A WHITE PAPER BY
BOB MAYNARD, CIO

Illusions of precision, completeness and control (revisited)

A CASE FOR SIMPLE, TRANSPARENT PORTFOLIOS

UC San Diego
RADY SCHOOL OF MANAGEMENT
The Brandes Center

EDITOR'S NOTE

Institutional investors continue to face difficult asset allocation and risk-management decisions. Recently, the debate regarding the benefits and drawbacks of the "Endowment Model" (with its reliance on private equity, hedge funds and other less-liquid asset classes vs. a simpler approach that largely relies on publicly traded stocks and bonds) has resurfaced. Amid an uncertain environment, exacerbated by global stock market volatility during 1H22 and rising interest rates and inflation, we revisited Bob Maynard's popular "Illusions of Precision" white paper (first published at the Brandes Institute website in 2014) for practical guidance. In short, Maynard does not endorse the Endowment Model. In this piece, he explains why.

Bob Maynard has been Chief Investment Officer for PERSI (the Public Employee Retirement System of Idaho) since 1992. He plans to retire from that role in September 2022. Bob also serves as a member of the Brandes Center Advisory Board.

This piece offers insights on Maynard's "simple, transparent" approach to managing PERSI's $24 billion in assets on behalf of approximately 170,000 members (current, non-current and retired).

Here, we present the original white paper along with new comments from Bob, as well as updated charts. We believe the insights Maynard shared roughly eight years ago are still relevant—and likely will endure for decades to follow.

INTRODUCTION: THE MISAPPLICATION OF TOOLS IN BUILDING PORTFOLIOS

The Financial Crisis of 2008/2009 increased plan sponsors' desire to control risk – and we are still seeing the unfortunate effects. Many approaches adopted to control risk are ***illusions*** of risk control. Of particular concern is how sponsors are misapplying tools designed to ***monitor*** portfolios and relying on them to ***build*** portfolios. Portfolio design and reallocation decisions often are now driven by complex, but often incomplete, measurement tools. The premise of these tools assumes greater detailed structuring and monitoring leads to greater control over the generation of risk-adjusted returns. But is the promise of this approach paying off and are the trade-offs of complexity and lack of transparency worth it?

The purpose of this paper is to challenge what I see as an increasingly popular approach to portfolio construction and evaluation that relies on complex, quantitative models. As an alternative, I make a case for simple, transparent portfolios. I will focus on the misuse of mean-variance optimization and "nine-box" investment models, as well as the elusive search for alpha.

MY FOUR NEAR CERTAINTIES OF INVESTING

1. There is a fundamental trade-off between risk and reward and defining acceptable risk is essential to setting portfolio structure.
2. Asset allocation (particularly between equities and fixed income) determines the majority of portfolio returns.
3. The whole of a portfolio is not just the sum of its parts. Focusing on individual components may expose investors to potential biases or shortcomings at the aggregate portfolio level.
4. Markets are efficient at reflecting knowledgeable opinions—not measures of absolute value.

MEAN-VARIANCE MODELS AND THE *ILLUSION OF PRECISION*

Mean-variance optimization produces precise numbers and predictions. Yet, these precise numbers are based on questionable assumptions of typical investor behavior and problematic investment expectations. There also are practical limitations to implementing a mean-variance model's recommendations. Let's explore each of these issues in more detail.

INCONSISTENT INVESTOR BEHAVIOR

The traditional mean-variance model treats all volatility equally; excess returns are as risky as poor returns. It also assumes that investment behavior will be similar for a gain and an equivalent loss. Such behavior clearly is not the case. The work of Daniel Kahneman and Amos Tversky shows that losses are at least twice as influential as gains when making an investment decision.[1] Such work has helped spread awareness that assumptions about behavior at the heart of mean-variance models are, at best, incomplete. Some investors, however, remain unconvinced or ignore research results highlighting differences between investment theory and reality.

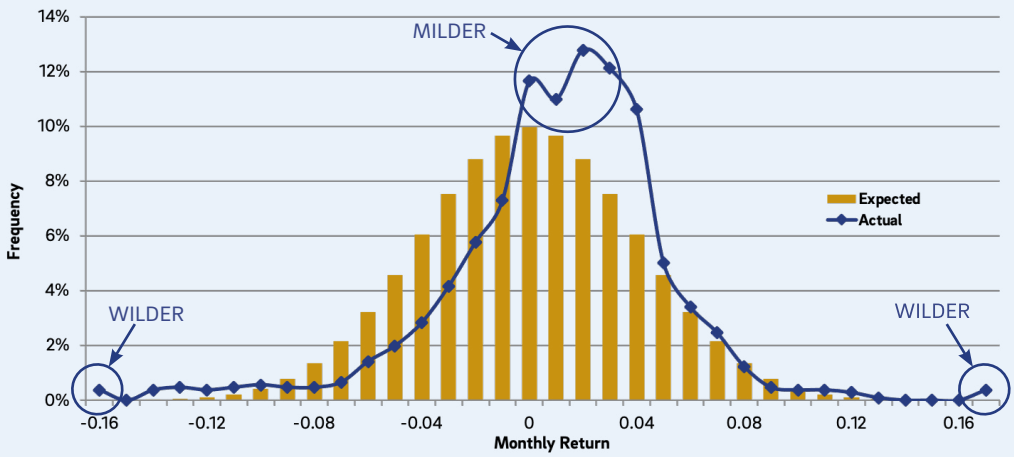
[1] Kahneman, Daniel, and Amos Tversky, "Prospect Theory: An Analysis of Decision Under Risk"

INACCURATE INVESTMENT ASSUMPTIONS

Whether full variance or semi-variance, models assume log-normal distributions, but actual returns are not normally distributed. Extreme events, like "fat tails," can skew returns. Plus, the severity and frequency of extreme events can be greater than predicted. Actual monthly U.S. equity returns have been different than forecast by a traditional bell-shaped distribution.[2] Exhibit 1 shows actual returns (blue line) have been milder and wilder than expectations (gold bars). Note the narrow, higher peak near the median and sharp, upward spikes at the tails.

Also, actual returns tended to have a higher frequency of modest returns, creating a false sense of calm. While the outliers or fat tail events were far less common, they did great short-term damage—both financially and psychologically.

EXHIBIT 1 | Expected vs. Actual Frequency of Monthly Returns for U.S. Stocks (1926–2013)

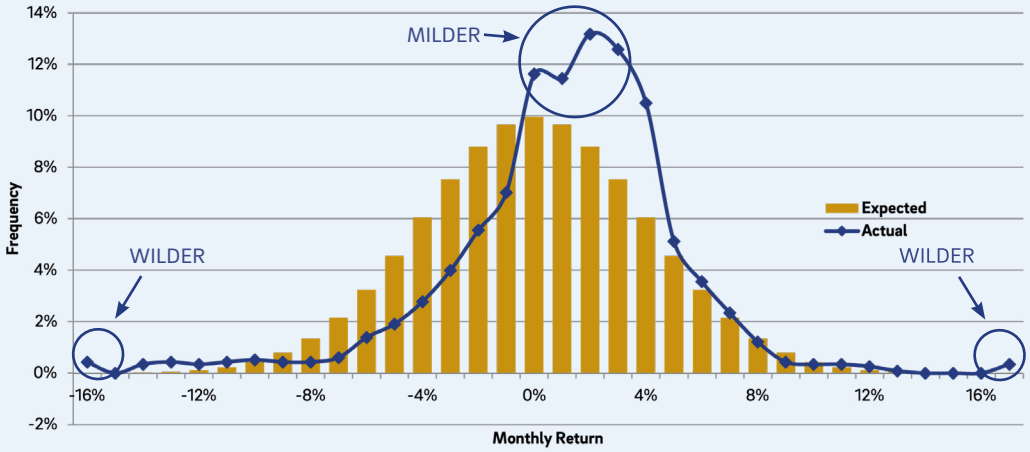


Source: Robert J. Shiller, Yale University. Expected returns were generated under the assumptions of a normal distribution using Robert Shiller data for 1926-2013. Past performance is not a guarantee of future results.

[2] To learn more, please see "Back to the Future: Conventional Investing in a Complex World" by Robert Maynard.

I share the updated version of this chart in Exhibit 1A.

EXHIBIT 1A | Expected vs. Actual Frequency of Monthly Returns for U.S. Stocks (1926-2021)

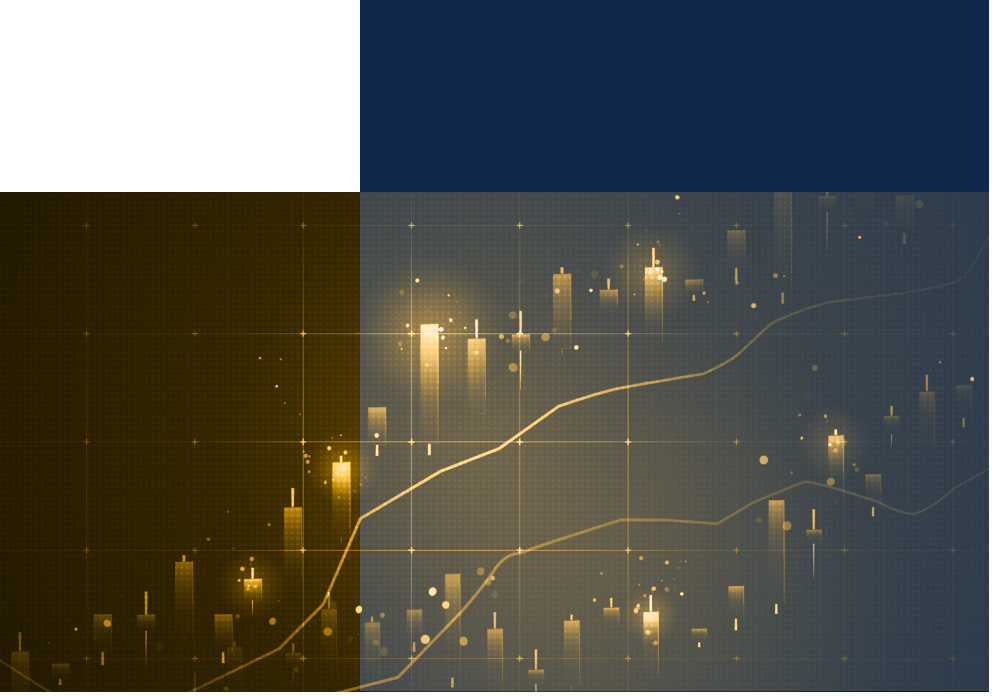


Source: Robert J. Shiller, Yale University. Expected returns were generated under the assumptions of a normal distribution using Robert Shiller data for 1926-2021. Past performance is not a guarantee of future results.

Before adding about 8 years of new data to a chart that spanned 95 years, I didn't expect to see a significant shift in the results. In fact, the mean and standard deviation of actual returns based on the updated data were within one decimal point of the data used in the original chart. But, I also wondered about the more recent period. Would the long-term pattern be similar to what we've witnessed over the last two decades?

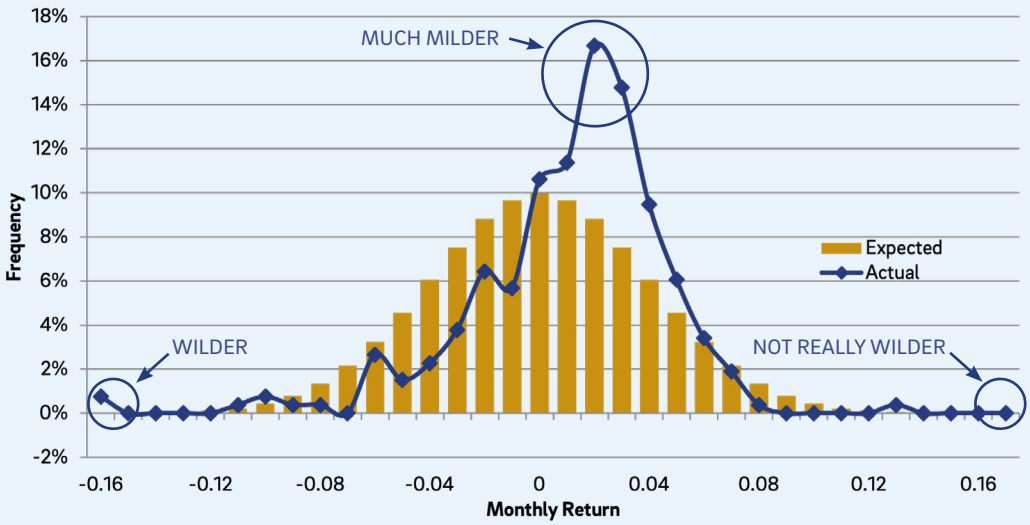
In Exhibit 1B, I focused on the last 22 years, since the turn of the century (2000 to 2021). I wanted to include some "wild" periods, including the bursting of the internet stock bubble in 2000 and the Great Financial Crisis (GFC) of 2008/2009. Given the resulting chart, I might want to change the title to: "How to Lull a Generation of Investors Into a False Sense of Security."

Note that over the past two decades we have experienced more steady, small gains vs. the full history (as shown by the blue line peak) and a lot fewer, small losses (note where the gold bars are above the blue line). The mean numbers are comparable—largely because there have been more, big "wild" negative months (see the left oval) and virtually no "wild" positives.



Only one of the big monthly declines (by 7% or more) occurred in the last decade (that was the coronavirus quarter of 1Q20). The other six were in the earlier era of the internet bubble or GFC. This dynamic may reinforce a sense of false security. In essence, investors may have been trained for the last two decades to expect steady, moderate gains—and to buy on any decline. I wonder if investors are even considering the potential for a reversion to mean—a reversion to "expected" returns. Or even a greater frequency of negative monthly returns.

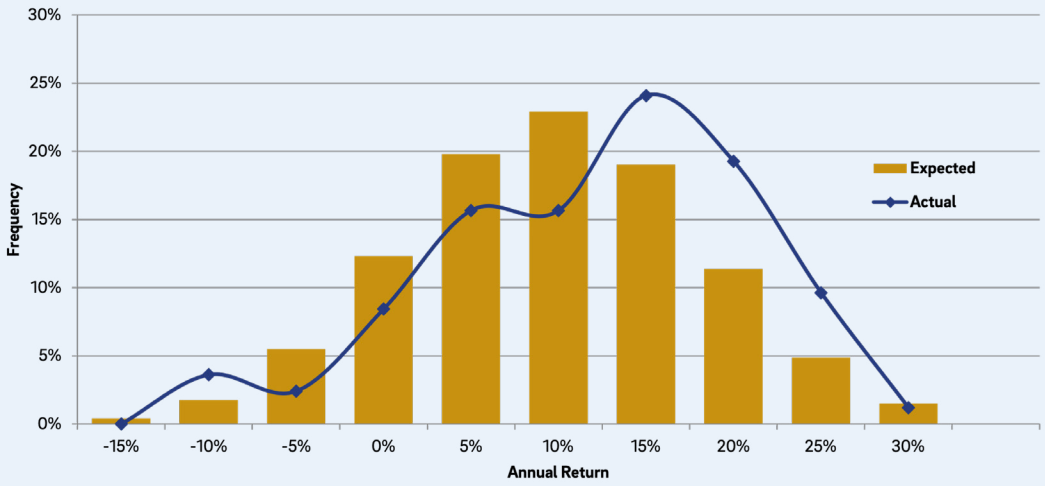
EXHIBIT 1B | Expected vs Actual Frequency of Monthly Returns for U.S. Stocks (2000-2021)



Source: Robert J. Shiller, Yale University. Expected returns were generated under the assumptions of a normal distribution using Robert Shiller data for 1926-2021. Past performance is not a guarantee of future results.

To be fair, however, volatility fades over time. Exhibit 2 shows that annualized 5-year rolling stock returns were more consistent with expected returns.

EXHIBIT 2 | Expected vs. Actual Frequency of Annualized, 5 Year Rolling Returns (1926-2013)

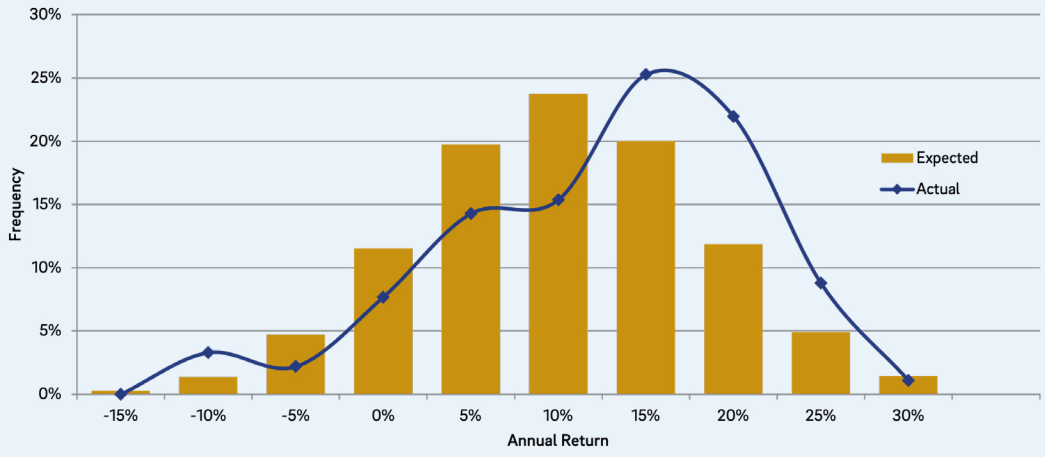


Rolling periods represent a series of overlapping, smaller time periods within a single, longer-term time period. A hypothetical example is the 20-year time period from 12/31/82 through 12/31/02. This long-term period consists of 16 smaller five-year "rolling" segments. The first segment is the five-year period from 12/31/82 to 12/31/87. The next rolling segment is the five-year period from12/31/83 to 12/31/88, and so on.

Source: NYU Stern School of Business, as of 12/31/13. Expected returns were generated under the assumptions of a normal distribution using Ibbotson data. Past performance is not a guarantee of future results.

I updated Exhibit 2, as well, and see a very similar pattern, as shown in Exhibit 2A.

EXHIBIT 2A | Expected vs. Actual Frequency of Annualized, 5 Year Rolling Returns (1926-2021)



In addition, because mean-variance models are linear, they do not account for discontinuous events. That is, there is no way to account for the long stretches of mild returns interrupted by bursts of dramatic swings in the market.

Using a mean variance model is like strapping yourself to a jet, taking off, and then putting on a blindfold. Small errors in navigation or rudder control can lead to large deviations from the intended destination.

I underscored PERSI's long-term focus in a 26-page report called "The PERSI Investment Portfolio" published **here** at the PERSI website. That report notes, "Investment decisions and considerations will be taken with the time horizon of at least 3-5 years, and usually longer. Consequently, investment approaches that aim to enhance returns over the near or medium term (quarterly to 3-4 year time periods), often termed 'tactical asset allocation', are not employed (although strict rebalancing may be impacted at various times). Particularly, 'hedge funds', quantitative 'black box' strategies (e.g. '130/30') and other short-term oriented strategies (tail risk insurance, covered call option writing, portable alpha, 'crisis risk offset', etc.) will not be employed."

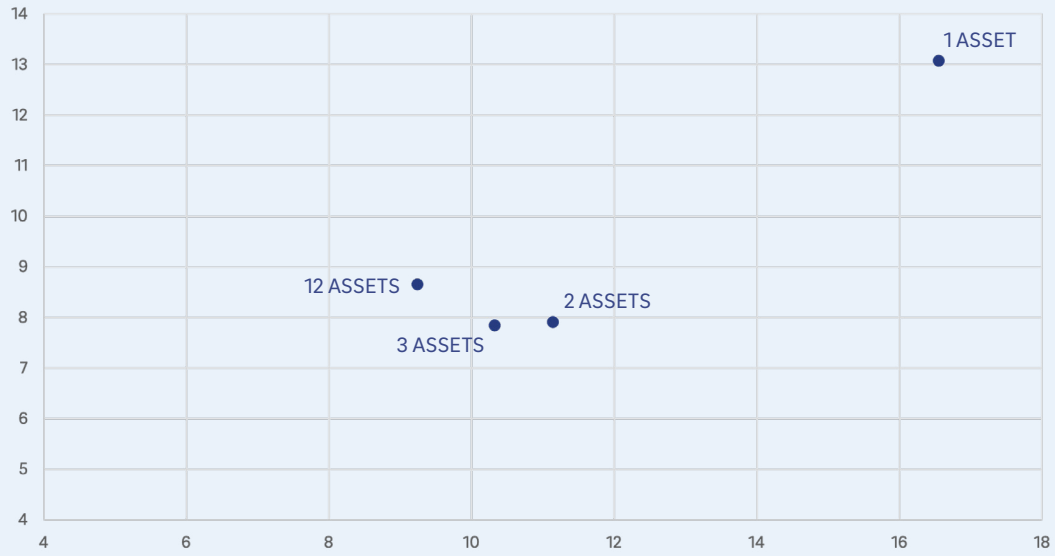
PRACTICAL LIMITATIONS

Having multiple asset classes with small allocations (less than 5%-10% of the total portfolio) adds rigidity and complexity to the portfolio—without adding a real benefit. A model may recommend small proportions to particular asset classes (e.g., 3% to private equity or 5% to real estate). Yet under normal ranges of risk and correlation, it takes over a 10% allocation to an asset class to make an appreciable impact on overall portfolio risk or return.

Furthermore, the benefit in lowering standard deviation falls off precipitously after three asset classes are added to a portfolio (see Exhibit 3). In fact, a hypothetical 12-asset class portfolio has a slightly ***higher*** standard deviation than the portfolio with only three asset classes—and a ***lower*** return over the 10-year period through year-end 2021. See the Appendix for more details on the composition of each of these hypothetical portfolios.

EXHIBIT 3 | Diminishing Benefits of Diversification (Dec. 2011 to Dec. 2021)

Adding More Asset Classes to a Portfolio Does Not Necessarily Lower Overall Standard Deviation



* See Appendix for more details.

Source: Morningstar, as of 12/31/21. All calculations based on 10 years ending 12/31/21. Diversification does not assure a profit or protect against a loss in a declining market.

Critics may point to the higher Sharpe Ratios more complex portfolios can generate (see Appendix for more details), but Sharpe Ratios are useless in a fat tail/high peak world and, in fact, can drive plan sponsors to create portfolios that seek to pick up proverbial nickels while standing in front of a silently approaching steamroller; greater complexity often makes plans more susceptible to suffering devastating consequences when fat-tailed events roll through.

Also, these complex, widely accepted models can create a false sense of confidence for plan sponsors with concrete consequences at certain thresholds, such as statutory amortization periods requiring increases in contributions once a specific funding level is breached. Lastly, models tend to assume rebalancing is available for all asset classes; however, rebalancing is not easily available for many standard asset classes (e.g., private equity and real estate[3]).

[3] More specialized asset classes such as real estate and private equity also are more likely to have large estimation errors vs. traditional asset classes such as large-cap stocks and corporate bonds. These specialized asset classes also tend to have the highest estimated returns and/or the lowest estimated correlations with other asset classes; erroneous estimations can drive asset allocation models to extreme results.

MEAN-VARIANCE MODELS: LIABILITY MISMATCHES AND LIMITED FLEXIBILITY

The most serious problems with the mean-variance model lie in how it is used; inaccurate estimates, disconnections to liabilities and the model's inability to react to changing market conditions can lead to large deviations from the intended goal. Inaccurate estimates are endemic, and the consequences can be large. Estimations of future returns, risks and correlations are fraught with error. Even a small change in return assumptions (as low as 0.1%), standard deviation or correlations can move recommended allocations by more than 10.0%.

Furthermore, very few asset models connect to liabilities in a meaningful way. Pension fund liabilities are driven mainly by future salaries and expected lifespans. But people have a tendency to live longer than estimates based on "fixed" actuarial studies. The use of out-of-date mortality tables has caused funding difficulties.

Future salaries are determined by inflation and "real" salary gains. To keep pace with inflation, most retirement funds have both short- and long-term goals. Unfortunately, assets that respond well to inflation over a longer time frame (15-30 years) have the poorest response to inflation in the short term (under 5 years). Consider U.S. assets, over the long term they will compensate for inflation in the United States, but it takes time. A continued reinvestment of interest and dividends as well as new contributions in U.S. stocks and bonds generally will allow a portfolio to keep pace with inflation. However, the exact opposite is true over the short term—when inflation goes up, U.S. stocks and bonds tend to fall.

In my more recent piece, "The PERSI Investment Portfolio," I provide reasons why the plan's asset mix has shown a bias toward U.S.-based securities. But elements of the logic supporting that decision also apply to how the portfolio is positioned to handle inflation (certainly a topic of discussion today):

> PERSI's liabilities ... are linked to U.S. inflation, and should be responsive to long-term movements in U.S. inflation. Since U.S. inflation is caused by higher U.S. prices, and higher U.S. prices are mainly charged by U.S. corporations, U.S. equities have been shown to respond to U.S. inflation quite well over longer periods of time (10-25 years).

Finally, mean variance models lock a portfolio into certain asset class assumptions that severely limit the portfolio's flexibility and ability to react to changing market conditions. It reverses the normal presumption that an investment in an asset type occurs when one believes it will outperform the general market. An express allocation from a mean variance model will "fill" an asset class unless there is a clear reason ***not*** to do so. This essentially makes investments in default positions and places the burden on plan sponsors to prove such allocations will ***not*** perform well in the future—which is nearly impossible given the uncertainty and inaccuracy of future predictions.

NINE-BOX INVESTING AND THE *ILLUSION OF COMPLETENESS*

Nine-box investing attempts to divide U.S. equity markets into well-defined categories based on market capitalization (small, mid and large) and style (value, core and growth) to search for alpha—return beyond risk/return characteristics of an asset class. The theory is that by filling each box with a particular manager or style, the portfolio as a whole will reflect the primary risk/return characteristics of the broad market. Subsequently then, if each manager beats the benchmark for its particular box, the manager will generate alpha—however, alpha is not the same as outperformance. A manager with low beta can fail to generate better-than-benchmark returns while still generating alpha. Similarly, a portfolio with an overweight to a particular asset class or high correlations among asset classes can deliver asset-specific alpha, but not outperformance at the portfolio level.

LOW BETA

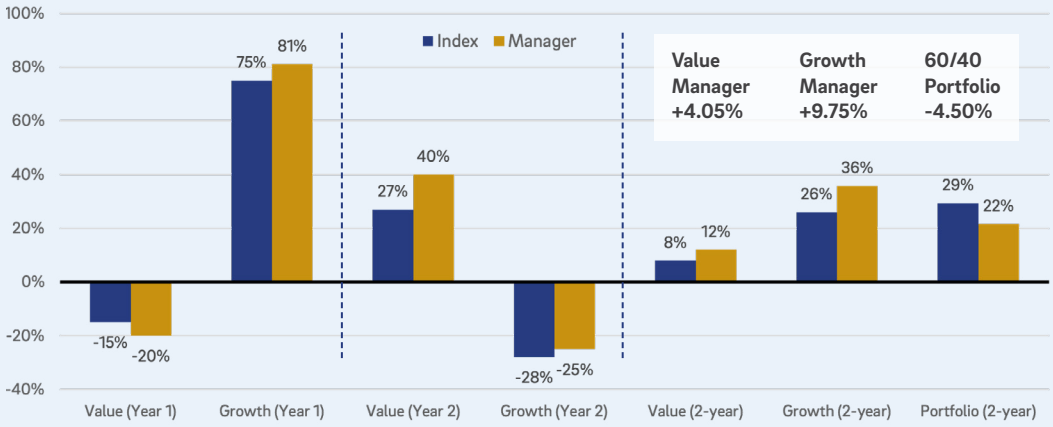
A manager with a slightly lower correlation to an asset class may generate alpha—and still underperform. For example, if the risk free rate is 1.0% and the asset class

return is 11.0%, a manager with a beta of 0.8 will be expected to return 9.0%.[4] A manager that returns 10.0% would have an alpha of 1.0% while underperforming its benchmark by 1.0%. The plan as a whole could underperform if several of the nine-box managers had a similar experience.

OVERWEIGHTING

Now, consider a hypothetical plan with two managers: 60% of assets assigned to a value manager and 40% to a growth manager. Assume the value manager underperforms its index in the first year while the growth manager beats its benchmark (see Exhibit 4). In the second year, the opposite is true; the value manager outperforms while the growth manager lags. Over the full term (2 years) both the value and growth manager outperform their corresponding indices. Yet when combining the two managers, the plan would still significantly underperform a style-neutral index (50% value, 50% growth) because of the overweight to value.

EXHIBIT 4 | Individual Manager Outperformance Can Be Offset by Weightings at Aggregate Portfolio Level



Source: Hypothetical illustration. Actual results will vary.

CORRELATION

Over the years, I have seen a number of instances where a manager had a good positive alpha against its benchmark, but when brought back into the overall portfolio, that positive alpha turned negative. A classic example was when bond managers were getting positive returns from high-yield debt and emerging market equity managers were delivering positive returns, as well. The correlation between

[4] Expected Return = Risk-Free Return + Beta(Expected Asset Class Return – Risk-Free Return)

high-yield debt and emerging market equities tended to drown out any positive alpha individually generated by the bond managers. In this case, "diversifying" into a new asset class failed to lower the overall portfolio's risk/return profile – even if the manager delivered positive alpha.

INFINITELY COMPLEX

One of the biggest problems when investing is the presumption that any market, let alone one as complex as the United States, can be divided into just nine categories that will together capture the entire market's risk/return profile. Moreover, all value managers are not alike—neither are all core or growth managers. Thus, when one hires an active manager, one really makes two decisions:

1. The area covered is necessary
2. The manager is the best for that area

Ultimately, I believe nine-box investing adds complexity to an investment structure and can leave large holes in the portfolio.

KEY QUESTIONS FOR ACTIVE MANAGEMENT

1. What benchmark (and why?) is an active manager trying to beat? And can the manager do that consistently?
2. Can one identify these outperforming managers in advance?
3. Will skillful managers add to portfolio returns? Is alpha, even if identified, additive across managers at the portfolio level? Too often, the inquiry about active management stops with the first question when the others are just as serious.

SEARCH FOR ALPHA AND THE *ILLUSION OF CONTROL*

To beat the market, one has to believe that there are professionals who can consistently have better opinions than those of all other experts collectively—and that one can correctly identify those professionals in advance. At the same time, those opinions cannot be held by those professionals alone. In order to realize value one has to find others who agree. The true skill of a manager, therefore, is to discover value ***prior*** to it being realized by others.

Even if such managers exist, it is not clear they can be picked in advance. Past performance alone has not been a consistent indicator of superior future performance. There is no proven formula or approach for picking, in advance, those managers that will consistently provide above-average returns in the future. With more than 7,000 professional managers and mutual

funds in the United States alone, at any one time, more than 200 managers can claim consistent (and very impressive) 5-year track records. Yet three to five years may not be enough time to accurately judge a manager. Instead, consistent long-term, above-average performance will tend to weed out the great from the average.

If there is good performance data over the past 10-20 years with similar management, I believe one can legitimately rely on a high past ranking as a basis for hiring. However, when performance data is really only for 5-10 years (including changing investment personnel) the ranking screen is, at best, only one factor among many.

Conventional investing accepts capital market volatility and accepts that the volatility will be greater than the standard tools assume. With this understanding, the key is making portfolios that are sturdy and ensure liabilities are being funded. The key to success is not attempting to avoid that volatility and reaching for shorter-term gains.

SIMPLE, TRANSPARENT AND FOCUSED

Rather than mean-variance optimization and nine-box investing, plan sponsors may be better served concentrating on what I call "conventional" investing that emphasizes portfolios that are simple, transparent and focused. This approach includes limiting investment to asset classes such as global equities and investment grade fixed income (with an addition of some private investments such as real estate or private equity). Plan sponsors also should maintain a consistent presence in those markets and rebalance as appropriate to keep positions relatively constant over time. Rebalancing is especially vital after periods of high volatility. Ultimately, this conventional approach depends on long-term market movements, not short-term tactical moves, for success. In addition, the approach demands core holdings primarily in instruments that can be readily sold and confidently priced. Thus, it favors public markets as well as independently verifiable daily pricing for non-public instruments.

PORTFOLIOS DESIGNED FOR THE LONG TERM

Conventional portfolios' base positions have major exposures to the public markets of U.S. large and small-capitalization equities, international developed market equities, emerging markets equities, real estate securities, inflation-indexed securities (TIPS), investment grade bonds and straightforward, government-guaranteed mortgage securities. The combination of these exposures is designed to give a high probability of achieving the return needed over long periods. For return needs in the 4%-5% range, this would result in a portfolio consisting of roughly 50% to 60% equities and 20% to 30% fixed income. Exhibit 5 shows PERSI's asset allocation. I simply added a column to the right of the original table to show PERSI's allocation as of January 14, 2022, the latest date for which data is available.

EXHIBIT 5 | PERSI Asset Allocation Reflects Simplicity and Transparency

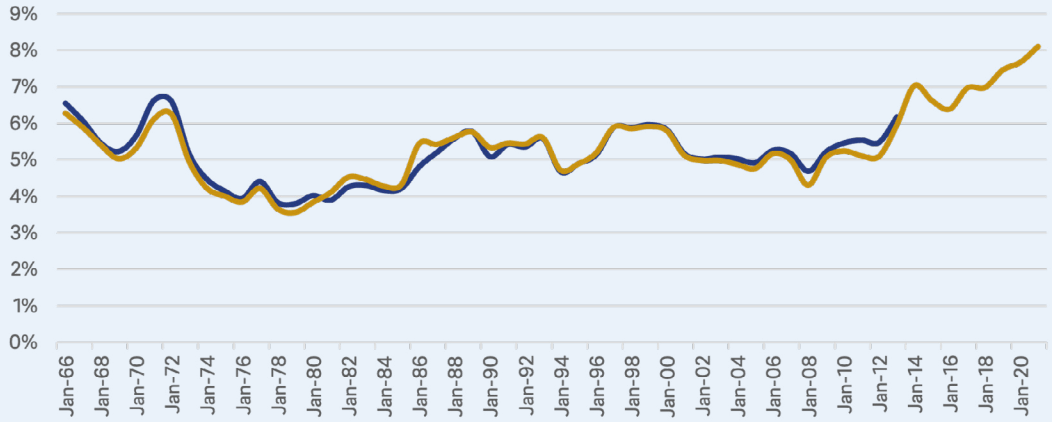
	As of 7/31/14	As of 1/14/22*
US Equities	29%	30%
Non-US Equities	15%	15%
Emerging Market Equities	10%	9%
TIPS	10%	10%
Fixed Income	15%	15%
Private Equity	8%	6%
REITS	4%	5%
Private Real Estate	4%	5%
Idaho	5%	4%

Source: PERSI, *Allocations as of 1/14/22 also include about 1% in cash

Plans should aim to provide a return of 4.0% above inflation over the long term—an achievable goal when considering an investment horizon of several decades.

In the original paper, Exhibit 6 showed returns for a simple 65/35 equity/bond portfolio from 1926 to 2013 averaged a 5.2% real return over rolling 40-year periods, dipping below 4.0% only four out of 49 rolling periods. I updated this chart through Dec. 31, 2021 and switched to Shiller data—the same source used for Exhibits 1 and 2. In Exhibit 6, I kept the original line (from 1926 to 2013) in blue from the 2014 paper and added a gold line representing rolling 40-year returns from 1926 to 2021. While the data sources for these lines are different, the resulting patterns are very similar.

EXHIBIT 6 | 40-Year Real Returns for 65% Equity, 35% Bond Portfolio (1926-2013 and 1926-2021)



Source: For the blue line (1926-2013), U.S. stocks returns represented by data from Ibbotson Associates via Morningstar. Long-term U.S. Government bonds represented by data from Ibbotson Associates via FactSet through yearend 2002 and Barclays US Treasury 25+ years from January 2003 through yearend 2013. Performance is for the period January 1926 to December 2013. For the gold line (1926-2021), data was drawn from Robert Shiller, Yale University. Performance is for the period from January 1926 to December 2021.Past performance is not guarantee of future results. Once cannot invest directly in an index. Rolling periods represent a series of overlapping, smaller time periods within a single, longer-term time period. For example, over the illustrated 87-year period, there are 49 40-year rolling periods, with the first one running from 1926 through 1965, the next running from 1927 through 1966, and so on.

This investment approach is simple and easy to follow, and would not tactically allocate the portfolio in any significant way over near-term periods.

CONTROLLING RISK THROUGH TRANSPARENCY

A conventional approach relies on transparency as the primary method for risk control and uses index funds as base positions, primarily in the larger, more liquid markets. Because the style or portfolio is very clear and transparent with daily and independently priced securities, activity can be monitored contemporaneously. Unexpected behavior, if it occurs, is instantly clear and explanations for unexpected behavior can be quickly determined. Opaque investing, like "black box" investing that uses algorithms and pre-programmed logic to determine optimal trading practices is avoided. And there is a strong preference for public securities that can be independently priced daily and private strategies that would be understandable to reasonably intelligent people who may not have extensive investment training. This helps provide continuity and consistency in the event of personnel departures at the plan sponsor.

CONCLUSION

Plan sponsors live in a world of practical challenges—not theoretical problems with elegant, mathematical solutions. We must bow to the inevitable—we cannot precisely predict the behavior of future liabilities nor capital market returns. Persistent questions about manager skill, limitations of predictions and the uncertainty surrounding alpha generation preclude reliance on categorizing investment markets and tightly structured portfolios to deliver added returns over time. While certain formulas provide support for such a complex approach, I believe such efforts are ultimately wasted time.

Instead, after accounting for the four near-certainties of modern investing, I believe the values of clarity and transparency outweigh the limited benefits of the more detailed and increasingly popular quantitative structures used by many institutions. For example, instead of relying on a 9-box approach, mean-variance optimization and an elusive search for alpha, I look to clear and transparent styles that can be understood and followed by board members and constituents through all market cycles.

Once such a portfolio is constructed, it can be monitored with available tools to ensure unexpected biases do not alter original intentions unintentionally. Such tools, including regression analysis and performance measurement against benchmarks or style assessments are useful to monitor portfolio traits; they can provide understanding of the portfolio once it has been created, but should not be used to create the portfolio in advance. The latter often creates levels of detail and complexity that are unnecessary and costly—especially as these unintended consequences often may prevent an ability to clearly identify issues when temporary, and inevitable, underperformance periods (such as late 2008/early 2009) arise.

APPENDIX

Exhibit 3 | Additional Disclosure

Return (annualized) and standard deviation (of quarterly returns) of four different portfolios were calculated over 10 and 20 years ending 12/31/2021.

Each portfolio is composed of asset class indexes. We assume annual rebalancing of index weights.

Portfolio 1: 100% US large-cap stocks
Portfolio 2: 60% US large-cap stocks, 40% US bonds
Portfolio 3: 50% US large-cap stocks, 40% US bonds, 10% international stocks
Portfolio 4: We used 12 different asset classes, combined as follows:

- 15% US large-cap stocks
- 10% US small-cap stocks
- 5% international stocks
- 5% US mid-cap stock
- 5% US micro-cap stocks
- 5% international small-cap stocks
- 5% emerging market stocks
- 10% US bonds
- 10% US high-yield bonds
- 10% TIPS
- 10% global bonds
- 10% global real estate

For each asset class, the following indexes were used:

Asset Class	Index
US large-cap stocks	S&P 500 Index TR USD
US bonds	Bloomberg Aggregate Bond TR USD
International stocks	MSCI EAFE NR USD
US small-cap stocks	CRSP US Small Cap TR USD
US mid-cap stocks	CRSP US Mid Cap TR USD
US micro-cap stocks	CRSP US Micro Cap TR USD
International small-cap stocks	S&P Global ex US Small Cap TR USD
Emerging market stocks	Morningstar MSCI Emerging Markets
US high yield bonds	Bloomberg Ba to B US High Yield TR USD
TIPS	Bloomberg Global Inflation
Global bonds	S&P Bond Composite Global TR USD
Global real estate	DJ Global World Real Estate TR USD

DISCLOSURES

The Bloomberg U.S. Aggregate Bond Index is a broad-based benchmark that measures the investment-grade, U.S. dollar-denominated, fixed-rate taxable bond market. This index is a total return index which reflects the price changes and interest of each bond in the index.

The Bloomberg Ba to B US High Yield Bond Index includes all fixed income securities having a maximum quality rating from Moody's Investor Service of Ba1, a minimum amount outstanding of $100 million, and at least one year to maturity.

The Bloomberg Global Inflation-Linked US TIPS Index represents securities that protect against adverse inflation and provide a minimum level of real return. To be included in this index, bonds must have cash flows linked to an inflation index, be sovereign issues denominated in U.S. currency, and have more than one year to maturity.

The S&P 500 Index with gross dividends measures equity performance of 500 of the top companies in leading industries of the U.S. economy.

The S&P Global ex-U.S. SmallCap Index is a comprehensive, rules-based index measuring performance of the lowest 15% of float-adjusted market cap in each developed and emerging country, excluding the U.S. It is a subset of the S&P Global BMI, a comprehensive, rules-based index designed to track global stock market performance.

S&P Bond Composite Global Index covers the most liquid portion of the global investment grade fixed-rate bond market, including government, credit and collateralized securities.

The CRSP U.S. Small Cap Index includes U.S. companies that fall between the bottom 2%-15% of the investable market capitalization. There is no lower limit in market capitalization, other than what is specified by investability screens. The index includes securities traded on NYSE, NYSE Market, NASDAQ or ARCA.

The CRSP US Micro Cap Index includes the smallest U.S. companies, with a target of including the bottom 2% of investable market capitalization. The index includes securities traded on NYSE, NYSE Market, NASDAQ or ARCA.

The CRSP U.S. Small Cap Value Index includes U.S. companies that fall between the bottom 2%-15% of the investable market capitalization. The CRSP U.S. Value Style Indexes are part of CRSP's investable index family. Once securities are assigned to a size-based market cap index, they are made eligible for assignment to a value or growth index using CRSP's multifactor model. CRSP classifies value securities using the following factors: book to price, forward earnings to price, historical earnings to price, dividend-to-price ratio and sales-to-price ratio.

The CRSP U.S. Mid Cap Index includes U.S. companies that fall between the 70%-85% of investable market capitalization. The index includes securities traded on NYSE, NYSE Market, NASDAQ or ARCA.

The Dow Jones Global World Real Estate Index consists of companies included in the Dow Jones Global Universe Index and derive their primary revenue from the real estate sector. The Dow Jones Global Universe Index covers 95% of the underlying free-float market capitalization at the country level for developed markets (excluding Europe) and at the aggregate level for Europe and emerging markets (all Europe and all emerging markets).

The Morningstar Emerging Markets Index measures the performance of emerging markets targeting the top 97% of stocks by market capitalization. This Index does not incorporate Environmental, Social, or Governance (ESG) criteria.

The MSCI EAFE Index captures large and mid cap representation of developed market countries excluding the U.S. and Canada.

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