PGIM QUANTITATIVE SOLUTIONS

BUILDING AND EVALUATING BETTER RISK-AWARE STRATEGIC PORTFOLIOS

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Given that investment risk and returns for institutional asset owners will depend on strategic portfolio allocation decisions, what are the optimal strategies for constructing and evaluating portfolios?

Key Findings

- Many asset classes, and the multi-asset portfolios constructed with those assets, exhibit non-normal return distributions.
- Challenges to constructing strategic portfolios fall into two major categories: 1) What forecast inputs to use and 2) Understanding the various quantitative approaches and their inherent strengths and weaknesses.
- One means to help manage higher dimensional risk in strategic portfolios is to add a defensive equity allocation to hedge against those risks. We evaluate the impact of using PGIM Quantitative Solutions' US Market Participation Strategy.
- To reach realistic assumptions in building strategic portfolios, forward-looking expectations based on initial conditions in the current environment must be incorporated.

This brief summarizes the research paper with the same name by Lorne Johnson, PhD; John McClure, PhD; Manoj Rengarajan, CFA.

Building and Evaluating Better Risk-Aware Strategic Portfolios

Strategic portfolio allocation decisions are the main determinants of investment risk and returns for institutional investors. But what is the optimal method for constructing and evaluating strategic allocations, incorporating risk metrics that span beyond standard deviation? The importance of evaluating multiple risk metrics cannot be overstated, especially when considering that many multi-asset portfolios, and the asset classes comprising them, exhibit non-normal return distributions, negative skewness and considerable drawdown risk beyond what can be summarized with the conventional metrics of return and standard deviation. To examine these issues, we evaluate a range of available portfolio construction options, considering different risk metrics. To better assess potential return paths for different allocations we also conduct forward-looking simulations that incorporate various investment regimes that are historically more representative of negatively skewed asset classes contained in multi-asset portfolios.

The shortcomings of portfolio construction methods that assume all asset returns are normally distributed have been widely documented. Multiple studies have identified significant negative skewness and excess kurtosis in equity returns. Studies have further found that investors are averse to negative skewness and will seek hedging assets in longer-horizon portfolios on the expectation of occasional periods of adverse investment climates.

The assumption of elliptical multivariate normal distributions for asset class returns contradicts their behavior. Because these methods often place no weighting on asymmetric return distribution or serial correlations, they are not an ideal guide for choosing among portfolios. While several models that evaluate single-period negative outcomes demonstrate the probability of experiencing losses, some fail to determine the magnitude of losses, making them flawed choices for optimizing risk metrics.

Our evaluation of common public market assets using monthly data from January 1992 to July 2021 is consistent with the aforementioned studies. Significant negative skewness is evident in selected equity markets, commodities, US High Yield bonds and REITs. In contrast, US Treasuries exhibit some degree of positive skewness and can be viewed as hedging assets with respect to negative skewness.

Table 1: Historical Summary of Asset Class Return Outcomes: Jan 1992 – July 2021

	Intermediate US Treasuries	Long US Treasuries	US Aggregate Bonds	US High Yield Bonds	US Large Cap Equities	EAFE Equities	Emerging Market Equities	US REITs	Commodities
Annualized Return	4.4%	7.2%	5.3%	7.6%	10.0%	5.6%	7.6%	10.1%	2.7%
Standard Deviaton	3.0%	10.2%	3.5%	8.3%	14.4%	16.1%	21.9%	19.4%	14.7%
Skew	0.10	0.24	-0.19	-1.31	-0.65	-0.53	-0.65	-0.77	-0.51
Skew Significance	0.78	1.86	-1.45	-8.09	-4.68	-3.90	-4.68	-5.43	-3.81
Kurtosis	0.63	1.27	0.74	10.53	1.42	1.40	2.10	8.28	2.20
Kurtosis Significance	2.14	3.42	2.39	8.75	3.66	3.63	4.58	8.15	4.70
Maximum Drawdown	3.4%	19.4%	5.1%	33.3%	50.9%	56.7%	61.4%	70.5%	72.0%
Sharpe Ratio	0.69	0.52	0.84	0.67	0.60	0.28	0.35	0.50	0.09
Sortino Ratio	2.72	1.23	2.67	1.34	1.12	0.59	0.64	0.87	0.32
DD on Stdev	1.16	1.90	1.46	4.02	3.53	3.52	2.81	3.63	4.91

Source: PGIM Quantitative Solution. Net total return as of July 31, 2021.

We consider several risk metrics used in portfolio construction, which broadly fall into two categories: those that measure individual period risk (such as portfolio variance) and those that measure cumulative risk (such as maximum drawdown). Since portfolio return processes with high variance tend to have higher drawdowns and vice versa, choosing the appropriate metric is difficult and requires a deeper analysis of the asset return process.

We therefore examine a range of options for building strategic multi-asset portfolio allocations, considering multi-dimensional risk parameters. We illustrate how portfolio construction incorporates managing risk across three dimensions: 1) What are the outcomes under Mean-Variance Optimization (MVO) and alternative risk models that consider equal risk contribution, historical drawdowns, historical shortfall to target and portfolio higher moments; 2) How ex-ante constraints on asset classes and asset class groups impact those outcomes; and finally, 3) How increasing the opportunity set with a defensive equity allocation impacts outcomes.

Given the higher volatility and skewness present in equities, we evaluate the impact on strategic portfolio outcomes of including a defensive equity allocation to help manage higher dimensional risk. We examine PGIM Quantitative Solutions' US Market Participation Strategy (MPS), which allows upside participation when the US equity market advances, while reducing downside risk. The strategy utilizes long-dated S&P 500 call options in combination with US Treasury bonds. The call options provide upside participation, while US Treasury bonds serve as a safe haven during turbulent market conditions and provide downside protection. Using a disciplined process, exposures (market, volatility and duration) are actively managed in response to the changing market environment using a rules-based framework.

In contrast to US Large Cap Equities, MPS provides a historical annualized return that is approximately 85% of the return of US Large Cap Equities with considerably lower volatility and modest positive skewness.

Table 2: MPS vs. US Large Cap

	US Large Cap Equities	MPS
Annualized Return	10.0%	8.7%
Standard Deviaton	14.4%	8.7%
Skew	-0.65	0.18
Skew Significance	-4.68	1.38
Kurtosis	1.42	3.51
Kurtosis Significance	3.66	5.91
Shortfall	43.8%	25.0%
Maximum Drawdown	50.9%	19.0%
Sharpe Ratio	0.60	0.77
Sortino Ratio	1.12	1.78
DD on Stdev	3.53	2.18

Source: PGIM Quantitative Solutions. Net total return as of July 31, 2021.

We show that adding MPS to the asset universe meaningfully improves portfolio outcomes for all evaluated risk models. The resultant portfolios have lower volatility, reduced drawdowns and a substantial increase in skewness to positive and significant levels in some cases. Sharpe ratios of all risk model portfolios with added defensive equity allocation are improved with no reduction in annualized returns.

Table 3: In Sample - Performance Across Risk Models - Group Constraints

Assets	MVO	MVSK	MSO	CDaR	EQ Risk
Annualized Return	8.1%	8.1%	8.1%	8.1%	9.7%
Standard Deviaton	5.6%	6.1%	5.7%	6.0%	7.1%
Skew	-0.25	0.23	-0.06	0.17	-0.84
Skew Significance	-1.93	1.78	-0.46	1.33	-5.79
Kurtosis	1.31	2.43	1.49	2.16	3.39
Kurtosis Significance	3.48	4.95	3.77	4.65	5.81
Shortfall	18.6%	19.1%	18.4%	19.0%	24.5%
Maximum Drawdown	10.6%	7.5%	9.7%	7.4%	22.6%
Sharpe Ratio	1.06	0.97	1.04	0.98	1.07
Sortino Ratio	1.82	1.72	1.82	1.74	1.72
DD on Stdev	1.91	1.23	1.71	1.23	3.20

Source: PGIM Quantitative Solutions. Net total return as of July 31, 2021.

Investors with access to a tail-risk hedged product such as MPS are able to construct portfolios that performed competitively with Equal Risk portfolios historically, while also improving the risk measures which they focus on, such as Sharpe Ratio, drawdowns and return symmetry.

The more realistic exercise in building strategic portfolios is to incorporate forward-looking expectations based on initial conditions. PGIM Quantitative Solutions' Capital Market Assumptions (CMAs) underpin the long-run outlook for strategic allocations in our individual strategies and multi-asset portfolios. They are the product of a highly systematic process for generating consistent projections across the capital markets. Our latest CMAs are forecasting more modest outcomes for the subset of asset classes in this analysis over the next ten years, attributable to the current lower yield environment, more modest expectations for economic growth and inflation as well as elevated valuations for US equities relative to long-term averages.

Table 4: Summary of Q3 2021 CMAs

Assets	Arithmetic Mean	Geometric Mean	Standard Deviation	Sharpe Ratio
Intermediate US Treasuries	1.3%	1.2%	3.0%	0.30
Long US Treasuries	3.2%	2.7%	10.2%	0.28
US Aggregate Bonds	2.3%	2.2%	5.6%	0.35
US High Yield Bonds	3.3%	2.9%	8.5%	0.34
US Large Cap Equities	6.4%	5.2%	15.1%	0.40
EAFE Equities	8.0%	6.7%	16.0%	0.48
Emerging Market Equities	9.4%	6.7%	23.6%	0.38
US REITs	6.3%	4.8%	17.4%	0.34
Commodities	2.4%	1.3%	14.6%	0.14
MPS	4.8%	4.4%	8.7%	0.51

Source: PGIM Quantitative Solutions as of July 31, 2021.

Finally, to better evaluate the potential future path of strategic portfolio outcomes in the presence of negative skewness, we evaluate a regime-aware simulation methodology that seeks to replicate the historical characteristics of asset classes and portfolio outcomes. This analysis sheds additional light onto the important task of building long-horizon strategic portfolios to meet long-term funding requirements that incorporate risk beyond the conventional metrics of mean and variance.

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