization above a certain specified level, style characteristics that mimic those of the benchmark, restricting trades to round lots, and using only stocks that will keep rebalancing costs low.

Roll (1992) and Jorion (2003) demonstrate that running an optimization to minimize tracking error can lead to portfolios that are mean–variance inefficient versus the benchmark. That is, the optimized portfolio may exhibit higher risk than the benchmark it is being optimized against. They show that a useful way to address this

problem is to add a constraint on total portfolio volatility. Accordingly, the manager of an optimized index-based fund would aim to make its total volatility equal to that of the benchmark.

Fabozzi, Focardi, and Kolm (2010) note that in practice, index-based portfolio managers often conduct a mean–variance optimization using all the index constituents, the output from which shows highly diverse weightings for the stocks. Given that investing in the lowest-weight stocks may involve marginal transaction costs that exceed marginal diversification benefits, in a second, post-optimization stage, the managers may then delete the lowest-weighted stocks.

Optimization can be conducted in conjunction with stratified sampling or alone. Optimization programs, when run without constraints, do not consider country or industry affiliation but rather use security level data. Optimization requires an analyst who has a high level of technical sophistication, including familiarity with computerized optimization software or algorithms, and a good understanding of the output.

Advantages of optimization involve a lower amount of tracking error than stratified sampling. Also, the optimization process accounts explicitly for the covariances among the portfolio constituents. Although two securities from different industry sectors may be included in a portfolio under stratified sampling, if their returns move strongly together, one will likely be excluded from an optimized portfolio.

Usually the constituents and weights of an optimized portfolio are determined based on past market data; however, returns, variances, and correlations between securities tend to vary over time. Thus, the output from an optimization program may apply only to the period from which the data are drawn and not to a future period. Even if current results apply to the future, they might not be applicable for long. This means that optimization would need to be run frequently and adjustments made to the portfolio, which can be costly.

Blended Approach

For indexes that have few constituent securities, full replication is typically advisable. When the reverse is true, sampling or optimization are likely to be the preferred methods. But such indexes as the Russell 3000, the S&P 1500, and the Wilshire 5000 span the capitalization spectrum from large to small. For these indexes, the 1,000 or so largest constituents are quite liquid, which means that brokerage fees, bid–ask spreads, and trading costs are low. For the largest-cap portion of an indexed portfolio, full replication is a sensible and desirable approach. For the index constituents that have smaller market capitalizations or less liquidity, however, a stratified sampling or optimization approach can be useful for all the reasons mentioned previously in this section. Thus, an indexed portfolio can actually be managed using a blended approach consisting of full replication for more-liquid issues and one of the other methods for less-liquid issues.

6 TRACKING ERROR MANAGEMENT

☐ discuss potential causes of tracking error and methods to control tracking error for index-based equity portfolios