

IMPROVING ASSET ALLOCATION WITH FACTOR ANALYSIS

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The Case for Factor Analysis

Determining an investment program's optimal asset allocation requires a robust understanding of portfolio risk. But risk is difficult to quantify and investment outcomes are experienced differently by different investors. At NEPC, we believe that the best way to determine an asset allocation that meets goals is to incorporate a multi-disciplinary framework that takes a holistic approach to risk management. Yet, even a robust approach with multiple perspectives can obscure important insights about sources of risk in the investment program, if those perspectives are focused solely on asset classes. In NEPC's factor analysis framework, asset classes serve as carriers of different combinations of risk factor exposures. The interaction of these factors helps define the risk profile of the portfolio. Volatility becomes a function of broad macroeconomic factors. Asset allocation decisions can then be adjusted in order to refine the factor risk profile.

We believe our factor analysis framework provides new insights into sources of risks in a portfolio and strengthens the asset allocation decision-making process. It identifies risk concentrations more consistently and allows macroeconomic views to be expressed more granularly than an asset class-focused approach, informing allocation decisions that can lead to better diversification. For example, its focus on inflation sensitivity resonates with endowments, foundations, and other investors that require real returns to meet spending needs. Evaluating exposure to growth (and the chance that growth falls below expectations)—the dominant risk factor for many investment programs—is a helpful exercise for any

asset owner with sizeable allocations to equities or alternatives. Furthermore, factor analysis helps pension sponsors examine exposure to rates across their assets and liabilities to ensure that underlying risks are appropriately aligned.

That said, NEPC cautions against over-reliance on this method to manage risk due to data limitations and time-varying relationships between asset classes and factors. To this end, we consider factor analysis as a complement to, rather than a replacement of, a traditional asset class-based risk framework.¹ We believe our factor analysis enhances the understanding of portfolio risk within a robust asset allocation framework.

Re-Thinking Risk

Investors often think about portfolio allocations in buckets of asset classes, for instance, equities, fixed income and commodities. We buy and sell asset classes. Investment products are packaged relative to asset class performance. We have data for asset class returns going back several decades. It is only natural to assume that volatility should be deconstructed into asset class categories. And indeed it can, as investors have done for decades. But viewing risk management exclusively through an asset class lens can capture an incomplete picture. Asset class relationships can change drastically in certain economic regimes. A single macroeconomic event can impact many different asset classes that are usually uncorrelated. For this reason we encourage our clients to incorporate factor analysis into their existing portfolio risk management framework. We believe that a "mosaic" approach, that is, combining multiple perspectives on portfolio risk—including mean

¹For more details on NEPC's perspective on managing portfolio risk, refer to research paper *"Shedding Light on the Future: Asset Allocation and Risk Management in a Post-Credit Crisis World."* November 2013.

Other Types of Factor Analysis

Style- or characteristic-based factor analysis—using factors such as size, value, momentum and carry—seeks to account for observable portfolio characteristics that have historically shown the ability to deliver excess returns. It may be used to identify trading opportunities within a portfolio, exploit historically demonstrated risk premia, or quantify active management from prior returns.

Statistical factor analysis, such as Principal Component Analysis, deconstructs portfolio returns into unnamed factors using the covariances of asset returns. This too may be used to identify attractive buying opportunities in the context of a quantitative model.

variance optimization, risk budgeting, scenario analysis, liquidity analysis, and factor analysis—leads to a better understanding of portfolios.

The global marketplace makes certain assumptions about financial metrics such as economic growth and interest rates. Asset prices reflect this consensus information. When something unexpected occurs, like the release of a disappointing growth metric or a sudden spike in interest rates, the market experiences volatility. Investors gain useful insights about sensitivities contained in a portfolio during volatile markets by evaluating betas, or exposures, to various risk factors. Asset classes serve as the carriers of these exposures—the means through which we access factor risk premia.

The phrase “factor analysis” may refer to a few different things (see sidebar). At NEPC, our factor analysis framework deconstructs an investment program’s market volatility into broad macroeconomic factor weights. This is consistent with our disciplined approach to asset allocation, which is meant to be more strategic than tactical.² We attempt to quantify a portfolio’s exposure to broad global market data to help understand how changes in these metrics impact a portfolio.

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Risk Factors

We have identified five main macroeconomic risk factors that we believe substantively explain a diversified portfolio’s realized volatility:³

- Economic growth
- Real interest rates
- Inflation
- Foreign currency
- Illiquidity

We also allow for additional sub-factors in our modeling where there are meaningful differences between holding different types of these exposures (Exhibit 1). We believe this framework provides the appropriate balance of precision and simplicity to ensure that the conclusions drawn from factor analysis are sufficiently actionable when evaluated alongside other asset allocation tools.

- Growth:** Growth fuels returns when macroeconomic conditions associated with economic output, for instance, industrial production and consumer spending, are favorable. Found in most risky assets, including equities, credit and many real assets, it is typically the dominant risk exposure for an institutional investor.

Exhibit 1: Factors and Sub-Factors Used

Growth	Real Rates	Inflation	Currency	Illiquidity
Domestic Growth	Short Real Rates	Rising Global Inflation	Developed vs. Base	Contractual Illiquidity
Developed Int'l Growth	Intermediate Real Rates	Falling Global Inflation	Emerging vs. Base	Pricing Illiquidity
Emerging Growth	Long Real Rates			
IG Credit Spreads				
HY Credit Spreads				

Source: NEPC

² We believe that focusing on macroeconomic risk exposures is the best of the three factor-based approaches for determining an optimal asset allocation, while style and statistical factor analyses are more appropriately used in the strategy implementation phase of the investment process.

³ While alpha can also be an important risk exposure for many investors, our focus on macroeconomic risk exposures means that more idiosyncratic exposures, like alpha, are evaluated separately as part of a strategy implementation process.

tor. Within growth, we differentiate a portfolio's relative exposure to developed and emerging market growth, and exposure to credit spread risk. Thus, while equities provide the greatest exposure to growth, we also recognize growth exposure in fixed income investments with credit risk, as well as certain sovereign securities such as emerging market debt.

THE OPTIMAL FACTOR ALLOCATION IS NOT ONE OF PERFECT RISK BALANCE

- ii. **Real rates:** This measures the exposure to the global term structure of interest rates, adjusted for inflation and excluding credit spreads. Exposure to real rates is present in most fixed income securities as a component of sovereign and corporate bonds, Treasury Inflation Protected Securities (TIPS) and other inflation-linked bonds. We consider separately interest rate exposure at the short-, intermediate- and long-end of the yield curve in order to better quantify the impact of a changing shape of the curve for a portfolio. Seeking exposure outside one's home country provides the opportunity for diversification in terms of geography and term structure.
- iii. **Inflation:** This represents sensitivity in a portfolio to changes in domestic and international inflation. Here, the directional exposure is important, as some assets, such as commodities, are likely to benefit from a spike in inflation, whereas other assets, like Treasuries, generally respond positively if inflation is falling.
- iv. **Currency:** The currency factor (FX) represents volatility caused by changes in foreign currencies relative to the portfolio's base currency. At NEPC, we think about exposures to developed and emerging currencies separately for several reasons. Our research suggests that an investor is unlikely to receive adequate compensation for the volatility related to holding developed market currencies over a market cycle.⁴ On the other hand, exposure to emerging markets' currencies may provide

an attractive return premium as artificially low exchange rates may approach fair value over time. In addition, these exposures are often relatively small and expensive to hedge. Thus, for many clients the optimal currency exposure will be positive in emerging markets, and low or even zero in developed markets.

- v. **Illiquidity:** This exposure reflects how certain investments prone to infrequent but large changes in value are expected to compensate investors over time through a return premium. In our model this encompasses both contractual illiquidity and pricing illiquidity. Contractual illiquidity refers to restrictions around redemptions outlined in many alternative asset agreements. For example, a private equity contract may state that committed capital will be called as needed over three to five years and then distributed with the total life of funds, often lasting 10 or more years. For funds with long investment horizons and access to top managers, this illiquidity premium may be an attractive source of return. On the other hand, pricing illiquidity refers to an investment that may be thinly traded. For example, a small number of potential buyers of high yield bonds could lead to a spike in the bid-ask spread. An investor bearing this risk should be mindful of the possibility that price illiquidity will most likely manifest during a market crisis.

Making Factor Analysis Work for You

At NEPC, factor analysis is a risk exercise, not a return exercise. While we do not explicitly assign return expectations to each risk factor, we believe that some (such as growth and illiquidity) are likely to be relatively high, while others (such as currency) are low or even negative. Thus, in our view the "optimal" factor allocation is not one of perfect risk balance. Based on the unique objectives of each investor, some might be comfortable with a large exposure to inflation, while others will want to hedge or minimize exposure to it. Some might want to reflect liability factors by considering volatility in a surplus (assets minus liabilities) context, while others will find the asset-only approach most relevant. Investors may look beyond the investment pool to the broader enterprise to help better define the appropriate framework for

⁴For more details on NEPC's perspective on hedging currency risk, refer to research paper "Managing Developed Country Currency Risk - A Proactive Approach." April 2011.

risk management. Our investment recommendations reflect our clients' individual sensitivity to each risk factor as well as our belief about how they will be compensated for holding each risk factor.

Once the factor risk profile is understood for the current portfolio allocation (Exhibit 2), our framework also helps demonstrate how new investment opportunities will change the profile on the margin. Given an increase in allocation to one asset class and a pro-rata reduction of all other allocations, we show which factor exposures have been increased and which have been cut (Exhibit 3). In this example, the dominant factor exposure to US growth is most effectively diversified by the fixed income asset classes, ranging from Treasuries to emerging market debt. Adding these asset classes generally keeps total portfolio volatility the same or lower, while reducing exposure to US growth risk.

While each portfolio's factor risk profile looks different, there are some takeaways that may be widely applicable:

- i. **Growth exposure likely dominates many portfolios with a sizeable allocation to equities and/ or alternatives:** Some investors may conclude that this concentration is unacceptable and seek a more balanced approach. Others may embrace the dependence on economic growth, determining that the overall level of exposure is necessary to meet their return goals, while seeking better diversification within the growth category, either through a more globally-weighted equity allocation or by moving up the capital structure to take on more debt.
- ii. **Some investment programs will appear underexposed to rising inflation:** Carrying a limited exposure to rising inflation is a strategy that has worked fairly well over the past 30 years. However, continued low inflation over a long period of time seems unlikely. For endowments, foundations, and other investment programs where spending needs would accelerate in an inflationary environment, a robust real assets program may be appropriate. Additional exposure to rising inflation could also be used as a diversifier for more concentrated positions in growth.

Exhibit 2: Factor Risk Profile

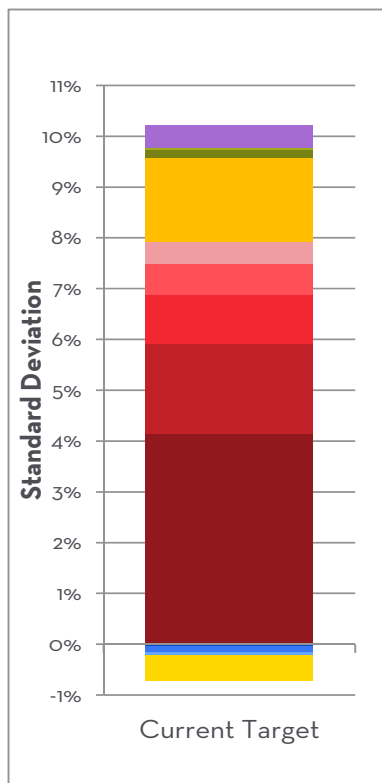
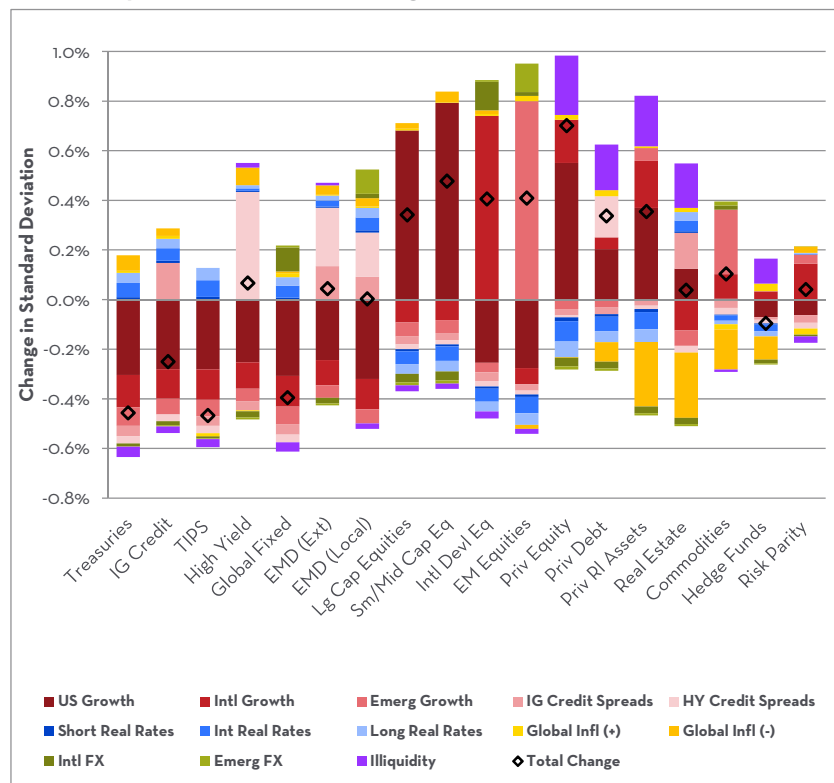


Exhibit 3: Impact of 5% Allocation Changes on Factor Risk Profile



Source: NEPC



⁵ While economic theory would suggest that a risk-free liability be discounted with a risk-free interest rate, many corporate pension plans are permitted to use high-quality corporate bond yields, which, by definition, carry credit spread exposure.

- iii. **Risk parity may represent a capital-efficient way to access balanced exposures across multiple risk factors:** For many diversified portfolios, risk parity may serve as an attractive core investment because of its relatively balanced exposure to growth, real rates and inflation. The leverage employed within the product ensures that meaningful exposures to lower volatility risk factors, like real rates and inflation, can be obtained for risk management purposes while preserving more of the portfolio's capital to seek returns.
- iv. **Pension plans that view liabilities more granularly through a risk factor framework may find themselves overexposed to interest rate changes:** There are several macro factors that impact both assets and liabilities. Corporate pension discount rates change due to movements in real rates, inflation and credit spreads.⁵ For most corporate pensions, surplus factor volatility is dominated by interest rate exposure when a hedging program is not in place. This may be particularly acute for underfunded plans and plans with longer duration profiles.

FACTOR ANALYSIS BETTER BALANCES THE RISK PROFILE BY AVOIDING MISLEADING DIVERSIFICATION

Advantages of Factor Analysis

The factor analysis approach is better suited to investors with a macroeconomic perspective on risk management because it describes risk concentrations more explicitly than risk management tools that solely evaluate and categorize risk based on asset classes.

Advantage #1: Correlation Stability

Using traditional portfolio theory, an investment program's volatility can be estimated based on the volatility and weight of individual assets, and the correlations between assets. However, the static correlation assumptions between asset classes can overstate diversification benefits during a crisis when correlations spike. Research has shown that correlations across macroeconomic risk factors are both lower and more stable than correlations across asset classes.⁶ Thus, a factor

approach to diversification would help alleviate (but not eliminate) this limitation.

Advantage #2: Avoid Misleading Diversification

Traditionally, investors have viewed fixed income as an effective diversifier of equity volatility. However, in today's lower-yield environment, return expectations for nearly all assets have compressed, and many investors have revisited the structure of their fixed income portfolio in order to boost returns. Yet, many of the more return-oriented fixed income asset classes, for example, high yield bonds and emerging market debt, achieve a higher-return outlook by taking on a larger growth tilt. Shifting a fixed income portfolio in this direction can erode its risk-mitigating properties because the underlying exposures are more similar to equities.

Assume an investor adds a fixed income allocation to an all-equity portfolio for better diversification, but the fixed income portfolio is growth-oriented (Exhibit 4). Total expected volatility for the new portfolio has come down and the risk contribution from each asset class has been reduced. However, the impact on factor risk is more nuanced. Diversification benefits are largely driven by the fixed income portfolio's exposure to real rates, whereas growth and inflation exposures are present across both equity and fixed income allocations. In this example we have actually *increased* the exposure to inflation while modestly diversifying growth and completely diversifying away real rates exposure. Isolating the underlying exposures that are truly driving risk sensitivities can allow us to find an asset allocation that better balances the portfolio's risk profile by avoiding misleading diversification.

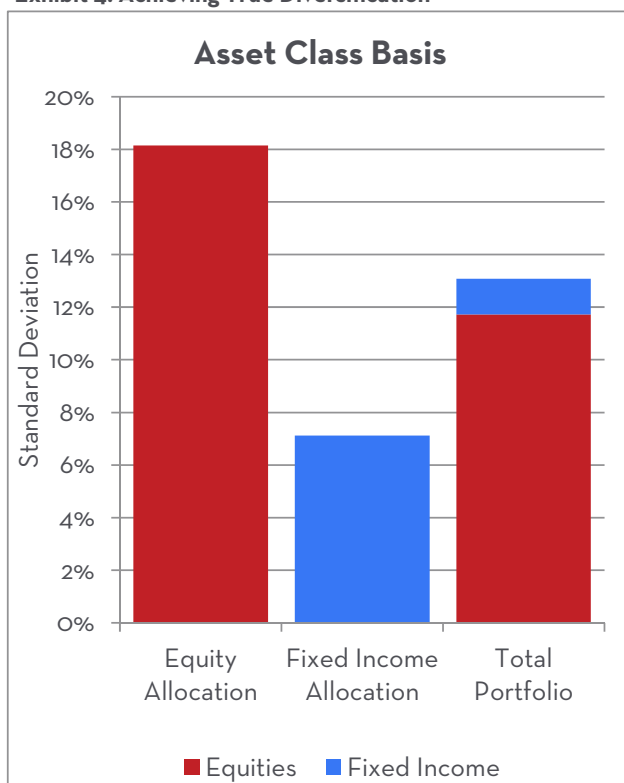
Advantage #3: Granularity of Views

At NEPC, we believe having views about asset classes include aggregating multiple views about changes in economic factors. When changes in financial markets cause the forward-looking outlook to alter, adjusting each factor's assumptions directly may be more sensible than attempting to modify multiple assumptions for asset classes consistently, each of which is impacted by factors in different ways. Changes in the investment landscape or internal changes within an organization could cause the desired risk exposure to each factor to evolve over time. In these instances, a factor-based approach helps ensure that the ap-



⁶ Myth of Diversification: Risk Factors vs. Asset Classes. Viewpoints, PIMCO, September 2010.

Exhibit 4: Achieving True Diversification



Source: NEPC

appropriate allocation decisions can be made. Knowing the level of expected volatility being driven by a single factor can lead to greater awareness of risk exposures throughout the entire portfolio.

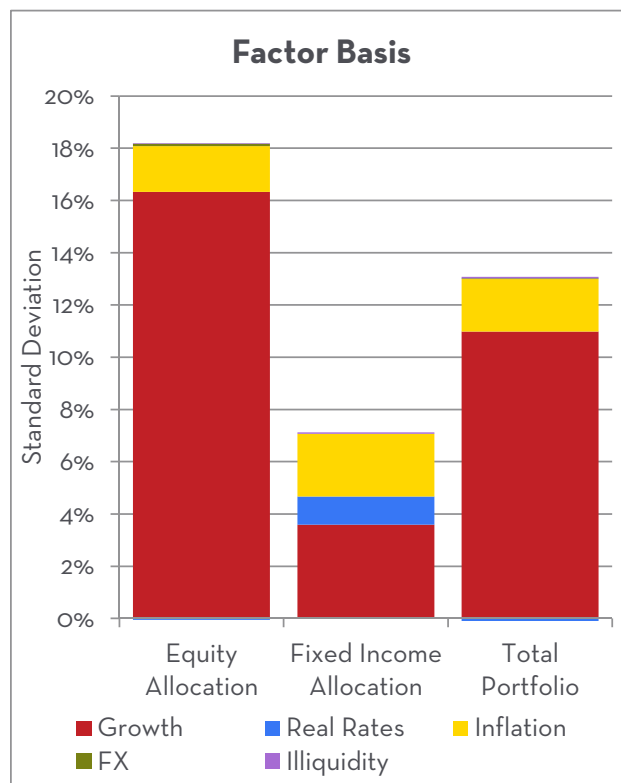
Disadvantages of Factor Analysis

Factor analysis is susceptible to some of the same weaknesses as conventional risk management tools, and has other limitations that we discuss below. We advocate the use of multiple risk perspectives and caution against heavy dependence on any one method to evaluate risk. To this end, we recommend factor analysis as a complement to, rather than a replacement of, a traditional asset class-based risk framework.

Disadvantage #1: False Precision

We believe a framework that employs risk factors is better suited to explain investment relationships than one using only asset classes. That said, our factor analysis approach still uses the principles of portfolio theory and is subject to the criticism that risk is modeled too simplistically.

As we have discussed, portfolio theory uses static assumptions for volatility and correlations between asset classes. This can overstate diversifi-



cation benefits during a crisis when correlations spike. Certain factors—particularly illiquidity—that demonstrate sudden increases in volatility and correlations may be underrepresented in a portfolio's risk profile because of this limitation.

Disadvantage #2: Data Challenges

Investments do not fit into factor buckets as neatly as asset class categories, as most asset classes carry exposures to multiple factors. This means that it may be challenging to implement a precise long-only allocation of pure factor exposures. Also, an asset class category's factor betas shift over time, resulting in changes to the portfolio's risk composition. Finally, it is often more difficult to obtain historical data to inform the very assumptions that one is trying to make. This is particularly true with less tangible factors like inflation, which is experienced differently by investors and may be difficult to quantify with a single benchmark. The tradeoffs between precision and simplicity underscore the importance of using factor analysis to supplement, rather than replace, traditional risk management.

A FACTOR-BASED APPROACH IS A MORE CONSISTENT WAY TO IMPLEMENT MACROECONOMIC VIEWS

Conclusion

The asset allocation philosophy at NEPC incorporates multiple perspectives on portfolio risk management as part of a dynamic framework. For many of our clients, this has included traditional mean variance optimization, asset class risk budgeting, economic scenario analysis, and liquidity analysis, as well as holistic considerations like funded status forecasting, spending analysis, and enterprise risk management. Despite the challenges inherent in deconstructing a portfolio into a reasonably small number of risk factors, we believe that a factor-based approach presents a more consistent way to implement macroeconomic views in a portfolio. By defining portfolio volatility in a new way—as a function of exposures to growth, real rates, inflation, currency and illiquidity—we believe our factor analysis framework provides important new insights for many investment programs.

Disclaimers and Disclosures

- Past performance is no guarantee of future results.
- All investments carry some level of risk. Diversification and other asset allocation techniques do not ensure profit or protect against losses.
- The information in this paper has been obtained from sources NEPC believes to be reliable. While NEPC has exercised reasonable professional care in preparing this paper, we cannot guarantee the accuracy of all source information contained within.
- The opinions presented herein represent the good faith views of NEPC as of the date of this paper and are subject to change at any time.
- This paper contains summary information regarding the investment management approaches described herein but is not a complete description of the investment objectives, portfolio management and research that supports these approaches. This analysis does not constitute a recommendation to implement any of the aforementioned approaches.

