SECTION 1

Overview of Stock and Bond Returns

FOREWORD

Why aren't we all rich?

The stunning capital market returns documented in *Exponential Wealth: Centuries of Stock and Bond Returns* seem to provide a pathway for anyone with even a little extra income to accumulate a large sum over a lifetime, providing for, at the very least, a comfortable retirement—and perhaps a head start for the kids, a big donation to a favorite charity, some unexpected luxuries.

Usually, it doesn't happen. Why?

Most of the literature on this question blames costs, portrayed as a wedge between investment returns and investor returns. The most burdensome costs are taxes and management fees. There's also inflation, which bites us all hard.

And some people don't have enough money available for investing to make them rich no matter how generous the capital markets are, or they have the money available but spend it all instead of investing. Those problems are beyond the ken of this book.

But taxes and other costs can be managed. Although we can't do much about inflation, equity markets have provided a total return (capital gain plus dividends) far in excess of inflation. Because of the bounty of capital markets, exponential wealth is available to more people than ever before in human history.

How to Miss the Greatest Money-Making Opportunity in the World

Most people try to make money by working. That is right and just, and it is where everyone should start. But it is hard to really get ahead that way. Even as one's skills expand and paychecks grow larger, so do needs and wants, with the result that there isn't much surplus.

Yet, right alongside the path to riches (or at least security and then comfort) represented by working harder and, especially, working smarter is another path that *does not involve working*. It's *easy*. That parallel path consists of putting some of one's money to work in the capital markets, where the users of the capital provided invent things, build factories, design software, mine for raw materials, sell merchandise, and do a myriad of other things that are intended to produce a profit. When they do, a proportionate share of the profit is returned to you in the form of capital market returns. This path can best be understood as a way to get *other people* to do some of the work required to make you rich, instead of your doing it all yourself.

The basic requirement for participating in the marvelous rates of return presented in this book is to invest as much as you can as soon as you can and then stay invested. But this is more difficult than it sounds—and not just because most young people are broke, which I'll get to.

The nonobvious reason that it's difficult is *procyclicality*. This is a fancy way of saying that people have little money to invest at the best times and are flush with cash at the worst times.

The best times in history to invest have been when stock prices are low because the economy is bad and people are short of money. And people being short of money is the reason the market is cheap at such times—it's all very circular—so it's hard to put much money to work at bargain-basement prices. At the other extreme, the worst time to invest is when people are feeling flush because there has been an extended economic boom, but that is also when stock prices are high and expected returns are limited.

Looking at the human life cycle instead of the economic one, the best time to invest is when you're young. The data in *Exponential Wealth* suggest a much higher probability of getting rich if you can leave your money in the market for 50 years than for 10 or 20 years. But most people are poor when they're young. Actually, it's worse than that. Paul Samuelson said that everyone is born short a roof over their heads. That's a big hole to dig out of. You have to not only cover that short position but build a long one—at a time when your income is likely the lowest it will ever be. That's just one of many reasons why we're not all rich.

Can We Fix the Problem?

Is it possible to fix these problems? Yes and no. Anyone with available funds can climb on the exponential wealth ladder: Just buy the broad market, and hold it forever.

I wish it were that simple. First of all, few investors have (or should have) the stomach for the 100% equity allocation that in the absence of taxes, management fees, and other costs would have produced the 14,751-to-1 nominal wealth gain (which inflation reduced to a still impressive 814-to-1 real wealth gain) over the last 100 years.

Second, few people have a 100-year investment horizon. You may think you're investing for your great-grandchildren, but between now and the time they show up to collect the money, life happens and money gets spent. Also, with fertility rates at the lowest level in history, your great-grandchildren may never be born.

Third, taxes bite and bite hard if no action is taken to minimize them. Tax-preferred investment vehicles such as IRAs and 401(k)s help, but it is impossible for individual investors to avoid all taxation. Investors should minimize taxes as much as possible because of their profound effect on long-term returns.

Finally, inflation grinds away at the real value of all investments. The $14,751 nominal wealth gain today (per $1 invested at year-end 1925) becomes $814 after inflation. It's a big comedown, but it's nevertheless fair to call this result exponential wealth. There's no other way to make more than 800 times your money in a century at manageable levels of risk.

A Fallacy of Aggregation

But the outcome for an individual who buys the market (whether through an index fund or diversified active management) and holds it forever doesn't scale to the whole population! *We can't all earn these rates of return* by imitating the person described in my example.

Why not? The reason is subtle and counterintuitive and results from a fallacy of aggregation—that is, what is possible for one investor is not possible for all. Although not everyone holds or should hold index funds, this point is made clearest by using such funds as an illustration.

As this book shows, most of the return from long-term investment in stocks results from reinvestment of dividends into the rising market. And as I wrote in the foreword to a CFA Institute Research Foundation brief by Paul McCaffrey,

> For the investor to realize the index total return, dividends would need to be reinvested in the fund, and if everyone is an indexer, there are no spare shares of the fund to buy. Investors would have to buy the shares from another indexer who already owned them. Any attempt to pursue this ultimately fruitless plan would drive the fund share prices up and expected returns down—*way* down.[1]

In other words, an indexer's attempt to earn the market's total return by buying index fund shares from another indexer with the money received as dividends prevents that other indexer from earning the market's total return! Sad but, when you think carefully about it, obviously true. And the principle applies to active management in almost exactly the same way that it does to indexing.

Thus, my half-serious exhortation to just buy the market and hold it forever can't work for everybody because of the fallacy of aggregation. But don't worry! It is almost impossible to imagine this simple rule being followed by enough people to ruin the prospects of equities.[2] Exponential wealth will continue to be offered to investors who are disciplined in their savings and very patient and who have a global rather than local view of what their investment opportunities are.

Squirrels

When Roger Ibbotson asked me to write this foreword—a sequel to my first published piece of writing, the foreword to the 1982 edition of Ibbotson and Sinquefield's *Stocks, Bonds, Bills, and Inflation*—he reminded me that in that old foreword, I wrote about squirrels. He was hoping I wouldn't do it twice. Surprise! Here I am writing about squirrels again.

"An investment is an asset that we do not consume," wrote the distinguished investment manager and author Mark Kritzman.[3] This seeming oversimplification contains an important truth: Most resources are consumed; otherwise, one wouldn't have bothered to gather or produce them in the first place. Most creatures on Earth are constantly hungry and are in almost immediate danger of starving. For them, it isn't a priority to store resources for a future that may not occur.

In 1982, I wrote:

> Squirrels hoard. Knowing that they must have food in the winter, they willingly forego present (certain) consumption in exchange for future consumption which is also more or less certain. . . .

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[1] Paul McCaffrey (foreword by Laurence B. Siegel), *Stocks for the Long Run Revisited: Dividends and "The Return Nobody Got"* (Charlottesville, VA: CFA Institute Research Foundation, 2026), p. 2.

[2] Some worry that the current high level of the stock market is, at least in part, the result of excessive fund flows into equities by personal investors, especially in retirement portfolios. I don't give this argument much credence because markets "work"—they usually discover the right price for capital assets. Any equity investor is free to sell at any time, rebalancing into bonds and cash, which currently have quite respectable yields (unlike in the recent past). The ability to reallocate assets in response to price changes is what keeps asset prices within a reasonable range of fair value.

[3] Mark P. Kritzman, *Puzzles of Finance: Six Practical Problems and Their Remarkable Solutions* (Hoboken, NJ: John Wiley & Sons, 2000), p. 130.

> Yet squirrels do not build wealth over time. The offspring of particularly industrious squirrels do not find their lives made richer by their parents' past efforts; squirrels as a species are not better off than they were a hundred years ago. Clearly, hoarding or storage (the exchange of present for future consumption, both under certainty) is not a sufficient condition for building wealth.[4]

I was slightly off. Acorn stashes are wealth, but they're not *exponential* wealth. They don't make life for each generation easier than for the one before, resulting eventually in an affluent society of squirrels.

The Greatest Social Invention in History

Squirrels, then, discovered the virtue of saving but did not invent investing or markets or capitalism. Nor has any other living creature except human beings—and human beings did it only in the last few thousand years, out of the tens or hundreds of thousands of years that we've existed. Investing, markets, and capitalism have existed for only an instant in geologic and biologic time. We are sublimely lucky to live within that instant.

Even though individual and group enterprise flourished in many societies in ancient and medieval times and made quite a few people rich, it still didn't create exponential wealth. According to the late economic historian Angus Maddison, global GDP per capita was stuck in a range of roughly $1,000 to $1,500 from AD 1 until the middle 1800s.[5] Some countries did better for a while, but the prosperity didn't last: Italy soared to double that level in the Renaissance but never grew significantly after that until the 1870s! The Netherlands, the United Kingdom, and the United States did better once the Industrial Revolution began, but growth was painfully slow even then, with only a 50% rise in incomes between the American Revolution and the 1840s.

The Takeoff into Self-Sustaining Economic Growth

Then, beginning in the West and extending eventually to almost every corner of the world, economic growth went wild. Those living in the United States today enjoy per capita incomes about 20 times the 1840s level (after adjusting for inflation). In Western Europe, the situation is about the same. Unlucky China and India didn't achieve rapid growth until the last quarter of the twentieth century, but once liberated from the shackles imposed by their political systems, the growth rates exceeded anything seen in the West or anywhere else. We are moving rapidly toward a middle-income world.[6]

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[4] Roger G. Ibbotson and Rex A. Sinquefield (foreword by Laurence B. Siegel), *Stocks, Bonds, Bills, and Inflation: The Past and the Future (1982 Edition)* (Charlottesville, VA: Financial Analysts Research Foundation, 1982), p. viii.

[5] Following Maddison, all money amounts in this section are in US dollars at 2011 prices. Multiply by 1.5 for 2026 prices. See www.rug.nl/ggdc/historicaldevelopment/maddison/?lang=en.

[6] According to a commentary piece published by the Brookings Institution, as of 2018, half the world's population was middle class or better. The authors' definition of middle class may not match American or Western European expectations, but it sure beats poverty: "Those in the middle class have some discretionary income that can be used to buy consumer durables like motorcycles, refrigerators, or washing machines. They can afford to go to movies or indulge in other forms of entertainment. They may take vacations. And they . . . can weather an economic shock . . . without falling back into extreme poverty." See Homi Kharas and Kristofer Hamel, "A Global Tipping Point: Half the World Is Now Middle Class or Wealthier," Brookings Institution (27 September 2018), www.brookings.edu/articles/a-global-tipping-point-half-the-world-is-now-middle-class-or-wealthier/.

To what do we attribute this sudden change in fortunes? Economic historians may never agree on the answer—even though at least one Nobel Prize has been awarded for work on the topic—but the emergence of relatively free markets in labor, goods, and capital is almost universally regarded as a key element of the "great enrichment" (the economist Deirdre McCloskey's phrase). Because this book is about capital markets, let's focus on the capital component.

The Purpose and Magic Ingredients of Capital Markets

Big enterprises—those that create a lot of wealth, employ a lot of people, and produce big paychecks—require a lot of capital, all gathered in one place and deployed by entrepreneurs long before any profits have materialized. How might one raise such risk capital, with everyone concerned knowing that the enterprise might fail?

The answer turns out to be complicated. The best, perhaps only, way to raise large amounts of capital systematically and reliably is by selling identical, divisible shares in the enterprise to a great many people, all of whom can diversify their investments so they need not fear a total loss in one of them. This is the stock market.

The two nearly miraculous inventions required to make this happen are thus *divisibility* and *limited liability*. Divisibility (of ownership of a business) means that one share is as good as another, so they can be traded with confidence. Even more important, limited liability prevents losses in one investment from eating the rest of the investor's portfolio—an absolute requirement for raising capital from far-flung, quasi-anonymous investors who have positions in many different companies. Adam Smith was the first to notice that these are the key components of joint-stock capitalism. Two centuries later, the Nobel Prize–winning economic historian Douglass North expanded on the idea.

The first stirrings of these innovations took place in Toulouse, France, in the late 1300s, as documented by Will Goetzmann, a coauthor of several of the chapters in this book.[7] But it wasn't until more than two centuries later, with the establishment of the Dutch and British East India companies in the early 1600s, that joint-stock companies with tradable shares and limited liability began to catch on. After that, it was "only" another two centuries or so—good things take time—before stock markets became the prevailing mechanism for raising large amounts of capital.

To sum up, the takeoff into self-sustaining economic growth, in the West at first and then globally, was closely correlated with the use of the stock market to raise capital for businesses. Correlation may not mean causation, but it sure can be a hint.

The Democratization of Exponential Wealth

The unexpected side effect of this development was that participation in the growth engine became *democratized*. The opportunity for (although obviously not the guarantee of) exponential wealth was available to anyone with a little money. The modern world was emerging. This book follows the blossoming of capital markets through the centuries and

[7] Goetzmann's magisterial book, *Money Changes Everything: How Finance Made Civilization Possible* (Princeton University Press, 2016) documents the history and evolution of capital markets in an accessible and entertaining manner. I highly recommend it.

across countries, examining the returns of these markets as they experienced bubbles, crashes, and periods of stability, retrenchment, and steady increase. Adding all these types of events together, we see a picture of inexorable growth over time, as long as one remained diversified across companies and, most importantly, across countries because investments in some countries failed completely as a result of war, revolution, or other calamities.

This book is about creating stock and bond indices to measure these results in the past and to help us place future outcomes in context as they unfold. Capital markets accessible to everyone are highly beneficial, but we need well-constructed indices of the various asset classes so we can be better informed when we decide how to invest.

The last few centuries of human history have seen the emergence of widespread, shared prosperity because of capitalism, freedom, and—most importantly in the context of this book—liquid and efficient capital markets. This trio constitutes the most important social invention of all time.

The fruits of this social invention are a prize beyond measure. Let's nurture it, not tear it down. Our descendants, near and far, and our brothers and sisters living in every corner of the world deserve the chance to earn exponential wealth in the markets.

Laurence B. Siegel
Wilmette, Illinois, and Del Mar, California
April 2026

CHAPTER 1. INTRODUCTION

Roger G. Ibbotson, PhD
Professor in the Practice Emeritus of Finance, Yale School of Management
Chair, Zebra Capital Management, LLC

Today, we have an array of technological financial tools at our fingertips, making it almost impossible to look back and fully understand the impact of Rex Sinquefield's and my 1976 article "Stocks, Bonds, Bills, and Inflation: Year-by-Year Historical Returns (1926–1974)" (Ibbotson and Sinquefield 1976a). First published in the University of Chicago's *Journal of Business*, the article on the topic of Stocks, Bonds, Bills, and Inflation®, known as SBBI®,[1] was written during a revolution in the field of academic economics and finance in the early 1970s. Rex and I were surrounded by a panoply of future Nobel Prize winners at the University of Chicago's Graduate School of Business. Brilliant minds were rapidly developing economic theories around us on that campus, and we were in the right place at the right time. SBBI provided the risk and return measures that helped put these theories into practice.

Although diversification had long been a principle of investing, Harry Markowitz, finishing his doctorate at the University of Chicago in 1952, developed the mathematics and theory behind diversification. During the 1950s and 1960s, there was considerable work on the random walk hypothesis, asserting that stock price fluctuations are independent, random, and unforeseeable. By the 1960s, William Sharpe (1964) and John Lintner (1965) had independently developed the capital asset pricing model (CAPM), which explained the relationship between risk and return and demonstrated that in perfect capital markets with common beliefs, everyone would hold the market portfolio, with cash or leverage.

Shortly after I arrived at the University of Chicago, Eugene Fama (1965, 1970) developed the efficient market hypothesis, which asserted that prices of securities were fair and reflected all available information, making it impossible to consistently "beat the market" or achieve superior returns without taking higher risks. In an efficient market, prices adjust instantly to new information, aligning market value with intrinsic value, suggesting that neither technical nor fundamental analysis is capable of consistently outperforming the market.

In the late 1960s, I decided to earn a PhD after failing in two post-MBA jobs. My interest in finance had been sparked early: I was investing in stocks as a teenager, so a career in finance was appealing. The approaches being developed at the University of Chicago, however, were totally different from the bottom-up security analysis with which I had been familiar. Because markets were relatively efficient, what really mattered was "modern portfolio theory," with expected returns related to risk, fair prices, diversified portfolios, and the start of index funds. Even as a PhD student, I was given an opportunity to manage the bond portfolio at the university investment office and soon after to consult on equity index funds, all the while participating with top-tier theorists—a perfect storm. Eugene Fama was chair of my dissertation committee, and my close colleagues at the university included Fischer Black, Myron Scholes, and Merton Miller.

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[1] SBBI® and Stocks, Bonds, Bills, and Inflation® are registered trademarks of Precision Information, LLC, DBA Financial Fitness Group. Any mentions of SBBI and Stocks, Bonds, Bills, and Inflation in this book are nominative, are made for the purpose of providing historical context, and do not imply any ownership of the relevant marks, or endorsement by or affiliation with Precision Information, LLC, DBA Financial Fitness Group or any entity affiliated with same.

Not only was the university a great place for theory; it was also a major repository of financial data. James H. Lorie and Lawrence Fisher had set up the Center for Research in Security Prices (CRSP) at the University of Chicago in 1960, and 10 years later, computers were in widespread use on campus. Things began to heat up: CRSP had the data, and we were armed with the knowledge to use the data.

Enter SBBI

The CAPM had already provided a formal theory of how the risk–return relationship might work. Rex Sinquefield and I took 50 years of data from the stock market and compared stock returns with the yields on riskless bonds to measure the equity risk premium. Economists had talked about risk premiums long before SBBI, but SBBI gave us a measure of it. Indices are really important: They give you the long-term history and tell you collectively how stocks and bonds have performed.

Rex went on to cofound Dimensional Fund Advisors (DFA), which is now one of the world's largest investment managers, with one of my former University of Chicago roommates, David Booth. For more than 40 years, I was on the board that oversaw DFA's funds, which use efficient market concepts to manage the assets.

By including both stock and bond data, we could measure a number of different risk premiums: the equity risk premium, the horizon or interest rate term premium, the default risk premium, and all the inflation-adjusted real returns, including the short-term real riskless rate of interest. As with the Fisher and Lorie (1964, 1968) studies, we started our data in 1926, and suddenly, with our dataset, market participants could understand the payoffs for risks.

Timing is often critical; our results came out just after the 1973–74 recession and the corresponding market crashes. In contrast, the historical 50-year returns that we had measured were high. We also extrapolated the high achieved risk premiums for another 25 years out to the end of the century. Because the numbers were high, the realized and forecasted stock market returns were very reassuring to the financial press. Our studies quickly became famous.

The returns we measured were "total returns," which included both the income return and the capital gains or losses. This was not the common practice at the time; price-only returns were typically reported along with a separate income yield. For decades, our total return stock and bond data were the go-to source when an analyst, adviser, financial trivia seeker, or teacher needed detailed information on the historical total returns, expected returns, and risks of a variety of asset classes.

Our work might have had more practical appeal than academic appeal. Creating stock and bond market total return indices had a tremendous impact on the business world. Investors were interested to know what kind of long-term return to expect from the stock market, and they were just beginning to realize the enormous impact of compounding, which, as we know, leads to exponential growth of wealth. It seems obvious 50 years later, but, for example, with a 10% return compounded over 50 years, $1 grows to more than $117. This concept astounded investors and made them realize that simply investing in an overall stock market index could create tremendous wealth over a long period.

The original stock and bond data were published in the *Journal of Business*. In the second of these articles, "Stocks, Bonds, Bills, and Inflation: Simulations of the Future (1976–2000)"

(Ibbotson and Sinquefield 1976b), we used the historical data as the starting point for modeling inflation, real interest rates, and various risk premiums to simulate long-term stock and bond probability distributions of future returns. Although the forecasts were bootstrapped a quarter-century forward, the simulations out to 2000 turned out to be remarkably accurate, including nominal stock market returns. In the latter sections of this book, we will be using current financial markets to predict the future. One of the prediction chapters in this book, coauthored by Will Goetzmann, Otto Manninen, and me, uses methods similar to those in the original article (Ibbotson and Sinquefield 1976b) to predict asset returns from 2026 through 2050.

History of Creating Stocks, Bonds, Bills, and Inflation Indices

In the years after the original SBBI series was published, we continued to update the series, which included our first CFA Institute Research Foundation (formerly named Financial Analysts Research Foundation) publications (Ibbotson and Sinquefield 1977, 1979, 1982). In 1977, I founded Ibbotson Associates (IA), which eventually took over the updating and publication activities, publishing the first *Stocks, Bonds, Bills, and Inflation Yearbook* in 1983. The Yearbooks continued to be published by Ibbotson Associates every year from 1983 through 2006, when Morningstar, Inc., purchased Ibbotson Associates. Starting in 1999, Ibbotson Associates also published Valuation Editions of the *Stocks, Bonds, Bills, and Inflation Yearbook*.

After it purchased Ibbotson Associates in 2006, Morningstar continued to produce the SBBI data and the Yearbooks. Morningstar discontinued the Valuation Editions of the Yearbooks in 2013. In 2016, it discontinued the remaining Classic Editions of the Yearbooks, transferring the publication rights to Duff & Phelps, Inc., which also spun off this activity in 2021 to Kroll Inc. Kroll continued to publish the Yearbook until the last one was published in 2023. Morningstar had sold off the SBBI trademark, and in the recent past only charts and tables have been produced under the SBBI trademark. Morningstar continued to publish the underlying stock and bond indices through 2024 but publicly announced it was discontinuing the indices in early 2025.

Back to the Future

Flash forward 50 years, and we are now celebrating the 50th anniversary of the original publication of "Stocks, Bonds, Bills, and Inflation: Year-by-Year Historical Returns (1926–1974)." Because the data we collected for this flagship tool started in 1926, it is also the 100th anniversary of the dataset. The original SBBI data are being discontinued, but the purpose of this project, which includes this book, is to continue with a replacement dataset that incorporates the original US markets, with some additional detail. The replacement data are now called Ibbotson®[2] Equity and Bond Indices, and we are using CRSP data to create the new indices.

[2] Ibbotson® is a trademark owned by Morningstar, Inc. The information contained in the indices has not been prepared by Morningstar, and Morningstar is not responsible for any damages or losses arising from any use of this information. Past performance is no guarantee of future results. These indices may also be referred to as Ibbotson Equity and Bond Indices, Ibbotson Equity Indices, or Coleman Fisher Ibbotson (CFI) Bond Indices.

The primary purpose of this book is to promote and analyze the new replacement stock and bond return indices, as well as to take a look back. These Ibbotson Indices start in 1926, as the prior series did. Of course, the US markets started before 1926, and they are not the only important stock and bond markets in the world, nor is the most recent 100 years the only period that matters. Thus, although I am the primary editor of this book, I rely on a host of coauthors, many of whom are friends and colleagues around the world, who help contextualize the last 100 years of US data.

Although I have continued over the years to straddle business and academia, I have partnered with many of the coauthors of this book from both worlds to make their academic work more clear to laypeople and finance experts. Collectively, these coauthors are many of the top researchers in creating the historical data that have become so useful in understanding our financial markets.

The Voices in This Book

Gathered in these pages are some of the seminal voices in finance and economics over the last 50 years. Many of these experts "grew up together" in this field, and we have relied on each other as sounding boards, reviewers, contrarians, and, for the most part, friends.

Larry Siegel, a student of mine at the University of Chicago, became my first employee at Ibbotson Associates. He was a consultant, writer, editor, and media spokesperson. The financial press flocked to IA for comments, and Larry was accessible, smart, and accurately quotable. Ibbotson Associates became a household word in the finance community, partly because of SBBI but also because Larry knew how to communicate its relevance. Although Larry and I have not worked together in decades, we remained friends and have reunited for this book. Larry serves as executive editor of this book, coauthoring several chapters, writing the foreword, and closely editing every chapter. One of the chapters Larry coauthored is Chapter 9, written with Carla Nunes, until recently a managing director at Kroll (formerly Duff & Phelps), on "The Equity Risk Premium."

IA hired Tom Coleman when he was a PhD student at the University of Chicago in the early 1980s. In 1984, I became a faculty member at the Yale School of Management, and Tom was at Stony Brook University. In the late 1980s and early 1990s, we worked with the late Lawrence Fisher to build yield curves using his newly constructed CRSP US Treasury bond files. The three of us were dynamic: I organized and funded the project, Lawrence provided much of the expertise and datasets, and Tom worked on the programming and implementation. Tom and I have extended and updated our Coleman Fisher Ibbotson (CFI) indices in Chapters 7 and 8.

James Harrington, another Ibbotson Associate from the early 2000s, took over producing the SBBI Yearbook after it was sold to Morningstar. When Morningstar discontinued SBBI, Jim followed the Yearbook to Duff & Phelps and later to Kroll, producing it until 2023. More than anyone, he understands the background of the formulas, so we asked him to co-write Chapter 3 on index construction. Jim has been a lifelong supporter of SBBI. His writing is brilliant and fluid, and his formulas are accurate.

When Worlds Collide: Academia and Business

We would have made a grave mistake to produce a book on the history of stocks, bonds, bills, and inflation without including a historian in the mix. Financial historian and Yale professor William Goetzmann, author of *Money Changes Everything: How Finance Made Civilization Possible* (Goetzmann 2016), has worked on several chapters, including "The London Market, 1870–1929" (Chapter 12), with Geert Rouwenhorst and Fernando Reyes De La Luz. Will is currently a professor and the faculty director of the International Center for Finance at the Yale School of Management. He takes great interest in bootstrapping, working with Otto Manninen and me on "Forecasting Equity and Bond Returns" (Chapter 20).

Yale University has been highly supportive of me, for which I express deep appreciation. Many chapters of this book were written by or coauthored with my Yale colleagues.

Will and I met when he was an MBA and doctoral student at Yale. He left to teach at Columbia University, and I worked to hire him back at Yale, where he founded the International Center for Finance. Will and I published our separate and coauthored research papers related to the equity risk premium into a volume, *The Equity Risk Premium: Essays and Explorations* (Goetzmann and Ibbotson 2006), and he brings his expertise to coauthoring Chapters 5 and 6, "Statistical Analysis of Equity Returns" and "Bubbles, Booms, and Crashes, 1792–2024."

Another former Ibbotson Associate, Thomas Idzorek, moved from IA to Morningstar in 2006, when the latter firm bought the former. Tom is a good example of the "bridge" between academia and business. He thinks like an academic in the corporate world. Tom, along with Larry Siegel, helped me write Chapter 2, "Highlights of the Past 100 Years." Paul Kaplan, another IA alumnus, recently retired from Morningstar, and Tom, Paul, and I have coauthored many papers and monographs over the years, several of them on popularity. (Spoiler alert! See Chapter 18, "Popularity and Premiums.") Perhaps the most influential publication the three of us cowrote (along with James X. Xiong) was *Popularity: A Bridge Between Classical and Behavioral Finance* (Ibbotson, Idzorek, Kaplan, and Xiong 2019), which includes a foreword by Larry Siegel.

With the ability to produce the math behind the concepts, Paul Kaplan has been my reliable "go-to" brain for quantitative thinking over the last several decades. He was able to recast an earlier paper I had written on equilibrium theory with the popularity asset pricing model as the result. Paul was a director of research at Morningstar, responsible for the quantitative methodologies behind Morningstar's fund analysis, stock analysis, advice, adviser tools, and other services. His chapter on "Parametric Forecasting" (Chapter 19) perfectly reflects his ability to express data and forecasts quantitatively.

Geert Rouwenhorst and I have been in the same academic circles at Yale for 25 years but have never coauthored a publication. He created a suite of new commodity indices and founded a US commodities investment management firm in 2009. Geert is able to communicate difficult concepts about commodities gracefully, bridging the gap between the corporate and the academic worlds. His chapter, "An Index of Commodity Futures Returns Since 1871" (Chapter 13), written with Rajkumar Janardanan and Xiao Qiao, offers good insights on a complex topic.

My work with the staff of Zebra Capital, where I am chair, has also been helpful in constructing the stock and bond indices. I am particularly grateful to Michael Holmgren for analyzing and refining data and finding ways to display the data effectively.

Across Space and Time

Although the book focuses primarily on SBBI and its impact in the United States over the past 100 years, we are fortunate to have a section that summarizes market returns that are not covered by the Ibbotson Indices. We start in Chapter 10 with Edward McQuarrie's "US Stocks and Bonds Before 1926." Although Will Goetzmann, Liang Peng, and I collected the NYSE stock data over 1815–2025, we were unable to include much dividend or capitalization data. Ed came along several years ago and was able to fill in many of the gaps, using various sources from the internet.

Bryan Taylor, chief economist at Finaeon, collected an incredible trove of data to examine global markets in previous centuries. He begins his story (Chapter 16) way back in 1601, when only one stock traded on the Amsterdam stock exchange; by 1914, thousands of stocks and bonds traded on dozens of stock exchanges throughout the world.

The well-known work of Elroy Dimson, Paul Marsh, and Mike Staunton is summarized in Chapter 11, "Global Markets over the Last 126 Years." Elroy and I have known each other for more than 25 years. While I was compiling US data for stock and bond indices starting in 1926, Elroy was putting together indices from every country in the world. Our work is complementary and synergistic. Elroy also worked with David Chambers, Antti Ilmanen, and Paul Rintamäki on evaluating and critiquing index construction (Chapter 17).

Asian equity and bond markets were added to the mix more recently, and both Chinese and Japanese stock markets have been influenced strongly by historical and political forces. Tadaaki Komatsubara and Peng Chen present their new Japanese and Chinese market indices in Chapters 14 and 15, respectively.

Tadaaki cofounded Ibbotson Associates Japan in 2000 and has served as its chief investment officer for more than 25 years, working as a leading provider of investment consulting services to institutional investors in Japan. Although it was acquired by Morningstar in 2006, the firm is still known as Ibbotson Associates Japan. Tadaaki calls himself the "Last Samurai," still feeling connected to the Ibbotson brand. Peng Chen was chief investment officer of IA and later served as president of Morningstar Investments, before heading up Dimensional Fund Advisors in Asia for many years. He is now a consultant to Morningstar, Inc., and several other organizations.

Otto Manninen is responsible for compiling much of the US data and writing several chapters. A new member of the Ibbotson galaxy, Otto received his master's degree at the Yale School of Management in 2024 and stayed on to assist Will Goetzmann, me, and other faculty with our work, including coauthoring Chapters 4, 5, and 20. His contributions to the development of the book are too numerous to mention, and his intellectual capabilities bode well as an example of his rising generation's contributions to the fields of economics and finance.

As can be seen from this description, this book represents a reunion of the many years all of us have worked together, as well as a reunion of the project. The original two SBBI papers are now (in 2026) celebrating their 50th anniversary, and the dataset now covers 100 years. A data and book project of this complexity requires special organization, and Katherine Hinds has served as an exceptional project manager, both organizing and editing this book.

The Outline of This Book

The book is divided into four sections. It starts with an overview. The second section features a discussion of the past 100 years in US markets using the new Ibbotson Equity and Bond dataset. The next section is a presentation of US data prior to 1926 and data from global markets over multiple centuries. The final section focuses on using historical data to help predict the future.

We hope you learn from it, enjoy it, and pass it on.

Bibliography

Ibbotson Publications

Journal of Business Articles

Ibbotson, Roger G., and Rex A. Sinquefield. 1976a. "Stocks, Bonds, Bills, and Inflation: Year-by-Year Historical Returns (1926–1974)." *Journal of Business* 49 (1): 11–47. doi:10.1086/295803.

———. 1976b. "Stocks, Bonds, Bills, and Inflation: Simulations of the Future (1976–2000)." *Journal of Business* 49 (3): 313–38. doi:10.1086/295854.

CFA Institute Research Foundation

Ibbotson, Roger G., and James P. Harrington. 2020. *Stocks, Bonds, Bills, and Inflation® (SBBI®): 2020 Summary Edition*. Charlottesville, VA: CFA Institute Research Foundation. https://rpc.cfainstitute.org/research/foundation/2020/sbbi-2020-summary-edition.

———. 2021. *Stocks, Bonds, Bills, and Inflation® (SBBI®): 2021 Summary Edition*. Charlottesville, VA: CFA Institute Research Foundation. https://rpc.cfainstitute.org/research/foundation/2021/sbbi-2021-summary-edition.

Ibbotson, Roger G., and Rex A. Sinquefield. 1977. *Stocks, Bonds, Bills, and Inflation: The Past (1926–1976) and the Future (1977–2000)*. Foreword by Jack L. Treynor. Charlottesville, VA: Financial Analysts Research Foundation. https://rpc.cfainstitute.org/research/foundation/1977/rf-v1977-sbbi-past-and-future.

———. 1979. *Stocks, Bonds, Bills, and Inflation: Historical Returns (1926–1978)*. Charlottesville, VA: Financial Analysts Research Foundation. https://rpc.cfainstitute.org/research/foundation/1979/rf-v1979-sbbi-historical-returns.

———. 1982. *Stocks, Bonds, Bills, and Inflation: The Past and the Future (1982 Edition)*. Foreword by Laurence B. Siegel. Charlottesville, VA: Financial Analysts Research Foundation. https://rpc.cfainstitute.org/research/foundation/1982/rf-v1982-sbbi-past-and-future.

———. 1989. *Stocks, Bonds, Bills and Inflation: Historical Returns (1926–1987)*. Research Foundation of the Institute for Chartered Financial Analysts and Dow Jones–Irwin. https://rpc.cfainstitute.org/sites/default/files/-/media/documents/book/rf-publication/1989/rf-v1989-n3-sbbi-historical-returns.pdf.

CFI US Treasury Yield Curves

Coleman, Thomas S., Lawrence Fisher, and Roger G. Ibbotson. 1989. *U.S. Treasury Yield Curves, 1926–1988*. New York: Moody's Investors Service, Inc.

———. 1993. *Historical U.S. Treasury Yield Curves (1993 Edition)*. Moody's Investors Service, Inc., and Ibbotson Associates.

———. 1995. *Historical U.S. Treasury Yield Curves Update: Data Through December 1994*. Moody's Investors Service, Inc., and Ibbotson Associates.

SBBI Classic Yearbooks

Stocks, Bonds, Bills, and Inflation, SBBI®: Market Results (Classic Edition). Yearbooks 1983–2006. Chicago: Ibbotson Associates.

Stocks, Bonds, Bills, and Inflation, SBBI®: Market Results (Classic Edition). Yearbooks 2007–2015. Chicago: Morningstar, Inc.

Ibbotson, Roger G. *Stocks, Bonds, Bills, and Inflation (SBBI®): U.S. Capital Markets Performance by Asset Class*. Yearbooks 2016–2021. Chicago: Duff & Phelps.

Ibbotson, Roger G. *Stocks, Bonds, Bills, and Inflation (SBBI®): U.S. Capital Markets Performance by Asset Class*. Yearbooks 2022–2023. Chicago: Kroll, Inc.

SBBI Valuation Yearbooks

Stocks, Bonds, Bills, and Inflation Yearbook: Market Results (Valuation Edition). Yearbooks 1999–2006. Chicago: Ibbotson Associates.

Stocks, Bonds, Bills, and Inflation Yearbook: Market Results (Valuation Edition). Yearbooks 2007–2013. Chicago: Morningstar, Inc.

Additional Ibbotson References

Goetzmann, William N., and Roger G. Ibbotson. 2006. *The Equity Risk Premium: Essays and Explorations*. Oxford, UK: Oxford University Press. doi:10.1093/oso/9780195148145.001.0001.

Goetzmann, William N., Roger G. Ibbotson, and Liang Peng. 2001. "A New Historical Database for the NYSE 1815 to 1925: Performance and Predictability." *Journal of Financial Markets* 4 (1): 1–32. doi:10.1016/S1386-4181(00)00013-6.

Ibbotson, Roger G., Thomas M. Idzorek, Paul D. Kaplan, and James X. Xiong. 2019. *Popularity: A Bridge Between Classical and Behavioral Finance*. Charlottesville, VA: CFA Institute Research Foundation. https://rpc.cfainstitute.org/research/foundation/2018/popularity-bridge-between-classical-and-behavioral-finance.

Other Publications

Fama, Eugene F. 1965. "The Behavior of Stock-Market Prices." *Journal of Business* 38 (1): 34–105. doi:10.1086/294743.

———. 1970. "Efficient Capital Markets: A Review of Theory and Empirical Work." *Journal of Finance* 25 (2): 383–417. doi:10.2307/2325486.

Fisher, Lawrence, and James H. Lorie. 1964. "Rates of Return on Investments in Common Stocks." *Journal of Business* 37 (1): 1–21. doi:10.1086/294647.

———. 1968. "Rates of Return on Investments in Common Stock." *Journal of Business* 41 (3): 291–316. doi:10.1086/295107.

Goetzmann, William N. 2016. *Money Changes Everything: How Finance Made Civilization Possible*. Princeton University Press.

Lintner, John. 1965. "The Valuation of Risk Assets and the Selection of Risky Investments in Stock Portfolios and Capital Budgets." *Review of Economics and Statistics* 47 (1): 13–37. doi:10.2307/1924119.

Markowitz, Harry M. 1952. "Portfolio Selection." *Journal of Finance* 7 (1): 77–91. doi:10.1111/j.1540-6261.1952.tb01525.x.

Sharpe, William F. 1964. "Capital Asset Prices: A Theory of Market Equilibrium Under Conditions of Risk." *Journal of Finance* 19 (3): 425–42. doi:10.1111/j.1540-6261.1964.tb02865.x.

CHAPTER 2. HIGHLIGHTS OF THE PAST 100 YEARS

Roger G. Ibbotson, PhD
Professor in the Practice Emeritus of Finance, Yale School of Management
Chair, Zebra Capital Management, LLC

Laurence B. Siegel
Gary P. Brinson Research Director Emeritus, CFA Institute Research Foundation

Thomas M. Idzorek, CFA
Chief Investment Officer, Morningstar

Introduction

Fifty years ago, in 1976, the publication of Roger Ibbotson and Rex Sinquefield's "Stocks, Bonds, Bills, and Inflation" (SBBI®) in the *Journal of Business* (Ibbotson and Sinquefield 1976a) marked the first time that data on the total returns and associated exponential wealth indices of the major asset classes were compiled. This research allowed investors to study the historical returns, understand the distributions of returns, and see how each of these asset classes interacted with each other. Their study used data beginning in 1926. Now, in 2026, we celebrate the highlights of the past 100 years!

Within the past several years the SBBI indices in their original form were discontinued, but the SBBI trademark continues to be used in connection with the publication of charts and tables. The authors of and contributors to this book, however, have replaced, renamed, updated, and expanded the stock and bond series. The new indices are generated from Center for Research in Security Prices (CRSP) datasets.[1] The new stock and bond indices presented here cover the 100-year period 1926–2025.

100 Years of Stock and Bond Returns

The Ibbotson® Equity and Bond Indices (Ibbotson Indices) are monthly total return indices that start in 1926 and now cover a full century.[2] Following Ibbotson and Sinquefield (1976a, 1976b), the Ibbotson Indices cover US large-capitalization stocks, US small-cap stocks, US long-term

[1] CRSP was created in 1960 at the University of Chicago Graduate School of Business (now Chicago Booth), becoming a wholly owned LLC subsidiary of the University of Chicago in 2020. In 2026, it was acquired by Morningstar, Inc.

[2] Ibbotson® is a registered trademark of Morningstar, Inc. The information contained in the Ibbotson Equity and Bond Indices has not been prepared by Morningstar, and Morningstar is not responsible for any damages or losses arising from the use of the information. Past performance is no guarantee of future results. Morningstar is not responsible for this content and has no liability for its use.

Treasury bonds, "cash" (US 30-day Treasury bills), and US inflation, along with several additional size categories of US stock markets and maturity categories of US Treasury bonds.

The names of all individual and composite indices in the Ibbotson® Equity Indices and selected indices in the Coleman Fisher Ibbotson® Bond Indices[3] are displayed in the sidebar below.

Ibbotson Equity and Bond Indices: List of Index Names

Ibbotson Equity Indices*

Base Indices

Ibbotson 25
Ibbotson Large Cap (includes Ibbotson 25)
Ibbotson Mid Cap
Ibbotson Small Cap
Ibbotson Micro Cap

Composite Indices

Ibbotson Large Cap Composite (Large Cap + Mid Cap)
Ibbotson SMID Composite (Mid Cap + Small Cap + Micro Cap)
Ibbotson Small Cap Composite (Small Cap + Micro Cap)
Ibbotson All Cap Composite

Coleman Fisher Ibbotson (CFI) US Treasury Par Bond Yield and Return Indices**

CFI 30 Day Treasury Bills (T Bills)
CFI 3 Month T Bills
CFI 6 Month T Bills
CFI 1 Year T Bills
CFI 2 Year T Notes
CFI 3 Year T Notes
CFI 5 Year T Notes
CFI 7 Year T Bonds
CFI 10 Year T Bonds
CFI 20 Year T Bonds
CFI Long Term T Bonds

*All equity indices include total return, income, and capital gain series.

**All bond indices include annualized yields, monthly yield returns, returns in excess of yield, and total returns.

[3] For more information, see Thomas S. Coleman, Lawrence Fisher, and Roger G. Ibbotson, *US Treasury Yield Curves 1926–1988* (Moody's Investors Service, 1989).

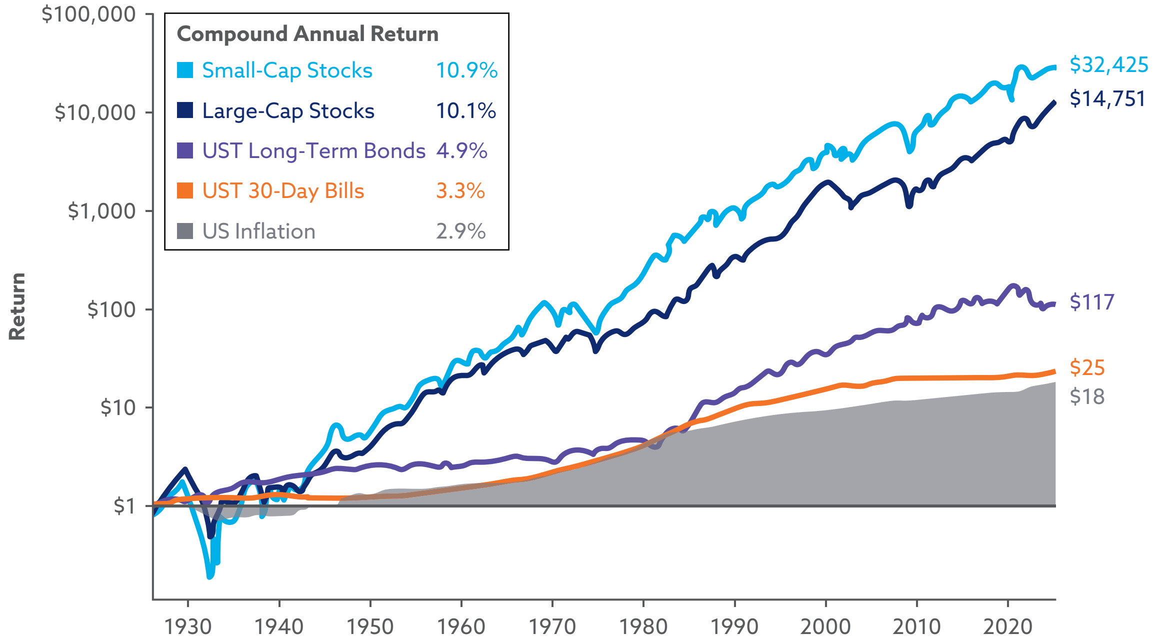
The Growth of a Dollar over the 100 Years

In **Exhibit 2.1**, we show what happened to the stock and bond markets over the last 100 years. If we invested $1 at the beginning of 1926 and reinvested all the dividends and income, holding these indices over the entire 100-year period ending in 2025, we can see how much wealth is created.[4] Exhibit 2.1 is drawn in log scale, so on the vertical axis, the difference between $1 and $10 is the same as that between $10 and $100, as is the difference between $100 and $1,000. Thus, the slope on the graph represents the rate of return over time, no matter how much is invested at any one time and no matter what time interval in the 100-year time period is examined.

Starting with US large-cap stocks, which represent the bulk of the US stock market, $1 invested in 1926 grew to almost $15,000 over the 100-year period, providing a compound annual return or geometric mean return of 10.1%. US small caps did even better, with a 10.9% compound return, causing $1 invested in these stocks in 1926 to grow to more than $30,000!

The bond market returns are nowhere near as high. US long-term Treasury bonds earned a 4.9% return, and US Treasury bills delivered a 3.3% return, growing to around $117 and $25,

Exhibit 2.1. Ibbotson Equity and Bond Total Return and Wealth Indices, 1926–2025



Source: Ibbotson Equity and Bond Indices, derived from CRSP data.

Note: UST stands for US Treasury.

[4] This result assumes the investor incurred no costs, such as management fees, transaction fees, or taxes.

respectively, over the 100-year period. We will look at the impact of inflation shortly, but a key highlight is that equity markets produced an incredible amount of wealth, in both nominal and real (inflation-adjusted) terms, during the 100 years of exponential growth.

These returns were not realized in a vacuum. The last 100 years were filled with events that, in many cases, directly impacted capital markets. At times, the causality was in the opposite direction, with market events impacting the economy.

In Chapter 3, we explain how we calculate annual arithmetic mean returns, compound annual (geometric mean) returns, and the standard deviations of the return series.

The Stock Market

The period we study begins with the Roaring Twenties. That decade ended with the Great Crash of October 1929, which ushered in the Great Depression of the 1930s. The Great Depression was associated with the worst stock market returns of the 100-year period. After a partial recovery in the mid-1930s, the late 1930s ended with another large decline. By 1940, the market index (including total returns) was above its level at the beginning of 1926 but still well below its early September 1929 highs.

World War II started in 1939 and was initially not good for US stocks. The stock market dramatically improved by mid-1942, however, with strong returns as the prospects of the Allies improved. As World War II ended, the stock market was initially weak but soon recovered because the US economy was largely undamaged by the war. This expansion continued through the 1950s and 1960s, with only a few minor recessions. The Korean War and the Vietnam War were not as harmful to US capital markets as previous wars had been.

The long bull market that followed World War II ended with the severe recession of 1973 and 1974. The stock market had its largest major fall since the 1930s, with a total return of about –44% from monthly peak to trough. The market continued to advance through the 1980s, apart from the recession of 1981, with a positive total return even in 1987, when the largest one-day decline in history occurred in October of that year.

Although the 1990s started with a recession, returns throughout the decade were spectacular, especially for technology stocks. This expansion finally ended with the bursting of the tech bubble and the recession of 2000–2001, resulting in a three-year drop in stock prices with a total return of almost –50%. But the stock market recovered again until the global financial crisis of 2008. This latter drop was just as severe, again with a total return of almost –50% from peak to trough on a month-end basis, a drop exceeding those that accompanied the 1973–74 and 2000–01 recessions.

The stock market recovered again, however, and then more recently moved to new highs. Since 2009, we have had only a few bad periods. One occurred during the COVID-19 pandemic, which led to a large drop in March 2020, but after this decline, the move to new highs was relatively quick in coming and large in magnitude. After three years of double-digit increases, the market fell in 2022. But as our century of data comes to an end in 2025, the stock market was once again at an all-time monthly high, the result of three more double-digit up years.

The Bond Market

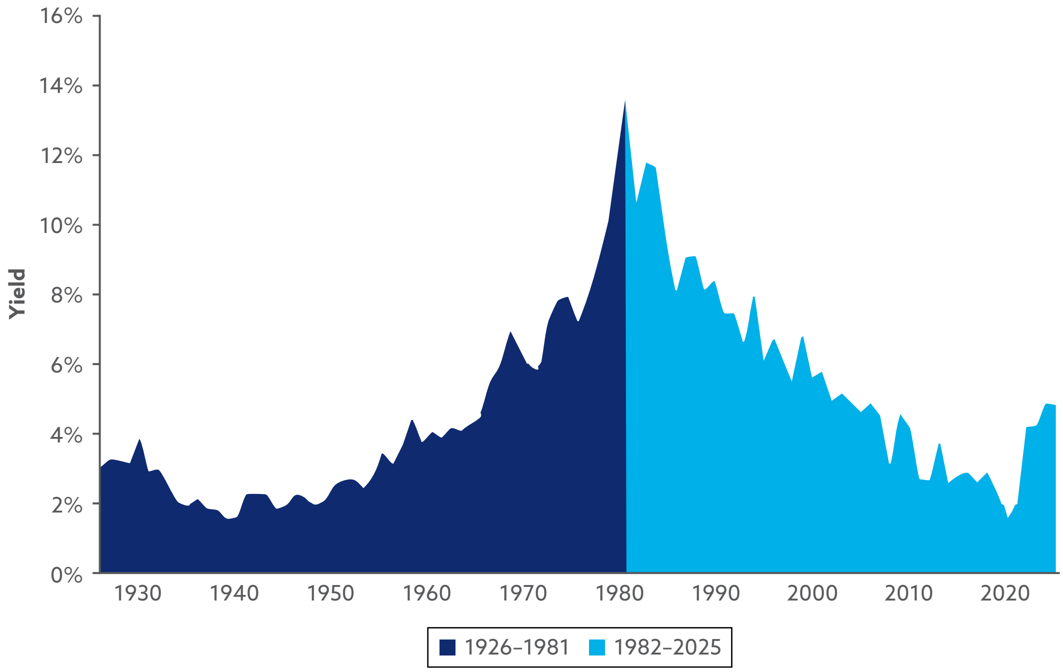
The fixed-income side contains a remarkable long-term event, which in other work we have called the "bond mountain." When bond yields rise, bond prices fall. When bond yields fall, bond prices rise. The return on a bond is the bond's initial yield plus the *return in excess of yield*. This latter quantity, arising from changes in the bond's price, is approximated by the duration of the bond multiplied by the negative change in the yield of the bond.

Yields mostly fell from 1926 until the middle of World War II, when they hit their bottom because of price controls. After that, bond yields rose, as if climbing a mountain, to levels that were unprecedented except in wartime. The peak was reached in 1980–1981, when long-term US Treasury yields exceeded 15%, reflecting the double-digit inflation rates of the time.

After the 1981 peak, bond yields fell sharply and continued to fall in a more or less continuous decline for the next four decades on the way to yields below 1% in 2021. The decline in yields meant that bond *prices* rose dramatically—so much so that the total returns of long-term US Treasury bonds almost matched the total return of stocks during the long bull markets that started in the early 1980s.

Exhibit 2.2 shows bond yields over 1926–2025. The bond mountain is by far the most prominent feature of the exhibit.

Exhibit 2.2. Year-End Yields on Coleman Fisher Ibbotson US Treasury 20-Year Bonds, 1926–2025



Source: Coleman Fisher Ibbotson US Treasury Indices.

Summary Statistics

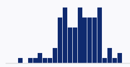
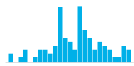
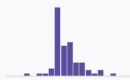
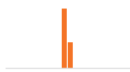
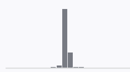
Exhibit 2.3 summarizes the data. We show the compound annual return and the arithmetic mean return along with the standard deviation, which is a measure of the risk of the asset. We also include, in the last column, bar graphs showing the distributions of the corresponding 100 annual returns, all on the same scale; this is another way of showing that the risk of stocks is much higher than the risk of bonds.

The Negative Impact of Inflation

Thus far, we have focused on investment returns without adjusting them for inflation. Inflation is a decline in the purchasing power of money. For investors, it is particularly harmful because it causes them to be paid back in dollars that are worth less than those they originally invested.

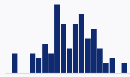
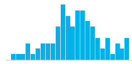
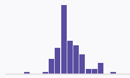
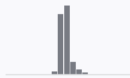
Inflation can be deceptive. During inflationary periods, nominal asset prices (those that are observed) can increase even while their economic value declines. People can feel wealthier even though they are able to purchase less with their money. Inflation thus contributes to nominal growth but not to actual growth. To address this issue, economists calculate "real" returns—that is, the nominal return is adjusted for inflation, reflecting the fact that inflation drags down the purchasing power of a dollar.

Exhibit 2.3. Ibbotson Equity and Bond Returns and Risk, 1926–2025

	Compound Annual Return	Arithmetic Annual Return	Risk (standard deviation)	Return Distribution
Large-Cap Stocks	10.1%	11.8%	18.9%	
Small-Cap Stocks	10.9%	14.4%	27.5%	
UST Long-Term Bonds	4.9%	5.4%	10.6%	
UST 30-Day Bills	3.3%	3.3%	3.1%	
US Inflation	2.9%	3.0%	3.9%	
				–90 ← 0 → 90

Source: Ibbotson Equity and Bond Indices, derived from CRSP data.

Exhibit 2.4. Inflation-Adjusted Stock, Bond, and Bill Returns and Risk, 1926–2025

	Compound Annual Return	Arithmetic Annual Return	Risk (standard deviation)	Return Distribution
Large-Cap Stocks	6.9%	8.7%	18.9%	
Small-Cap Stocks	7.8%	11.2%	27.1%	
UST Long-Term Bonds	1.9%	2.5%	11.5%	
UST 30-Day Bills	0.3%	0.4%	3.9%	
US Inflation	2.9%	3.0%	3.9%	
				–90 0 90

Source: Ibbotson Equity and Bond Indices, derived from CRSP data.

As shown at the bottom of Exhibit 2.1, consumer prices went up 18-fold—a 2.9% rate of inflation—over the 100-year period. Stated differently, at the end of 2025, you would need $18 to purchase what $1 could have purchased at the beginning of 1926. In **Exhibit 2.4**, we show the evolving inflation series and adjust the stock and bond series to show the real or inflation-adjusted exponential growth of $1.

By comparing the real returns in Exhibit 2.4 with the nominal returns in Exhibit 2.1, we can see the significant negative impact of inflation on real growth. Nevertheless, the *real* returns that the stock market provided were generous indeed: We could have made more than 800 times our money even *after* inflation. We would not have made that kind of money in the bond markets. After inflation over the last 100 years, we would have made less than eight times our original investment in long-term US Treasury bonds and less than twice our money in Treasury bills.

Is Exponential Wealth Attainable?

Some commentators have argued that creating wealth indices by linking total returns produces an illusion of very large returns, which, some assert, are unattainable by investors. This critique points out that a wealth index constructed from total returns is not macro-consistent—that is, not everybody can earn these returns because dividends are mostly consumed rather than being reinvested in markets.[5] However, we are measuring what is possible for those who *do* reinvest, even if not everybody can do so. Total returns are the relevant measure of performance.

We have already indicated in the discussion accompanying Exhibit 2.4 that real (inflation-adjusted) returns are more relevant than nominal returns. Investors also have costs, including management fees, transaction costs, and, most importantly, taxes. Thus, in practice, one cannot earn exactly the exponential wealth numbers that we present. The total returns that we present, however, are mostly for indices that can be matched closely with index funds. With their very low fees and transaction costs, such funds earn before-tax returns close to those documented here. Indexing also results in substantially less realization of gains subject to tax than traditional active management.

Some critics also argue that during a substantial part of the period studied, it would have been very difficult for investors to construct portfolios that match the indices provided here. This assertion is undoubtedly true during the first 50 years of our sample, but by 1976, when the original Ibbotson and Sinquefield (1976a, 1976b) articles were written, equity index funds—with their low fees, limited trading, and low tax impacts—already existed.

A Volatile and Sometimes Painful Journey

By any reasonable assessment, it has been a wonderful 100 years for investors, especially for equity investors, as demonstrated by the high rates of return and levels of terminal wealth shown in the foregoing sections. With such favorable long-term results, it is easy to overlook the volatility of the journey and the periods of pain—times when the market went down and stayed down—associated with that volatility.

Drawdowns: Periods of Pain

Looking back at Exhibit 2.4 and focusing on US large-cap stocks, we can see that these stocks produced a lot of *real* wealth—"real" both in the sense that the wealth measure is inflation adjusted and in that the amount of wealth created is economically significant.

Yet this journey had at least three periods of 10 years or longer—accounting for about one-third of the 100-year history—in which investors felt extended periods of pain.

In **Exhibit 2.5**, the "pain pools" are shown as shaded areas. These are periods when the value of the inflation-adjusted total return index remains below its previous high-water mark. The length of the pool represents the amount of time it took to return to the previous high-water mark on an inflation-adjusted basis. The volume of the pain pool—a measure of investor pain—depends on the depth and the length of the pool. The "fluid" in these pools is inflation-adjusted dollars.

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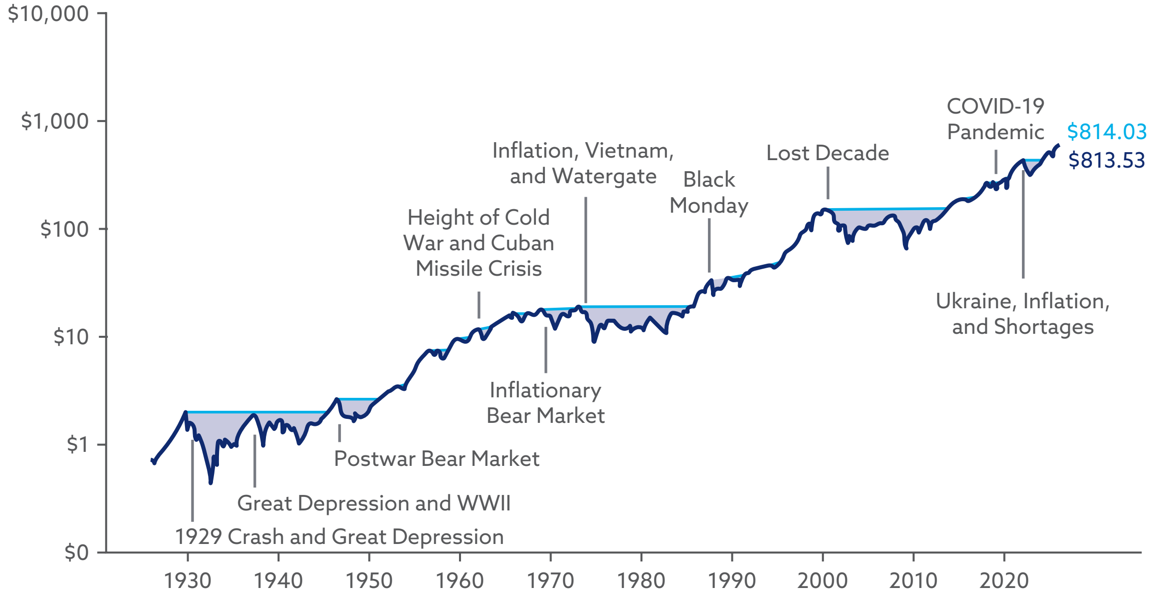
[5] If everybody tried to be a total return investor, when they received a dividend they would be attempting to invest it in shares of the index. But because (in this hypothetical world) everyone is an index investor, all shares of the index are already held by other investors. Thus, if the would-be total return investor managed to buy shares of the index, she would be buying them from another investor who, as a result of the transaction, could not earn the index total return. This is why it is impossible for *everyone* to earn the total return, even though *any given investor* can do it.

Exhibit 2.5. Real Growth of $1 in US Large-Cap Stocks Showing Pain Periods (logarithmic scale), 1926–2025



Source: Ibbotson Large Cap stock index, adjusted for inflation.

Note: The dark blue value ($813.53) is the ending real (inflation-adjusted) value as of 31 December 2025, which is slightly below the previous high-water mark ($814.03) shown in light blue.

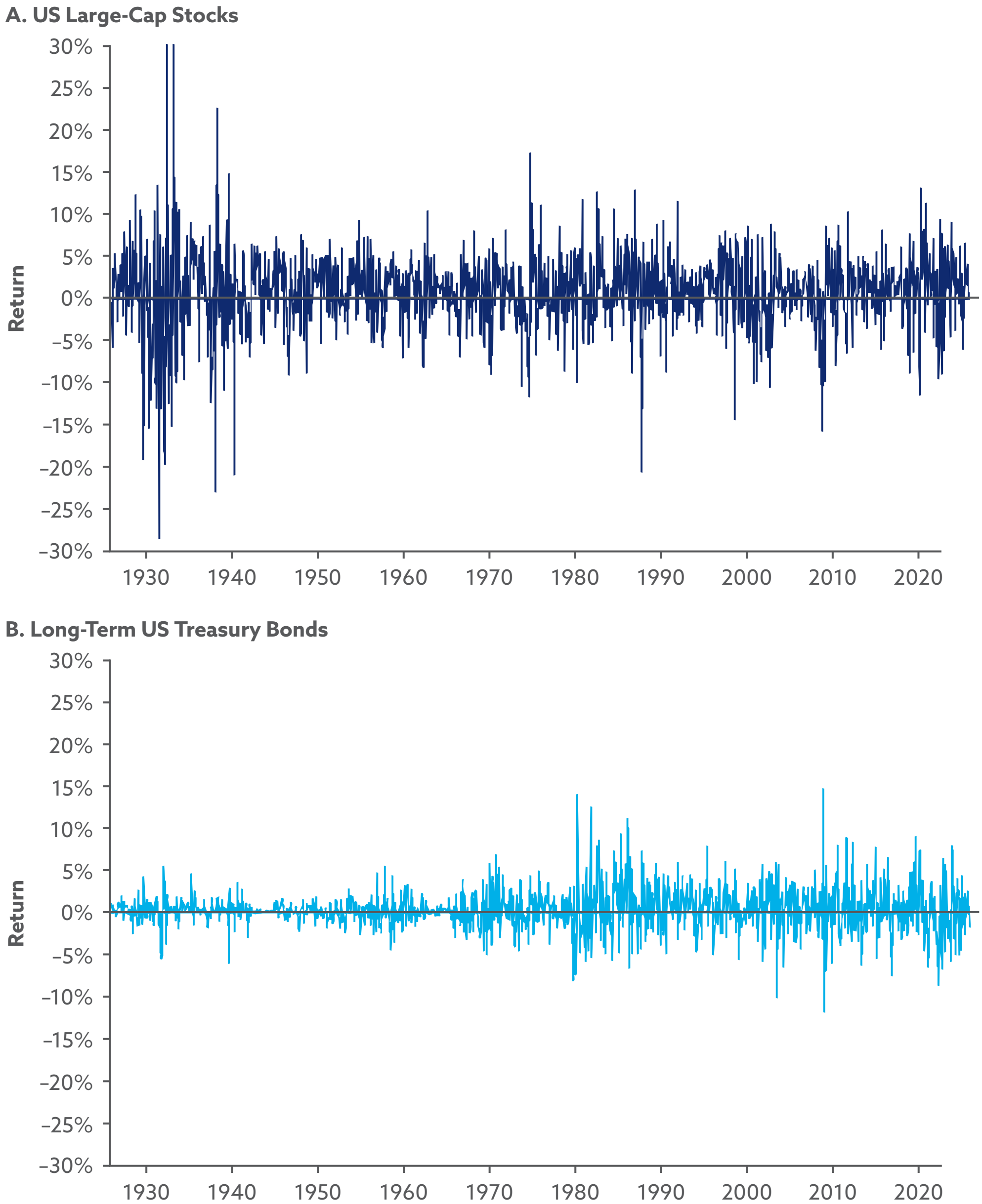
The trifecta of the 1929 crash and Great Depression, World War II, and the post–World War II recession represent a particularly painful two-decade stretch for equity investors in both real and nominal terms. Likewise, the 16-year period from 1966 to 1982 saw almost no growth in real terms. Moving to the twenty-first century, the period from the dot-com bubble through the 2008–09 global financial crisis is frequently referred to as the lost decade. The more recent COVID-19 pandemic–related downturn in the first quarter of 2020 is hardly visible.

Volatility and Risk

Another way to think about pain and risk is volatility. By looking at a graph of realized monthly returns, one can see and compare the volatility of the different asset classes. **Exhibit 2.6** shows the monthly returns of US large-cap stocks and US long-term government bonds. We use the same scale for all series.

Volatility is one of the most important components, if not the dominant component, of risk. As such, stocks are much riskier than bonds. Likewise, US small-cap stocks are riskier than US large-cap stocks, and long-term US Treasury bonds are riskier than Treasury bills. Investors have to be compensated in expectation for taking this extra risk; otherwise, no one would want to invest in the riskier asset classes.

Exhibit 2.6. Monthly Returns on Stocks and Bonds Shown on a Common Scale, 1926–2025



Source: Ibbotson Equity and Bond Indices, derived from CRSP data.

Risk Premiums as Compensation for Risk: The Building Block Approach

Investors are risk averse—that is, to induce investors to hold risky assets (stocks) instead of safer ones (bonds or bills), the risky assets must be priced to offer a higher expected return. We have seen that on average over long periods of time, this expectation has been realized. This difference in returns—realized or expected—between stocks (represented by a cap-weighted market index) and bonds or bills is called the equity risk premium (for more information, see Chapter 9).

In this section, we provide some detail on the premiums that exist in the market. Later, in Chapter 18, we explain why premiums, or return differentials, may result not only from risk but because of other factors as well.

By breaking total returns into their component parts, we can gain a better idea of how inflation and the various premiums sum to the total returns. The building block approach starts with inflation and the real interest rate; these components are embedded in the total return of all the asset classes. When inflation is high, nominal asset returns have to be high enough to offset the degradation of real returns from inflation. Because we are typically measuring risk premiums, asset returns must also attempt to recoup the real interest rate. The real interest rate plus inflation equals the short-term nominal riskless rate, or essentially the return on riskless cash invested in US Treasury bills.

Exhibit 2.7 presents a building block approach to understanding the total return on equities. We start with the return on cash—the sum of inflation and the real interest rate—to give us a

Exhibit 2.7. Building Blocks of Equity Return Premiums

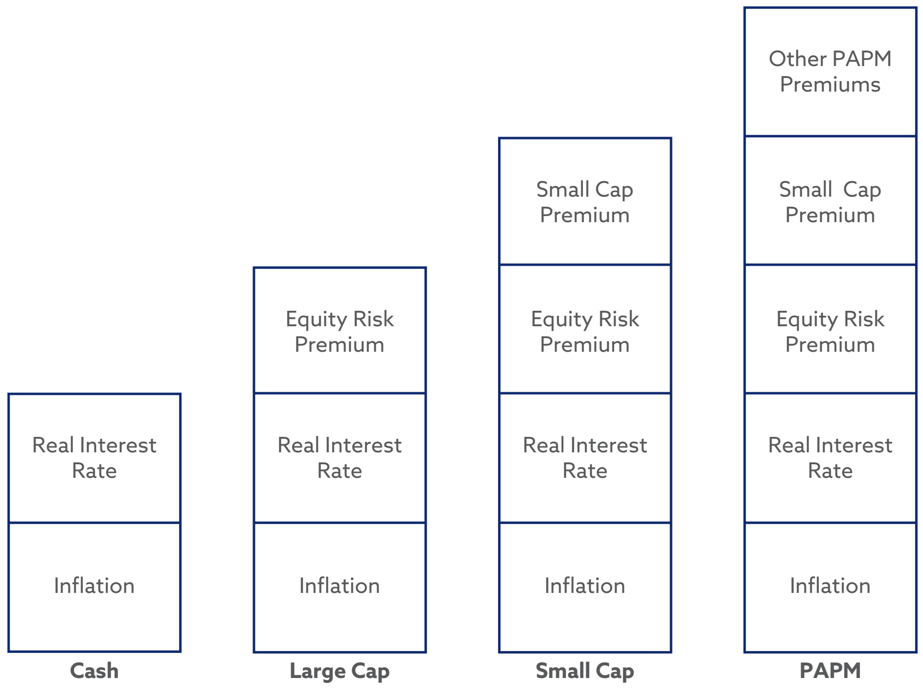
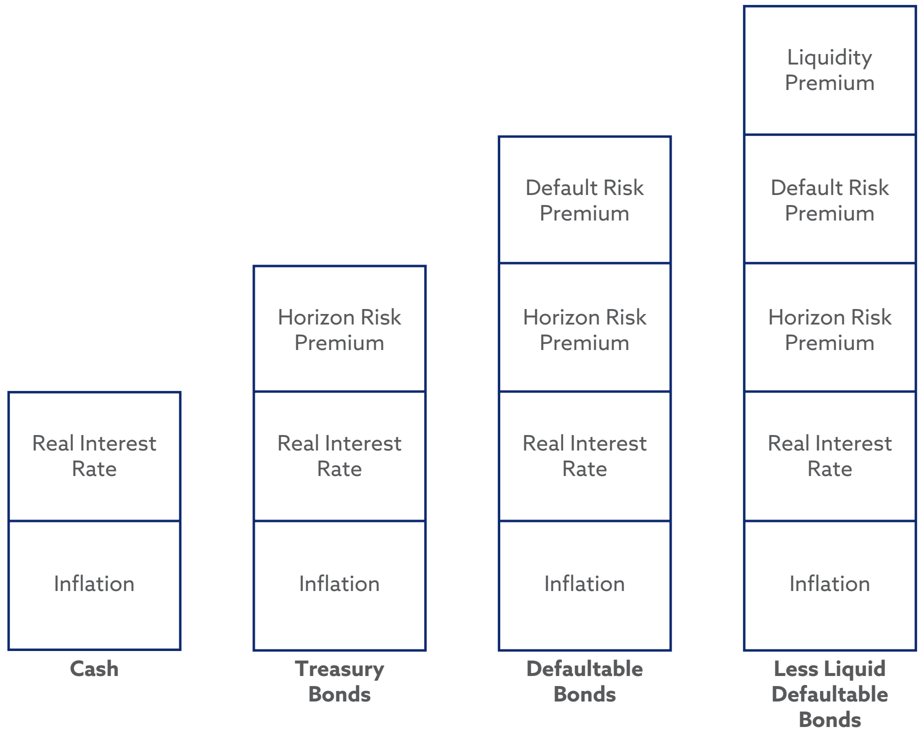


Exhibit 2.8. Building Blocks of Bond Return Premiums



riskless rate. For large-cap equities, we add in the equity risk premium. The historically higher return on small-cap stocks reflects a small-cap premium, which we add to the total return on large caps. We can also add in other premiums as well, including those suggested by the popularity asset pricing model (PAPM), described in Chapter 18.

Moving to fixed income in **Exhibit 2.8**, we also start with inflation and the real interest rate. This sum is merely the US Treasury bill yield, which is directly observable. Adding in the bond horizon premium gives us the US Treasury bond yield. These yields are also observable. The US Treasury yield curve is usually considered to be free of default risk, which means the yield on a US Treasury bond is also the expected return of the bond over the lifetime of that bond.

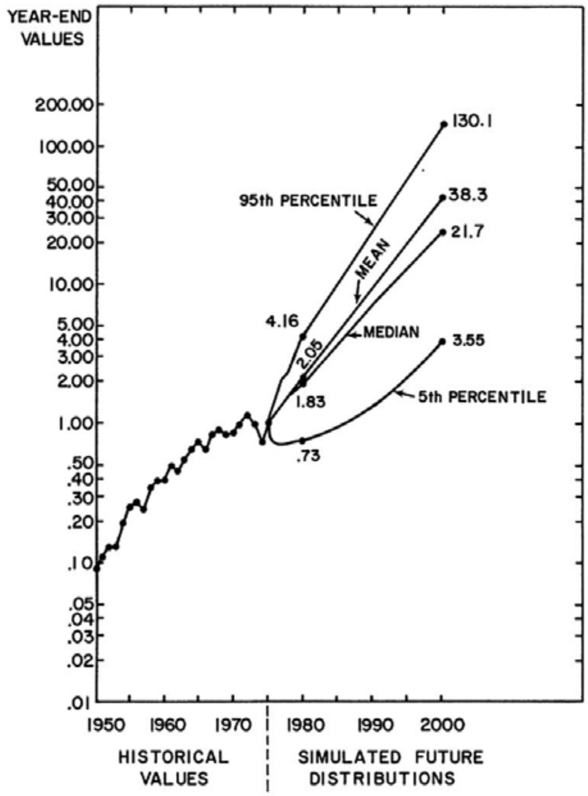
Most other bonds can default. Defaultable bonds have yield spreads over and above the US Treasury yield curve. These yields have to be high enough to compensate investors for any expected defaults and, in addition, high enough to include a default risk premium that investors expect to keep, net of defaults. Thus, investors anticipate realizing higher returns from defaultable bonds than from US Treasury bonds—but not as high as their yields, because they anticipate losing some of their returns to defaults.

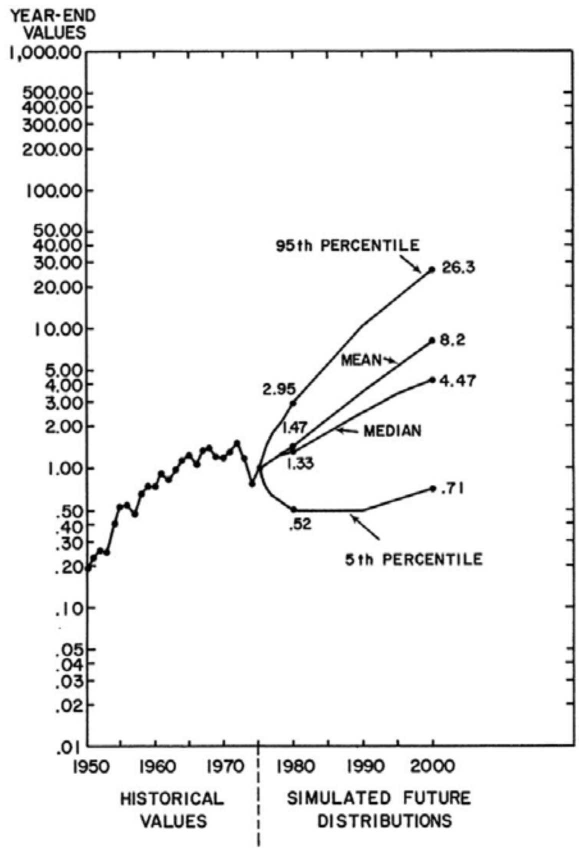
Exhibit 2.8 shows the return that investors expect from the various types of bonds. They expect the return from US Treasury bills to cover inflation and the real interest rate. They expect an additional return from buying longer-term US Treasuries because many investors have short-term time horizons, whereas bond issuers prefer to lock in capital over longer periods. Thus, investors prefer shorter-term bonds and have to be compensated for the extra interest rate risk from locking their money up over time; this is the horizon risk premium. Investors also require and expect a default premium for taking on default risk. Finally, investors need to be compensated with a higher yield for holding less liquid bonds.

Forecasting

The "stacks" in Exhibits 2.7 and 2.8 can be used to analyze the past or the future. When an investor is establishing future expectations, yields currently observable in the bill or bond markets, rather than historical average returns, should be used for the parts of the stacks where market yields exist. These include inflation and the real interest rate in Exhibit 2.7 and inflation, the real interest rate, and the horizon premium in Exhibit 2.8. Chapter 9 presents historical averages for each of the risk premiums in these exhibits.

Exhibit 2.9. Original Figures 2 and 4 from Ibbotson and Sinquefield (1976b): Simulated Growth of $1, Nominal and Real, 1976–2020





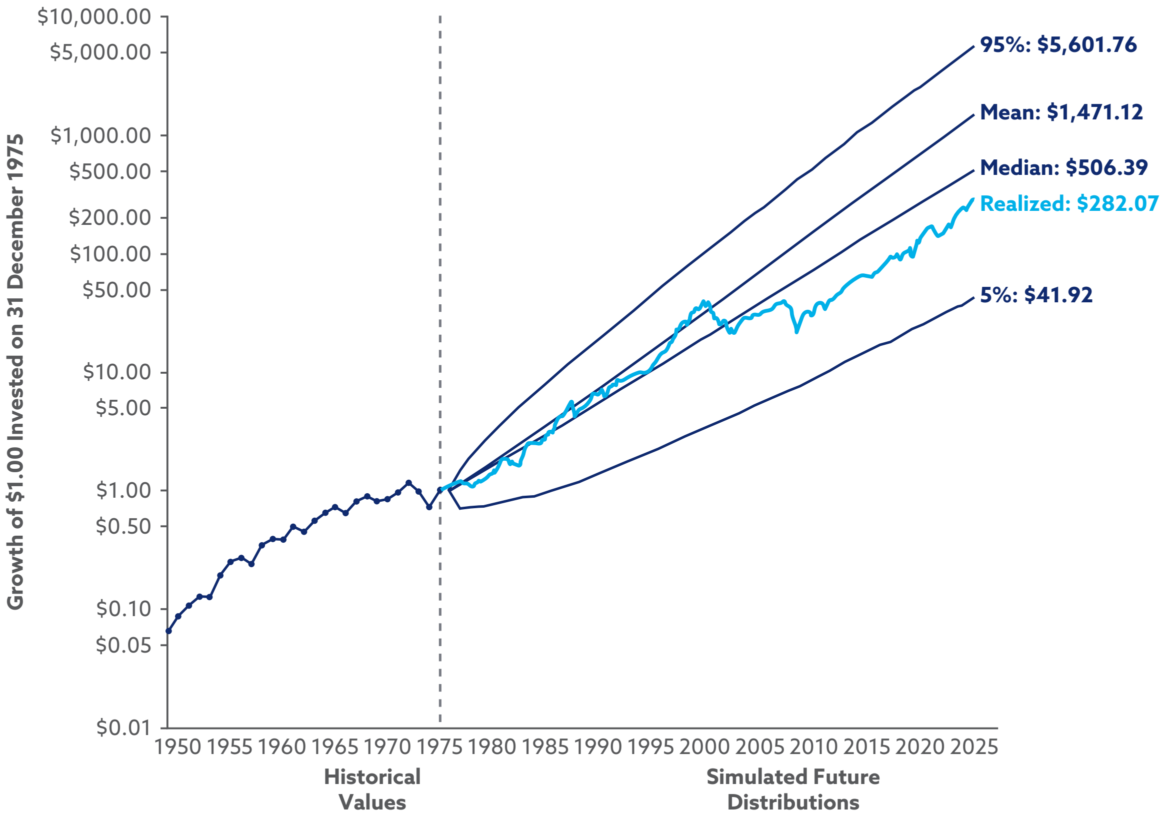
Source: Ibbotson and Sinquefield (1976b).

Note: Year-end values are dollars per dollar invested on 31 December 1975 (left panel shows nominal dollars; right panel shows real or inflation-adjusted dollars).

In "Stocks, Bonds, Bills, and Inflation: Simulations of the Future (1976–2000)," Ibbotson and Sinquefield (1976b) used the various premiums or "building block" approach to simulate future returns—the future at that time being 1976–2000. Now that we have experienced 50 years of returns "out of sample"—that is, after the 1976 forecasts were made—we can assess the accuracy of those forecasts. We perform that assessment next; in Chapters 19 and 20, we return to the topic of forecasting and present two separate ways to forecast future returns and distributions, looking forward from today.

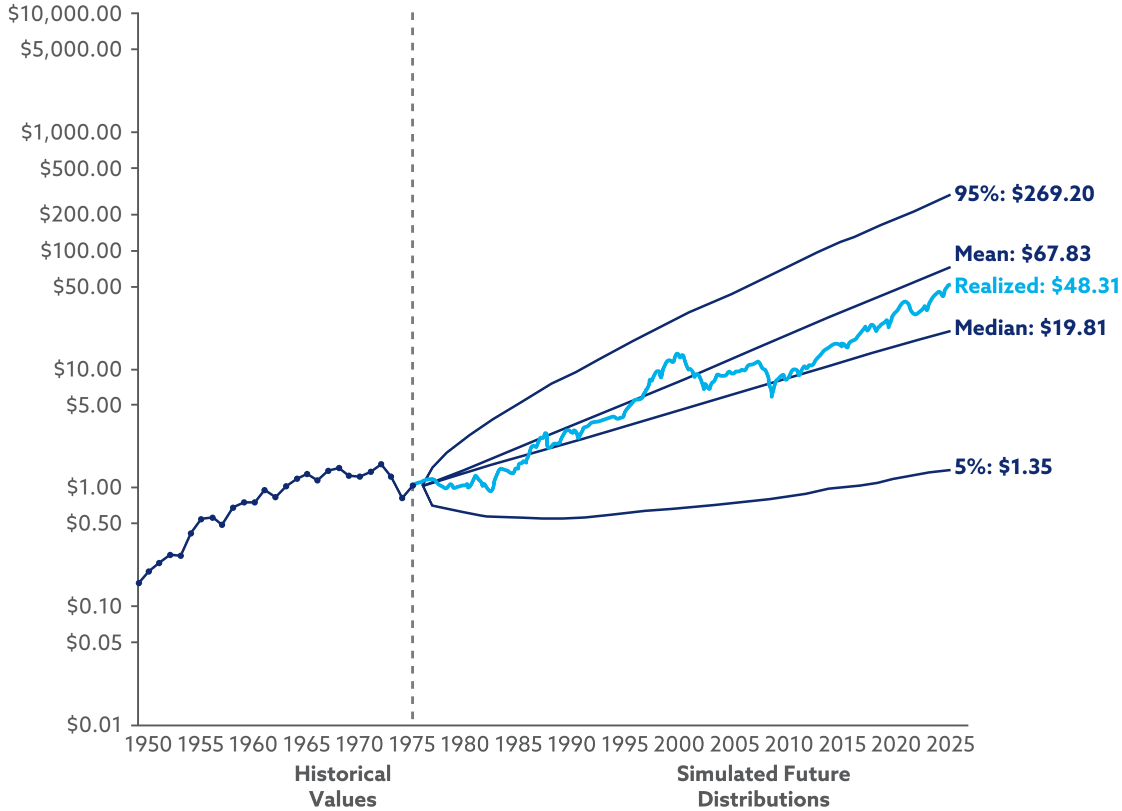
The left and right panels in **Exhibit 2.9** are direct copies of Figure 2 and Figure 4, respectively, from Ibbotson and Sinquefield (1976b). The left panel (originally Figure 2) shows forecast *nominal* returns, and the right panel (originally Figure 4) shows the forecast *real* (inflation-adjusted) returns from 1976 to 2000. Both panels display the forecast mean and median values, along with the values associated with the 95th percentile (approximately the best case) and 5th percentile (approximately the worst case) outcomes using the lognormal simulation method.

Exhibit 2.10. Forecast and Realized Wealth Indices of Common Stocks, 1976–2025, Based on Ibbotson and Sinquefield (1976b)



Source: Ibbotson Equity and Bond Indices.

Exhibit 2.11. Real Forecast and Realized Wealth Indices of Common Stocks, 1976–2025, Based on Ibbotson and Sinquefield (1976b)



Source: Ibbotson Equity and Bond Indices.

In **Exhibit 2.10**, we now apply the 1976 forecasting methodology, using the data and parameters from 1976 (that is, using only information that was available in 1976), to simulate the return distribution over the subsequent 50 years (1976–2025). We also overlay *realized* US large-cap stock returns.

Starting with *nominal* returns, Exhibit 2.10 shows the mean, median, 95th percentile, and 5th percentile growth of $1 in US large-cap stocks. The light blue line shows the actual, or realized, returns on the Ibbotson Large Cap stock index. For the first half of the forecast period (1976–2000), realized returns mostly hovered between the mean and median of the forecast. Then, in the second half of the period (2001–2025), with lower inflation and interest rates, realized returns fell somewhat below the forecast median.

Moving to *real* returns, **Exhibit 2.11** shows the mean, median, 95th percentile, and 5th percentile growth of $1 invested in US large-cap stocks in inflation-adjusted terms. As before, the light blue line shows the realized returns—in this case, real returns—corresponding to the Ibbotson Large Cap stock index. In real terms, the simulation based on the 1976 methodology and parameters does an exceptional job of forecasting the subsequent 50 years' real returns.

Key Takeaways

- We measure the total returns of stocks and bonds. For stocks, total returns consist of capital gains plus reinvested dividends. For US Treasury bonds, total returns consist of the bond's yield plus the return in excess of yield.
- The compound annual total return on US common stocks was 10.1% and on US Treasury bonds was 4.9% during the 100-year period 1926–2025.
- We link (compound) the annual returns to create wealth indices illustrating the creation of exponential wealth through long-term investing. Most of the return represented by these indices is attainable by investors who keep their costs low and reinvest income instead of consuming it.
- Equity returns were approximately the same in both halves of the period. Bonds, however, did poorly because of rising yields until 1981 and then did very well because of falling rates afterward.
- Equities outperformed bonds but with higher risk, providing a high realized equity risk premium.

References

Ibbotson, Roger G., and Rex A. Sinquefield. 1976a. "Stocks, Bonds, Bills, and Inflation: Year-by-Year Historical Returns (1926–1974)." *Journal of Business* 49 (1): 11–47. doi:10.1086/295803.

———. 1976b. "Stocks, Bonds, Bills, and Inflation: Simulations of the Future (1976–2000)." *Journal of Business* 49 (3): 313–38. doi:10.1086/295854.

CHAPTER 3. INDEX CONSTRUCTION: PRINCIPLES AND MODERN DEVELOPMENTS

James P. Harrington
Director, Valuation Services, Kroll

Roger G. Ibbotson, PhD
Professor in the Practice Emeritus of Finance, Yale School of Management
Chair, Zebra Capital Management, LLC

Introduction

In the preceding chapter, we examined the historical performance of major asset classes over the past century. We observed how $1 invested at the beginning of 1926 in the Ibbotson Large Cap stock total return index grew to $14,751 by the end of 2025 (100 years) and had a compound annualized return of 10.1%. These remarkable results raise an important question: How exactly do we construct the indices that measure such performance?

The answer is far from trivial. The methodology underlying index construction has profound implications for both performance measurement and investment strategy. This chapter builds on the foundations laid in Chapter 2 by exploring the mechanics of index construction, the evolution of index methodologies, and recent innovations that have transformed how we measure market performance. The choice of index methodology can materially affect measured returns and, consequently, investment decisions affecting trillions of dollars globally.

What Indices Measure

When we track the performance of asset classes, we use indices to represent their cumulative wealth creation. At their core, indices serve three fundamental purposes: They provide the list of portfolio constituents and weights for index funds, supply a benchmark for evaluating the performance of non-index investments, and quantify the returns available to investors who hold a diversified portfolio within an asset class.

First, indices provide the portfolio list for index funds. Conventional index funds and exchange-traded funds are designed to replicate the performance of a specific index by mirroring its composition. The fund manager's primary goal is to minimize tracking error—the difference between the index's return and the fund's return—and the portfolio changes only when the underlying index rebalances.

Second, active managers use the index as a benchmark to evaluate their ability to add value. They might overweight certain stocks or sectors they believe will outperform or underweight those they believe will underperform. In essence, index funds use the index as a strict roadmap, whereas active managers use it as a base map from which they *intentionally* deviate to seek higher returns.

The distinction between index levels and index returns is crucial. An index level represents the cumulative level of wealth resulting from an initial investment, typically normalized to \$1.00 at a base date. Returns represent the percentage change in wealth over a specific period. Applying the compound annual return of large-cap stocks (10.1%) to all 100 years over the 1926–2025 period results in the same \$14,751 terminal index level:[1]

$$\$1 \times (1 + 10.1\%)^{100} = \$14{,}751. \tag{3.1}$$

Weighting Schemes: A Critical Choice

A fundamental decision in index construction is how to weight the constituent securities. This choice determines which securities have greater influence on index performance and shapes the risk–return characteristics of the index.

Price Weighting: Theoretically Weak

First published in 1896, the oldest major US equity index, the Dow Jones Industrial Average (DJIA), is price weighted. Under this scheme, a stock's influence on the index is proportional to its share price, not its market capitalization. A \$200 stock receives twice the weight of a \$100 stock, regardless of the company's relative economic importance.

Consider a two-stock index consisting of Company A (share price of \$100, market capitalization of \$1 billion) and Company B (share price of \$200, market capitalization of \$1 million). Price weighting would give Company B twice the weight of Company A, even though Company B is 1/1,000 the size. This arbitrary scheme persists primarily because of the DJIA's historical prominence and brand recognition. Most modern indices have abandoned this approach in favor of more economically meaningful alternatives.

Market-Capitalization Weighting: The Theoretical Standard

Market-capitalization weighting has become the dominant method to construct modern indices. Each security's weight equals its market capitalization (share price multiplied by shares outstanding) divided by the total market capitalization of all constituents.

This weighting scheme has theoretical support from the capital asset pricing model (CAPM), which implies that the market-cap-weighted portfolio is the optimal portfolio for all investors. Market-cap-weighted indices are also "macro-consistent": The index's composition attempts to match the overall holdings of investors in the market, making it self-rebalancing for ordinary price changes. Corporate actions such as dividend payments, stock splits, and mergers require adjustment, but routine price movements do not.

Nearly all major modern indices use market-cap weighting, including the S&P 500 Index, MSCI World Index, Russell 3000 Index, and FTSE All-World Index.

[1] The precise compound annual return of the Ibbotson Large Cap stock total return index over the 1926–2025 period is 10.07488%; the difference results from rounding.

Creating a Market-Cap-Weighted Index

A market-cap-weighted index consists of the returns of the individual index constituents "weighted" by their respective market capitalizations. Consider a simple two-constituent portfolio consisting of Company A (market cap = $1 million) and Company B (market cap = $2 million). The aggregate market cap is $3 million, so Company A represents 33% and Company B represents 67%. If the returns of Company A and Company B are 7% and –2%, respectively, the overall return of a portfolio consisting of Company A and Company B is calculated as

$$(33\% \times 7\%) + (67\% \times -2\%) = 1\%. \tag{3.2}$$

Note that the overall return (1%) is closer to Company B's return (–2%) than Company A's return (7%). This is because Company B carries more "weight." **Exhibit 3.1** extends this concept to five companies for February 2025.

First, we must understand a critical concept: When weighting by market cap, the market caps are "lagged." This means that the market caps as of the end of the *previous* month are used to weight the returns of the *current* month[2] (e.g., in the example in Exhibit 3.1, the January 2025 market caps are the weights that should be used to calculate the returns of February 2025).

Lagging the weighting component, regardless of what it is, is standard practice in index construction—and for a very good reason: In the case of market-cap weighting, the return of a stock is *embedded* in the market cap.

For example, say Company A in Exhibit 3.1 had a $1,000,000 market cap at the end of January 2025 and it increased to $1,045,000 by the end of February 2025 (a 4.5% return). If we used

Exhibit 3.1. Month-End Market Caps and Returns for Companies A, B, C, D, and E

	Month	Market Cap	Percentage of Aggregate Market Cap	Month	Return
Company A	January 2025	$1,000,000	4.5%	February 2025	7.0%
Company B	January 2025	$2,000,000	9.1%	February 2025	–2.0%
Company C	January 2025	$10,000,000	45.5%	February 2025	12.0%
Company D	January 2025	$7,000,000	31.8%	February 2025	8.0%
Company E	January 2025	$2,000,000	9.1%	February 2025	2.0%

[2] In this example, a monthly return is calculated. The concept of "lagging" also applies to different time periods (e.g., day, week, quarter).

the February 2025 market cap ($1,045,000), we would be "double counting" the 4.5% return that Company A experienced in February 2025.[3]

The February 2025 return of the index in Exhibit 3.1 can be calculated as follows:[4]

$$(4.5\% \times 7\%) + (9.1\% \times -2\%) + (45.5\% \times 12\%) + (31.8\% \times 8\%) + (9.1\% \times 2\%) = 8.3\%. \tag{3.3}$$

Float Adjustment: Refining Market-Cap Weighting

A critical refinement to market-cap weighting emerged in the early 2000s: float adjustment (McBride 2000). This methodology recognizes that not all shares are equally available for investment. Closely held shares, cross-holdings, and government stakes are subtracted from total shares outstanding to determine the "free float," the portion available for public trading.

Consider a company with a large market capitalization where 70% of its shares are held by a founding family. Float adjustment ensures that index weights reflect the reality that investors can access only the remaining 30%. Most major index providers have adopted float adjustment as standard practice.

Equal Weighting

In an equal-weighted index, every stock receives the same weight—simply $1/N$, where N is the number of stocks. The S&P 500 Equal Weight Index does exactly this, holding the same 500 companies as the standard S&P 500 but weighting them *equally* at each quarterly rebalance.

This approach reduces concentration in the biggest companies and introduces a built-in contrarian effect: At each rebalance, the index trims stocks that have risen and adds stocks that have fallen. To the extent that stock prices exhibit mean reversion,[5] this discipline can generate a modest rebalancing premium. Equal weighting also tilts the portfolio toward *smaller* companies, which have historically earned slightly higher returns as compensation for higher risk. Together, these effects help explain why the equal-weighted S&P 500 total return index had a compound annual return of 11.1% since 1990 (36 years), slightly ahead of the 10.8% for the cap-weighted version.

The tradeoffs are significant. Price movements constantly push weights away from $1/N$, requiring frequent rebalancing and generating higher transaction costs. Since 1990, the equal-weighted S&P 500 total return index had an annualized monthly standard deviation of 18.4%, greater than the 16.4% for the cap-weighted version.

Equal-weighted indices are not macro-consistent. They do not reflect how the market is actually held in aggregate, making them more of an active strategy than a neutral benchmark.

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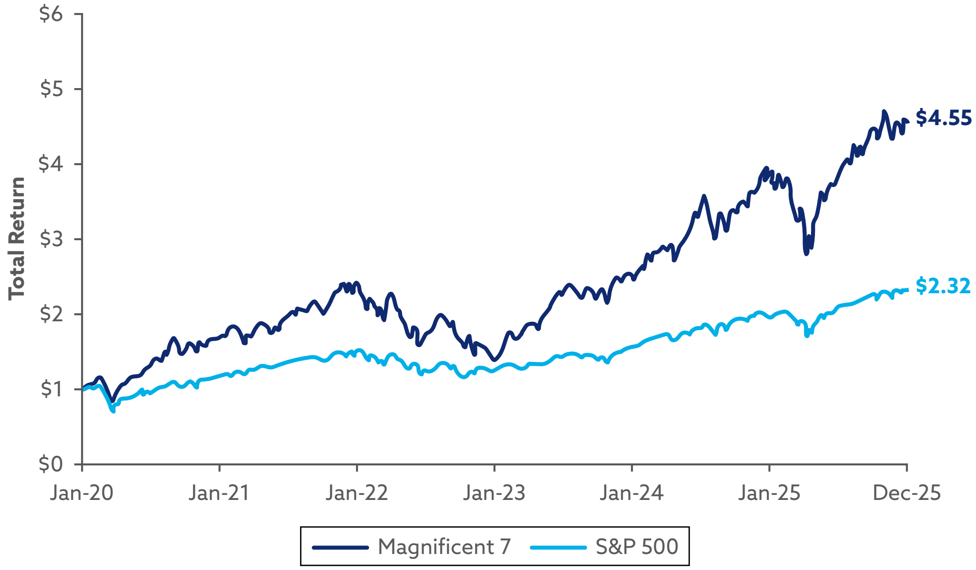
[3] The same argument for "lagging" can be made for most weighting factors to ensure that the weighting factor is independent of returns.

[4] A Microsoft Excel formula can be used to calculate this more easily: SUMPRODUCT(Market Caps, Returns)/Sum(Market Caps).

[5] "Mean reversion" is simply the tendency for assets that have risen above their long-run average to subsequently pull back and for those that have fallen below it to subsequently recover.

Exhibit 3.2. S&P 500 Total Return Index and a Portfolio Consisting of the Magnificent 7, 2020–2025 (year-end 2019 = $1.00)



Sources: Calculations by the authors using data from Datastream and LSEG.

The growing dominance of a handful of mega-cap stocks in cap-weighted indices makes this debate increasingly consequential. When just a few very large companies account for a significant portion of total index weight, such as the so-called Magnificent 7 (Alphabet, Amazon, Apple, Meta, Microsoft, NVIDIA, and Tesla), a cap-weighted index can behave less like a broad market measure and more like a concentrated bet. These seven stocks had an aggregate market capitalization of more than $19 trillion at the end of 2025, accounting for nearly one-third of the approximate $61 trillion aggregate market capitalization of the S&P 500.

Over 2020–2025, a market-cap-weighted portfolio of just the Magnificent 7 compounded at 28.7% annually, compared with 15.1% for the S&P 500 total return index. Stated differently, $1 invested in the S&P 500 at the beginning of 2020 would have grown to $2.32 by the end of 2025, while $1 invested in the Magnificent 7 would have grown to $4.55 (see **Exhibit 3.2**).

Exhibit 3.3 summarizes the key characteristics of the three principal weighting approaches discussed in this section: price-weighted, market-cap-weighted, and equal-weighted indices.

Alternative Weighting Schemes

The past two decades have witnessed an explosion of alternative weighting schemes, marketed under such labels as "smart beta," "strategic beta," and "factor investing." These approaches weight securities based on characteristics other than market capitalization, such as fundamental measures (book value, earnings, sales) or inverse volatility. Although each scheme has its proponents, they share a common trait: They represent active strategies rather than neutral market benchmarks.

Exhibit 3.3. Characteristics of Price-Weighted, Market-Cap-Weighted, and Equal-Weighted Indices

	Price Weighting	Market-Cap Weighting	Equal Weighting
How weights are set	By share price	By market capitalization	Each stock receives 1/*N*
What drives weight differences	Higher-priced stocks receive more weight	Larger companies receive more weight	Nothing—all equal at rebalance
Rebalancing frequency	Only when stocks split or index changes	Minimal—self-adjusting	Frequent (typically quarterly)
Turnover	Low	Low	High
Concentration risk	High—dominated by highest-priced stocks	High—dominated by mega-caps	Low—reduces concentration in largest stocks
Size effect	None—unrelated to company size	Toward larger stocks	Toward smaller stocks
Macro-consistent?	No	Yes	No
Prominent example	Dow Jones Industrial Average	S&P 500	S&P 500 Equal Weight
Key advantage	Simple, long history	Low cost, represents aggregate market	Diversified exposure, rebalancing premium
Key drawback	Arbitrary—a stock split changes the weight	Concentration in largest stocks	High turnover and transaction costs

Fundamental Weighting

Fundamental weighting, introduced by Robert Arnott, Jason Hsu, and Philip Moore (2005) in an influential *Financial Analysts Journal* article, weights constituents by accounting measures, such as book value, earnings, or sales, rather than market price. The key insight is that cap weighting systematically overweights overvalued stocks and underweights undervalued ones because price is embedded in the weight. Fundamental weights, anchored to economic fundamentals rather than price, produce a structural tilt toward value stocks that has historically generated modest return premiums over long periods, although the premium is cyclical and can disappoint for extended stretches, as value investors discovered during the 2010s.

Inverse-Volatility and Minimum-Variance Weighting

Inverse-volatility weighting assigns larger weights to less volatile securities in proportion to the inverse of each stock's historical standard deviation of returns. The intuition is that lower-volatility stocks have historically delivered surprisingly competitive long-run returns relative to their risk—a result that challenges the simple CAPM prediction that higher risk should command a higher reward. Minimum-variance indices extend this idea through portfolio optimization, identifying the combination of weights that minimizes total portfolio variance while accounting for correlations among securities. Both approaches tilt toward defensive sectors (such as utilities and consumer staples) and require regular rebalancing as volatilities and correlations shift, generating higher transaction costs than a cap-weighted index.

Common Tradeoffs

All alternative weighting schemes share several important limitations. First, they are not macro-consistent; investors in aggregate cannot hold a fundamentally or volatility-weighted index the way they can hold the cap-weighted market portfolio. Second, they require active rebalancing, generating turnover, transaction costs, and, in taxable accounts, potential capital gains tax liabilities. Third, their return premiums, to the extent they exist, are generally explainable as compensation for known risk factors or as a mechanical rebalancing premium, not necessarily evidence of market inefficiency.

When Roger Ibbotson and Rex Sinquefield constructed the original SBBI® return series in the 1970s, they chose market-cap weighting precisely because it represents the most neutral, broadly available investment approach—one that any investor could, in principle, replicate. That logic remains sound for the purpose of long-run market measurement. Alternative weighting schemes serve a different purpose and should be evaluated accordingly.

Index Construction Methodology

Beyond weighting, index construction involves numerous methodological choices that collectively determine an index's characteristics and behavior, including security selection criteria, reconstitution frequency, and corporate action treatments.

Company Universe Definition and Security Selection

The first step in index construction is defining the investment universe. For US equity indices, this universe typically includes all securities listed on major exchanges (NYSE, Nasdaq, NYSE American) that meet certain eligibility criteria.[6] Most index providers exclude, for example, American Depositary Receipts, limited partnerships, and closed-end funds.

Index providers differ in how they draw boundaries between market segments. The S&P 500 uses a committee-based approach, considering factors beyond pure market capitalization, including liquidity, financial viability, and sector representation. In contrast, the Russell 3000 uses rule-based criteria to select the 3,000 largest securities, with no committee discretion. These methodological differences can produce meaningful differences in composition and performance, even among indices supposedly measuring the same market segment.

[6] The NYSE American exchange was formerly called NYSE MKT and, prior to that, the American Stock Exchange.

Fixed-Count vs. Percentage-Based Index Construction

An important methodological distinction among index providers is how they define the boundaries between market-capitalization segments. Two principal approaches exist: fixed-count methods and percentage-of-capitalization methods.

Under a fixed-count approach, the index defines its constituents by ranking companies by market capitalization and selecting a predetermined number. The S&P 500 selects approximately 500 large-cap companies; the Russell 1000 Index takes the 1,000 largest; and the Russell 2000 Index takes companies ranked 1,001 through 3,000. This approach is intuitive and produces a stable number of constituents.

Fixed-count methods have a notable limitation, however: The number of publicly listed companies changes substantially over time. According to data from the Center for Research in Security Prices (CRSP), the number of listed US common stocks rose steadily through the 1980s and into the 1990s. It peaked at approximately 7,300 in 1996, before declining sharply as delistings, mergers, and private equity acquisitions of public companies after the dot-com bubble mounted, falling to roughly 4,200 in recent years.[7]

In its first decades, the CRSP database, which initially covered only NYSE-listed stocks, contained far fewer companies. A portfolio defined as the "top 500 stocks" could represent 70% of total market capitalization in one era and 85% in another, depending on how many stocks are listed and how concentrated the market is. The economic exposure of a fixed-count index can shift meaningfully over time even though its count remains constant—a subtle but important limitation for long-run performance measurement.

Two CRSP Index Methodologies

CRSP constructs a variety of stock indices. In this subsection, we focus on its two principal kinds of indices: decile methodology and market ("cap cuts") methodology.

CRSP Decile Methodology

Used for research purposes, CRSP's decile methodology takes a different approach to defining boundaries between market segments. Rather than fixing an absolute number of constituents, CRSP sorts the NYSE universe into 10 equally populated deciles in a way that is economically meaningful and consistent across time.

The foundation of this first (i.e., older) CRSP methodology is its decile framework. CRSP first ranks the eligible NYSE-listed common stocks by total market capitalization and divides them into 10 deciles, each holding an equal number of NYSE stocks. The largest and smallest capitalizations in each decile set its breakpoints. NYSE American- and Nasdaq-listed common stocks are then assigned to those deciles by their own market capitalizations. Decile 1 contains the largest companies; Decile 10 contains the smallest.

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[7] The CRSP US Stock Databases include daily and monthly market data and corporate actions for more than 32,000 active and inactive securities. To learn more, visit www.crsp.org/research/crsp-us-stock-databases/.

In February 2026, Morningstar, Inc., acquired CRSP from the University of Chicago. To learn more, see Morningstar (2026).

Because these breakpoints are set by NYSE stocks alone, not by the combined exchange universe, the decile definitions stay consistent over time. They remain the same even as smaller NYSE American and Nasdaq names crowd into the lower deciles, so that (after 1962 when these smaller stocks were added) the deciles do not have equal populations. This approach has been applied to periods dating back to 1926, enabling genuinely comparable size-based analysis across the full span of US market history.

CRSP Market ("Cap Cuts") Methodology

CRSP's Market Indices, which are used as the basis for a number of index funds, form a separate and newer index family. They segment the market by cumulative capitalization (which we call the "cap cuts" methodology) rather than by number of companies, providing consistent economic exposure to "size" regardless of how many companies are listed at any given time. CRSP's Mega-Cap Index contains companies that collectively represent approximately the top 70% of total US market capitalization. Its Mid-Cap Index captures the next 15%, its Small-Cap Index captures the next 13%, and its Micro-Cap Index captures the remaining 2% (CRSP 2026). Whether the market has 3,000 or 7,000 listed companies, the CRSP Large-Cap Index will always represent approximately the top 85% of market capitalization.

Morningstar, which acquired CRSP in 2026, is renaming the CRSP indices under its own brand (for example, the CRSP US Total Market Index becomes the Morningstar US Total Market Index). The underlying methodology, however, is unchanged.

Compare these approaches with a fixed-count methodology. Suppose an index always holds the 500 largest stocks. In the early 1930s, when fewer than 1,000 common stocks traded publicly, those 500 names might represent well over 90% of total market capitalization. By the late 1990s, when more than 7,000 stocks were listed, the top 500 represented a far smaller fraction. So although the index has the same name and the same count, it measures something quite different in each era. Both CRSP approaches ("deciles" and "cap cuts") sidestep this problem: A "large-cap" stock in 1935 and a "large-cap" stock in 1999 both occupy the same relative position in the size distribution, making the indices comparable across decades.

CRSP further refines its cap cut methodology with transitional "bands" around each breakpoint. Rather than rigidly moving a company from one index to another the moment that company crosses a capitalization threshold, CRSP uses a "packeting" system that allows holdings to be shared between adjacent indices during transitions. This arrangement cushions the movement of companies near breakpoints, reduces unnecessary turnover, and maintains greater style purity—a practical solution to a common problem in rule-based index construction.

The Ibbotson Equity Indices

The Ibbotson Equity Indices presented in this book use a hybrid approach that draws on the CRSP decile framework. For the earlier period (1926–1975), when the total number of securities in the CRSP file was relatively low, the indices are based on CRSP decile portfolios ranked by size. For the later period (1976–2025), the indices transition to fixed numerical counts that produce size-based portfolios with economic exposures broadly consistent with the percentage-based breakpoints used by CRSP's commercial indices.

For example, the Ibbotson Large Cap stock total return index uses CRSP Deciles 1 and 2 through 1975, and then it uses the top 300 stocks from 1976 onward. The correlation between the Ibbotson Large Cap stock total return index and the CRSP S&P 500 replication is approximately 0.99.

Reconstitution and Rebalancing

Indices must periodically update their composition to reflect changes in the investment universe. Reconstitution accounts for companies that go out of business, are acquired, or fail to continue meeting index inclusion criteria. Size-related indices must also be reconstituted periodically to reflect stock price changes that shift companies from one size category to another.

The Russell size indices reconstitute annually each June.[8] The S&P 500 is rebalanced quarterly for reweighting purposes in March, June, September, and December, and its Index Committee meets monthly to review pending corporate actions.[9] More frequent reconstitution keeps the index more current but generates higher transaction costs for index-tracking portfolios. Less frequent reconstitution reduces costs but may allow the index to drift from its intended market representation.

Treatment of Corporate Actions

Index construction requires clear rules for handling corporate actions, including stock splits, spinoffs, mergers, acquisitions, and bankruptcies. For total return indices, such as those presented in Chapter 2, dividend reinvestment is automatic; the index assumes that all cash distributions are immediately reinvested in the index. This approach ensures that total return indices reflect the complete return available to long-term investors. Price return indices, by contrast, ignore dividends and capture only capital appreciation.

The treatment of spinoffs varies across providers. Some immediately add spun-off entities if they meet eligibility criteria, and others wait until the next reconstitution.

Calculating Returns and Index Values

The mathematical relationship between returns and index values is fundamental to understanding long-term wealth accumulation. As illustrated in Chapter 2, the cumulative wealth from holding large-cap stocks grew from $1 to $14,751 over the 1926–2025 time period—a testament to the power of compounding.

Measuring Single-Period Returns

We typically measure the total return of a security or portfolio over a specific period. Equation 3.4 expresses the total return as the sum of two components: the capital gain (or loss)

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[8] Starting in 2026, the Russell size indices (e.g., the Russell 1000 and Russell 2000) will start rebalancing twice per year, on the fourth Friday in June and the second Friday in November. For more information, see Yoshimoto (2025).

[9] For more information, see S&P Dow Jones Indices (2026).

and the income received. The first term captures the percentage change in value from V_{t-1} to V_t, and the second term represents the dividend or income yield, D_t, earned over the period:

$$R_t = \underbrace{\frac{V_t - V_{t-1}}{V_{t-1}}}_{\text{\% Capital gains}} + \underbrace{\frac{D_t}{V_{t-1}}}_{\text{\% Dividends}} . \tag{3.4}$$

Portfolio Returns

Returns across securities can be aggregated into portfolio returns. In Equation 3.5, the return of portfolio p, R_p, is the weighted sum of the returns of the individual securities, R_i, with the weights, W_i, summing to 1:

$$R_p = \sum_{i=1}^{n} W_i R_i . \tag{3.5}$$

From Returns to Index Values

Index values are calculated by linking (compounding) returns over successive periods. We start with an initial value V_0 (typically \$1.00). In Equation 3.6, we compound the single-period returns, R_t, over T multiple periods using the product operator $\prod$, which multiplies the single-period wealth relatives $(1 + R_t)$ to obtain ending wealth V_T:

$$V_T = V_0 \prod_{t=1}^{T} (1 + R_t), \tag{3.6}$$

or, equivalently,

$$V_T = V_0 \times (1 + R_1) \times (1 + R_2) \times \ldots \times (1 + R_T). \tag{3.7}$$

This formulation makes explicit the multiplicative nature of wealth accumulation. A 10% gain followed by a 10% loss does *not* return an investor to the starting point; the ending value is $\$1 \times (1 + 10\%) \times [1 + (-10\%)] = \$0.99$. For larger price changes, the outcome is more dramatic: A 50% decline requires a 100% increase, not 50%, to break even.

Arithmetic and Geometric Mean Returns

We can summarize returns over T periods using two averaging methods. The arithmetic mean return, R_A, is the simple average of single-period returns:

$$R_A = \sum_{t=1}^{T} \frac{R_t}{T} . \tag{3.8}$$

Alternatively, we can calculate the geometric mean return, R_G, by taking the Tth root of the ratio of ending wealth to beginning wealth and subtracting 1:

$$R_G = \left(\frac{V_T}{V_0} \right)^{\frac{1}{T}} - 1. \tag{3.9}$$

Equivalently, we can express the geometric mean as the *T*th root of the product of wealth relatives minus 1:

$$R_G = \left[\prod_{t=1}^{T}(1+R_t)\right]^{\frac{1}{T}} - 1. \tag{3.10}$$

The geometric mean, equivalent to the compound annualized return, tells us the constant rate of return that would produce the observed terminal wealth. The arithmetic mean represents the simple average of periodic (e.g., annual) returns.

The difference between the geometric mean and arithmetic mean is related to the variability of returns. The arithmetic mean is always greater than the geometric mean, except in one unique situation: where all the periodic returns are identical and "variability" is absent. The more variable the periodic returns are, the greater the difference between the arithmetic and geometric average.

This relationship can be illustrated with an extreme example. If we invested $1 million in Period 0 and then experienced a return of +50% in Period 1 and a return of –50% in Period 2, our ending wealth (using Equation 3.7) would be

$$V_T = \$1{,}000{,}000 \times (1 + 50\%) \times [1 + (-50\%)] = \$750{,}000. \tag{3.11}$$

This would give an arithmetic mean (using Equation 3.8) of

$$R_A = \frac{[50\% + (-50\%)]}{2} = 0\% \tag{3.12}$$

and a geometric mean (using Equation 3.9) of

$$R_G = \left(\frac{\$750{,}000}{\$1{,}000{,}000}\right)^{\frac{1}{2}} - 1 = -13.4\%. \tag{3.13}$$

Alternatively, the geometric mean can be calculated using Equation 3.10:

$$R_G = \left\{(1+50\%) \times [1+(-50\%)]\right\}^{\frac{1}{2}} - 1 = -13.4\%. \tag{3.14}$$

In this example, the volatility of returns was very high (50% swings up and down), creating a large difference between the arithmetic mean (0%) and the geometric mean (–13.4%).

These examples demonstrate that the simple or arithmetic average of returns, R_A, does not provide us with a very clear picture of what has happened. The geometric mean, which summarizes the compounding of returns, does.

The geometric annual return goes by many names: compound annualized return, annualized geometric mean return, compound annual growth rate, and so on. These terms all have the same meaning.[10]

[10] Geometric mean returns can be measured using any base period of time (e.g., daily, monthly, quarterly, annually). Annualized geometric returns are usually the ones we are most interested in.

The Rule of 72

Equations 3.9 and 3.10 provide the exact calculation of how money compounds. It may also be useful to have a simple formula that gives us an approximation of the number of years it takes to double our initial wealth.

The Rule of 72 provides a rough approximation of how many years it takes to double your wealth. It is simple enough to calculate in your head:

$$n \approx \frac{72}{R}, \tag{3.15}$$

where n is the number of years to double your initial wealth and R is the compound annualized return expressed as a percentage. For example, a compound annual return of 12% would double your initial wealth in about six years:[11]

$$n \approx \frac{72}{12} \approx 6 \text{ years.} \tag{3.16}$$

Decomposing Total Returns

Total returns for equity indices can be decomposed into two primary components: (1) capital appreciation return and (2) income return. Income return measures the periodic dividend payment many stocks make, and capital appreciation return captures changes in the price of the stock, typically resulting from earnings growth or market sentiment.

Many investors focus on capital appreciation return. For example, buying a stock at $50 that increases in value to $60 is, after all, quite satisfying. But income (i.e., dividend) return and its reinvestment, rather than capital appreciation return, have historically accounted for the vast majority of long-term equity returns.

We previously saw that an investment of $1 in the Ibbotson Large Cap stock total return index (a "total return" index includes both capital appreciation returns and dividend returns) over the 1926–2025 period would have grown to $14,751 by the end of 2025. But investing $1 over the same period in an equivalent index that measures only capital appreciation returns would have grown to a mere $398, implying that $14,353 ($14,751 – $398)—or an astonishing 97%—of the growth of the total return index can be attributed to dividend returns and their reinvestment.[12] This striking statistic underscores the importance of dividend reinvestment in long-term wealth creation.

For bond indices, the decomposition takes the same form. Income return is defined as the return that would have been realized if the yield had not changed over the period; it is essentially the return attributable to coupon payments. The remainder—the "return in excess of yield"—captures price changes caused by movements in interest rates.

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[11] A more exact formula for the Rule of 72 is $n = \ln(2)/\ln(1 + R)$. Assuming a compound annual return of 12% and using this formula, it would take 6.12 years to double your initial wealth.

[12] The "equivalent index" used in this example is the Ibbotson Large Cap stock capital gain index.

Measuring Risk

The typical way we measure risk or volatility is by using the standard deviation of returns. This starts with the calculation of the variance, which measures the average squared deviation of individual-period returns from their mean. The standard deviation is then the square root of the variance.

Population vs. Sample Standard Deviation

Before presenting the equations, we must address an important question: Should the variance be calculated by dividing by n (the number of observations) or $n - 1$?

Dividing by n produces the *population* standard deviation. It is appropriate when the dataset represents the complete population of interest—for example, if you measured the height of every student in a class and wanted to describe only that class's variability, with no intention of making inferences about a broader set of possible outcomes.

Dividing by $n - 1$ produces the *sample* standard deviation.[13] This incorporates Bessel's correction, used when the true mean of a population is unknowable—that is, when the observations being analyzed are a sample, not the full population.

Returning to the classroom example, if you measured only some of the students and wanted to *estimate* the variability of the entire school, you would use $n - 1$. A sample tends to cluster closer to its own average than the full population does, naturally understating the true spread. Dividing by $n - 1$ slightly inflates the result to compensate.

In finance, we nearly always work with a sample drawn from a theoretically larger population. Even 100 years of annual stock returns represent only a sample of the return-generating process, not the complete universe of returns that could have occurred, that have occurred in other countries, or that will occur in the future. For this reason, the sample standard deviation may be the more appropriate choice.

In the past, the *Stocks, Bonds, Bills, and Inflation® (SBBI®) Yearbook*, published by Ibbotson Associates, then Morningstar, then Kroll, used the sample version of the standard deviation when measuring the standard deviation of returns. We continue that convention in this book. We acknowledge that many practitioners and textbooks use the population formula (dividing by n) for long historical return series, particularly when treating the data as a complete record rather than a sample. Either approach is defensible; what matters is applying it consistently.[14]

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[13] Excel users are familiar with the standard deviation function in Excel (STDEV), which calculates standard deviation using the formula for "sample" (i.e., it uses "$n - 1$" in the variance calculation). Microsoft has replaced the STDEV function with STDEV.S for "sample" calculations and STDEV.P for "population" calculations. For more information, visit https://support.microsoft.com/en-us/office/stdev-function-51fecaaa-231e-4bbb-9230-33650a72c9b0.

[14] For long data series, the practical difference is negligible. For example, when calculating the annual standard deviation of the Ibbotson Large Cap stock total return index over the 1926–2025 period (100 observations), the material impact of dividing by 99 (sample) rather than 100 (population) is negligible (19.04% versus 18.94%, respectively).

Calculating the Variance and Standard Deviation

The variance of a sample of n return observations is

$$\sigma^2 = \frac{1}{n-1}\sum_{t=1}^{n}(R_t - R_A)^2. \tag{3.17}$$

The standard deviation is simply the square root of the variance:

$$\sigma = \sqrt{\sigma^2}. \tag{3.18}$$

Calculating the Standard Deviation of Annual Returns

If we have annual data, we calculate the annual standard deviation of returns. For a three-year period with returns of 10%, –20%, and 40%, the arithmetic mean is

$$R_A = \frac{[10\% + (-20\%) + 40\%]}{3} = 10\%. \tag{3.19}$$

The variance is calculated using Equation 3.17:

$$\sigma^2 = \frac{[(10\% - 10\%)^2 + (-20\% - 10\%)^2 + (40\% - 10\%)^2]}{3-1} = \frac{[(0\%)^2 + (-30\%)^2 + (30\%)^2]}{2} = 9\%. \tag{3.20}$$

The standard deviation can be calculated using Equation 3.18:

$$\sigma = \sqrt{9\%} = 30\%. \tag{3.21}$$

Note that using the population formula (dividing by $T = 3$) would give a variance of 6% and a standard deviation of 24.5%. The difference between the sample (30%) and population (24.5%) standard deviations is substantial in this small sample (three observations). With larger samples, the difference diminishes, but using the sample version consistently ensures internal consistency across all calculations and comparisons.

Annualizing Monthly Standard Deviation

In practice, standard deviation is often calculated using monthly return data, which provide more observations and can make estimates more statistically reliable. A series of *monthly* returns produces a *monthly* standard deviation. The following approximation is often used by analysts to express a monthly standard deviation in annualized terms:

$$\sigma_n = \sigma_1 \times \sqrt{n}, \tag{3.22}$$

where σ_1 is the monthly standard deviation and n is the number of periods—in this case, 12.

Exhibit 3.4 shows monthly returns for January–December 2020—the year in which the COVID-19 pandemic hit, with unusually volatile returns.

Exhibit 3.4. Ibbotson Large Cap Stock Total Return Index, January 2020–December 2020

	Return
January 2020	0.6%
February 2020	–7.9%
March 2020	–11.4%
April 2020	13.3%
May 2020	5.0%
June 2020	2.3%
July 2020	6.1%
August 2020	8.3%
September 2020	–4.0%
October 2020	–2.9%
November 2020	11.5%
December 2020	4.0%

Using Equation 3.8, the arithmetic mean of the monthly returns in Exhibit 3.4 can be calculated as follows:

$$R_A = \frac{\begin{array}{c}[0.6\% + (-7.9\%) + (-11.4\%) + 13.3\% + \\ 5.0\% + 2.3\% + 6.1\% + 8.3\% + \\ (-4.0\%) + (-2.9\%) + 11.5\% + 4.0\%]\end{array}}{12} = 2.1\%. \qquad (3.23)$$

The variance is calculated using Equation 3.17:

$$\sigma^2 = \frac{\begin{array}{c}[(0.6\% - 2.1\%)^2 + (-7.9\% - 2.1\%)^2 + (-11.4\% - 2.1\%)^2 + \\ (13.3\% - 2.1\%)^2 + (5.0\% - 2.1\%)^2 + (2.3\% - 2.1\%)^2 + \\ (6.1\% - 2.1\%)^2 + (8.3\% - 2.1\%)^2 + (-4.0\% - 2.1\%)^2 + \\ (-2.9\% - 2.1\%)^2 + (11.5\% - 2.1\%)^2 + (4.0\% - 2.1\%)^2]\end{array}}{12 - 1} = 0.57\%. \qquad (3.24)$$

The monthly standard deviation for calendar year 2020 can be calculated using Equation 3.18:

$$\sigma = \sqrt{0.57\%} = 7.5\%. \qquad (3.25)$$

The *monthly* standard deviation (7.5%) can be *annualized* using Equation 3.22:

$$\sigma_n = 7.5\% \times \sqrt{12} = 7.5\% \times 3.46 = 26.0\%. \tag{3.26}$$

The average and median annualized monthly standard deviation for *all* calendar years (1926–2025) for the Ibbotson Large Cap stock total return index are approximately 15% and 13%, respectively, demonstrating that market returns in 2020 (the first year of the COVID-19 pandemic) were unusually volatile.

The Relationship Between Geometric and Arithmetic Means

Measuring risk is important because it appears to be the major determinant of the equity risk premium, the difference between stock and bond returns. Risk is also the reason that geometric means are lower than arithmetic means.

The divergence between these measures is proportional to return volatility. The approximate relationship is as follows:[15]

$$R_G \approx R_A - \frac{\sigma^2}{2}. \tag{3.27}$$

This well-known approximation states that the geometric mean is approximately equal to the arithmetic mean minus one-half the variance. It works reasonably well when standard deviations are moderate but becomes less accurate when standard deviations are high.

The standard deviation of the annual returns on the Ibbotson Large Cap stock total return index over the 1926–2025 period is 19%, implying a variance of about 3.6% (because $19\%^2 \approx 3.6\%$). The arithmetic average annual return of the index is 11.8%, so the geometric mean can be estimated using Equation 3.27:

$$R_G \approx 11.8\% - \frac{3.6\%}{2} = 10\%. \tag{3.28}$$

This estimate approximates the previous empirical observation that the Ibbotson Large Cap stock total return index produced a 10.1% compound annualized return over the 1926–2025 period.

The important concept to remember is that the *higher* the standard deviation, the *greater* the difference will be between compound (i.e., geometric) and arithmetic average returns.

The choice between geometric and arithmetic means depends on the purpose. For measuring historical performance and wealth accumulation, the geometric mean is appropriate. For forward-looking expected returns in portfolio optimization, many practitioners prefer arithmetic means.

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[15] Mindlin (2011) provided a more thorough treatment, presenting four approximate relationships between the arithmetic expected return, geometric expected return, and variance and checking their accuracy against historical data. His analysis confirms that the "one-half variance" adjustment in Equation 3.27 is a convenient first approximation but that more precise formulations exist for applications where accuracy is critical.

Modern Developments in Index Construction

The field of index construction has evolved substantially since the inception of the Ibbotson return series in the 1970s. Recent decades have witnessed innovations in methodology and technology, as well as the proliferation of specialized indices targeting specific investment strategies or market segments.

Environmental, Social, and Governance (ESG) Indices

ESG indices emerged in the first decade of the twenty-first century and gained substantial momentum through the 2010s. They screen securities based on nonfinancial criteria such as carbon emissions, labor practices, board diversity, or alignment with sustainable development goals. According to Morningstar, assets in ESG-focused funds reached $3.9 trillion in 2021 (Murugaboopathy and Maan 2021).

ESG investing has since encountered significant headwinds (Furness 2025; Cifrino 2025). Sustainable fund inflows slowed sharply after 2022, amid political and regulatory pressures in certain jurisdictions and widespread concerns about "greenwashing"—the practice of overstating a fund's environmental or social credentials. From an index construction standpoint, ESG indices face a fundamental methodological problem: ESG rating agencies frequently produce divergent assessments of the same company, reflecting the absence of a universally agreed-upon standard. A company rated highly by one provider may rank poorly with another, depending on how each agency weights the underlying criteria. This inconsistency makes it difficult to evaluate ESG indices on equal footing or to know precisely what they are measuring.

Performance results have been mixed. ESG indices are not designed to be neutral market benchmarks; they are, by construction, exclusionary. Excluding entire sectors, such as fossil fuels, defense, or tobacco, introduces sector tilts that can help or hurt performance depending on the market environment. During the ESG boom years of 2019–2021, the exclusion of energy stocks was a tailwind; then, as energy surged in 2022, it became a headwind. ESG indices remain a significant segment of the index landscape, but investors should understand them for what they are: a set of active bets about which companies and sectors society will reward over time.

Factor-Based and Multifactor Indices

The academic literature on factor investing has spawned a proliferation of factor-based indices that tilt portfolios toward such characteristics as value, momentum, quality, low volatility, liquidity, or size. Single-factor indices target one characteristic; multifactor indices combine several, attempting to harvest premiums from multiple sources while diversifying across factor exposures.

Factor indices blur the line between passive and active management. Although they follow rule-based approaches, they make deliberate bets that deviate from market-cap weighting. The implementation of factor indices requires careful consideration of factor definitions, weighting methodologies, and rebalancing frequencies.

Cryptocurrency and Digital Asset Indices

The emergence of cryptocurrencies and digital assets has created an entirely new domain for index construction. These indices face unprecedented methodological challenges: Cryptoassets trade around the clock with extreme volatility, lack traditional corporate structures, and present novel questions about what should be weighted (market capitalization based on fully diluted supply or current circulating supply) and what qualifies as an eligible asset. Several providers have launched cryptocurrency indices using market-cap weighting with minimum liquidity thresholds, equal weighting, or capped weighting. Methodological standards continue to evolve.

Custom and Direct Indexing

Technological advances have enabled "direct indexing," under which investors hold customized portfolios of individual securities rather than pooled index funds. These customized portfolios are intended to replicate the performance and risk of an index while enabling tax-loss harvesting at the individual security level and, if desired, customization to reflect personal values or constraints. Direct indexing represents the logical extension of index methodology, from a single benchmark that serves all investors to personalized portfolios tailored to individual circumstances.

Practical Considerations in Index Selection

For practitioners seeking to measure performance or construct portfolios, choosing appropriate indices requires careful consideration of several factors beyond just historical returns.

Investability

An ideal index represents an investable opportunity. Investors should be able to replicate the index's returns with reasonable effort and cost. Doing so requires adequate liquidity in constituent securities, enough supply, and reasonable transaction costs. The Ibbotson Indices avoid such pitfalls as survivorship bias by focusing on broad, liquid markets with transparent pricing and accessible trading.

Transparency and Replicability

Index methodologies should be transparent and consistently applied so that investors can understand what they are measuring. The S&P 500's committee-based approach introduces an element of discretion that has occasionally generated controversy. Other index families emphasize rule-based methodologies with minimal discretion. Both approaches have merits; the key is that the methodology be clearly documented and consistently applied.

Historical Consistency

For long-term analysis, such as the studies discussed in Chapter 2, historical consistency is paramount. The index methodology should be stable over time, allowing for meaningful comparisons across decades. The transition to float adjustment in the early part of the twenty-first century created a methodological break that index providers handled in different ways, with some reconstructing historical data retroactively and others maintaining values based on full market capitalization. Users of long-term return series must be aware of such shifts when conducting historical analysis.

Conclusion

The indices that form the foundation of Chapter 2's historical performance analysis are far more than neutral scorecards. They embody specific methodological choices about weighting, universe definition, reconstitution, and corporate action treatment—choices that profoundly influence measured returns and our understanding of market behavior.

Market-capitalization weighting has emerged as the dominant approach because of its theoretical foundation in modern portfolio theory and its practical advantages in terms of investability and macro-consistency. The addition of float adjustment refined this methodology to better represent investable opportunities.

The CRSP decile framework offers a powerful solution for long-run market analysis. By defining size segments based on the relative position of companies in the overall capitalization distribution rather than fixed counts, CRSP delivers consistent economic meaning across decades, which is why the Ibbotson Indices rely on CRSP decile portfolios for the pre-1976 period and adopt comparable fixed counts for the modern era.

In recent decades, we have witnessed an explosion of index innovation, from ESG indices and factor-based strategies to cryptocurrency indices and direct indexing. These developments expand the toolkit available to investors but also introduce complexity. Not all innovations represent improvements over traditional market-cap weighting for the core purpose of broad market measurement.

The fundamental principles remain as relevant as ever: broad diversification, transparent methodology, investability, and theoretical soundness. The $14,751 terminal wealth from a $1 investment in the Ibbotson Large Cap stock total return index documented in Chapter 2 was built on indices that maintained methodological consistency over a century. Understanding how they are constructed is inseparable from understanding what they tell us.

Key Takeaways

- Index construction methodology matters. The choices embedded in an index guide the measurement of returns and risk characteristics and influence investment decisions affecting trillions of dollars globally.
- Market-capitalization weighting is the dominant approach because it is grounded in the CAPM, requires minimal rebalancing, and is macro-consistent. Float adjustment refined this methodology by ensuring that index weights reflect shares actually available for public investment.
- Alternative weighting schemes—equal weighting, fundamental weighting, and "smart beta" strategies—offer different perspectives on diversification and concentration risk, but they represent active strategies rather than neutral benchmarks.

- The geometric mean, not the arithmetic mean, tells us what an investor actually earned. The higher the return volatility, the greater the gap between the two.
- When selecting an index, investability, transparency, and historical consistency should guide the decision. A well-constructed index is not just a scorecard—it is the foundation for performance evaluation, risk measurement, and capital allocation.

References

Arnott, Robert D., Jason Hsu, and Philip Moore. 2005. "Fundamental Indexation." *Financial Analysts Journal* 61 (2): 83–99. doi:10.2469/faj.v61.n2.2718.

Cifrino, David A. 2025. "The Politicization of ESG Investing." *Harvard Advanced Leadership Initiative Social Impact Review* (24 January). www.sir.advancedleadership.harvard.edu/articles/politicization-of-esg-investing.

CRSP. 2026. "CRSP Market Indexes Methodology Guide" (January). www.crsp.org/wp-content/uploads/guides/CRSP_Market_Indexes_Methodology_Guide-January_2026.pdf.

Furness, Virginia. 2025. "Sustainable Funds Market Inflows Halve as ESG Falls out of Favour." Reuters (27 January). www.reuters.com/sustainability/sustainable-finance-reporting/sustainable-funds-market-inflows-halve-esg-falls-out-favour-2025-01-27/.

McBride, Sarah. 2000. "MSCI Will Adjust Indexes to Reflect Free-Float Shares, Not Capitalization." *Wall Street Journal* (11 December). www.wsj.com/articles/SB976476678643622201.

Mindlin, Dimitry. 2011. "On the Relationship Between Arithmetic and Geometric Returns." Working paper, CDI Advisors (14 August). doi:10.2139/ssrn.2083915.

Morningstar. 2026. "Morningstar Completes Acquisition of CRSP and Extends Relationship with Vanguard." Press release (2 February). https://newsroom.morningstar.com/news/news-details/2026/Morningstar-Completes-Acquisition-of-CRSP-and-Extends-Relationship-with-Vanguard/default.aspx.

Murugaboopathy, Patturaja, and Anurag Maan. 2021. "Global Sustainable Fund Assets Hit Record $3.9 Trillion in Q3, Says Morningstar." Reuters (29 October). www.reuters.com/business/sustainable-business/global-sustainable-fund-assets-hit-record-39-trillion-q3-says-morningstar-2021-10-29/.

S&P Dow Jones Indices. 2026. "S&P U.S. Indices: Methodology" (April). www.spglobal.com/spdji/en/documents/methodologies/methodology-sp-us-indices.pdf.

Yoshimoto, Catherine. 2025. "Russell US Indexes: Moving to a Semi-Annual Index Reconstitution Frequency." FTSE Russell (17 December). www.lseg.com/content/dam/ftse-russell/en_us/documents/announcement/russell-us-indexes-move-to-semi-annual-reconstitution.pdf.