Product Strategy

FIDELITY INSTITUTIONAL INSIGHTS

A Fidelity Approach to Providing Advanced Risk Analytics for Investors

New technology and innovative analytical techniques may help investors deepen their understanding of investment risk management as part of portfolio construction processes.

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KEY TAKEAWAYS

- Supported by advances in data science, machine learning, and computing power, advances in investment risk modeling have the potential to better inform and strengthen portfolio construction.
- New approaches may help address existing complexities in modeling investment risk-return tradeoffs that result in underappreciation of portfolio loss sensitivity. These include the use of point estimates as estimations for model inputs and outputs, overreliance on the assumption of normal return distributions, and methodology premised on constant asset correlations through time.
- Fidelity believes that evolving and innovative methods of risk analysis—together with intuitive tools to use them—should be available to a wide range of investors for direct investment applications.

In our age of rapid digital innovation and democratization, sophisticated technologies can now be adapted for direct use by a large portion of the population, rather than remaining the exclusive advantage of large, tech-savvy organizations.

In investing, ongoing advances in market data collection, machine learning, and high-performance computing have created the potential for meaningful evolution of the tools available to decision-makers. Importantly, access to advanced approaches to portfolio construction, risk management, and outcome modeling may help change the ways investors think.

This article will explore some of the ways Fidelity is working to bring modern methods of decision support analysis to our clients, and the reasoning behind our efforts. Specifically, we will focus on how advances in investment analytics and modeling have contributed to further advances in informed risk management, which lies at the core of professional investing. Exhibit 1 shows a brief overview of the key ideas discussed.

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Axioms for investment analytics

New tools may initially seem complex and unfamiliar, so we believe focusing on underlying principles and assumptions is an important starting point. In practice, we have seen key axioms get obscured by pragmatic compromises, sometimes due to limitations in available analytic tools. Today, the potential for delivering better solutions through technology opens a path to reasserting "common sense" investment principles.

Key axioms for better understanding investment risk (described more fully below) include:

1. Investment risk is best understood probabilistically
2. Tail risks matter most for loss tolerance assessment
3. Time horizon is crucial when considering investment risk
4. Robust asset diversification requires consideration of shifting correlations and liquidity constraints
5. Investment models should support valuation discipline for "buying low and selling high"

EXHIBIT 1: New technology can help reinvent investment risk analysis

FROM LEGACY APPROACHES ...	... TO EVOLUTIONARY PROGRESS
Supported by new techniques of data analysis and modeling	
Statistical methods (using normally distributed returns and constant asset correlations)	**Data science and statistical methods** (for modeling non-normal, nonstationary asset relationships)
Predicted outcomes presented as numerical estimates	**Directional, visual insights** presented as outcome distributions that vary with market environments
Simplified **"optimal"** solutions calculated with rigid assumptions	Quantified **intuitive trade-offs** built on interdependences from controllable assumptions
History-based estimates of most likely asset relationships (return and volatility) extended into understated tail risk measures	**Forward possibilities and probabilities** with conditional outcomes and enhanced estimates of tail risks amid market stress
Data limitations framing the scope of analysis	**Smart data expansion** and quality validation via AI methods
Supported through harnessing greater computational power/cloud computing	
Limited scale, with personalized analysis available only to well-resourced institutions	**Expanded scale,** with potential for widely available personalized and adaptable analysis
Single, short analysis time horizon is standard	**Multiple, longer time horizons are possible**
Asset class and index-level portfolio modeling emphasis (implying style-pure products)	**Product-specific** analysis, across individual securities, mutual funds, and ETFs
Supported by Fidelity's commitment to sharing advanced insights with clients	
Emphasis on fitting **"textbook" investment metrics** (e.g., beta, VaR, duration) as model inputs	Option to add **Fidelity research-driven inputs** to expand risk understanding and conditional insight
Reliant upon algorithms in the **public domain**	Standard algorithms enhanced by building upon **Fidelity patented processes**

Source: Fidelity Investments.

Understanding risk probabilistically, which includes moving beyond point estimates

Economic uncertainties ensure that market predictions expressed as point estimates are prone to be off the mark. Yet many approaches to risk modeling advance point estimates, presenting the average of several possible paths as a seemingly precise prediction. Instead, risk models can be designed to help investors better understand both the **directionality** of likely outcomes and the potential **magnitude** of loss or gain, which could aid informed investment decision-making.

Accounting for tail risks, recognizing they are understated in traditional statistical methodologies

When presenting return outcomes probabilistically, risk analysis tools should help an investor understand a portfolio's performance under the most unfavorable circumstances. Tail risks—the risks of events at the "tails" of a distribution of results—are important to consider fully. These infrequent periods of high market stress historically generate the largest unfavorable outcomes for unhedged multi-asset class portfolios. Yet, the infrequent, lowest return outcomes across market cycles are commonly understated by traditional models. This inaccuracy is mostly due to the difficulty of capturing shifting market correlations using statistical modeling methodology. To better understand "left tail" (i.e., negative or "downside") outcomes, an investor needs to consider episodes of declining market liquidity when asset supply and investor demand became mismatched. Although historical stress periods can differ materially, identifying commonalities and applying those elements to forward scenarios can be illuminating. Machine learning techniques can enable that analysis. By reviewing a more realistic assessment of risk before it occurs, investors may remain more committed to a strategy when a modeled tail event actually occurs.

Incorporating time horizons in ways that align with the investment decisions being informed

Risk measurement and analysis are most useful when aligned with a portfolio's time horizon, and an investor's understanding benefits from the ability to compare calculations for different holding periods. For longer-term investment strategies it is important to recognize that performance simulation based on quarterly measurements (most relevant for tactical trading strategies) generally provides different insights from projections using annual measurements. Periods of market stress have tended to be short lived, followed by at least a partial rebound of battered asset prices. While some short-term negative returns may reflect recoverable price declines, others signal longer-term loss of capital through default or longer-term market revaluation. Analytical tools can help investors understand how time horizon impacts an assessment of potential portfolio outcomes by allowing views of differing time horizons.

Robust asset diversification requires consideration of shifting correlations and liquidity constraints

The benefits of investment diversification are well known, but harder to achieve in practice than in theory. In practice, correlations between asset classes are nonstationary—cross-asset class diversification effects can change with market conditions, especially during market tail events. The same applies for diversification within asset classes, such as across style boxes, size, and sectors for equity, or rate and credit rating diversification for fixed income. Indeed, as behavioral reactions to moving markets result in large asset flows, it is common to have price dislocations and liquidity costs (e.g., bid-ask spreads) become magnified. Risk models are more informative when they help investors consider diversification through different market environments.

Supporting "buying low and selling high"

A common-sense goal in investing is to take advantage of security valuations by buying at low prices and selling at high ones. Counterintuitively, some decision-support tools may encourage the opposite behavior. For example, selling exposures for the sake of derisking a portfolio when volatility has increased or when a loss threshold has been breached. Although "momentum" strategies can be effective as part of highly managed institutional strategies, they are harder to profitably implement in portfolios with less monitoring, lower turnover, and higher liquidity costs. For many investors, analytical tools are most practically used to align risk expectations with loss tolerance **prior to** declines in asset prices.

> The potential for delivering better solutions through technology opens a path to reassert "common sense" investment principles that are sometimes obscured by pragmatic compromises.

The trouble with normal

Tail risks describe extreme events. But tail events seem to happen more frequently than a classic normal distribution predicts. This can lead to "fatter" tails when a graph of actual outcomes is compared to most prior statistical estimates. To understand why, we spoke with Ren Cheng, former portfolio manager and CIO, and now senior investment advisor at Fidelity Investments:

"The normally distributed bell curve is a foundational tenet of the central limit theorem, and is used by investors in Modern Portfolio Theory, the efficient frontier, and more. This approach worked extremely well to model the market when it was introduced in the 1960s, and even into the 1980s. But behind the math is a key assumption of the independence of events making up that curve. When the flow of information was incomplete and slower, the normal assumption held because investors were making (more or less) independent decisions. But by the end of the twentieth century, the interconnection of markets and technology for rapid communication had tremendously weakened that assumption. Instant access to data—including data on what other investors are doing—encourages herding behavior.

"With investors studying the same textbooks, seeing the same information, and processing it near instantaneously, we have increased the risk that seemingly independent but homogeneous decisions create feedback loops that magnify events, accelerate herding, and create fatter tails. As the markets have become more complex, recognizing moments of dangerous resonance—when the system would benefit from breaking this synchronicity—has become more difficult. Until investors rethink the concept of risk and better understand the interdependence of outcomes, we need to brace for more extreme events than the normal distribution indicates. Indeed, normal distributions have now become the tail, and fat tail distributions have become the norm."

Process evolution in risk analysis

Risk analysis has evolved over the years into a suite of well-used methodologies, with challenges and trade-offs that are known yet irregularly acknowledged. While many well-resourced institutional investors may be skilled in balancing those trade-offs by considering a mosaic of decision-support inputs, Fidelity aspires to simplify and strengthen risk analytic insights for broader use. To support the next phase of modeling progress, we believe several quantitative methods for measuring and evaluating risk should be advanced and made more widely available.

Examples of current challenges that may be addressed by new tools and strategies include:

- **The tension between return objectives and risk management**—Typically, this tension has been handled by periodically revisiting portfolio positioning against essentially static investment objectives and time horizons. Looking forward, the capacity exists for a more nuanced set of parameters to support real-time evaluation of investment strategy through the presentation of comparisons across time horizons and market scenarios. This should facilitate better investor outcomes.
- **The imprecision of portfolio weight and exposure measures**—Decomposition of a portfolio into sub-classifications is a useful, common process for investor strategy review and communication. Yet, as a risk measurement method, disaggregation processes are not enough. Classifications are typically determined by measurable data. These data classifications, by their nature, vary in importance to return outcomes. Mapping exposures to market factors is a complex exercise. Understanding the potential interrelations of those exposures requires skill and nuance, particularly in grasping how those correlations may change in a tail environment. Tools for broader investor use should help investors better understand the potential impact of portfolio weights and exposures.
- **The assumptions within traditional return volatility models**—Modern Portfolio Theory, a mainstay of portfolio construction, suggests that individual investments be evaluated based on their impact on an overall portfolio's return and risk. Statistically based modeling processes are generally built upon the presumption of constant correlations and normally distributed return outcomes, which will cause a model to quantify the most likely relationships between portfolio assets. For understanding risk, however, it is important to understand that market stress can change correlations, as previously mentioned. New analytical approaches that combine statistical methods with machine-learning techniques can aggregate portfolio risk estimates with much greater clarity, which can enable better approximations of less frequent, highly significant tail events.
- **The limitations of stress tests**—One important input for risk measurement has come from replaying historical periods of stress and calculating expected loss for a current portfolio. This approach is intuitive and directional in its outputs. However, each market crisis differs from the others, and their infrequency complicates attempts at using historical data for forward-looking portfolio scenario modeling. Indeed, some institutional investors will spend time imagining unprecedented scenarios and studying the modeled outcomes for insights. For broader use, newer data analysis techniques, including the use of artificial intelligence through machine learning, hold the promise of creating stress tests that incorporate the possibility of novel crisis scenarios and build those scenarios into model outputs.

This review of risk measurement challenges is not intended to discourage the use of portfolio risk calculations. Despite limitations, existing quantitative risk tools can focus decision-making in portfolio construction, supplement fundamental analysis in selecting securities, and help align portfolios to risk

tolerance levels. Traditional measures can also be valuable in portfolio monitoring and oversight, such as in signaling portfolio "drift" from a desired risk level or asset allocation.

However, we have observed serious unintended drawbacks when traditional risk analysis tools and strategies are adopted without full understanding. Take for example the recent market tail event caused by the coronavirus crisis of 2020. A convergence of social, economic, and fiscal actions unlike any historical events on record caused a rapid shift in asset correlations. While 2020 has introduced tail risk of a new variety, it shares characteristics with previous market stress periods.

Importantly, some newly designed investment products may have experienced volatility and loss for the first time. This is reminiscent of the 2008 Global Financial Crisis during which the unexpected default rate of subprime mortgages caused huge losses for strategies that failed to account for the cumulative credit risk of unseasoned interdependent mortgage-backed securities. Likewise, leveraged municipal bond strategies hedged with Treasury instruments failed when these two high-quality sectors went from highly positive to negative price correlations unexpectedly. Traditional models did not help most investors prepare for these outcomes.

Investors should not need to be quantitative analysts to use risk analytics prudently. Our objective is to encourage better modeling, including the more lucid presentation of tail risks and the distributions of potential outcomes. By encouraging investors to think about portfolio risk in terms of probabilities and direction, we seek to avoid misuse of—and disappointment in—risk models.

The next generation of risk management tools

Advances in technology have made innovative risk modeling methods possible, methods that can help investors grasp portfolio loss potential under a variety of forward-looking market outcomes. Importantly, each modeled outcome can more accurately reflect the potential impact of negative tail risk in periods of market stress.

Ultimately, the purpose of offering a realistic understanding of portfolio risk is to provide decision support for successful investment processes. The digital revolution, through AI techniques and high-performance computing, has enabled development of new tools, as well as wider access to tools that have been under the purview of large institutions. Fidelity is committed to delivering the benefits of advanced analytics to investors.

In the development of new tools, three key, interconnected areas of decision support deserve focus: 1) better modeling; 2) conditional insights; and 3) direct portfolio applications. Exhibit 2 shows an example of these approaches being applied in a tool for constructing bond ladders.

Better modeling includes improvements in data inputs, evolving methods of analysis, and the inclusion of additional insights where applicable. New AI clustering and AI regression methods can help with integrating novel data sources, improving the quality of collected data, and aligning data sets for consistent and comprehensive analysis. Machine-learning techniques are being advanced to address the shortcomings of statistical modeling approaches, importantly eliminating the assumption of static market correlations and normally distributed return outcomes. Additionally, Fidelity strives to include insights based on our internal research and patented frameworks when creating analytics for consideration in portfolio construction processes.

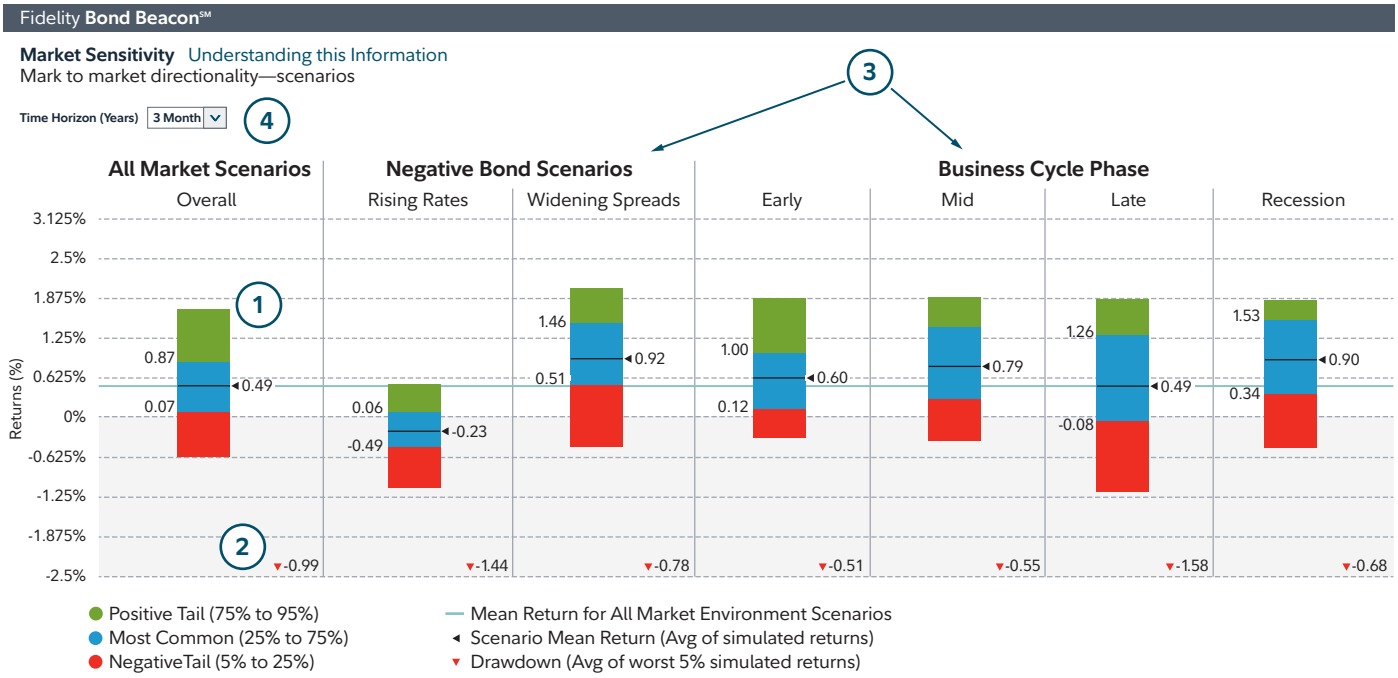
Conditional insights are important when confronting market uncertainties. The machine learning techniques developed to describe nonstationary asset price relationships can also enable analysis linked to refined market conditions. Fidelity is harnessing that capability to offer investment insights under a range of potential market paths.

EXHIBIT 2: Using advanced risk analytics to help investors

This illustrative example, for a hypothetical bond ladder built within Fidelity's Bond Beacon℠ trading platform, illustrates how advanced risk-modeling approaches may be presented in straightforward ways to help investors build portfolios.

Key elements:

1. Investors are able to **frame market uncertainties and observe the portfolio impact of specific securities** they are considering through real-time calculations linked to live bond offerings.
   - Portfolio outcomes are presented as a distribution of forward-looking simulated returns.
   - Quartile groupings indicate the likelihood of outcomes skewed on both sides of the distribution's average (commonly presented as the expected return).
   - Bond ladders with similar yields may have very different outcome distributions, which this approach can make apparent.
2. Modeling and **quantifying potential loss in periods of market stress** is important for alignment with an investor's risk tolerance, though extreme left tail events are rare.
   - The "drawdown" number represents the average of the worst five percent of simulated outcomes.
   - This approach enables focus on commonalities drawn from the most extreme market stress periods.
3. Scenarios can help investors understand a portfolio's **sensitivity to current market environment concerns,** and are selected to highlight important risks for specific asset types.
   - Preset scenarios are informed and regularly reviewed by Fidelity investment research staff.
   - Bond scenarios are customized to differentiate key risk elements: interest rates, credit yield spreads, and Fidelity's determination of the phases of economic business cycles.
4. **Time horizons can be compared** to show how longer holding periods may differ from shorter ones, helping investors consider their risk tolerance before and during periods of market stress.



* Business cycle phase as depicted uses the research-driven business cycle framework developed by Fidelity's Asset Allocation Research Team; see the Fidelity white paper "The Business Cycle Approach to Asset Allocation" for more details. For illustrative purposes only. The projections or other information generated by the Bond Beacon Bond Ladder regarding the likelihood of various investment outcomes are hypothetical in nature, do not reflect actual investment results, and are not guarantees of future results. Source: Fidelity Investments.

Considering a portfolio's return potential and examining the sensitivity of return outcomes to investor-determined market scenarios can provide important perspectives, allowing investors to ask "what if" while building or rebalancing portfolios. For example, conditional scenarios based on Fidelity's research on phases of the economic business cycle, or scenarios built to inform an investor's concern about changes in future interest rates or credit quality yield spreads, could help when assessing potential outcomes for bond portfolios.

Direct portfolio applications can be integrated with analytic modeling advancements. Fidelity is connecting data scientists, computer engineers, software developers, and investment staff to build tools to help inform clients as they consider portfolio options. One illustration of the benefits of this collaboration is in tools for financial intermediaries. Consider the many investors who build bond ladders by seeking to optimize yield without tools to quantify risk differences between individual bonds with similar yield. With advanced modeling techniques, portfolio interactions could be examined down to the level of individual securities, allowing the evaluation of how specific trades in an overall ladder could affect the distribution of potential outcomes. Additionally, model outputs can help align a ladder with the end-investor's risk tolerance by illustrating outcome distributions under a variety of market scenarios and time horizons. Other direct portfolio applications may include evaluating asset allocation across asset classes, within traditional asset classes, and across a variety of instrument types (e.g., securities, traditional mutual funds, ETFs, and index-based model portfolios).

Implications for investors

Fidelity is committed to adapting valuable new approaches for client use. The evolution of increasingly insightful risk modeling is being extended by new techniques of data analysis. Increased computing power and engineering techniques are enabling that analysis to be progressively personalized. By providing customized and intuitive insights that build from institutional knowledge and research, Fidelity aims to help investors make better-informed portfolio decisions.

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For Institutional Investors.

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