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Invesco Investment Solutions Focus Paper Series

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Assessing risk across a diversified portfolio can require evaluating hundreds or thousands of bonds, stocks, and other securities – their potential for return, embedded risk, and correlations to other investments. It's an enormously complex task, demanding access to vast amounts of continually changing data.

Factor analysis can simplify this process by identifying the key underlying drivers of risk and performance across securities, sectors, and asset classes. This approach allows us to untangle the often-complex relationships across investments that influence performance in a portfolio. Is performance tightly linked to equity market performance or economic growth? Is it affected by inflation? Is it sensitive to changes in interest rates? Factor analysis narrows the scope of risk analysis from a nearly unlimited pool of individual investments to a finite list of factors that describe their behavior.

The factor model used to describe the risks of and relationships between assets is central to risk management and portfolio construction exercises. The answers provided for these exercises rely almost exclusively on the estimates produced by the factor model.

In this paper we'll explore the nature of factors, the types of factors that are important for risk management, and how these analytical tools may provide a more informed approach to controlling risk in diversified portfolios.

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Understanding factors

Factors are persistent, quantifiable investment attributes that explain performance – risk, return, or both. When modeling factor exposures in a portfolio, factors are typically divided into three main categories: 1) macroeconomic factors, 2) statistical factors, and 3) fundamental factors.¹

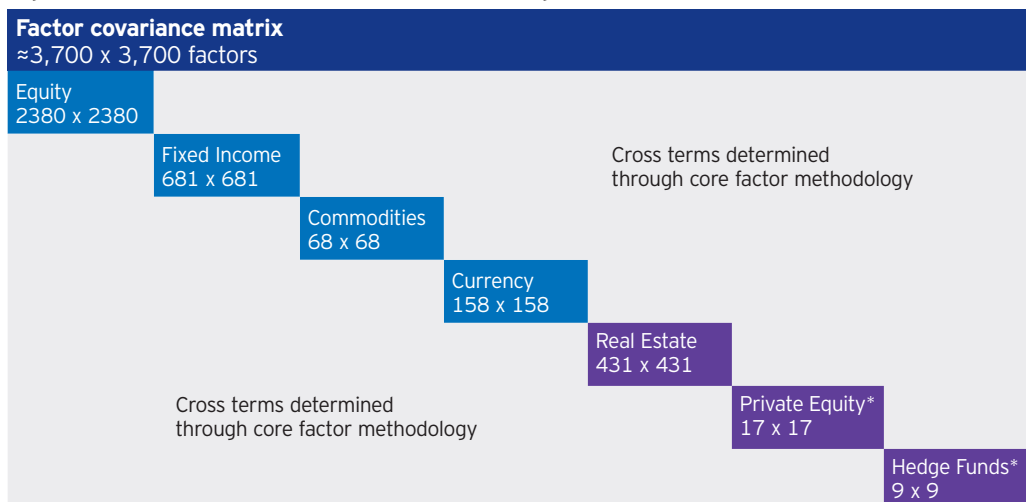
Macroeconomic factors are the most intuitive as they use observable economic time series information to explain security returns (e.g., GDP, inflation, interest rates, credit spreads, commodities, and currency). Not all macroeconomic factors produce a risk premium – for instance, currency exposure typically does not generate any consistent return advantage. However, macro factors can still be helpful in determining a portfolio's sensitivity to changes in the economic environment.

Statistical factors are much less intuitive as they are unobservable factors generally derived from statistical methods such as maximum likelihood or principal components analyses that produce factors that are statistical constructs of the data being analyzed used for explanatory purposes.

Fundamental factors use directly observable asset attributes (e.g., industry, price-to-earnings ratio, price momentum, market capitalization, etc.) to explain returns. These attributes are treated as sensitivities or betas which, when combined with risk indices that correspond to the various attributes identified, allow for the estimation of asset behavior. Style factors generally fall into this category but are distinguished by the fact that they are seen to exploit certain behavior biases and structural elements that may offer a premium. That is, exposure to these factors gives investors an opportunity to earn higher returns for the risk they are taking. (For a more detailed introduction to factors, see our companion white paper, "Factors for Potential Return Enhancement.")

While all of these factor types have potential benefits, a risk model based on fundamental factors tends to provide a high degree of flexibility in practice as well an intuitive understanding of the dependence of an asset's returns on well-defined attributes. For these reasons, we have selected a fundamental risk factor model to provide consistent estimates of the risks of and relationships between the assets and liabilities included in our Invesco Vision portfolio management decision support system. These estimates are derived from a fundamental factor-based covariance matrix. Rather than embarking on the daunting task of developing a proprietary fundamental risk model, Invesco Vision has incorporated BarraOne®, which is one of the most recognized and respected risk models available and provides information about approximately 3,700 asset attributes across a broad range of asset types. The chart below presents the factor covariance matrix used for asset and liability modeling along with the fundamental factors available by asset type.

Figure 4: Factor-based covariance matrix including alternative factors



* Private equity and hedge fund assets get exposure to both traditional asset factors as well as the indicated private factors, which are uncorrelated to any other factors.

Source: Invesco, BarraOne.

1. Gregory Connor (1995) The Three Types of Factor Models: A Comparison of Their Explanatory Power, Financial Analysts Journal, 51:3, 42-46.

To see this complete example of how Invesco Vision optimizes portfolios for absolute risk, see Case 1 in our white paper, "Invesco Vision: Portfolio Management Decision Support System."

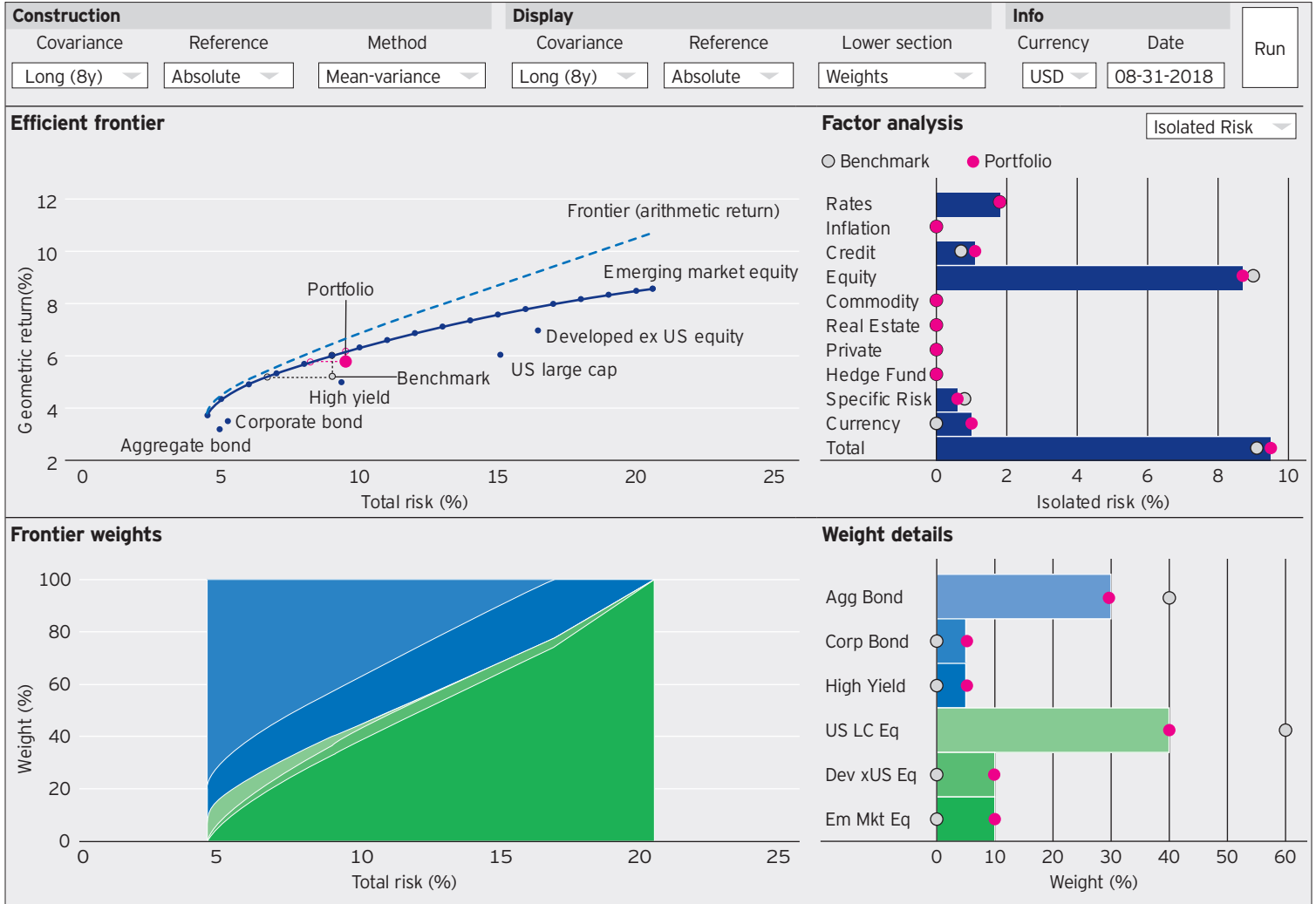
Diagnosing factor exposure

All portfolios have factor exposures even if they aren't measured or managed through factor analysis. Not understanding factor exposures can mean being exposed to hidden risks, even in portfolios that appear to be diversified by asset class.

At Invesco, the Invesco Vision system allows us to explicitly identify and quantify a client's portfolio factor exposures. For instance, we find that many institutional portfolios that have not been evaluated using factor analysis are often overexposed to equity risk, especially after a long period of economic growth in which this positioning has worked well. The visual below shows an example of a portfolio that is broadly diversified by asset class, but nonetheless derives the majority of its estimated volatility from equity factors.

C1a: Absolute risk optimization

Unconstrained mean-variance efficient frontier



For illustrative purposes only.

As a result, any factor process must begin with analysis of a client's existing holdings. To gain insight into risk, our Investment Solutions team runs analytics on factor exposures already embedded in the portfolio. Scenario analysis and stress testing provide insight into how the portfolio may perform under a variety of market conditions. Using this information, we can present our client with an overview of current factor exposures and risk levels. This consultative and customized process continues as we seek to understand our client's objectives, liquidity constraints, and investment policy guidelines. We learn which investment metrics matter most to the client. We also define the investible universe, given that client's specific restrictions and governance structure.

For a detailed, practical discussion of how Invesco Vision supports portfolio evaluation in historical and hypothetical scenarios, see Case 9 in our white paper, "Invesco Vision: Portfolio Management Decision Support System."

All of this information is fed into Invesco Vision, which can then provide information about the various risk-return trade-offs within the portfolio to help inform and guide the investor in identifying possible improvements to portfolio allocations. On a case-by-case basis, a factor approach can even account for factor risk exposure outside the portfolio itself, and in our client's businesses. For instance, financial corporations have a great deal of exposure to interest rate changes; in certain circumstances, their investment portfolios might, be advised to tilt away from this risk. Or consider sovereign wealth funds. Oil-rich countries' funds have significant exposure to energy prices – and are often drawn upon when oil prices drop. As a result, it might make sense for these portfolios to have lower exposures to factors tied to energy prices, so they don't experience drawdowns precisely when these countries need to tap them.

It's important to note that not all risk can be modeled by factor analysis. Idiosyncratic volatility is to be expected in a portfolio due to security selection, factor timing, and a variety of other nonsystematic exposures including issues with management quality or legal liabilities, which are difficult to model with factors. Moreover, since historical data on risks, returns, and correlations form the basis of factor analytics, this discipline evolves as new data emerges. Thus, there may be drivers of performance that we are not currently tracking and that will be discovered by subsequent research. But we still believe that, for a variety of reasons, the factor framework significantly improves our understanding of risk over that of the traditional asset class-based approach.

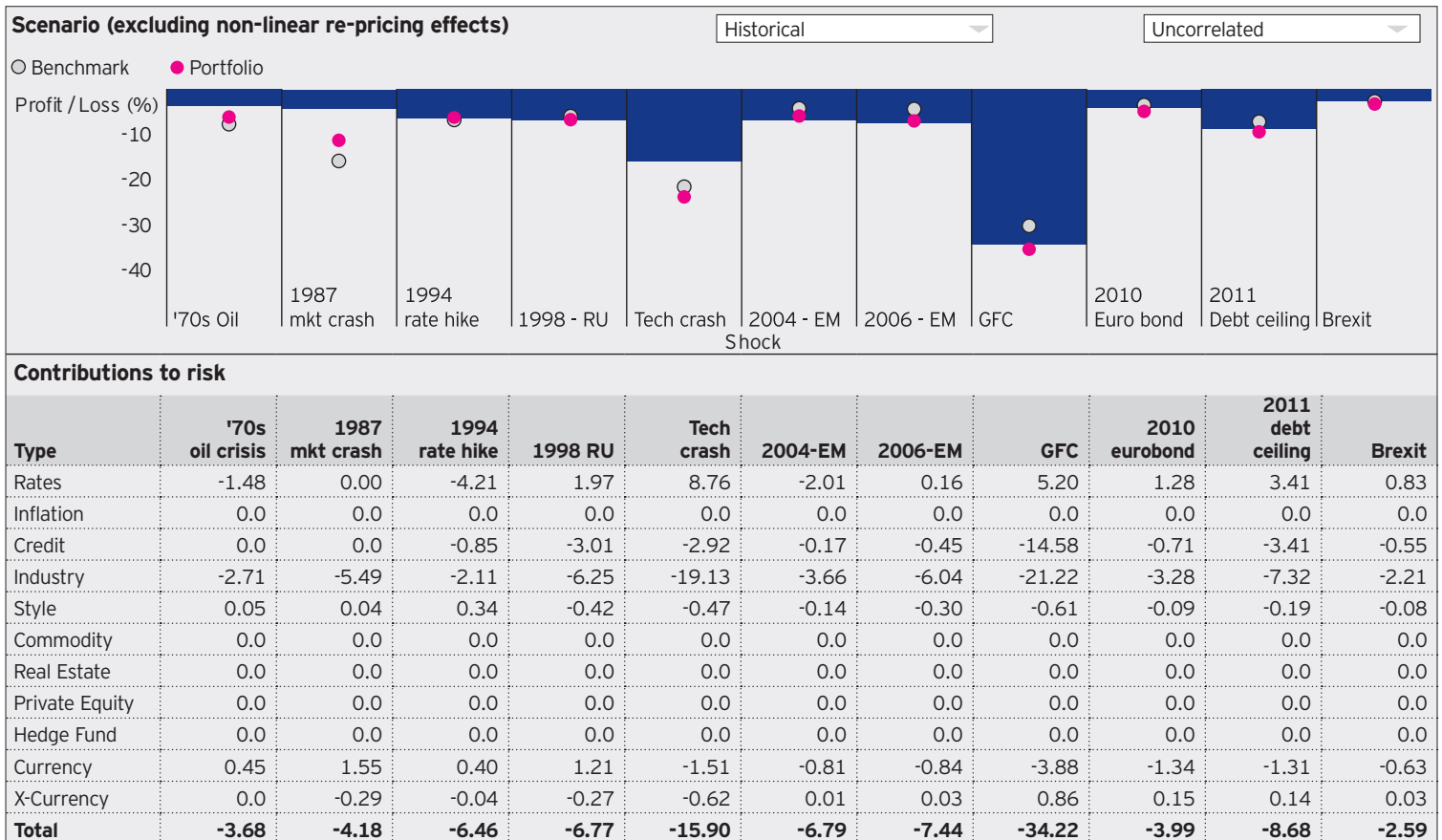
1. Factors can help us understand portfolio performance in varying market conditions.

Factor analysis is at the heart of consistent asset and liability modeling. As the most reliable tool we have for distinguishing signal from noise in investment performance – particularly in a portfolio context – factors are the starting point for any kind of modeling analysis.

For example, investors will want to stress test outcome-oriented portfolios to understand how they may perform in various market conditions. By relying on factor returns associated with specific time periods, a tool such as Invesco Vision can produce the hypothetical performance of a portfolio based on its current factor exposures.

The visual below illustrates the kind of detailed understanding provided by such analysis.

Figure C9a: Historical scenarios
Assuming uncorrelated sensitivities

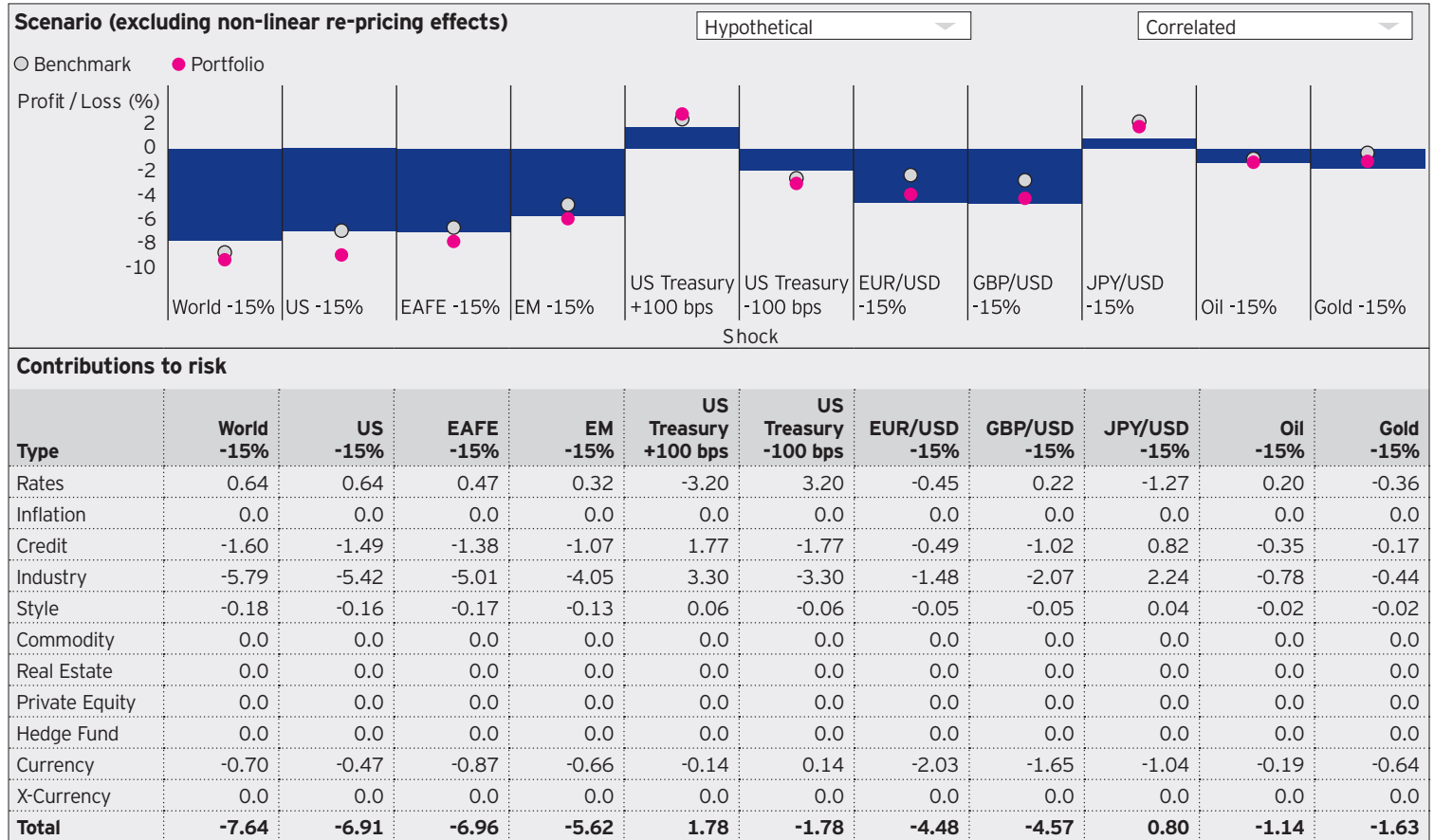


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Similarly, the same portfolio can be tested under certain hypothetical shocks (e.g., a significant drop in US equity markets or in the price of oil), using non-period-specific factor return assumptions. This analysis may be performed in uncorrelated mode, where only the shocked factors influence the portfolio, or in correlated mode, where specified factor shocks are propagated to remaining unspecified factors through their factor covariance structure. The hypothetical below shows the same portfolio subjected to 11 shocks, in correlated mode.

Figure C9b: Hypothetical scenarios

Assuming correlated sensitivities



For illustrative purposes only.

2. Factors can integrate and provide insight into alternative and newer investments.

Factor analysis can provide a common framework for both traditional and alternative assets, allowing investors to improve the expected risk-return characteristics of their portfolios by integrating private equity, private debt, and directly-owned real estate into their asset allocations. A factor lens can translate the characteristics of these relatively illiquid, hard-to-value investments into a common framework, so that they are compared on an apples-to-apples basis to traditional assets. Naik, Devarajan, Nowobilski, Page, and Pedersen (2016) show that many alternative assets can be well explained by a conventional set of factors. The table below shows the relative importance of eight conventional factors in driving risk and return for both alternative and traditional assets. Invesco has made a significant investment in developing the capabilities to assess risk and return drivers in these types of alternative assets.

The same factors affect traditional and alternative assets								
	US equity	Size	Value	Liquidity	Nominal duration	Real duration	Corporate spread	Equity beta
Private equity	0.5	-0.7	1.0	0.3			7.1	0.8
Venture capital	1.1	-0.6	-5.0					1.6
Infrastructure	0.7					3.3	4.5	0.7
Real estate (core)	0.4			0.3		1.6	2.1	0.4
Real estate (value added)	0.6			0.3		3.4	3.5	0.7
Real estate (opportunistic)	0.6			0.1		3.0	13.8	0.9
Hedge funds	0.4	0.2					1.7	0.2
US stocks	1.0							1.0
US bonds					4.7		2.3	0
US govt. bonds					5.4			0.2

Source: "Factor Investing and Asset Allocation: A Business Cycle Perspective," by Vasant Naik, Mukundan Devarajan, Andrew Nowobilski, Sébastien Page, CFA, and Niels Pedersen, CFA Institute Research Foundation, pages 156-157, 2016.

Institutional portfolios often contain assets or strategies with limited histories. It can be difficult to evaluate how they might perform in the future, as there is not enough historical information on them. Factors can provide an effective way to model the behavior of such assets or strategies. For example, in modeling private infrastructure or private commercial real estate debt, our Investment Solutions team uses existing factors to develop well-reasoned and defensible customized models that set factor exposure levels using quantitative and qualitative judgments. For these types of situations, a close collaboration with the client will serve to develop a common understanding of and an agreement in the assumptions being made in such modeling exercises.

In this fashion, factor analysis provides a great deal of flexibility in accessing new asset classes and emerging strategies early on, when the field is less crowded and return opportunities have not yet been fully exploited. Using factors as a framework for modeling assets and liabilities allows investors to compare new strategies with well-established ones, leveling the playing field and enabling them to seek a broader range of opportunities. Factors can also widen the field for investors who have traditionally required long track records from the investment vehicles they consider.

3. Factors enable more informed portfolio design

A single asset class often includes many investment subclasses with very different risk and return drivers. As a result, traditional asset class-based diversification may not provide the same risk mitigation benefits as a factor approach. For instance, consider a portfolio that includes two fixed-income assets: long US Treasuries and high yield bonds. From a historical return perspective, long Treasuries may appear to be similar in risk to high yield bonds. Using a factor lens, however, we see that Treasuries' risk and return is primarily driven by rates, while high yield bonds are exposed to both rates and credit factors. They will perform very differently under a variety of scenarios.

Thorough factor analysis can also reveal exposures that aren't necessarily evident or intuitive, even with investment vehicles purporting to offer specific factor exposures. For example, a 50/50 allocation to a value equity passive strategies and a momentum equity passive strategies appears to offer a straightforward factor exposure. Very likely, it may not. The momentum passive strategies likely contains a negative exposure to value, materially under-exposing the total portfolio to value. Such negative factor exposures exist in many investments, but will go undetected without a comprehensive factor analysis. Investors need these deeper insights to make truly informed investment decisions.

Understanding risk and return drivers becomes particularly crucial when constructing a portfolio to match long-term liabilities. That liability structure is itself sensitive to such factor exposures as duration and key rate duration (the duration specific to the portfolio's discount rate). There may also be some credit factor exposure.

To construct a solution, we allocate assets to investments that closely mirror the liability stream. For instance, say the liability has a duration of 15 years. We will make sure that the portfolio also has a duration of 15 years. We will also seek to match other factor exposures, such as credit, so that the portfolio has the best possible chance of meeting its liability targets. By matching factor exposures, rather than simply diversifying across fixed income sectors, we can more closely align a portfolio's assets with its liabilities.

4. Factors can identify changes in benchmark composition

We often think of performance benchmarks as unchanging yardsticks, but in fact, benchmarks change over time, and this can affect the risk entailed in seeking to track an index. Factor analysis allows us to scrutinize benchmark composition to see how the index's risk and return shift over time – and to make more accurate projections about the risk characteristics of the index in the future.

For instance, BBB-rated bonds – the lowest investment grade rating – today make up roughly half of the Bloomberg Barclays investment grade bond index. That's up from around 38% before the financial crisis and 25% in the 1990s.² That makes this index a great deal riskier than it has been, even in the fairly recent past. Portfolios that track this index need to be aware of this changing risk profile and base their investment decisions and asset allocations on risks that are present now, not on historical data. Factor analysis allows us to take a snapshot of the benchmark to gauge its forward-looking risk characteristics at any given moment.

Other indexes have changed as well. For instance, technology stocks made up 29% of the S&P 500 Index in 1999, just before the tech meltdown. By 2002, their weighting was down to under 15%. The same thing happened to financial stocks during the 2008 crisis, when their weighting slipped from over 22% of the S&P 500 in 2006 to under 9% in 2009.³ These broad market movements significantly shift the factor exposures of indexes, to the point where an index may no longer match a client's desired risk-and-return profile. Factor analysis allows us to constantly re-evaluate index risk and performance characteristics, and to adjust clients' targets accordingly.

² "Things Are Getting Stormy for Investment Grade Debt," CNBC, Oct. 8, 2018.

³ "S&P 500 Sector Weights - A Lot Has Changed In 8 Years," Seeking Alpha, March 14, 2017.

Conclusion

Aligning portfolios with risk and return objectives

Institutional portfolios may include thousands of securities, each with its own performance track record, risk profile, and liquidity characteristics. Factor analysis enables portfolio managers to distill these individual details into a concise list of factor exposures – how much exposure to economic growth, to interest rates, to liquidity risk, to the stock market – that can be aggregated and managed across the entire portfolio.

Factor analysis helps us better understand how much risk is in a portfolio, what kind of risk it is, and how this risk aligns with our clients' overall preferences and needs for performance, liquidity, and asset protection. It can provide information on new investments, and a more comprehensive understanding of benchmark composition. Factor analysis can be an important informational resource for portfolio construction exercises that can help guide decisions about the risk and return trade-offs being faced so that the portfolio that is ultimately developed for a client is well-aligned with their specific investment needs. For more information on our customized approach to factor-based risk management and how it could work for your organization, contact your Invesco representative.

Further resources

Factor Investing: Introduction & Research

Factor Investing: The Third Pillar of Investing Alongside Active and Passive
Annual Invesco Global Factor Investing Study

About risk

The value of investments and any income will fluctuate (this may partly be the result of exchange rate fluctuations) and investors may not get back the full amount invested.

Factor investing (as known as smart beta or active quant) is an investment strategy in which securities are chosen based on certain characteristics and attributes that may explain differences in returns. Factor investing represents an alternative and selection index based methodology that seeks to outperform a benchmark or reduce portfolio risk, both in active or passive vehicles. There can be no assurance that performance will be enhanced or risk will be reduced for strategies that seek to provide exposure to certain factors. Exposure to such investment factors may detract from performance in some market environments, perhaps for extended periods. Factor investing may underperform cap-weighted benchmarks and increase portfolio risk. There is no assurance that the factors discussed herein will achieve their investment objectives.

Momentum style of investing is subject to the risk that the securities may be more volatile than the market as a whole or returns on securities that have previously exhibited price momentum are less than returns on other styles of investing.

A value style of investing is subject to the risk that the valuations never improve or that the returns will trail other styles of investing or the overall stock markets. Low volatility cannot be guaranteed.

Stocks of small-capitalization companies tend to be more vulnerable to adverse developments, may be more volatile, and may be illiquid or restricted as to resale than large companies.

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