PENSION INSURANCE MODELING SYSTEM (PIMS) PEER REVIEW: INTEREST RATE AND ASSET RETURN MODELING

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Introduction

The Moving Ahead for Progress in the 21st Century Act (MAP-21, Pub. L. No. 112-141) was enacted on July 6, 2012. Section 40233(a) of MAP-21 requires the Pension Benefit Guaranty Corporation ("PBGC" herein) to contract with a capable agency or organization that is independent of the PBGC to conduct annual peer reviews of the Single-Employer (SE)-Pension Insurance Modeling System (PIMS) and Multiemployer (ME)-PIMS.

This report covers a targeted peer review of Single-Employer (SE)-PIMS and Multiemployer (ME)-PIMS. In particular, this review focuses on the development of PBGC's capital market assumptions, the projection of interest rates and other macroeconomic variables, along with an assessment of the process of modeling plan asset returns. Projected future interest rates and plan asset returns are an important component of the PIMS models, which are used to develop PBGC's annual Projections Report, a 10-year projection of the financial position of each of PBGC's two insurance programs – the Single-Employer Program and the Multiemployer Program. PBGC also uses these forecasting models to analyze the potential effects of legislative proposals that impact private sector defined benefit plans and the insurance programs.

The objectives of this PIMS Peer Review are to provide PBGC with an analysis of how effectively macroeconomic variables and future plan asset returns are developed and projected for the SE-PIMS and ME-PIMS models. This report reviews the current capital market framework used by PIMS and provides recommendations to improve the stochastic modeling of these variables. PBGC is embarking on a multi-year project to update and modernize the current PIMS models. The new versions are referred to as Transformational PIMS, or "T-PIMS". The new T-PIMS models will provide increased modeling flexibility and use more sophisticated modeling techniques. Thus, findings and recommendations from this analysis may inform improvements to the current PIMS models and the future T-PIMS models.

Project Scope

The review includes an analysis of the macroeconomic variables stochastically modeled within PIMS. Currently, PIMS uses the 30-year Treasury rate and U.S. aggregate stock returns as its key economic variables for plan asset returns. The 30-year Treasury rate is projected forward stochastically under a modified random walk model, where the random walk includes an underlying trend towards a specified level above inflation. Stock returns are then projected stochastically based on an expected spread over the 30-year Treasury rate. Our peer review analyzes the stochastic modeling of the 30-year Treasury rate and returns on Treasury bonds and equities. Additionally, the peer review includes an assessment of the PIMS assumptions used for future rates of inflation and future growth rates for wages and salaries and flat-rate plan benefits (benefit formulas that are not related to employees' pay). The peer review includes recommendations on ways the model can improve these capital market assumptions. In modeling plan investment returns, PIMS currently models only two asset types– fixed income and stocks. A uniform asset allocation between fixed income and stocks is applied to all plans in both SE-PIMS and ME-PIMS. More granular information on plans' actual asset allocation is reported on Schedule R of the Form 5500 but is not currently used in the models. The peer review analysis also looks at actual plan allocations and recommends how use of that data would improve model projections, particularly in times of market stress.

Many single-employer plan sponsors have adopted liability-driven investment (LDI) strategies designed to manage and/or minimize plan funded status volatility. Plan sponsors' management of interest rate risk and other risks are important considerations when projecting the future funded status of the plans and analyzing PBGC's risk exposure. As a result, the report includes information on recent trends in defined benefit plan asset allocation, plan practices related to investment risk management and recommendations for how this information could improve modeling in PIMS.

The American Rescue Plan Act (ARP) created a new, Special Financial Assistance (SFA) Program under which PBGC will provide one-time payments to troubled multiemployer plans that meet statutory eligibility requirements. ARP and the regulations thereunder impose investment restrictions on the SFA provided to eligible multiemployer plans, and as a result, ME-PIMS must allow for separate asset allocations for the two pools of plan assets – non-SFA and SFA. This report analyzes PBGC's existing modeling techniques and discusses potential recommendations regarding a modeling framework for projecting the performance and balances of the SFA and non-SFA portions of plan assets, reflecting the provisions of ARP and PBGC's regulations under Section 4262 of ERISA. This includes plan sponsors' expected practices for paying down SFA assets. This framework includes both the modeling of the SFA and non-SFA assets separately, as well as modeling assumptions that reflect the asset allocation policies adopted for total plan assets.

In summary, the review includes the following items:

1. The stochastic projection of key economic variables
2. The key economic variables used as the basis for projecting plan asset returns
3. Plan asset allocations, and whether and how the Schedule R data can be used to improve plan-by-plan asset allocations
4. The spreads used from the key economic variables to estimate asset returns for specified asset classes
5. The stochastic projection of the spreads between key economic variables and plan asset returns
6. The correlation between returns of different asset classes, and how those correlations may change in down markets
7. Asset allocations for SFA and non-SFA assets and plans' target policy for total plan asset allocations
8. The tail risk of asset returns in extreme down markets

All recommendations on approaches to reflect plan asset allocations and develop plan asset return assumptions used in the model reflect the purposes of the model and balance the resources required to incorporate the recommendations. Our specific recommendations can be found in Table 3. The scope of the review focuses on modeling related to ongoing pension plans. It will not review modeling for the future performance of assets managed by PBGC or by terminated and insolvent multiemployer plans that are currently or expected to receive traditional financial assistance under section 4261 of ERISA.

Approach

To conduct this review, Mercer held several meetings with PBGC staff to discuss the current approach to modeling economic variables and plan asset returns. Additionally, PBGC provided Mercer with supporting documentation for the model, inputs and data sources used to construct its model, as well as output from the models. These materials were used to conduct the peer review. To conduct the peer review Mercer analyzed PBGC's approach and compared it against industry best practices, financial theory, historical results. We also reviewed the modeling output to ensure it was consistent with the objectives and purpose of the model. Our focus was on whether the model was "fit for purpose". Recommendations provided herein were viewed in the context of seeking to improve the accuracy of the model in terms of projecting the net financial position of PBGC's two programs.

Findings

Overall, we find that PBGC economic scenario generator (ESG) utilized to generate economic and market variables and model plan universe returns is consistent with industry best practices. In the table below, we compare PBGC's ESG against the leading attributes as defined in The Society of Actuaries: Economic Scenario Generators: A Practical Guide[1].

Table 1: A Brief Comparison of PBGC's ESG Against Leading ESG Attributes Defined by the Society of Actuaries (SOA)

	Leading Attribute	Conclusion	Supporting Reasons	Potential Areas for Refinement
1	It provides a sound foundation for the way the models are built and the way the variables are interrelated; it balances practicality and completeness.	✓	The ESG is focused on modeling a select group of variables and does so in a thoughtful manner. The selected variables capture the main drivers of returns.	
2	It provides a suite of models sufficient to capture the asset classes and economic variables of greatest importance to the risk profile of the organization.	✓	The ESG focuses on modeling asset classes and factors that are of greatest importance to the PBGC. The ESG effectively captures the risks associated with the plan universe and PBGC assets and liabilities.	We recommend introducing the ability to model corporate bond spreads stochastically.
3	It is capable of accommodating many types of calibration views across a wide range of benchmarks.	✓	The ESG is able to capture the risk associated with the SE and ME Plan universes and major equity and fixed income benchmarks.	
4	While being capable of accommodating many types of calibration views, it produces simulation results that reflect a relevant view.	✓	Yes, the model is calibrated to achieve a specific distribution and specific long-term values for specific variables.	Certain parameters and variables, such as stock/bond correlations are a function of a randomness rather than calibrated to the economic environment. A potential T-PIMS enhancement is a regime switching mode that would provide the capability to adjust correlations based on the economic environment.

[1] Economic Scenario Generators: A Practical Guide. Society of Actuaries, authored by Conning. Published July 2016.
https://www.soa.org/493868/globalassets/assets/files/research/projects/research-2016-economic-scenario-generators.pdf

Table 1: A Brief Comparison of PBGC's ESG Against Leading ESG Attributes Defined by the Society of Actuaries (SOA) (continued)

	Leading Attribute	Conclusion	Supporting Reasons	Potential Areas for Refinement
5	It produces some extreme but plausible outcomes.	✓	Yes, for most variables the model captures left-tail scenarios such as very low interest rates.	PBGC could consider adjusting the equity distribution to account for left-tail events and negative skew. Also, it could adjust the information distribution to capture more extreme events.
6	It embeds realistic market dynamics.	✓	Ranges of outcomes are consistent with history and financial theory. The output includes a wide range of outcomes and the range of outcomes along a single path varies.	The stochastic modeling of corporate spreads and making the stock/bond correlations dependent on the economic environment are potential enhancements for either the existing models or T-PIMS.
7	It is computationally efficient and numerically stable.	✓	Yes, the number of variables and parameters have remained relatively stable over time.	An additional consideration would be to implement a governance structure to ensure current and potential parameters are re-tested and validated on a recurring basis.
8	It has capabilities for real-world and market-consistent simulations and uses consistent models across both modes.	✓	The model captures the range of potential outcomes for asset classes and plans.	Specifically for T-PIMS there is the potential to incorporate a regime switching model to capture dynamic market relationships. The PBGC could also consider modeling multiple points along the yield curve and multiple yield curve shapes.
9	It produces sufficient simulation detail for extensive validation.	✓	All parameters are clearly defined and the output can be matched to specific formulas and estimates. The model produces sufficient output items, which can be validated.	

In the table below, we summarize our key findings are it relates to the variables modeled by PBGC.

Table 2: Summary of Key Findings

Variable	Conclusion
30-Year Treasury Yield and Return	The PIMS Treasury yield and return projections provide a significant portion of the theoretical distribution. There are, however, circumstances where the simplicity of the model restricts its fit along the distribution. For this reason, incremental changes may enhance the current state of the PIMS model. For example, PBGC could review the process for setting the Target 30-Year Rate and its relationship with inflation. Also, incorporating multiple points along the yield curve and multiple yield curve shapes may result in a more realistic model.
Equities	The PIMS equity returns projections provide a significant portion of the theoretical distribution. There are circumstances, however, where the simplicity of the model restricts its fit along the distribution, but overall, PIMS has targeted the critical drivers of the ex-ante distribution. Incremental changes may enhance the current state of the PIMS model. Specifically, expanding the model to capture negative skew and fatter left-tails would enhance the model.
Correlations	The PIMS projections produce randomized correlations around a targeted value. This randomized process allows the model to capture a wide range of correlation scenarios which have been historically exhibited and theoretically probable. The calibration of the underlying correlation input likely warrants updating which should improve the fit of the model to economic conditions. Development in the T-PIMS model could target more robust economic indicators which would facilitate conditional correlations more akin to real world environments.
Corporate Spreads	PBGC should consider stochastically projecting credit spreads to more dynamically reflect the real-world sensitivity of plan assets and liabilities. There is no single approach to simulating spreads, but one example in the context of the current PIMS structure would include an additional disturbance term. This term would require additional correlations to the current stochastic projections of the disturbance term along with mean and variance estimate and continued use of the reversion term. Each of these elements will play key roles: The correlations will integrate the model. The new disturbance term will capture relationships along with idiosyncratic characteristics of the factor. Finally, the reversion variable will allow for a dynamic mean while capturing the serial correlation of spreads.
Modeling Plan Asset Returns	The three factors employed by PBGC explain a significant portion of plan asset returns. The addition of the credit risk factor may marginally improve the explanatory power of the model, but more importantly, it should integrate and enhance the estimation of the liabilities' present value. Additionally, revising asset allocations to reflect current plan positioning annually is appropriate.

Table 2: Summary of Key Findings (continued)

Variable	Conclusion
Modeling SFA and Non-SFA Assets	The methodology and assumptions reasonable for the 2021 Projections Report, given how the SFA legislation is structured and what is currently observed in ME SFA request filings. However, additional Plan information, obtainable from 2021 Form 5500 filings, should be implemented in a timely manner in order to better project Plan eligibility. In addition, specific Plan determinations of SFA are increasingly becoming available as applications are filed. We recommend PBGC incorporate all requested SFA amounts as stated in applications immediately upon processing. Accordingly, we see no value in refining the estimation of SFA amounts as such information will quickly become obsolete. **Other considerations** – Plans that receive SFA are subject to certain conditions imposed under ERISA Section 4262(m). These conditions include restrictions on benefit improvements, contribution reductions, asset allocation, and withdrawal liability. We understand these restrictions are not explicitly modeled in ME-PIMS. We understand, however, that these considerations are designed to preclude plan actions that might impair benefit security and the solvency of the program. Not modeling these conditions is therefore reasonable, since the primary purpose of the restrictions is to prevent unacceptable new behaviors that are not currently taking place. Accordingly, we do not believe it is imperative to incorporate these considerations into the model.
Key Investment Trends to monitor	The use of liability-driven investing, asset allocation glide paths, and the use of alternatives may impact the PIMS models. The ability to incorporate changing (dynamic) asset allocations that change by year or funded status may improve modeling accuracy. Additionally, being able to assume different asset allocations based on plan funded status and other circumstances (open vs. closed) may improve plan modeling and is a potential T-PIMS consideration. However, updating asset allocations and factor exposures annually may capture shifts as changes occur.

Table 3 outlines our key recommendations and the model for which they are applicable. Overall, our finding is that the models are thoughtfully constructed and appropriately balance complexity with accuracy. As suggested, we believe our recommendations are not critical, but would improve the robustness of the model. Many of these recommendations might be applicable to T-PIMS rather than the existing PIMS given the complexity of developing them.

Table 3: Summary of Recommendations

Recommendation	Model Applicability	Priority	Impact
Develop a defined governance structure for reviewing and testing underlying inputs, assumptions, and plan asset allocations utilized to stochastically model variables and plan asset returns. This includes the documentation of the process and the establishment of a regular schedule of review.	SE-PIMS, ME-PIMS, T-PIMS	High	Low
Stochastically model credit spreads and corporate bond returns.	SE-PIMS, ME-PIMS, T-PIMS	High	Medium
Adjusting the distribution of equities, yields and inflation to capture fatter left-tails and more extreme downside events.	SE-PIMS, ME-PIMS, T-PIMS	High	Medium
Modeling multiple yields and maturities to allow for complete modeling of the yield curve, including different yield curve shapes.	T-PIMS	Medium	Medium
Incorporate dynamic correlations through a regime switching model.	T-PIMS	Medium	Medium
Incorporate the ability to model year-by-year asset allocations or multiple asset allocations.	SE-PIMS, ME-PIMS, T-PIMS	Low (updating asset allocations and factor exposures annually should minimize risk)	Low

Section 1: Economic Scenario Generator (ESG) - Leading Practices Overview

In this section, we will review what an economic scenario generator (ESG) model is and what are the leading practices of an ESG model. This will include the governance structure that oversees the development of a model as well as the inputs that feed into the model. We will also review the purpose of the ESG model and capital market assumptions as its specifically relates to Single-Employer (SE) and Multiemployer (ME) Pension Insurance Modeling System (PIMS). Further we will discuss the PBGC's approach to developing its ESG model and whether it is fit for purpose in terms of the specific needs of PBGC and general leading practices.

Purpose of Economic Scenario Generators

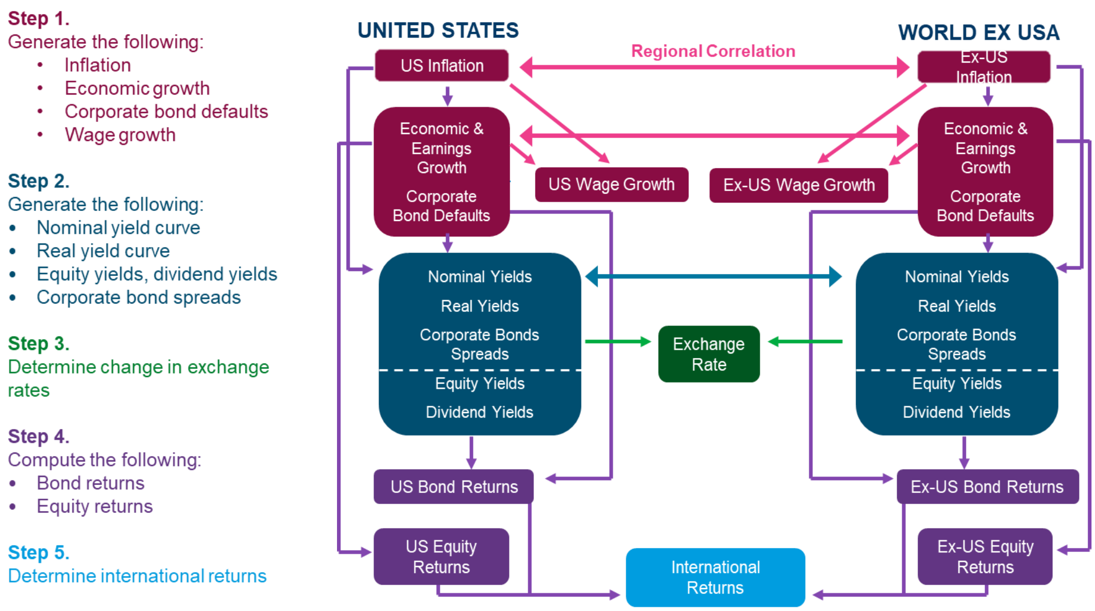
The Society of Actuaries: Economic Scenario Generators: A Practical Guide An economic scenario generator (ESG) defines an ESG as a computer-based model that seeks to produce simulations of financial market values and economic variables.[2]

At its foundation, an ESG is concerned with simulating future economic growth, inflation, interest rates and equity returns. Financial markets operate within the context of the growth and volatility of economic and market variables. An ESG typically builds off economic variables such as inflation and economic growth. It then seeks to project Treasury yields for a specific maturity or an entire yield curve. It often then considers implications of corporate bond yields and returns that include default, transition behavior and stochastic spreads. Next, equity markets, foreign exchange considerations and alternative assets are considered. An ESG model creates correlations through direct relationships with other simulated variables. Often, these variables and their interrelationships are modeled through an integrated cascade structure to maintain model integrity. A cascade structure is a framework whereby each subsequent variable depends on prior values of the variable and the values of variables that lie above them in the cascade structure. Below, we show a hypothetical integrated cascade structure. The ESG currently utilized by PBGC has limited cascade components, although variables and parameters are inter-related. However, utilizing a more fundamental cascade structure is a potential enhancement for T-PIMS. As shown below, it would allow for greater control over variables and more defined parameters, which would enable easier addition of new asset factors (classes) and allow for modeling of more clearly defined relationships between variables. For example, such a structure would make it easier to create a regime switching structure where the size of the equity risk premium and the correlation between bond yields and equity returns would vary based on the economic environment (e.g. the level inflation).[3]

[2] Economic Scenario Generators: A Practical Guide. Society of Actuaries, authored by Conning. Published July 2016. https://www.soa.org/493868/globalassets/assets/files/research/projects/research-2016-economic-scenario-generators.pdf

[3] Economic Scenario Generators: A Practical Guide. Society of Actuaries, authored by Conning. Published July 2016. https://www.soa.org/493868/globalassets/assets/files/research/projects/research-2016-economic-scenario-generators.pdf

Figure 1: Sample Cascade ESG Structure



Over the years, many investment organizations have developed capital market models utilizing stochastic regression techniques within a cascade model structure to generate simulations of both economic variables (economic/wage growth and inflation) and capital market returns (stocks and bonds). The primary goal of these models is to generate a set of future economic scenarios that spans the range of possible future outcomes for use in risk management applications. Although economic scenario generators are extremely useful in gaining insight into future financial risk and rewards, like any model, they have limitations. Modeling the future dynamics of the economy and financial markets presents many challenges, such as accounting for extreme events and regime changes. Additionally, the future is inherently uncertain, and may not always resemble the historical observed pattern. It is imperative that users of these models understand the strengths and weaknesses of any particular ESG, to ensure the ESG utilized is appropriate for the analysis being performed.[4]

Leading Practices of ESG

The Society of Actuaries: Economic Scenario Generators: A Practical Guide lists the attributes of a leading ESG as following:

1. It provides a sound foundation for the way the models are built and the way the variables are interrelated; it balances practicality and completeness.
2. It provides a suite of models sufficient to capture the asset classes and economic variables of greatest importance to the risk profile of the organization.
3. It is capable of accommodating many types of calibration views across a wide range of benchmarks.
4. While being capable of accommodating many types of calibration views, it produces simulation results that reflect a relevant view.
5. It produces some extreme but plausible outcomes.
6. It embeds realistic market dynamics.
7. It is computationally efficient and numerically stable.

[4] Economic Scenario Generators: A Practical Guide. Society of Actuaries, authored by Conning. Published July 2016. https://www.soa.org/493868/globalassets/assets/files/research/projects/research-2016-economic-scenario-generators.pdf

8. It has capabilities for real-world and market-consistent simulations and uses consistent models across both modes.
9. It produces sufficient simulation detail for extensive validation.

In terms of building an ESG there is often a focus on parametrization and calibration. The parameters are the part of the ESG that can be changed and that govern the dynamics of an economy. A particular choice for the parameters is referred to as a parameterization. An ESG can have several hundred parameters—mean, standard deviation, correlations, mean reversion speed, "jump" behavior, to name just a few—that make it possible to produce future paths that have features and qualities consistent with the desired targets. Poor parameterization will result in a model that does not exhibit behavior consistent with the desired targets. Some of the key decision points when parameterizing a real-world model include (a) selecting the appropriate steady-state levels, (b) determining the appropriate values for the initial conditions, (c) identifying the key parameterization targets or “stylized facts” that are necessary for the application, (d) controlling the expected reversionary paths of economic variables, and (e) identifying general assumptions.[5]

Calibration is the process of setting the parameters of the ESG. A calibration may be done with the primary objective of fitting to historical targets, or it may reflect a particular view of markets. For example, Treasury yields may be calibrated to reflect historical yields or a specific future view of the world based on forecasted economic growth and inflation. In either case an ESG should be calibrated so that parameters reflect the desired end-impact sought by the user. As the model equations increase in complexity to account for more robust dynamics, the number of model parameters increases, and the linkage between the input parameters and the desired output statistics becomes less intuitive. The calibration process thus becomes increasingly challenging as additional variables and parameters are incorporated into the model. This suggests a balance between complexity and accuracy. Overall, we think there should be a focus on modeling a few variables well, which may accurately capture most of what is needed from an operating perspective, rather than modeling a lot of variables poorly. Modelers should not confuse complexity with a well-designed model that is fit for purpose.[6]

Stylized facts refer to generalized interpretations of empirical findings that provide a basis for consistent understanding of markets or economic drivers across a wide range of instruments, markets and time periods. Analysis of historical data is commonly used as the basis for determining stylized facts and setting calibration targets; however, stylized facts can also be based on expert judgement. Stylized facts are important in guiding the design of an ESG in that they help establish and prioritize the properties that the ESG model must have to be useful for a given application. The historical record of economic and financial markets is an indispensable guide to the dynamics that govern ESG model simulations. Detailed knowledge of these dynamics is essential for setting ESG model calibration targets and understanding strengths and weaknesses of various ESG model frameworks. Users of ESG models need to incorporate a view of future market dynamics into their risk-modeling environment.[7]

Purpose of Economic Scenario Generators within SE and ME PIMS

The Pension Benefit Guaranty Corporation (PBGC) insures against the loss of participants’ pension benefits in private-sector pension plans. PBGC operates two separate insurance programs — one for multiemployer defined benefit pension plans and one for single-employer defined benefit pension plans — that are legally separate and operationally and financially independent. The two programs also offer different benefit guarantees and feature different funding mechanisms. The FY 2021 Projections report primarily includes 10-year projections, ending with FY 2031 (September 30,

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[5] Economic Scenario Generators: A Practical Guide. Society of Actuaries, authored by Conning. Published July 2016. https://www.soa.org/493868/globalassets/assets/files/research/projects/research-2016-economic-scenario-generators.pdf

[6] Economic Scenario Generators: A Practical Guide. Society of Actuaries, authored by Conning. Published July 2016. https://www.soa.org/493868/globalassets/assets/files/research/projects/research-2016-economic-scenario-generators.pdf

[7] Economic Scenario Generators: A Practical Guide. Society of Actuaries, authored by Conning. Published July 2016. https://www.soa.org/493868/globalassets/assets/files/research/projects/research-2016-economic-scenario-generators.pdf

2031), of the financial status of both programs under a range of future financial scenarios, plus additional projections beyond 10 years for the Multiemployer Program.

The PIMS is the modeling system that PBGC uses to prepare the Projections Report. It estimates the future position of the Single-Employer and Multiemployer Programs and is also used to model the U.S. private pension system. The PIMS models are unique and complex. Their purpose is to provide an actuarial evaluation of the future financial status of PBGC's Multiemployer and Single-Employer Programs. It does so by projecting solvency (adequacy of assets and income to meet cash needs) and balance sheet net financial position (assets minus liabilities) for the two programs under a variety of simulated future conditions.

Both systems use probabilistic distributions of investment returns, interest rates, and other variables to estimate a distribution of possible future outcomes. The Projections report uses averages and ranges to summarize the results of the stochastic simulations. They reflect a reasonable set of values that result from assumptions about these factors; those highlighted include the values simulated from the ESG and are the focus of this report.

- Inflation and wage growth
- Interest rates (e.g. 30-Year Treasury yields, corporate bond yields)
- Equity returns
- Plan sponsor decisions about contributions
- Multiemployer plan applications for SFA provided by ARP

The Projections Report presents two types of financial measures:

- Liabilities, which represent the present value of the guaranteed retirement benefits that will be provided by PBGC for the lifetime of participants and their beneficiaries. PBGC's liabilities are compared to its assets to determine a net position.
- Cash flows, which represent the benefit payments expected to be disbursed by PBGC during each year of the projection period. Cash flows provide the basis for examining PBGC solvency.

Focusing on capital market variables alone, SE and ME PIMS seek to model the universe of pension plans and risks to PBGC's net financial position resulting from different capital market outcomes. Put differently, the PBGC is not attempting to model individual plans in SE-PIMS, rather it models the overall funded status of the plan universe.

The ESG can impact the variables through the following mechanisms.

- Existing and potential new claims, which is largely a function of the risk/probability of bankruptcies. However, it is also a function of plan funded status, which is influenced by capital market conditions.
- The premiums received by PBGC. These are impacted by legislation, plan status (open/closed, risk transferred, etc.) and funded status, with capital market assumptions playing a smaller role.
- Size of potential liabilities incurred, which can be related to pension plan funded status, but is largely related to the potential for new claims.
- The performance of PBGC assets, which can be heavily driven by capital market performance.
- The overall financial position of the SE-plan universe, which is influenced by the aforementioned factors.
- Potential claims on SFA from ME-plans and the potential size of those claims, which are influenced by the current and expected funded status and funding necessary to meet financial obligations.

Given the objectives of SE and ME PIMS, along with the multiple inputs that feed into the models, it is critical to view PBGC's ESG model in the context of how it is utilized. In particular, the need to balance ease of use and fitness for purposes with complexity. Many risk management and investment firms have created ESG models that are commercially available.

These models have additional parameters and variables which are capable of creating very complex distributions and modeling outcomes. Often times, these models include tens if not hundreds of asset classes broken by duration, credit quality, equity region, equity capitalization, and alternatives (real estate, private equity, hedge funds, etc.). However, it would not be appropriate to compare the ESG, as it is utilized within PIMS to these other models with different purposes and uses. Those models are most useful for an individual institution seeking to model a specific plan rather than an organization such as PBGC that is attempting to capture the total capital market environment and the universe of plans. As such, when evaluating the ESG within PIMS against the criteria of leading attributes of a good model, it is critical to consider the purpose and the risk concerns of PBGC. When evaluating changes to existing parameters and variables or the introduction of additional factors it is important to assess whether or not such changes will make the model more fit for purpose and help the PBGC along with its stakeholders better understand the expected future distribution of the Corporation's net financial position.[8]

Mercer's assessment for how ESG models should be utilized with SE and ME PIMS

- Preference for modeling a select group of market returns that are of greatest importance to PBGC rather than a very extended list of asset classes and risk factors given that ESG is just one component within the PIMS models, and a significant portion of plan asset exposure can be captured via a handful of variables/risk factors.
- A focus on left-tail risks and ensuring relationships between variables and parameters is consistent with financial theory and history.
- Having an established process in place for reviewing parameters to ensure an appropriate governance framework and risk management process.
- Balancing ease of communication versus ease of modeling when modeling plan asset exposure with a focus on whether changes result in more accurate modeling or clearer communication.

Does the ESG model utilized within SE and ME PIMS contain the appropriate leading attributes?

In this section, we provide an overview of whether the ESG model meets the criteria of containing the high-level attributes of a good model. Our focus in this section is not on the details of how individual variables, parameters, stylized facts are modeled, but rather on the broad nature of the model itself. In the subsequent section, we conduct our more detailed modeling assessment.

Parameters, Calibration and Stylized Facts:

Conclusion: Yes. ESG has clearly defined parameters, a well-articulated calibration process and makes appropriate use of stylized facts.

Supporting Reason: All the parameters are clearly defined, logical, well supported by historical data and financial theory, and are capable of being modeled and tested. For example, below are the formula and parameters for stock returns.

For example, stock returns, based on the *Standard and Poors' 500 Index*, are modeled as a function of the beginning of period Treasury yield and a long-term spread parameter, s*.

$$\ln\left(1 + r_{s,t} - y_{t-1}\right) = s^* + \varepsilon_{s,t}$$

PIMS' current parameter assumptions are:

- s* = 2.48%

[8] FY 2021 PBGC Projection Report. Pension Benefit Guaranty Corporation. Published September 9, 2022. [FY 2021 Projection Report (pbgc.gov)]

- $\varepsilon_{s,t}$ is distributed normally with mean = 0, standard deviation = 0.18972, and the correlation between $\varepsilon_{s,t}$ and $\varepsilon_{TB,t}$ = -0.22401.

In this case, the process for developing equity returns is clear and the parameters are well defined and logical. The size of the equity risk premium and the correlation between stocks and bond yields are based on financial theory and observed historical data, although as we will discuss later, we suggest a historical lookback and a potential regime-dependent model to ensure a more complete model.

Potential area for refinement: We would suggest establishing a framework for testing or confirming the validity or appropriateness of parameters as well as reviewing the period over which parameters are set. This would not necessarily result in changes to the parameters themselves, but we believe it is best practice to test and confirm them over time. For example, in the above example, the correlation between Treasury yields and equity returns and the size of the equity risk premium have not been tested since 2008 and they only capture the period from 1973 to 2007. While the process for modeling equity returns is logical and the parameters themselves reasonable and supported by financial theory and historical data, a best practice would be to periodically test to ensure the parameters remain consistent with data and the evolving nature of markets and avoid the risk of using stale data. For example, PBGC could establish a process for testing parameters every 3 to 5 years. Assuming a best practice approach to developing those parameters, we would not expect frequent changes. However, there may be scenarios where they do. A notable example would be the target 30-Year Treasury yield. Hypothetically, a target 30-Year Treasury yield developed in 2000 would be different than one developed in 2022 given the downward trend in rates and inflation post financial crisis. This would also apply to setting of exposure to factors within SE-PIMS. As discussed later, we would recommend confirming the weights on a regular basis to ensure they remain accurate.

Leading Attribute 1: It provides a sound foundation for the way the models are built and the way the variables are interrelated; it balances practicality and completeness.

Conclusion: Yes

While the ESG model maintained by PIMS is focused on modeling just a handful of variables (the 30-Year Treasury yield, 30-Year Treasury returns, and equity returns) it does so thoughtfully. Moreover, interest rate risk and equity risk dominate capital markets. Similarly, PIMS models risk factors rather than asset classes and weighs plan assets to the aforementioned factors. As discussed later in the report, this is a practical approach due to its straightforward nature, and the returns for most asset classes can be largely explained by those risk factors. However, as we discuss, there are some potential areas for refinement in terms of modeling variables and plan returns.

Leading Attribute 2. It provides a suite of models sufficient to capture the asset classes and economic variables of greatest importance to the risk profile of the organization.

Conclusion: Yes

The ESG models interest rates, equity returns, inflation, and wage growth. The biggest risks faced by PBGC are related to potential ranges in the size of PBGC's assets, potential liabilities, and cash flows. These risks are heavily influenced by multiple risk factors outside the ESG model (e.g. corporate bankruptcy/default, size of premium payments, etc.). However, as it relates to the ESG, the modeled variables/asset factors are of importance since they will drive the performance of the universe of plans as well as PBGC assets.

Potential area for refinement: Stochastic modeling of credit spreads. Currently, the ESG does not model corporate spreads stochastically. Corporate bond exposure accounts for a significant portion of plan assets and exposure to this risk factor is a critical input to the valuation of liabilities and funded status. The addition of corporate spreads would provide greater insight into the potential risks faced by the PBGC and its net financial position. Moreover, from a plan modeling perspective, corporate investment-grade fixed income allocations stochastically impact assets (through equity sensitivity) but are not mirrored on plan liabilities. Calculating corporate spreads and corporate bond returns stochastically would resolve this disconnect, in addition to the benefits mentioned earlier. Currently, PBGC seeks to capture spread risk on the equity side via underlying exposure to the equity risk factor. We discuss this potential enhancement in the following sections.

Leading Attribute 3. It is capable of accommodating many types of calibration views across a wide range of benchmarks.

Leading Attribute 4. While being capable of accommodating many types of calibration views, it produces simulation results that reflect a relevant view.

Conclusion Yes, for both Attributes 3 and 4

For example, the model assumes the long-run Treasury yield target (y*) is the sum of long-run inflation via 2021 OASDI Trustees Report, Table V.B1[9] and the 10-year average of the differences in monthly values of the 30-year Constant Maturity Treasury Yield (https://fred.stlouisfed.org/series/GS30) and the 30-year Breakeven Inflation Rate (https://fred.stlouisfed.org/series/T30YIEM). For the 10-year period ending December 31, 2021, that average is 0.70%, resulting in the calculation of the yield target being:

$$y^* = 2.4\% + 0.7\%$$
$$y^* = 3.1\%$$

In this case, the PBGC is making explicit decisions regarding the inflation rate and the appropriate implied real rate on the 30-year Treasury (0.7%). We discuss the appropriateness of this methodology in the following section, but the calibration of Treasury yields, the equity excess returns and other parameters reflect specific decisions by the PBGC. For example, the 0.7% is a specific figure selected by PBGC rather than an observable or imputed value. Of course, a different number would result in a different Target Rate and a different set of Treasury returns. As a result, the parameters could easily be adjusted to reflect a different view or calibrated to produce a different set of outcomes as desired.

Potential area for refinement:

There are certain parameters, which PIMS simulates through "randomness" rather than specific calibration decisions. For example, the average correlation between Treasury yields and equity returns across the scenarios represents a specific calibration decision. However, while the correlation varies across the scenarios, which is consistent with best practices, it does so through a randomness model rather than through a specific calibration decision. While not appropriate for the current version of PIMS, in T-PIMS, PBGC could consider incorporating a regime switching model in which the correlations between variables are conditional on the economic environment. For example, the correlation between Treasury yields and equity returns is typically low/negative when inflation is high and monetary policy is restrictive, but the correlation is high/positive when inflation is low and monetary policy is accommodative. Taking this a step further, several variables lack independent stochastic elements. For example, the 30-Year Treasury yield and inflation move in a tandem manner. One potential additional calibration decision that could be added in T-PIMS is the ability to vary this relationship to some degree so that the correlation is not ~1.0 (i.e. the real interest rate varies based on the environment and the 30-year Treasury yield may be more or less than 0.7% above inflation in a given year/scenario). Of note, the long-run fundamental linkages would remain, but this would increase the variance more akin to real world experiences.

[9] The 2021 OASDI Trustees Report. The U.S. Social Security Administration. Published August 31, 2021. https://www.ssa.gov/OACT/TR/2021/tr2021.pdf

Leading attribute 5. It produces some extreme but plausible outcomes.

Conclusion: Yes, but potential for refinement: In the table below, we show the lowest (1st percentile) and highest (99th percentile) returns for selected variables. Overall, the range of potential returns is wide. There is, however, potential to enhance the tails of the distribution, as we discuss later in this report. For example, the equity distribution is positively skewed and the lowest 1% of equity return is only -30%. By comparison, based on realized history it is closer to -40% for equity markets. The 1st to 99th percentile range for inflation is only between 0.3% and 9.6%. By comparison, from 1970 to 2022, the observed historical data range is -0.3% to 13.0%. Overall, this suggests that the equity model could be enhanced to include more severe left tail events and a negatively skewed distribution. For example, it could accommodate an environment of double-digit inflation or slight deflation and more severe equity losses.

Table 4

Percentile Distribution of Selected Variables (%)		
Variable	**1st Percentile**	**99th Percentile**
30-Year Treasury Yield	1.0	10.3
30-Year Treasury Return	-18.6	26.1
Stock Return	-29.9	62.1
Plan Return	-14.6	32.9
Corporate Rate	2.1	11.4
Inflation Rate	0.3	9.6
Wage Growth	1.6	11.0

Source: PIMS Single-Employer Fiscal Year 2021 projection.

Leading attribute 6. It embeds realistic market dynamics.

This refers to both the combined distribution of all the scenarios as well as individual scenarios and paths within those individual scenarios. The total distribution of outcomes along all scenarios should reflect a realistic view of how markets operate. Also important is how variables behave along a single scenario or the path variables take along that given scenario. For example, we would expect there to be scenarios that have low volatility and scenarios that have high volatility; we would expect the rate of volatility to vary across scenarios. Put differently, markets will go through periods of strong performance or weak performance along a single path/scenario and the correlation between variables may change along that single path/within one scenario. Also, there will be individual scenarios where equity returns will be high and others where they will be low and again the correlation between variables such as Treasuries and stocks will vary. At the same time, the relationships between the variables should be consistent with market dynamics. [10]

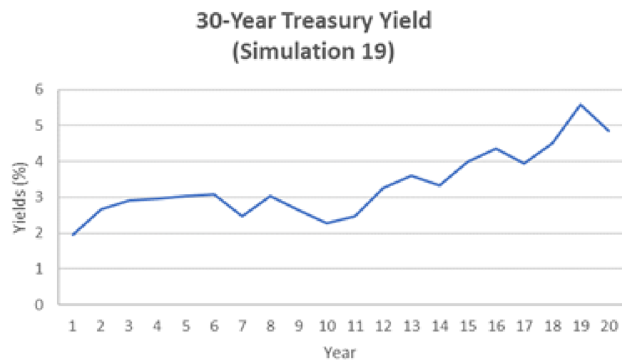
Conclusion: Yes

The range of 20-year annualized returns on 30-year Treasury bonds varies from 3.8% (1st) to -1.9% (99th), while the 20-year annualized equity returns range from -4.1% to 16.6%. The correlations between Treasury bond returns and equity returns ranges from -0.39 to +0.77. These represent realistic potential market outcomes.

There are also paths showing a varying degree of interest rate movements, which are not necessarily in a linear fashion. For example, we show two simulations below. In simulation 20, rates spike quickly before declining. In simulation 19, rates stay low for an extended period of time before rising sharply. There are many different paths for rates to move along and accurate simulation will effectively capture them.

[10] Economic Scenario Generators: A Practical Guide. Society of Actuaries, authored by Conning. Published July 2016. https://www.soa.org/493868/globalassets/assets/files/research/projects/research-2016-economic-scenario-generators.pdf

Chart 1 and 2: Sample of 30-Year Treasury Yield Simulations



Source: PIMS Single-Employer Fiscal Year 2021 projection.

Potential area for refinement: Correlations and Corporate Yields.

Since the stock/bond correlation is projected through randomness it could produce simulations inconsistent with market theory. Similarly, credit spreads and equity returns tend to be positively correlated. That is to say, it is reasonable to expect stocks to decline (equity risk premiums to increase) and corporate spreads to widen at the same time. However, under the current approach corporate yields are modeled using a reverting spread relative to Treasuries, so this market dynamic is not captured. This could be corrected by bifurcating corporate bond yields between interest rate duration risk (30-Year Treasury yield) and spread risk. A suggested earlier and discussed in more detail later in the report, a potential improvement may be to stochastically model spreads with the expectation that the spread component negatively correlates to equities.

Leading attribute 7. It is computationally efficient and numerically stable.

An ESG is a complex system of models, underlying variables and parameters. Choice of models should take into consideration those with properties that make them efficient to implement computationally—i.e., faster run times and greater accuracy. Choice of models should also be robust enough to maintain stable parameter estimates. A good ESG is calibrated over a broad enough range of history to reflect actual market dynamics. Parameter estimates for the models should exhibit some measure of robustness to the data window on which they were based. They should faithfully capture changing initial conditions while, at the same time, having underlying parameters that typically evolve at a moderate pace. Although there is an ongoing need to refine parameter estimates in light of evolving market risks, one generally seeks to maintain a degree of stability in the parameter estimates. First, robust ESG models naturally tend to have stable parameter estimates as new data are added to a large historical data window. Second, making significant parameter changes from estimation period to estimation period is disruptive to the broad ESG process, because it would induce notable changes in the risk profile of various asset classes. [11]

Conclusion: Yes

The number of variables and parameters has remained stable over time, while capturing the asset classes and risk factors that are of the greatest importance to PBGC. However, there are some potential areas of refinement. For example, when modeling correlations or equity excess returns, the model could benefit from looking at a longer historical window. While

[11] Economic Scenario Generators: A Practical Guide. Society of Actuaries, authored by Conning. Published July 2016. https://www.soa.org/493868/globalassets/assets/files/research/projects/research-2016-economic-scenario-generators.pdf

the stability of parameters is important, as discussed earlier, we think it makes sense to have an established framework in place for reviewing parameter estimates. It is not expected that a periodic review would result in a change in approach of specific estimates or specific variables or the calibration process itself.

Leading Attribute 8: It has capabilities for real-world and market-consistent simulations and uses consistent models across both modes.

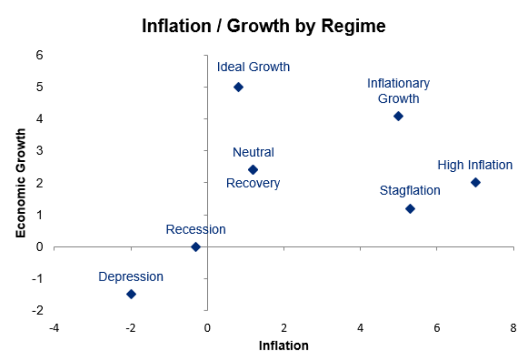
Conclusion: Yes

The current approach of PBGC to modeling plan exposures and asset classes differs slightly from that of a typical ESG. In particular, it seeks to aggregate plan asset exposure to three primary risk factors: 30-Year Treasury returns, equity returns, and cash (30-year Treasury yield). In that sense, the model is creating plan forecasts based on risk factors rather than asset classes, while the typical ESG is modeled to asset classes. As we will discuss later, this approach still reflects realistic market functionality and appropriately captures underlying plan returns and risks. Additionally, the approach to calibrating equity returns and 30-Year Treasuries is consistent with economic theory and the realized observed historical track record of markets.

Potential area for refinement:

Given the existing architecture of the PIMS models, we would not recommend significant changes. We think there are some potential enhancements that could result in a more realistic and market consistent approach. In particular, the relationships between variables and the stability of parameter estimates can vary over time. The correlation between stock returns and Treasury returns can vary over time based on the economic, inflation, and interest rate environment. While the correlation does vary in the existing model, it is due to randomness rather than economic reasons, which could theoretically result in an unusual market scenario. A potential area of refinement for T-PIMS would be to adopt a regime switching approach where the size of parameters (e.g. the equity excess returns) and the relationship between variables can vary. This could be accomplished by adopting a regime switching approach where parameter estimates vary based on the economic environment, but still converges to a desired distribution with defined long-term characteristics. However, this type of adjustment should still be considered carefully as the potential cost of such a change may not be justified by a marginally better outcome.

Chart 3: Sample Regime Switching Framework



Regime Transition Matrix
(Probability of Switching from Regime X to Y)

	Neutral	Recession	Stagflation	Inflationary Growth	Ideal Growth	High Inflation	Depression	Recovery
Neutral	38%	5%	30%	29%	29%	27%	10%	45%
Recession	13%	20%	11%	11%	15%	18%	10%	5%
Stagflation	13%	11%	33%	10%	4%	11%	10%	5%
Inflationary_Growth	12%	5%	10%	31%	12%	6%	5%	15%
Ideal_Growth	16%	10%	10%	11%	32%	7%	7%	15%
High_Inflation	5%	5%	4%	5%	5%	28%	5%	10%
Depression	3%	8%	2%	3%	3%	3%	33%	0%
Recovery	0%	36%	0%	0%	0%	0%	20%	5%

Source: Mercer

Leading Attribute 9. It produces sufficient simulation detail for extensive validation.

Conclusion: Yes

The output from the ESG includes a wide range of outcomes. It simulates 30-year Treasury yields, 30-year Treasury returns, equity returns, plan returns, corporate yields, inflation, and wage growth. As a result, each data point is observable. Also, PBGC has a defined parameters and formula for how the result in any given year is developed. As such, there is sufficient data to validate the model and the data is readily available to be modified and tested as needed. Over the following sections, we validate each of these variables as needed.

Overall conclusion

- The Economic Scenario Generator utilized by PBGC meets the leading attributes of ESG based on established criteria.
- Potential areas of refinement include:
    1. Establishing a governance framework for reviewing parameters to ensure they remain supported by financial theory and the historical track record.
    2. Consider using a longer data set where appropriate to calculate certain parameters. This will be discussed in more detail in the following sections.
    3. Consider the stochastic modeling of credit spreads.
    4. Consider implementing a negatively skewed distribution with a fatter left tail for equities. Consider implementing a wider distribution for inflation.
    5. Consider implementing a cascade structure/regime switching approach for T-PIMS to allow for more precise modeling of relationships.

Section 2: Economic Variable Evaluation

2.A. Treasury Yields and Returns

Purpose

The only fully stochastic interest rate modeled by PIMS is the 30-year Treasury bond yield. This yield is critical to PIMS simulation of pension plan funded status and provides the foundations for the Treasury returns, cash rate and returns, and pension plan liability discount rates. The Treasury and cash returns directly inform the simulated pension plan asset returns and in turn the market value while the discount rate drives the present value of the liability.

Process

The yield follows a random walk[12] with a decaying drift term to transition the mean over time to a target expectation. While the disturbance (error) term is normally distributed, the change is applied to the log yield resulting in a natural positive skew and eliminating the possibility of negative yields. The model requires four key inputs: starting yield, target yield, drift term, and disturbance standard deviation which generates the simulated yield.[13]

PIMS assumes a flat yield curve, so the simulated yield represents not only the 30-year Treasury, but also the complete term structure including the cash rate. For SE-PIMS, no changes are made to the term structure for liability valuation. For ME-PIMS, however, simple yield curve modeling is applied. The modeling approach uses the stochastic 30-year Treasury yield and applies the average curve shape since 2000 while maintaining a zero lower bound.

Additionally, the yields inform Treasury and cash returns for pension plan assets. Using the beginning and ending simulated yield for each year, the return for holding a 30-year annual coupon Treasury bond is calculated.

Assessment

The Treasury stochastic engine is relatively straightforward by design and requires three estimated inputs and one observable input which limits the potential for inconsistencies and calibration errors. The straightforward nature of the model is a strength, as the model is clear to follow and captures two critical moments of the distribution.

While the model targets only the 30-year Treasury, the longer-duration focus captures more key elements relevant to pension plan liabilities relative to the shorter maturities. PIMS's use of a target rate and drift term enables the model to adjust in response to potential deviations between current circumstances and longer-run expectations, helping reduce risks associated with single observation noise or temporary conditions.

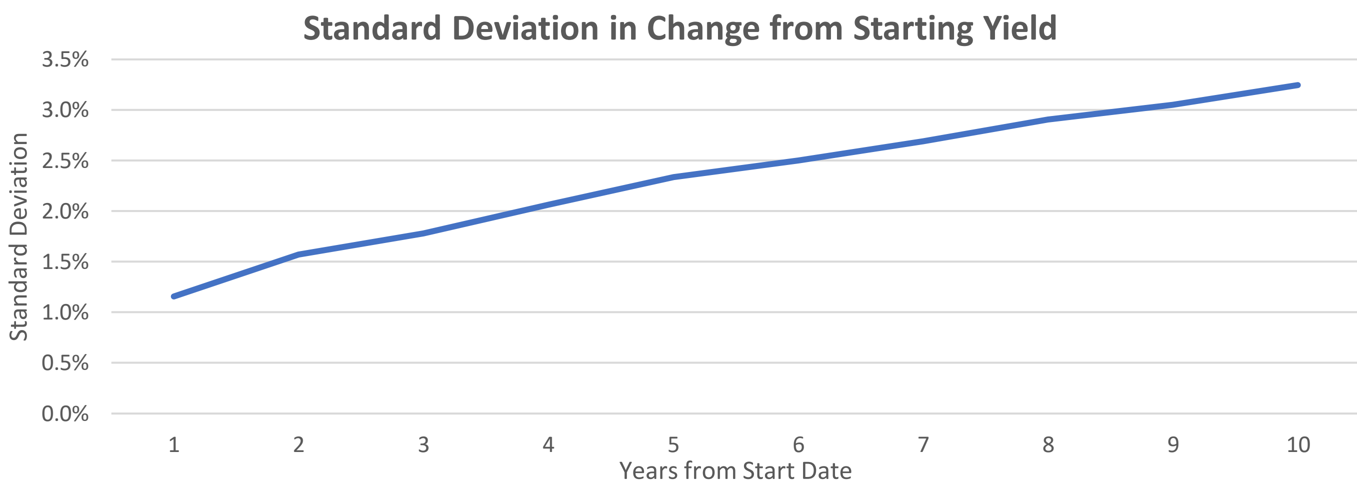
The resulting distribution's variance increases with time but is constrained by a zero lower bound. The increasing variance over time is consistent with economic theory and historical experience (Chart 4). As the simulation period extends, the range of outcomes may widen beyond theoretical expectations. For this reason, ME-PIMS employs a tail control process which reduces the deviation when yields exceed a predefined range.[14]

[12] $\ln(y_t) = \alpha_t + \ln(y_{t-1}) + \varepsilon_{TB,t}$;*y=30-year Treasury yield at time t, ε = Treasury yield disturbance term*

[13] These four inputs represent the core of the random walk projection. There are additional inputs associated with tail control.

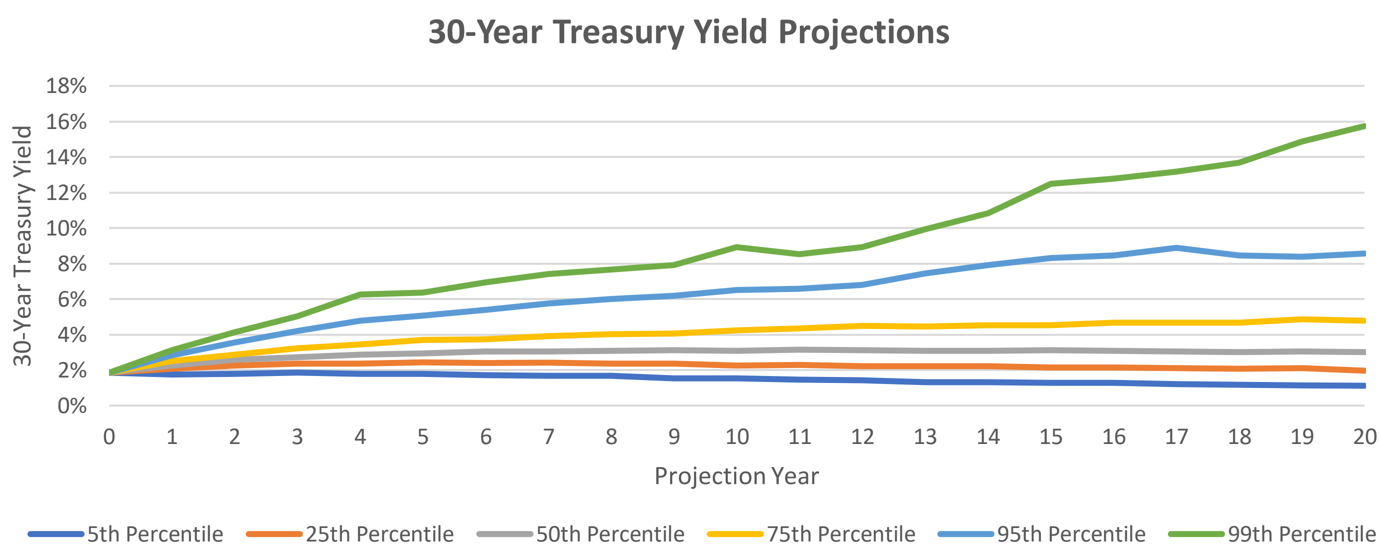
[14] Tail control process is triggered when the projected yield falls outside the range 0.85% - 10.0%. In such an event, the projected yield is replaced with one that reduces 25% of the deviation from the "normal" range. For example, if the unconstrained random walk process projects a yield of 11%, that value would be replaced with 10.75%. Similarly, a projected yield of 0.80% would be replaced with 0.8125%.

Chart 4



Source: The Federal Reserve Economic Data (FRED) database monthly 10-Year Treasury Constant Maturity Yield from January 1, 1962 to August 31, 2022.

Chart 5



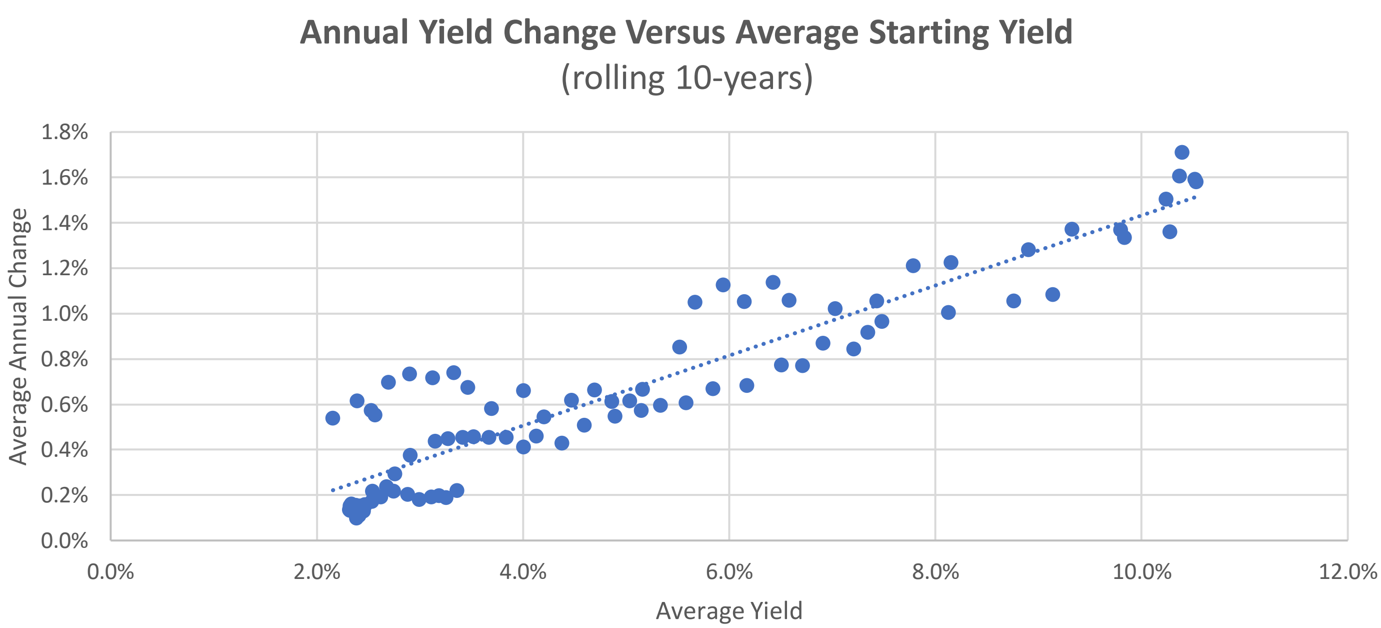
Source: PIMS Single-Employer Fiscal Year 2021 projection.

The zero lower bound does not present a significant risk, as negative rates in the US are more difficult to achieve relative to other geographies[15], but if the likelihood of negative rates increases, the model would require a redesign. Additionally, the relative importance would rise if PGBC began modeling non-flat yield curves and shorter-term rates which would be more susceptible to the evolving non-negative dynamics.

[15] Tokic, D. Negative interest rates: Causes and consequences. J Asset Management 18, 243–254 (2017). https://doi.org/10.1057/s41260-016-0035-2

The variance of the simulated yield change decreases with beginning yield, which is relatively intuitive and consistent with history, but may underestimate volatility at relatively low rates, as experienced during the decade following the 2008 financial crisis. Put differently, the model may miss a period where rates rise very quickly from an initial low level (e.g. the 30-year Treasury yield rising from 1.9% to 3.7% as it has over the last 12 months ending September 30, 2022). For this reason, PBGC may want to consider a more dynamic disturbance standard deviation based on the level of interest rates. The process could be as simple as designing a minimum volatility expectation, or more complex by estimating the first derivative of the disturbance standard deviation.

Chart 6

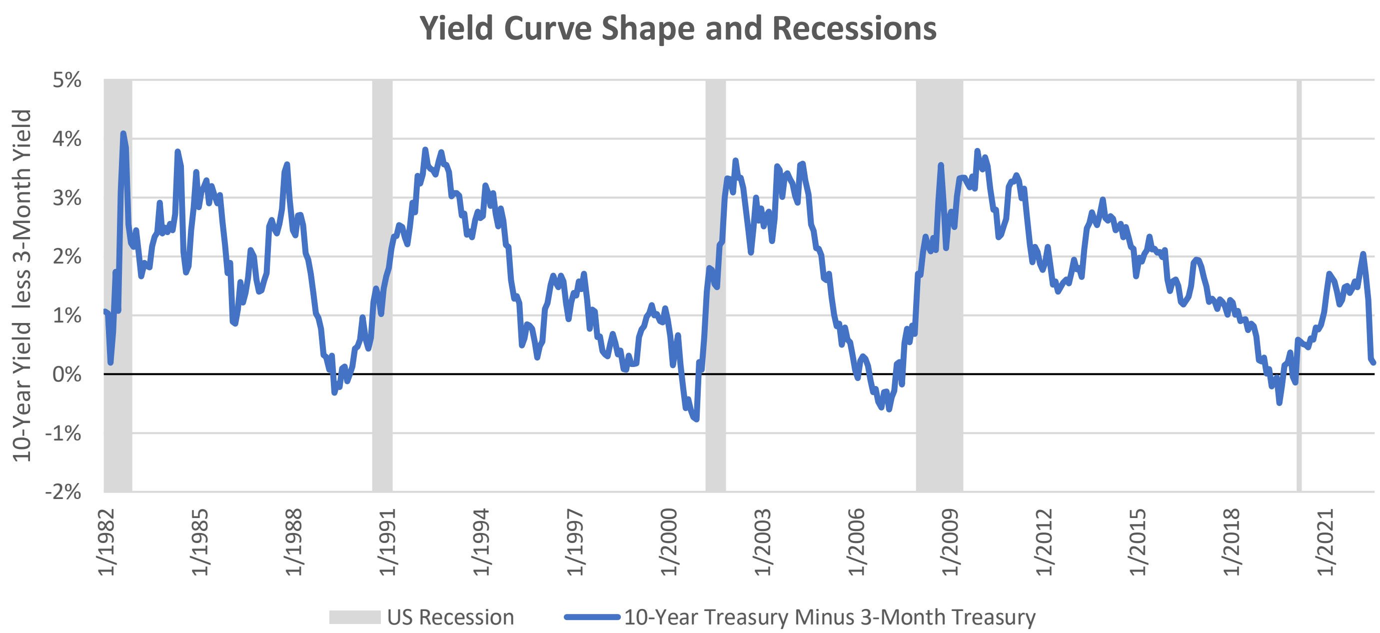


Source: Robert Shiller 10-year Treasury Data, December 1925 to December 2021, rolling 10-year data using December values, http://www.econ.yale.edu/~shiller/data.htm?adlt=strict

While the model does a reasonably good job producing a theoretical distribution of the 30-year yield, the flat yield curve assumption focuses exclusively on the first principal component of the yield curve (level)[16]. Limiting the model to the level of interest rates may ignore valuable data embedded in the shape of the yield curve. For example, the yield curve has shown to be a predictor of recessions[17]. This information in turn could drive the model to simulate more accurate correlations and asset response functions tied to economic regimes and monetary policy.

[16] Cochrane and Piazzesi (2008) "Decomposing the Yield Curve."
[17] Harvey, Campbell R. (1988) "The real term structure and consumption growth."

Chart 7



Source: Federal Reserve Economic Data (FRED) database using monthly 10-Year Treasury Constant Maturity Minus 3-Month Treasury Constant Maturity and The National Bureau of Economic Research (NBER) recession dating (January 1982 to August 2022).

<u>Calibration</u>

The three estimated inputs are calibrated with a combination of historical data, current financial market pricing, and professional forecasts. This process leverages the foundations of actual experience while incorporating forward-looking elements (market pricing and professional forecasts) to capture current conditions.

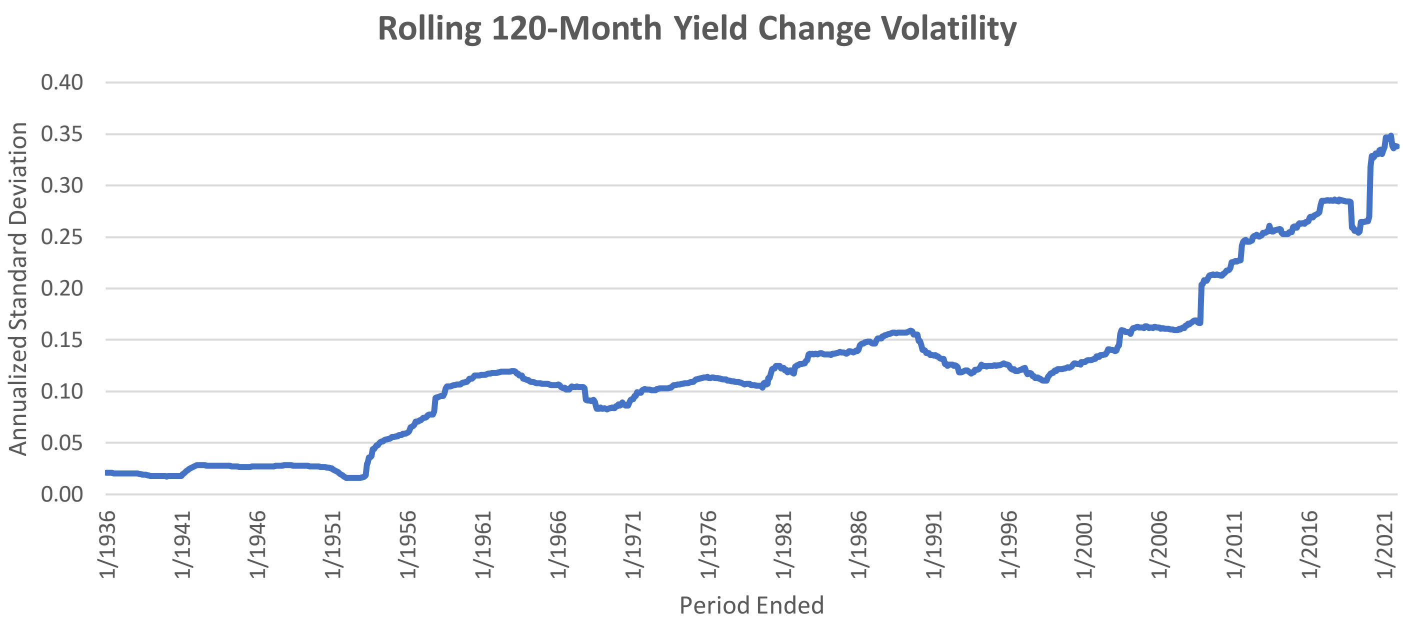
The variance of the yield is calibrated with historical data.[18] The use of log change helps capture the dynamic nature of volatility associated with various interest rate levels. Recent history, however, has shown that the decline in interest rate volatility may be less than forecast by the model (see Annual Yield Change Versus Average Starting Yield chart above). The extremely low rate and volatility experienced was last seen during 1940s/1950s. While is there is value to these historical data, interest rate dynamics changed in the 1970s, as the Bretton Woods Agreement dissolved[19]. The drift term is also estimated using historical experience and deviations from trailing 36-month averages.[20]

[18] Annual Changes in the logged long-term yield data from 1926-2012 were used in the estimation. A Seeming Unrelated Regression (SUR) analysis in SAS provides an estimated covariance matrix and PIMS standard deviation parameter comes directly from the square root of yield error term's variance taken from that covariance matrix. Note that the standard deviation derived this way is close to that of just taking the standard deviation of differences in logged yields using the same data

[19] Nixon Ends Convertibility of U.S. Dollars to Gold and Announces Wage/Price Controls, https://www.federalreservehistory.org/essays/gold-convertibility-ends

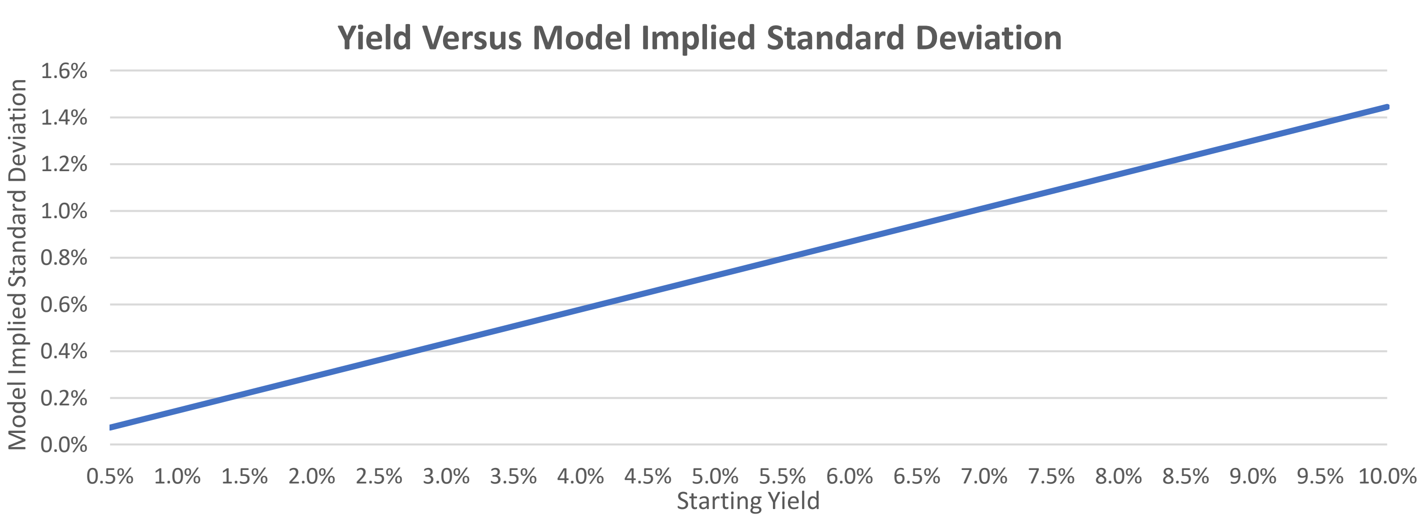
[20] The estimation used a nonlinear regression to estimate the monthly rate of adjustment in the yield-inflation spread toward its 36-month moving average.

Chart 8



Source: Robert Shiller 10-year Treasury Data, January 1, 1926 to December 31, 2021, rolling 10-year data using monthly natural log change values, http://www.econ.yale.edu/~shiller/data.htm?adlt=strict

Chart 9



Source: Mercer calculations, +/- 1 standard deviation of the yield change is estimated using the natural log of starting yield +/- 0.14392

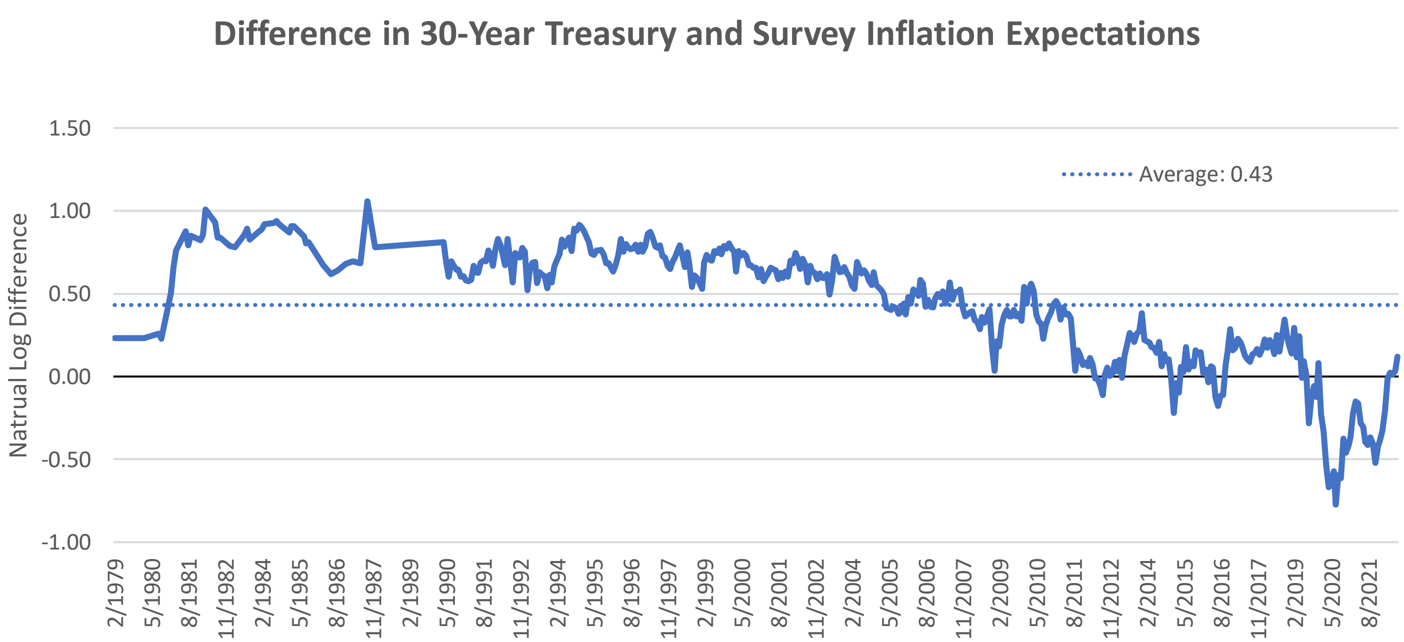
Finally, the target yield reflects a blend of historical data and professional forecasts. Over time, PGBC has changed its estimation process in response to noisy inputs. Currently, the estimate is derived from the 10-year average of the difference between the 30-year Constant Maturity Yield and the 30-Year Breakeven Inflation Rate (i.e. real yield) combined with inflation estimate to create the nominal target yield. The relatively short look-back period and potential issues with

Treasury Inflation Protected Securities[21] (TIPS) as a means of establishing appropriate nominal pricing may introduce noise in the simulation process. Similar to the flat yield curve assumption, this calibration assumes a flat inflation expectation curve. This stems from the use of thirty year spread over an inflation expectation with the same horizon, but the source of the inflation expectation is a twelve-year horizon. Over the long-run this assumption is practical, but it fails to account for periods where inflation expectations are particularly upward or downward sloping.

Area for refinement

To address some of the shortcomings of the current process, PBGC should consider potential corrections to the TIPS breakeven referenced by Don Kim, Cait Walsh, and Min Wei. Additionally, PBGC should expand its historical lookback period to complement its process. Since TIPS data are limited, PBGC will have to rely on nominal bonds relative to survey expectations. The survey data contribute forward-looking information while the yield provides current pricing relative to the expectation. The chart below is an example of an expanded horizon. Unfortunately, there is still a mismatch in the survey horizon (5-years, near-term expectation distortion) and market pricing noise.

Chart 10

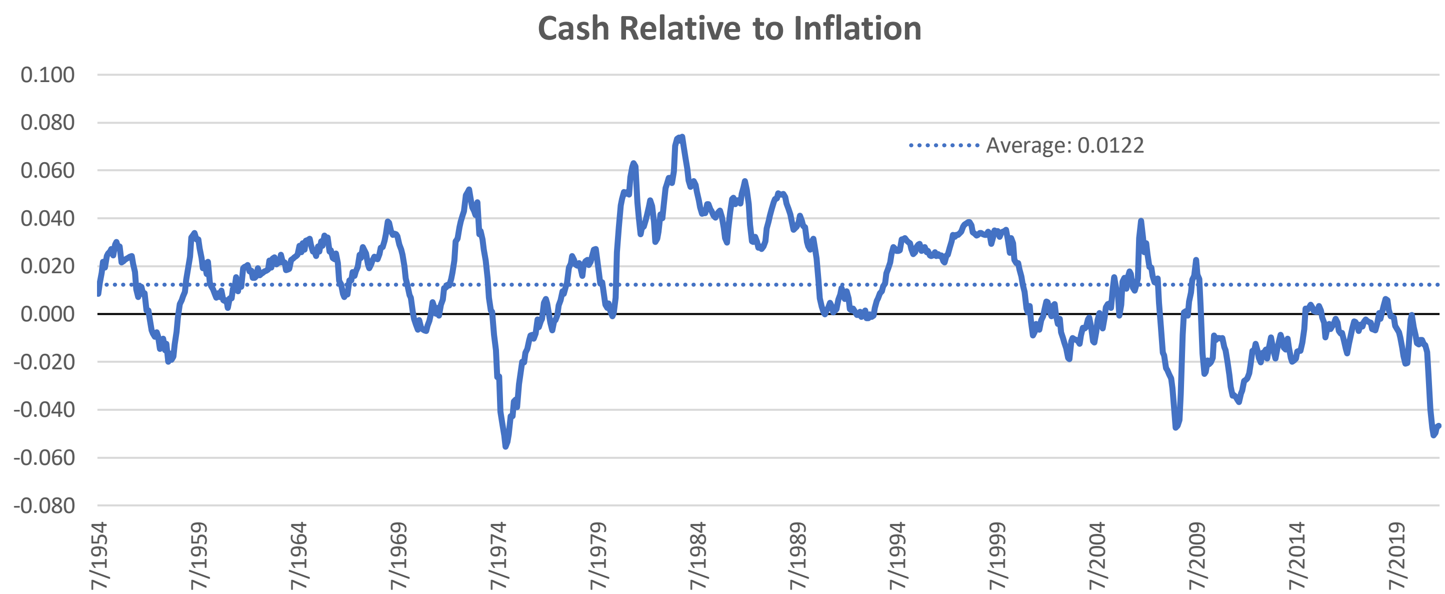


Source: Surveys of Consumers, the University of Michigan; Federal Reserve (FRED) database; Mercer calculations (data from February 1979 to August 2022).

Because of the analysis challenges, it is important to supplement this information. The chart below illustrates the difference between forward 12-month cash returns relative to trailing 12-month inflation (assumes prior inflation is correlated with near-term forward inflation) and leads to similar conclusions.

[21] Tips from TIPS: The Informational Content of Treasury Inflation-Protected Security Prices, Stefania D'Amico, Don H. Kim and Min Wei (2018) & https://www.federalreserve.gov/econres/notes/feds-notes/tips-from-tips-update-and-discussions-20190521.html

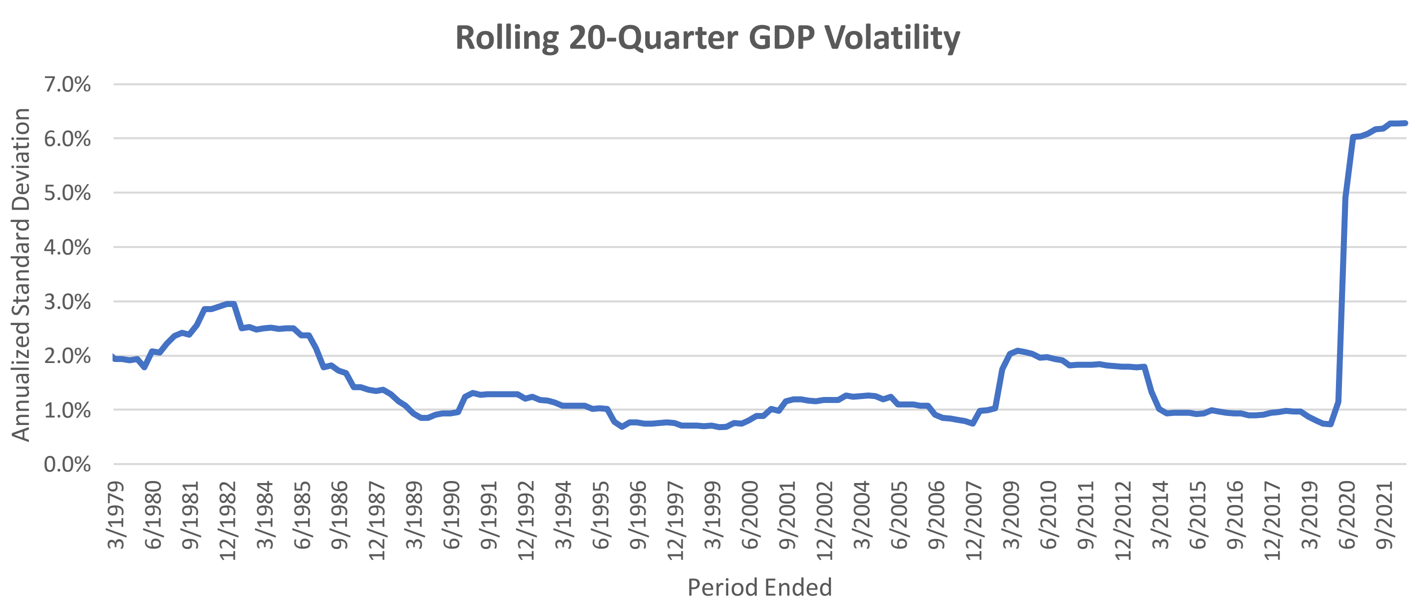
Chart 11



Source: Federal Reserve Economic Data (FRED) database and Mercer calculations. Cash yield is proxied by the Federal Funds rate (July 1954 to September 2021). The spread is calculated using trailing 12-month inflation relative to the forward 12-month Federal Funds estimated return.

In both charts, there appears to be a decline in the spread during recent decades. Similarly, outside the financial crisis and pandemic shock, US GDP and inflation volatility appear to have declined. This may have potential implications for the associated duration premium embedded in the 30-year spread. Blending each of these considerations should provide a more balanced estimate less prone to recent intermediate-term economic noise.

Chart 12



Source: Bureau of Economic Analysis (March 1974 to September 2021) and Mercer calculations, Nominal Gross Domestic Product, log change.

Potential Alternatives

PBGC could consider implementing a term structure stochastic projection model for an incremental improvement in liability valuation and enhanced asset class relationship modeling (see correlation section for further discussion). Implementing this model would provide PIMS with the ability to model yield curve shapes and the effects on asset prices. The model would require an update to PIMS along with additional calibration inputs for the relationships between interest rates and other assets. Additionally, PIMS may need to be amended to account for the (unlikely but) potential of negative short-term interest rates.

Conclusion

The PIMS Treasury yield and returns projections provide a significant portion of the theoretical distribution. As noted above, there are circumstances where the simplicity of the model restricts its fit along the distribution, but overall, PIMS has targeted the critical drivers of the ex-ante distribution. There, however, may be incremental changes that will enhance the current state of the PIMS model.

2.B. Equities

Purpose

PIMS stochastically models one equity return which designed from *Standard and Poor's 500 Index* (S&P 500). Similar to the Treasury returns, the simulated data directly affects the projected pension plan returns and market value. This single sensitivity serves as the broad equity exposure experienced by pension plans, as no other equity market segment is modeled.

Process

The equity return is a blend of the risk-free rate and the equity excess return. The risk-free rate is taken directly from the simulated Treasury yield while the equity excess return follows a lognormal distribution. While each period's equity excess return is independent, the risk-free rate is drawn from the end of the prior period. In addition to the Treasury inputs, the model requires two inputs: the mean equity excess return and standard deviation of the disturbance term[22] (correlations in a dedicated section).

Assessment

Like the Treasury component, the equity stochastic engine is straightforward and requires only two estimated inputs (correlations in a dedicated section). These inputs and modeling process emphasize the two critical moments of the distribution, estimated value and variance.

The building blocks approach using the risk-free rate and equity excess return is consistent with capital asset pricing model[23] and provides an integrated model. The model's use of the natural exponential function is a strength and a weakness. The lower limit of this function never breaches zero which prevents losses in excess of -100%, and for long only portfolios, the maximum loss represents dollars invested or a return of -100%. However, the function imposes a lognormal distribution and positively skewed returns. As a result, this distribution may underestimate the probability in left tail scenarios. The chart below illustrates how the model's distribution does a reasonable job mirroring historical experiences overall. Additionally, the minor mismatch associated with the realized negative skew of equity markets is captured in the left portion of the chart.

PBGC may consider amendments to the equity model to capture the negative skew inherent in markets. There are several ways which PIMS could shift the distribution with varying degrees of complexity. Shifting to a normally distributed (rather than a lognormal) simulation would remove the positive skew of the current process. This, however, comes with potential drawbacks (e.g. no –100% loss constraint) which would require addressing. Another step further in complexity would be to model skew into the disturbance term. Going another step, PBGC could apply an alternative building block approach which utilizes earnings growth rates, interest rates, retention ratios, and dividends to simulate elements driving equity prices. This final step would require integration into other components of the model (30-year Treasury yield) to ensure proper integration.

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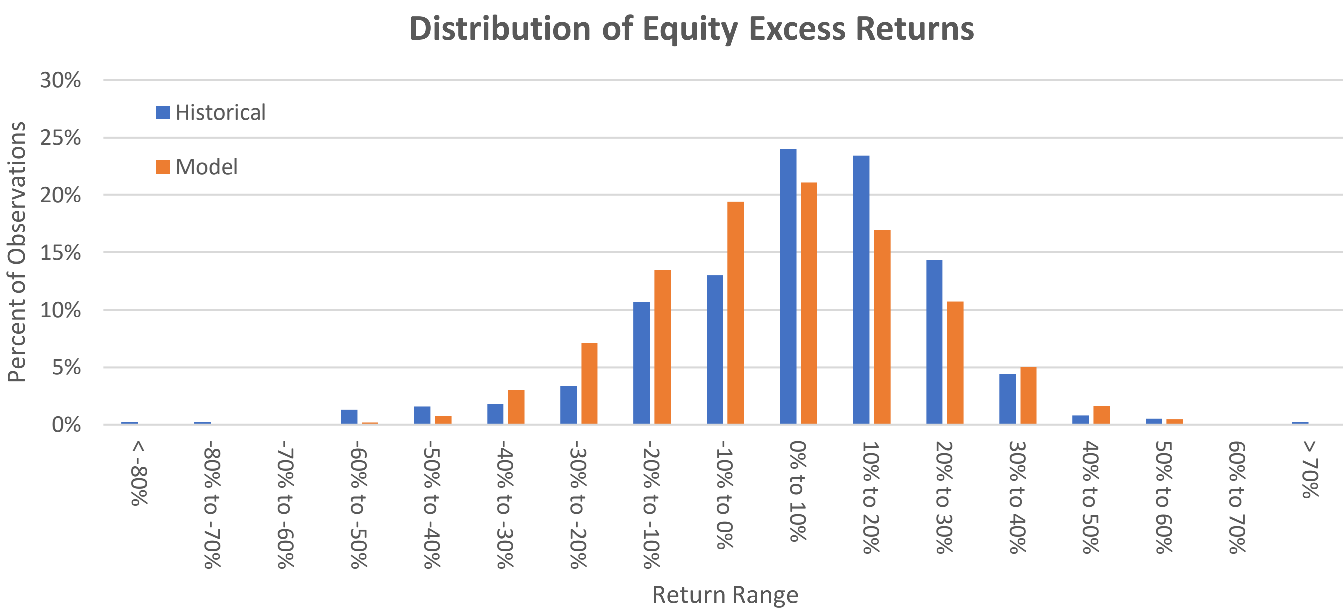
[22] $\ln(1+rs+y_{t-1}) = s*+\varepsilon_{s,t}$, r_s = stock return, y = 30-year Treasury yield at time t, ε = stock disturbance term, Note: the disturbance is simulated with a normal distribution but transformed by the natural exponential function.

[23] Sharpe, William 1964. "Capital Asset Prices: A Theory of Market Equilibrium under Conditions of Risk."

Chart 13



Source: Mercer Calculations, PIMS Single-Employer Fiscal Year 2021 projection log of equity excess returns, and Robert Shiller Standard and Poor's 500 Index and 10-year Treasury Data from March 1925 to December 2021. Rolling 4-quarter data was constructed using the natural log of equity excess returns plus one, http://www.econ.yale.edu/~shiller/data.htm?adlt=strict

Stochastically projecting only one equity sensitivity keeps the model concise, but with many pensions owning equities outside the US large capitalization space represented by the *S&P 500 Index*, PIMS could be ignoring additional sensitivities which affect asset class returns. Broadly, cross segment equity returns are relatively correlated, so the marginal benefit of adding additional stochastic simulations is reduced[24]. PBGC, however, could consider calibrating to a more global benchmark or estimating more granular sensitivities to equities outside of US large capitalization stocks (see asset allocation for further discussion).

Potential Alternatives

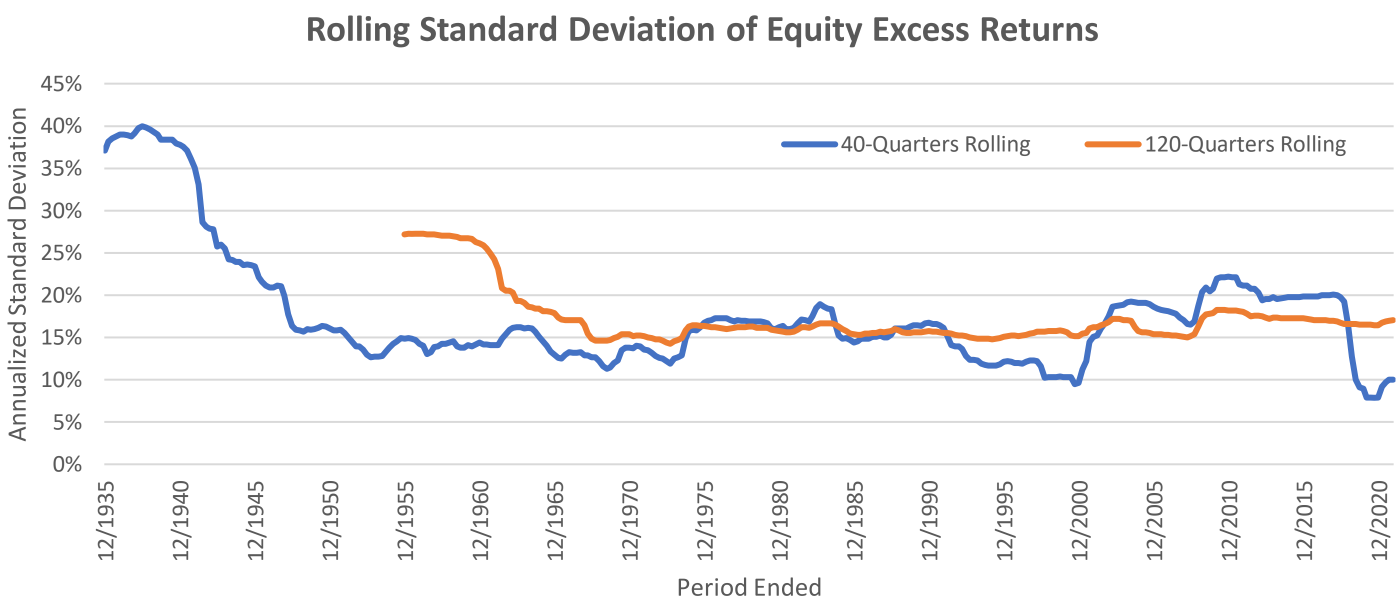
PBGC could consider decomposing the equity returns further (e.g. growth, earnings, dividends, etc.) to more holistically capture dynamic relationships and mirror the distribution shape. The current process of stochastically projecting equity excess returns based on an average correlation to interest rates limits the model's ability to capture varying relationships throughout the economic cycle. Decomposing the factor further, however, would entail calibrating additional inputs. Additionally, each new input should not be constructed in a vacuum, but rather, could inform other factors (e.g. earnings growth's relationship to interest rates). As such, the inner workings of the model would require updates.

[24] Credit Suisse YearBook (2021), https://www.credit-suisse.com/media/assets/corporate/docs/about-us/research/publications/credit-suisse-global-investment-returns-yearbook-2022-summary-edition.pdf

Calibration

Inputs to the equity model are drawn exclusively from historical experience. This process provides relatively stable inputs year-over-year, but also may fail to account for evolutions in market conditions. Outside the Great Depression, the volatility of the equity excess returns has remained relatively stable on a rolling 30-year basis. The recent 10-year period has been an outlier to the downside, but fundamentals of the asset class have not dramatically changed in a way that suggest a secular change has occurred. Additionally, because the model has a positive skew, depressed variance inputs could underestimate negative tail events.

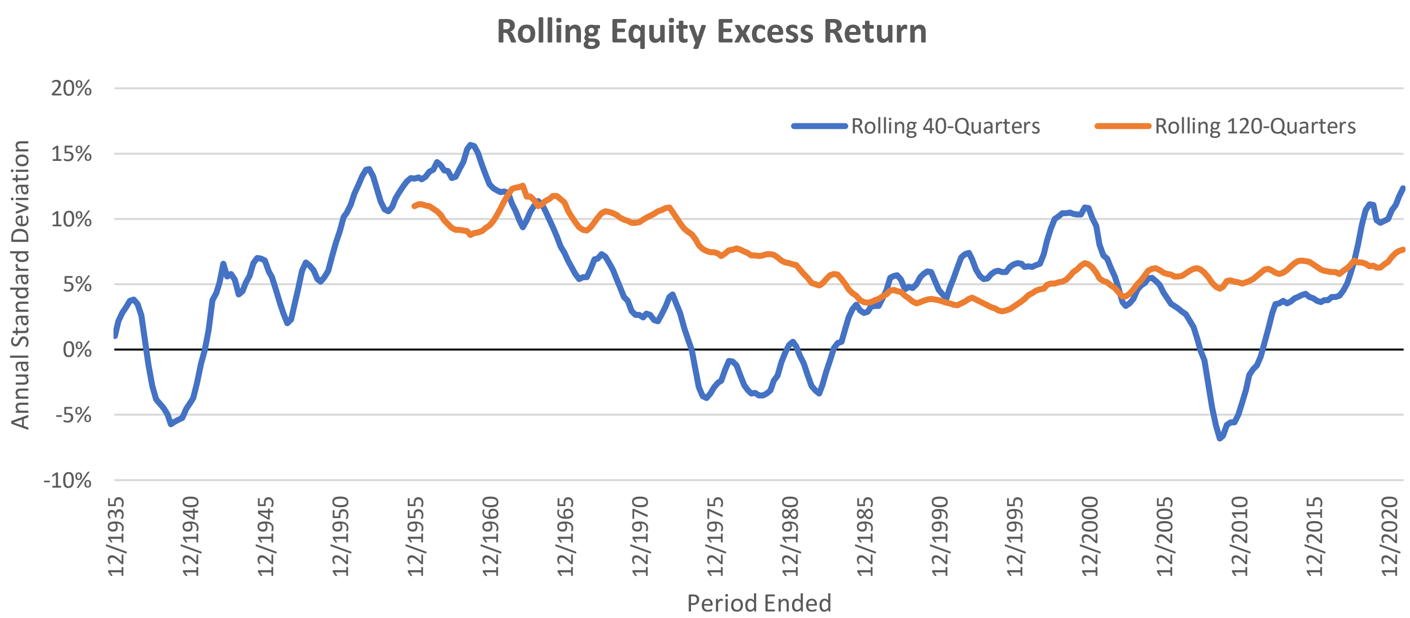
Chart 14



Source: Mercer Calculations, and Robert Shiller Standard and Poor's 500 Index and 10-year Treasury Data, March 1925 to December 2021, rolling 4-quarter data using the natural log of equity excess returns plus one, http://www.econ.yale.edu/~shiller/data.htm?adlt=strict

Like the variance of the equity excess returns, its mean value has remained relatively stable over rolling 30-year cycles. Unlike its variance, however, the 10-year mean value has shown more variation. This variation suggests that there may be ways of potentially incorporating current conditions into the projections. The target equity excess returns could be further refined by incorporating current market pricing.

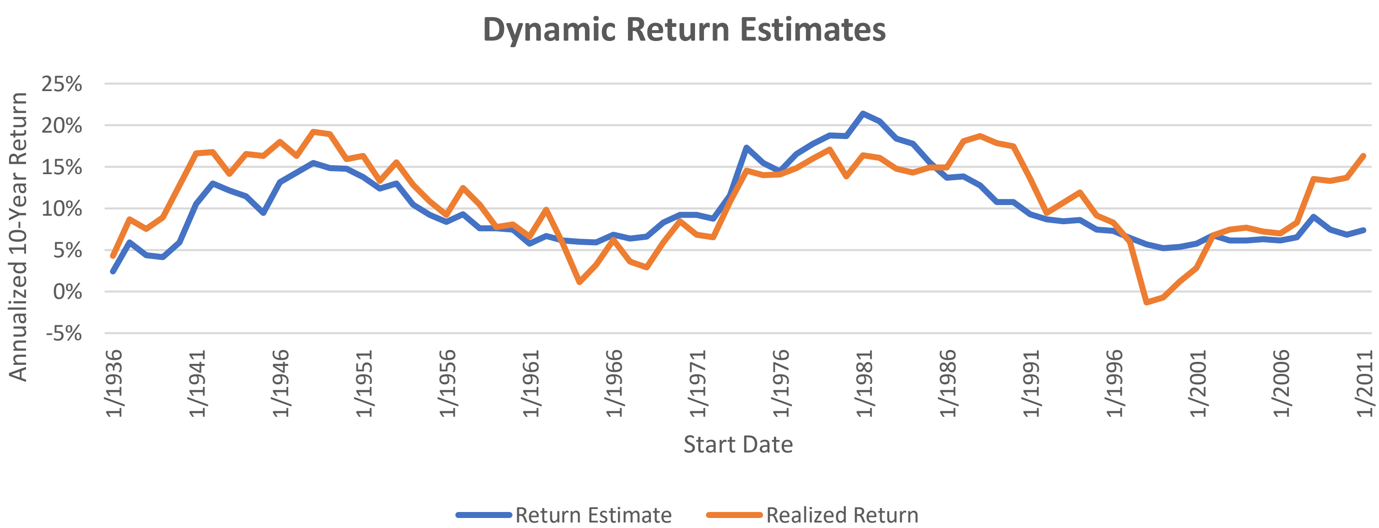
Chart 15



Source: Mercer Calculations, and Robert Shiller Standard and Poor's 500 Index and 10-year Treasury Data, March 1925 to December 2021, rolling 4-quarter data using the natural log of equity excess returns plus one, http://www.econ.yale.edu/~shiller/data.htm?adlt=strict

An example of capturing current conditions uses Robert Shiller's Excess CAPE Yield combined with the current 10-year Treasury yield. This metric incorporates averaged backward-looking earnings data with market pricing to estimate a forward-looking opportunity cost. Because this metric uses backward-looking earnings data, the forecast is susceptible to secular shifts in earnings potential (e.g. tax changes), so a review of deviations in operating conditions is warranted. The unaltered data, however, could provide PIMS current pricing data and informational value.

Chart 16



Source: Mercer Calculations, and Robert Shiller Excess CAPE Yield, Standard and Poor's 500 Index, and 10-year Treasury Data, January 1925 to December 2021, annual data using the excess CAPE yield plus starting 10-year Treasury Yield, http://www.econ.yale.edu/~shiller/data.htm?adlt=strict

<u>Conclusion</u>

The PIMS' equity returns projections provide a significant portion of the theoretical distribution. As noted above, there are circumstances where the simplicity of the model restricts its fit along the distribution, but overall, PIMS has targeted the critical drivers of the ex-ante distribution. There, however, may be incremental changes that will enhance the current state of the PIMS model.

2.C. Correlations

Purpose

PIMS correlates equity and Treasury yields directly which in turn correlates with Treasury returns. The process seeks to reflect the fundamental relationships inherent in the three elements. Because the three factors directly influence pension plan assets and liability valuation, the correlation has a strong effect on the projected variance of plan asset and plan funded status.

Process

PIMS begins by generating normally distributed random disturbance terms. These disturbance terms are then correlated by using a Cholesky decomposition of the imputed covariance matrix containing Treasury yields and equity excess returns. The resulting disturbance terms are correlated and have the targeted variance.

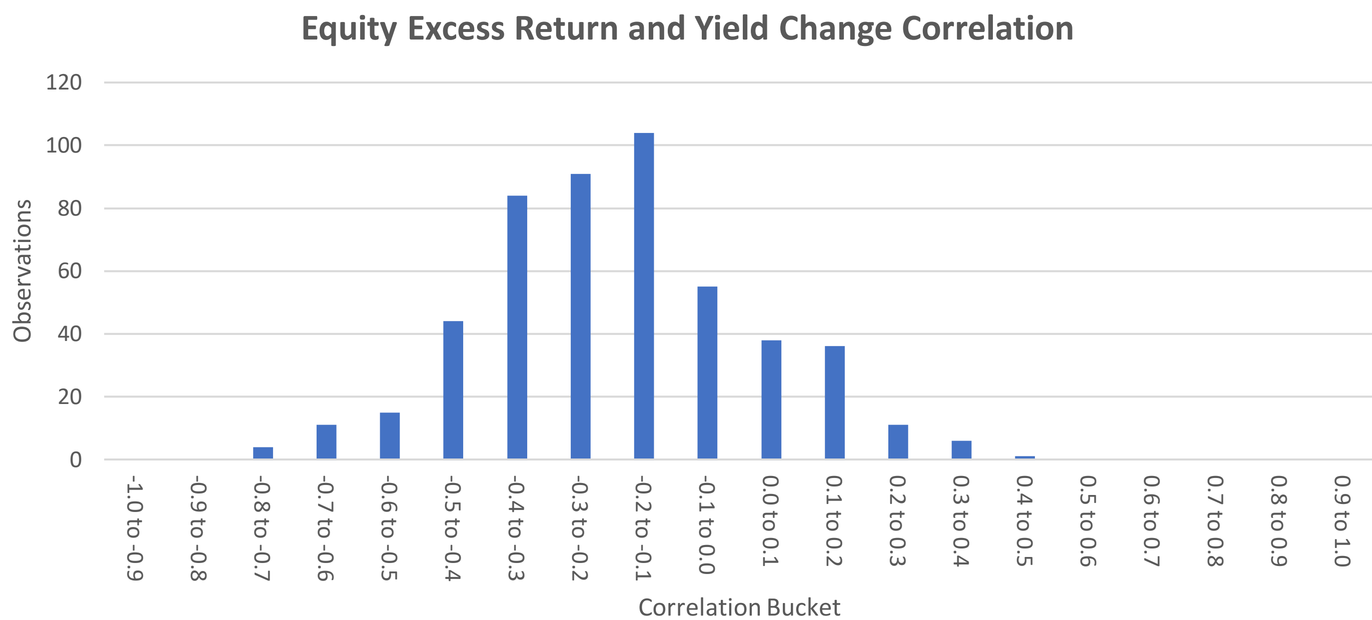
Assessment

PIMS' process is standard for correlating simulation variables[25]. Summarizing the fundamental relationship between elements with a single correlation is consistent with the philosophy employed throughout PIMS, and while the simulated correlation varies by trial, the overall distribution is characterized by the single input. Historically, the underlying relationships appear to be conditional on economic circumstances[26]. The chart below illustrates how equity excess returns and yield change correlations have fluctuated relative to the level of interest rates. This example, however, is an oversimplification of the economic environments that yielded these relationships. In particular, the state of monetary policy (accommodative versus restrictive) along with the prevailing inflation dynamic likely have had a strong influence on correlations (see calibration and alternatives for more details). For this reason, PBGC may consider creating a more dynamic correlation coefficient. Incorporating this layer would require additional inputs into the conditional process but would enhance the modeling of tail events.

[25] Casualty Actuarial Society (2020), "A user's guide to economic scenario generation in property/casualty insurance".

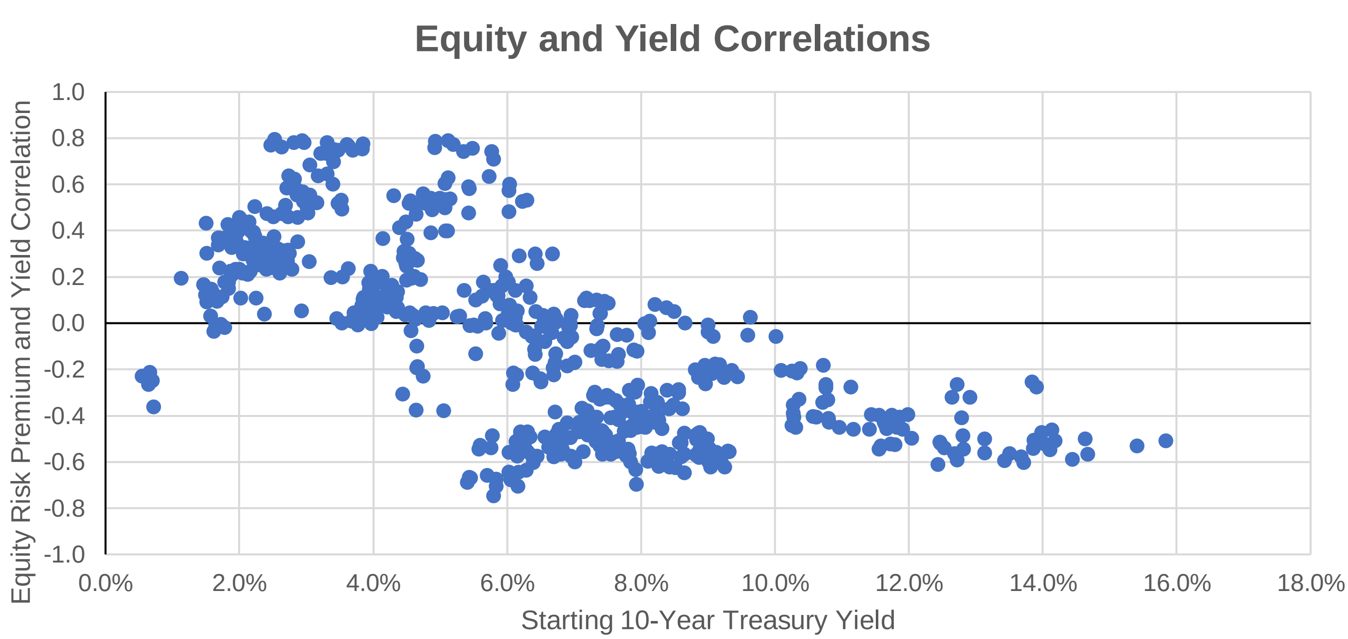
[26] Antti Ilmanen (2003), "Stock-Bond Correlations".

Chart 17



Source: PIMS Single-Employer Fiscal Year 2021 projection.

Chart 18



Source: Standard and Poor's S&P 500 Index, Federal Reserve Economic Database (FRED) database, and Mercer calculations. Monthly Standard and Poor's 500 Index and 10-year Treasury Data from December 1968 to August 2022 were used to calculate the rolling 24-month correlation between the natural log of the equity excess return plus 1 and the natural log yield change.

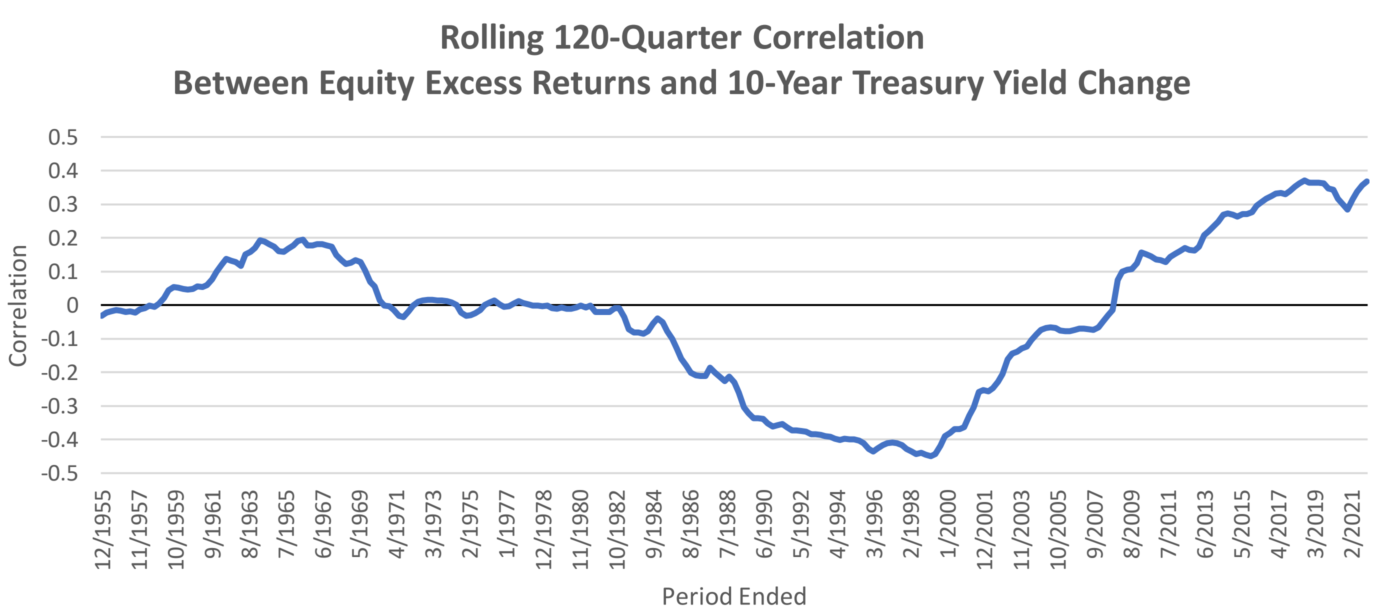
Potential Alternatives

There are several approaches that allow for conditional, dynamic correlations. In particular, the model would capture the evolution of financial conditions. For example, the model would simulate the negative correlation between rising rates and equity prices in restrictive environments which affect forward growth expectations, but also capture the positive relationship that can exist through the recovery and accommodative periods (e.g. rates rising because growth expectations are improving). While the yield level relative to the theoretical neutral provides some insight into these dynamics, this would focus on a single state of the economy rather than a dynamic one. One method for signaling conditions would use a non-flat yield curve to imply the economic regime being simulated and drive the underlying relationships. No matter the approach, however, the conditional nature requires additional variables to be designed and simulated to insure integration throughout the model.

Calibration

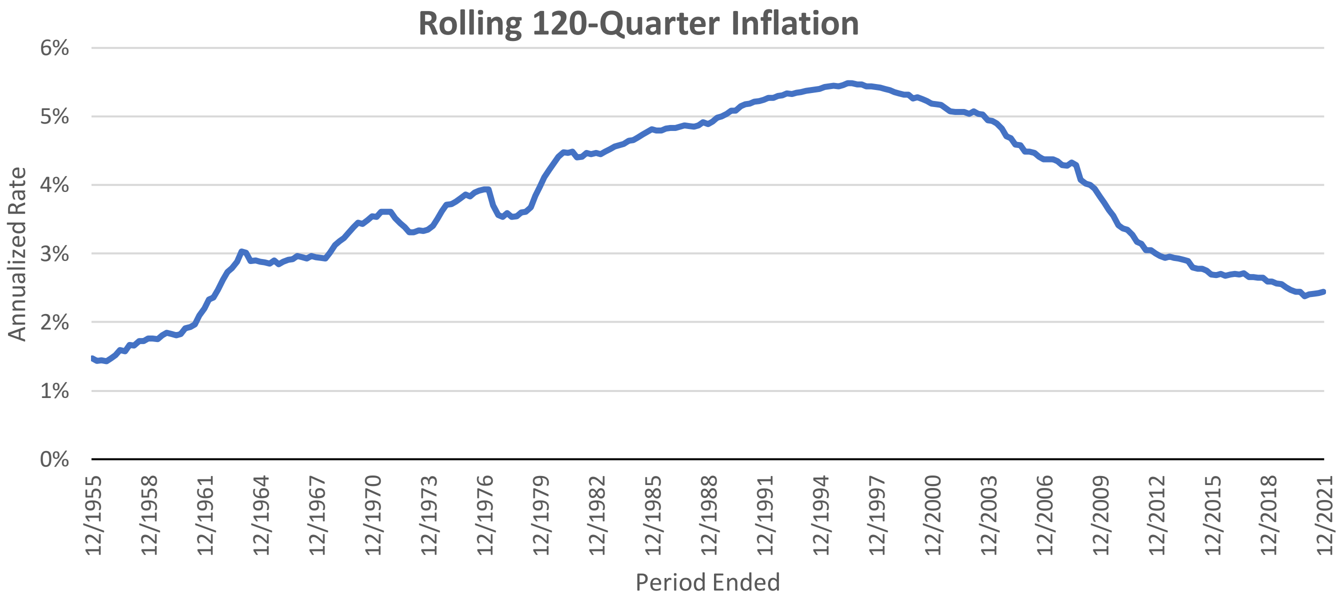
The estimation of the correlation coefficient was completed using historical data after the dissolution of Bretton Woods and excludes the post-financial crisis period. This period was significantly influenced by heightened levels of inflation and restrictive monetary policy. As represented by the chart below, correlations between equity excess returns and Treasury rates have fluctuated over time. As mentioned in the interest rate section, interpretation of the data prior to the 1970s can be challenging due to structural market changes, but it does reflect that the recent period is with precedent. We recommend PBGC expand its calibration window to include more recent data which drive the mean correlation closer to zero.

Chart 19



Source: Mercer Calculations, and Robert Shiller Standard and Poor's 500 Index and 10-year Treasury Data, March 1925 to December 2021, rolling 4-quarter data using the natural log of equity excess returns plus one, http://www.econ.yale.edu/~shiller/data.htm?adlt=strict

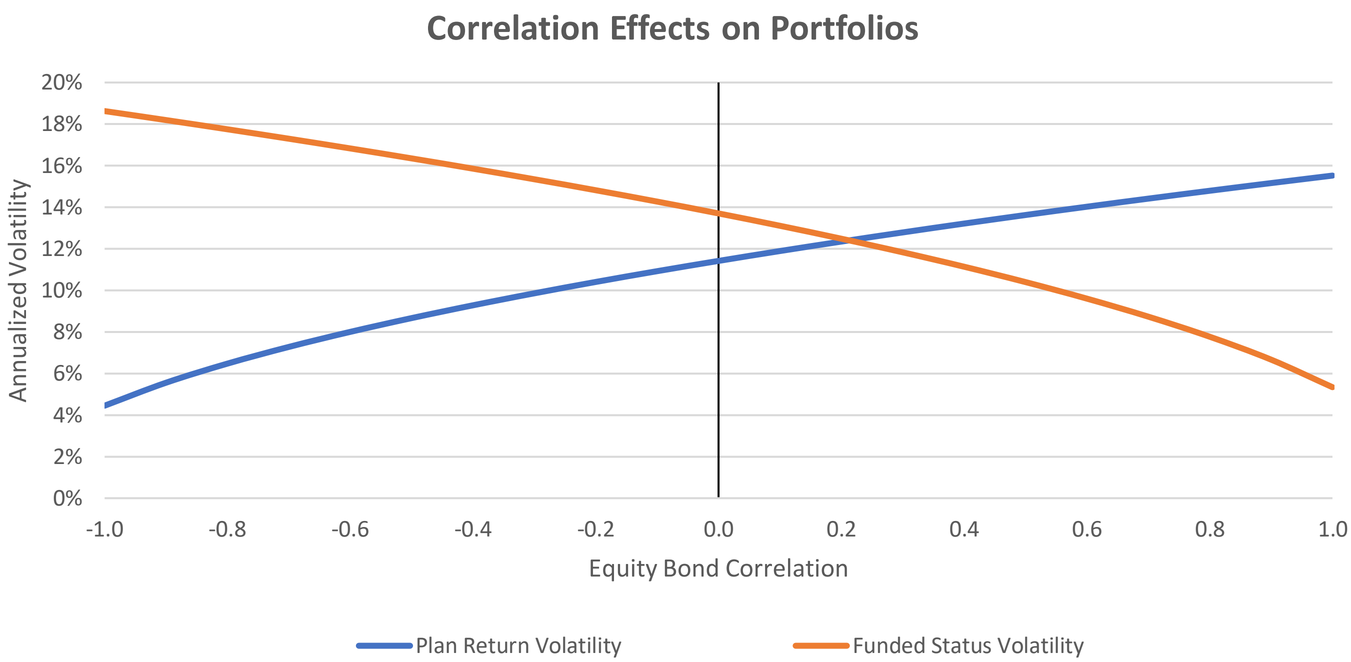
Chart 20



Source: US Bureau of Labor Statistics, and Mercer calculations using Consumer Price Index for All Urban Consumers: All Items in US City Average, not seasonally adjusted (December 1955 to December 2021).

The simulated correlation directly affects plan market values and liability valuations. As the chart below demonstrates, higher correlations between equities and bonds increases the volatility of plan assets, but this relationship decreases the projected funded status variance. As such, revising the correlation would likely decrease plan asset volatility but increase funded status volatility. It is important to note that the addition of a credit spread factor could influence the results below; further discussion in credit spread section.

Chart 21



Source: Mercer calculations. Portfolio volatility estimated using mean-variance assumptions containing 60% equity and 40% long duration bonds. Funded status volatility approximated with mean-variance assumptions of a portfolio containing 60% equity and -60% long duration bonds [40% minus 100% as a liability proxy]. Equity standard deviation, 19.97%; and long duration bonds, 11.07%.

<u>Conclusion</u>

The PIMS projections produce randomized correlations around a targeted value. This randomized process allows the model to capture a wide range of correlation scenarios which have been historically exhibited and theoretically probable. The calibration of the underlying correlation input likely warrants updating which should improve the fit of the model to economic conditions. Development in the T-PIMS models could target more robust economic indicators which would facilitate conditional correlations more akin to real world environments.

2.D. Credit Spreads and Corporate Bond Returns

Purpose

Corporate bond spreads are added to the stochastically modeled Treasury yields in order to estimate the yields on corporate bonds. Those yields on corporate bonds are then used to discount future plan benefits to determine plan liabilities.

Process

PIMS currently stochastically models 30-year Treasury yields. PIMS then takes the current credit spread on investment-grade corporate bonds and models it to revert toward its historic mean value over time. Therefore, the yield on corporate bonds can be described by the following equation, where yc_t represents the corporate yield at time t, y_t represents the 30-year Treasury yield at time t, and sc_t represents the spread on corporate bonds at time t:

Equation: $yc_t = y_t + sc_t$

The spread on corporate bonds can be described by the equation below, where sc^* represents the assumed long term spread on corporate bonds:

Equation: $sc_t = sc^* + \delta(sc_{t-1} - sc^*)$

The current assumptions are:

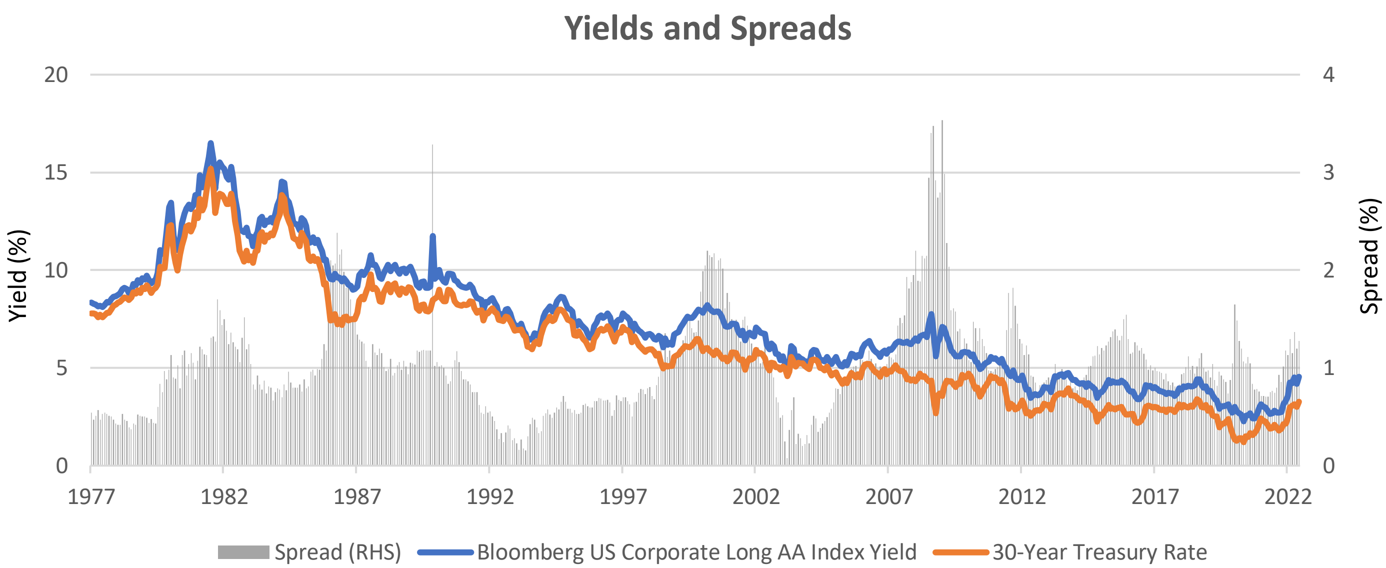
- sc^* = 1.1%
- δ = 0.4152

Assessment

The process above results in a scenario where after the period of reversion for corporate bond spreads to an assumed long-term level, a fixed spread is applied to 30-year Treasury bonds. Currently, Form 5500 Schedule R does not break out allocations to Treasuries and Corporate Bonds separately. There has been some discussion regarding future expansion of the asset classes included on form 5500, which could make the modeling and use of stochastically modeled credit spreads more attractive in calculations of projected asset returns. This potentially could also lead to more accurate valuation of liabilities as higher or lower spreads can impact the discount rate used to measure liabilities.

Given that corporate bond spreads historically have shown a strong tendency toward mean reversion, the current assumption of reversion to a target credit spread is reasonable in normal market environments and serves as a rational central tendency over longer time horizons. History has shown that credit spreads do vary with the state of the economy. Specifically, in times of market stress, credit spreads have shown a tendency to widen, often significantly.

Chart 22

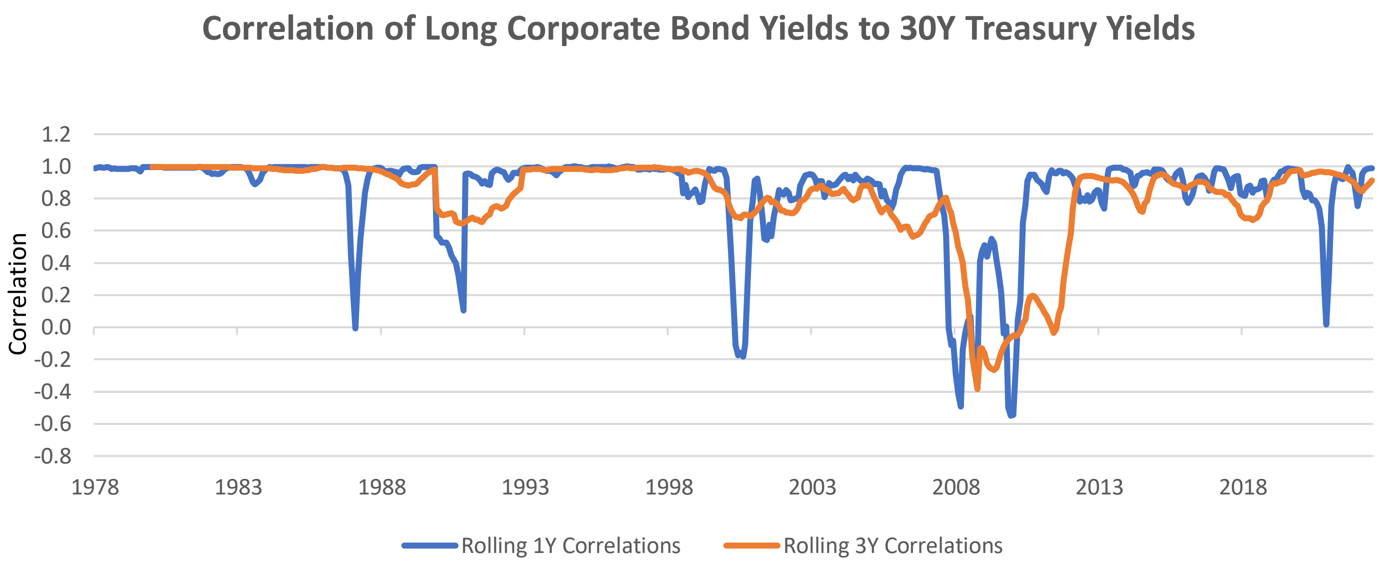


Source: Bloomberg, March 1977 to August 2022.

This assumption of static long-term spreads also leads to some inconsistency between the way yields are modeled for liability calculations and the way bond returns are modeled for asset returns. Specifically, the asset returns of corporate bonds are modeled to have sensitivity to equities, so when the model projects periods of equity declines, it will also weigh on bond returns. Historically, when this happens, yields on credit will typically rise due to widening spreads, which increases the discount rate for plan liabilities, thus lowering the value of those liabilities. In other words, in periods of equity weakness, the value of the liabilities will be affected by not only rate moves but also changes in spread which may soften yield and funded status declines. We believe that stochastically modeling spreads would better capture this dynamic.

The conclusions above also suggest that in PIMS, the correlation between corporate bond yields and Treasury yields revert toward 1 over time. Similar to the prior conclusions, in normal times and over the long-term, we would expect a strong positive correlation. However, in times of stress we expect correlations to break down and they often turn negative for a period of time. This is generally a result of the Fed's efforts to bring down Treasury rates to ease monetary conditions, while the bond market prices in higher default risk resulting in higher corporate bond spreads. As shown in the chart below, corporate and Treasury yields generally track one and other. However, at times there can be large shifts in correlations. This is due to the spread component of corporate bonds. As a result, isolating this spread and projecting it stochastically may lead to a more accurate representation of the corporate yield.

Chart 23



Source: Bloomberg, March 1977 to August 2022.

<u>Potential Alternatives</u>

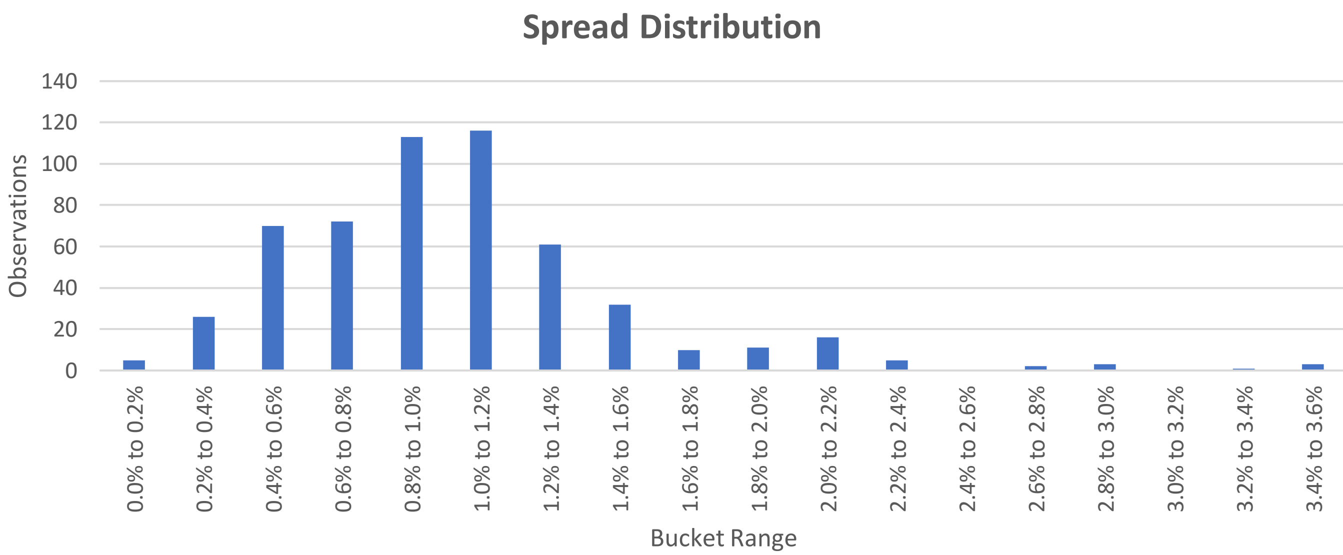
PBGC should consider stochastically projecting credit spreads to more dynamically reflect the real-world sensitivity of plan assets and liabilities. There is no single approach to simulating spreads, but we will walk through one in the context of PIMS current structure. This hypothetical approach would require additional correlations to the current stochastic projections, a new disturbance term (mean and variance), and confirmation of the reversion term. Each of these elements will play key roles. The correlations will integrate the model. The new disturbance term will capture relationships along with idiosyncratic characteristics of the factor. Finally, the reversion variable will allow for a dynamic mean while capturing the serial correlation of spreads. The equation below provides a hypothetical example of how this could be stochastically modeled.

<u>Equation:</u> $$\ln(Spread_t - Spread_{t-1}) = \ln(Spread_{t-1}) * reversion_{term} + intercept + distrubance$$

<u>Equation</u>: $$Spread_t = e^{(\ln(Spread_{t-1}) + \ln(Spread_t - Spread_{t-1}))}$$

The distribution of spreads has a positive skew similar to a lognormal distribution (illustrated below), so this process leverages a philosophy like the one employed in Treasury yield projection. Also, because PIMS projects the 30-year Treasury yield, the example continues that direction. The duration of long corporates and the 30-year Treasury generally are not equal, so it is possible that the spread could become negative.

Chart 24



Source: Bloomberg, Spread estimated using the Bloomberg US Corporate Long AA yield less the 30-year Treasury yield.

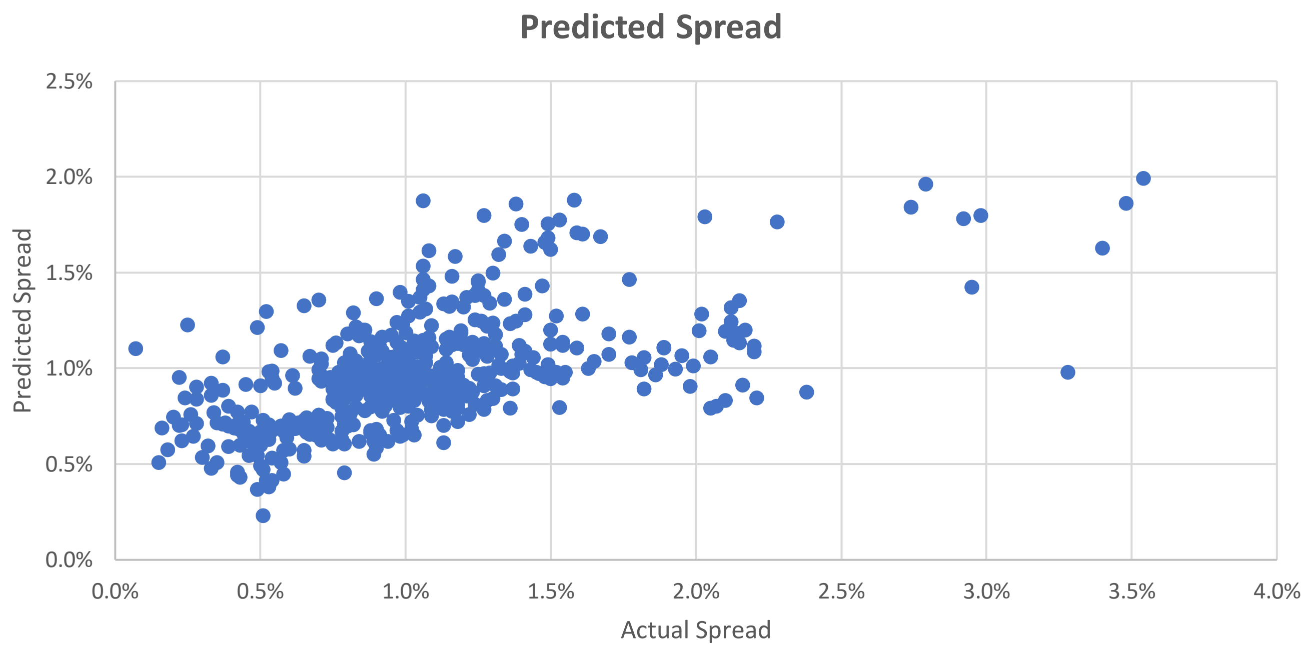
The process continues to use a reversion term, due to its predictive power with the correlated disturbance term to integrate the model and marginally improve fit (note this exercise focuses on the equity excess return for simplicity, but the disturbance term would have correlations to yield changes). The table and chart below show the predictive power of the starting spread and the combined model. As illustrated by the combined model, the disturbance term will contribute a significant amount of factor specific information, as the combination of starting spreads and equities does not perfectly fit the historical spread. As such, the calibration of the disturbance term should be completed on the unexplained variance to limit the any distortion from natural reversion of the spread term.

Table 5

Correlations	With Change in Spreads	Unexplained by Starting Spreads
Starting Spread	-0.479	--
Equity Excess Returns	-0.086	-0.190

Source: Bloomberg, Standard & Poors' 500 Index, and Mercer calculations of monthly data from March 1977 – August 2022. Spread estimated using the Bloomberg US Corporate Long AA yield less the 30-year Treasury yield. Spread change represents the natural log change over 12-months. The equity excess returns represent the natural log of the excess spread between the starting 30-year yield and 12-month equity return plus one.

Chart 25

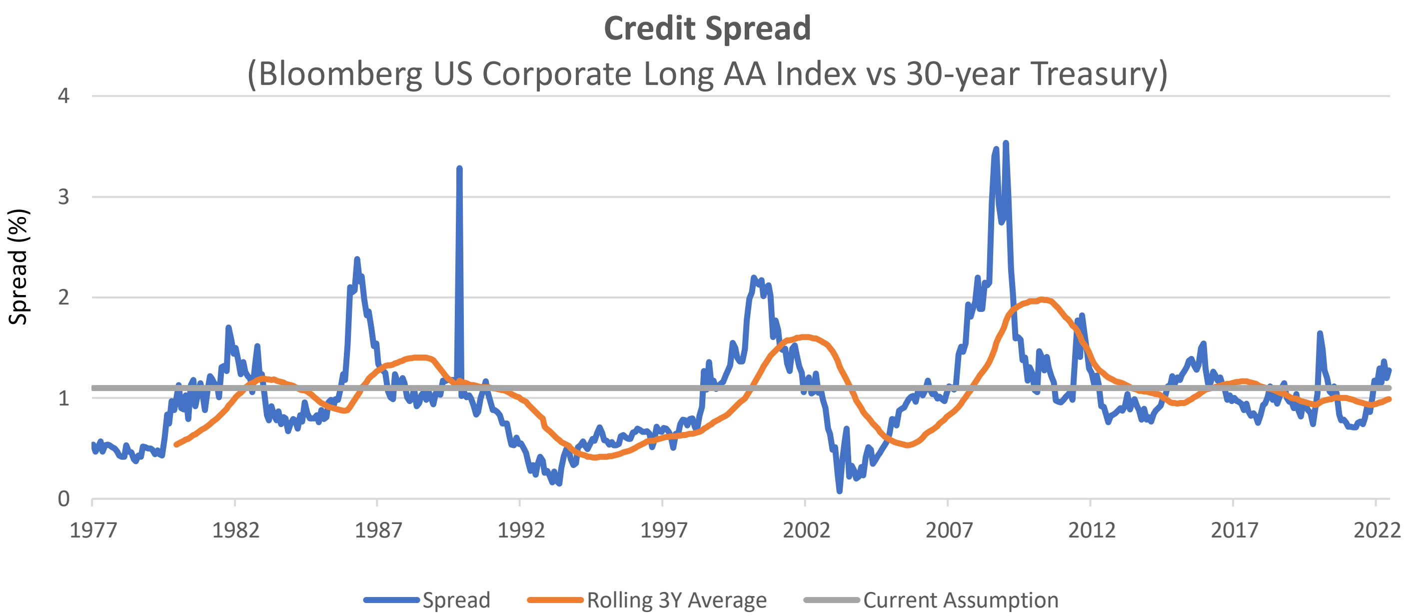


Source: Bloomberg, Standard & Poors' 500 Index, and Mercer calculations of monthly data from March 1977 – August 2022. Spread estimated using the Bloomberg US Corporate Long AA yield less the 30-year Treasury yield. Spread change represents the natural log change over 12-months. The equity excess returns represent the natural log of the excess spread between the starting 30-year yield and 12-month equity return plus one.

Calibration

PIMS currently assumes that corporate bond yields revert to an assumed level (sc*) of 1.1% above the stochastically modeled 30-year Treasury rate. This assumed credit spread was set in 2008 based on a first order regression. We have tested the assumption and believe that it continues to be an appropriate assumption. In testing the assumption, we compared the Bloomberg US Corporate Long AA Index yield to the 30-Year Treasury Yield on a monthly basis from March 1977 to August 2022. We found that the average and median spread over this period were 1.0%. Given that spreads have remained fairly stable since the 2008 financial crisis, without any major spikes above 2.0%, some modest drift downward in the calculated mean is to be expected and we do not view this as a meaningful discrepancy requiring adjustment.

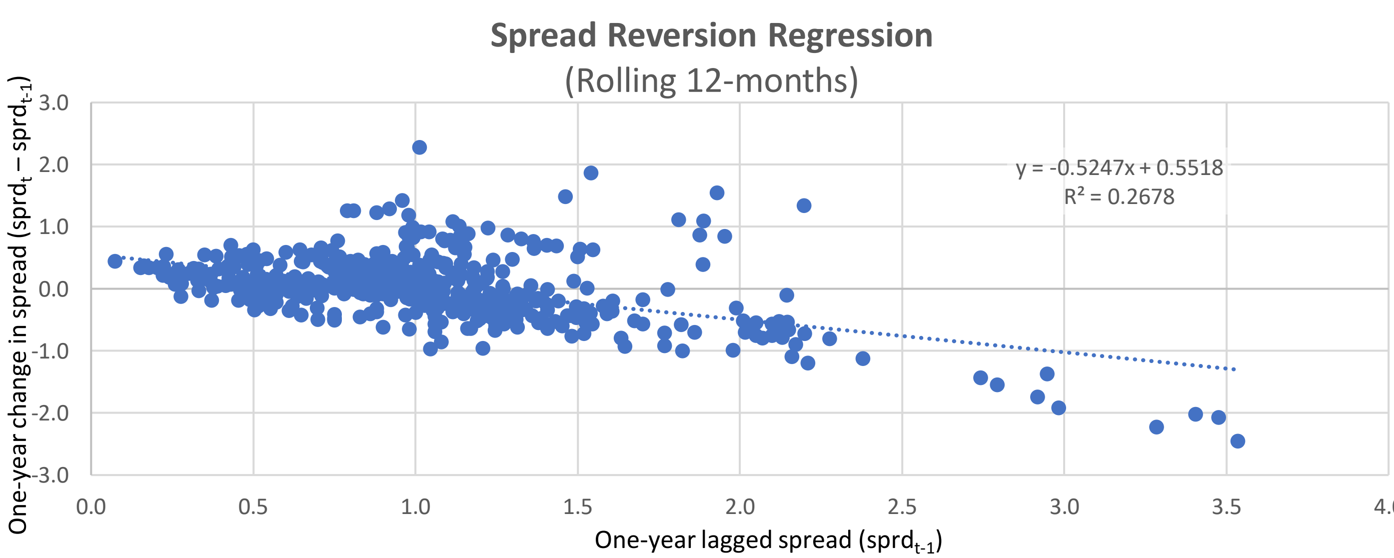
Chart 26



Source: Bloomberg, March 1977 to August 2022.

We also tested the regression analysis that was performed to determine the spread reversion factor and we believe it continues to be appropriate. This regression compared the one-year change in corporate spreads (y-axis) to the one year lagged spread (x-axis). We ran the analysis both on a rolling 12-month basis and on an annual basis for periods ending March 31, 2022.

Chart 27



Source: Bloomberg, March 1977 to March 2022.

This regression equation implies that:

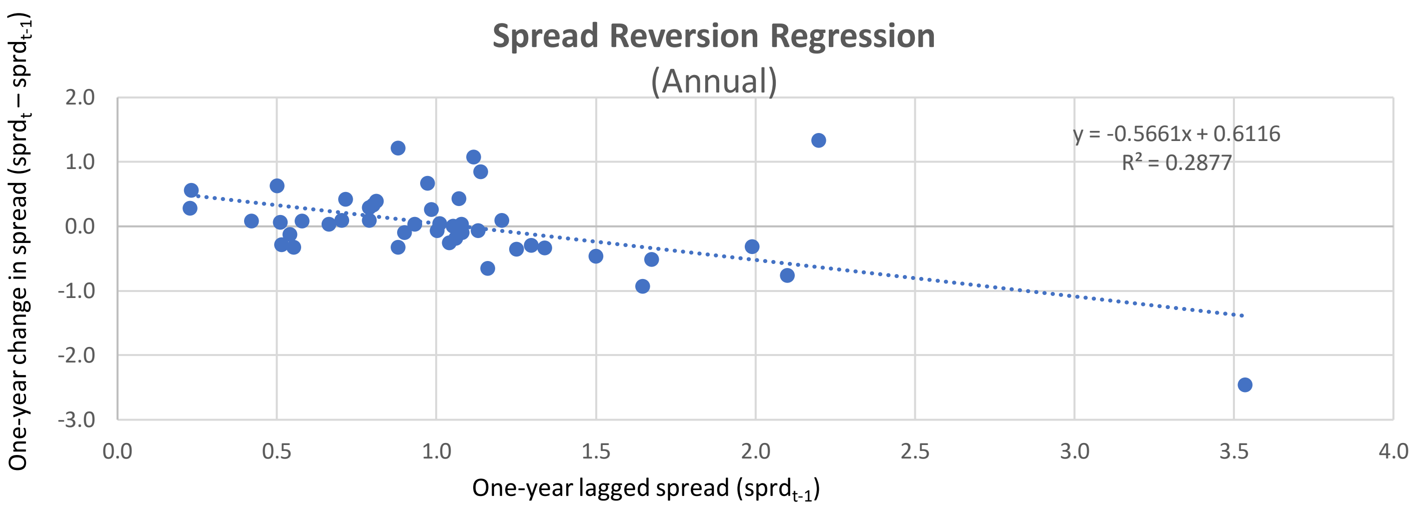
$$\text{Equation: } sprd_t - sprd_{t-1} = 0.5518 - 0.5247 * sprd_{t-1}$$

which reduces to:

$$\text{Equation: } sprd_t = 0.5518 + 0.4753 * sprd_{t-1}$$

which leads to an implied mean of 1.05% and a reversion term of 0.4753.

Chart 28



Source Bloomberg, March 1977 to August 2022.

This regression equation implies that:

$$\text{Equation: } sprd_t - sprd_{t-1} = 0.6116 - 0.5661 * sprd_{t-1}$$

which reduces to:

$$\text{Equation: } sprd_t = 0.6116 + 0.4339 * sprd_{t-1}$$

which leads to an implied mean of 1.08% and a reversion term of 0.4339.

Conclusion

We believe that the current approach to modeling corporate bond spreads, yields, and returns (via equity sensitivity) employed by PIMS provides a reasonable approximation for expected outcomes. We also believe that the current calibrations of the model remain appropriate.

One option for potential improvement to the model would be to stochastically model credit spreads. We understand that this may not be reasonable over the short-term. However, as PBGC works toward development of its new modeling tool (T-PIMS), we believe this is a change worthy of consideration. In our view, it would lead to better alignment of the modeling of assets and liabilities. It would better mirror the behavior of credit spreads' historical correlations to stocks and Treasuries. Additionally, it would marginally improve the projection of plan returns (discussed in asset allocation section).

Section 3: Assessment of PBGC's Factor Model to Determine Plan Outcomes

A long-standing debate among academics and practitioners in the investment universe has been whether asset returns on stocks and bonds are explainable. This examination has since been extended to non-marketable assets or "alternatives", such as private equity and hedge funds. Significant research has been undertaken to determine whether ex-ante observable factors can reliably predict ex-post returns in the form of risk premiums, or the rate of return over a risk-free short-term rate. In the absence of known asset allocation, how effectively can returns be modeled and what are the important considerations that must be made when examining various time periods, particularly in the event of a market tail event.

Harry Markowtiz's 1952 publication *Portfolio Selection*[27] in the Journal of Finance examined the relationship between risk and return. Markowitz developed a mean-variance model to demonstrate how to quantify both risk and return; the conclusion: assuming efficient markets, higher returns can be accomplished only by accepting greater (market) risk. This paper initiated several important and well-cited publications regarding the use of factors to predict investment returns.

One of the most frequently cited academic publications[28] to measure systemic risk was the capital asset pricing model, otherwise known as CAPM by Nobel Memorial Prize winning author William Sharpe. Sharpe concluded that one factor, known as market risk, could on average account for a vast majority of individual stock returns. Under CAPM, market risk is defined as the variability of an asset's return relative to that of the market. Beta, the coefficient of the independent variable in an ordinary least squares (OLS) regression equation to explain the dependent variable – the security return, measures the level of systematic or market risk. A beta of 1.0 indicates risk equivalent to that of the market, whereas a beta of less than 1.0 indicates a lower market risk and a beta greater than 1.0 indicates a higher level of risk relative to that of the market. While Sharpe's underlying methodology remains useful for understanding individual stock returns, over time new asset classes such as private equity and hedge funds have emerged. As a result, additional academic literature has sought to explain the performance of these strategies.

Stephen Ross[29] expanded upon CAPM, introducing the arbitrage pricing theory, or APT, recognizing several macroeconomic factors may be used to more accurately influence investment returns; factors included inflation, interest rates, and business activity. Like CAPM, APT consisted of a statistical process to measure a security's sensitivity to each systematic risk factor; however, the individual factors were not associated with readily identifiable variables. Simply put, CAPM clearly defines the sources of investment risk or factors, while APT does not explicitly define such factors.

While there has been extensive research on measuring the systematic risk factors of marketable securities, only until recently has there been a shift to identifying and quantifying exposures for alternative asset classes. The "Endowment Model", which argues for significant allocation "alternative" assets such as hedge funds, private equity, and real assets, has created the need of investors in the endowment and foundation space to measure such risks. It is critical to understand to what extent returns on these strategies can be explained by systematic risk factors, such as interest rates and the equity risk premium, alternative risk factors, such as illiquidity, and unexplained risk and alpha. In summary, there has been significant efforts to identify and quantify a common set of risk factors that impact a large portion of the market. The fundamental idea is that a large range of asset returns can be explained by a small range of factors. While the importance of these factors is dynamic across time, the common factors identified provide a valuable framework in understanding

27 Markowitz, Hany M. 1952. "Portfolio Selection," Journal of Finance 7 (March):77-91.
28 Sharpe, William F. 1964. "Capital Asset Prices: A Theory of Market Equilibrium Under Conditions of Risk." Journal of Finance 19 (September):425-42.
29 Ross, Stephen A., and Richard Roll. 1984. "The Arbitrage Pricing Theory Approach to Strategic Portfolio Planning." Financial Analysts Journal 40 (Maydune): 14-26.

and potentially projecting the path of growth for a given pool of assets. The remaining portion of this chapter seeks to provide evidence of the ability of these factors to explain various asset classes.

PBGC's PIMS currently employs a factor model consisting of the various sensitivities to project the economic net position of insurance assets for single-employer (SE) and multiemployer (ME) plans. As such, the remainder of this chapter examines and tests the statistical significance of these factors explaining both asset class returns and the simulated returns of the SE and ME Plans over various time periods. The following section will detail how well these factors can explain growth in both the plan returns and allocated assets.

Factors currently employed by PBGC's ESG, along with a description of how these factors were developed is shown in Table 6. It should be noted that these three factors represent key aspects of assets invested in portfolios within the US pension system. These factors are not meant to directly represent particular asset classes, but rather exposures; such exposures include an excess return on equities over a risk-free rate, duration, inflation and real yields.

Table 6: Factors Currently Utilized in PIMS[30]

Factors	Benchmark	Notes
Stock Returns	Dow Jones S&P 500 Composite	Reflects equity risk
Bond Yields	30-Year Treasury Yields	Represents the risk-free rate; modeled using 30-year treasury bonds, assuming a flat yield curve
Bond Returns	30-Year Treasury Bond Returns	Reflects duration, modeled using 30-year bonds

Mercer utilized Schedule R data provided by PBGC to estimate the asset-weighted asset allocation of both the SE and ME Plans. Asset allocations were provided on an annual basis for the ten-year period ending December 2020. For the purposes of this analysis, Mercer assumes monthly rebalancing of the 2020 average asset-weighted asset allocations provided through Schedule R to model both SE and ME plan returns.

The Special Financial Assistance (SFA) Program was enacted on March 11, 2021, as part of the American Rescue Plan Act of 2021. The SFA Program provides funding to severely underfunded ME Plans to pay benefits; eligibility is limited to financially troubled plans and is calculated to be the amount required for the plan to pay benefits through 2051. Per the latest PBGC *Projections Report FY2021*, PBGC currently estimates a mean total of $82.7 billion in SFA will be distributed to 197 plans[31], or an estimated 20% of the total number of ME Plans[32]. In July of 2022, PBGC published a final rule implementing changes pertaining to the investment of SFA assets; with the final ruling, PBGC will allow up to a third of SFA assets to be invested in return-seeking asset classes, such as stocks and alternatives; the remaining assets must be invested in investment-grade fixed income.

Of note, at the time of this publication, there were less than 10% of submissions for 2021 as there were for 2020; as such, this data was not included in the analysis. Given the recent implementation of the SFA Program, we are unable to see what significant changes to asset allocation across ME Plans will result from the disbursement of SFA assets to ME Plans

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[30] Information provided by PBGC's Policy, Research, and Analysis Department (PRAD) and not publicly available.
[31] FY2021 Projections Report. Pension Benefit Guaranty Corporation. Published September 2022. https://www.pbgc.gov/sites/default/files/documents/fy-2021-projections-report.pdf
[32] Special Financial Assistance to Troubled Multiemployer Plans. Fulcrum Partners. Published August 4, 2021. Accessed September 25, 2022. https://fulcrumpartnersllc.com/2021/08/04/special-financial-assistance-to-troubled-multiemployer-plans/#:~:text=More%20than%20200%20plans%20have%20been%20identified%20by,well%20as%20links%20to%20the%20interim%20final%20rule.?adlt=strict

in need. PBGC currently models SFA assets to be disbursed for benefit administration from plans who received this assistance; as such, most plans will hold SFA assets for up to five years. PIMS thus projects plan asset allocations will revert to their respective "policy" asset allocation within that time frame. While this will impact overall projections in terms of the net financial position, we do not believe this will impede the ESG's ability to explain the average plan asset return. We discuss the modeling of SFA assets and ME-plans in the next section as well.

Tables 7 and 8 provide an overview of the Schedule R data available for this analysis.[33]

Table 7: ME Plan Schedule R Data

Year	Total Schedule R Submissions	Total Submissions with Assets and Asset Allocations (AA)	Percent of Data Available for Analysis (by count)	Number of Plans over $1 billion (with AA)	Number of Plans Over $5 billion (with AA)
2011	1,421	808	56.9%	80	9
2012	1,402	787	56.1%	84	10
2013	1,401	797	56.9%	95	10
2014	1,393	800	57.4%	99	11
2015	1,371	811	59.2%	94	10
2016	1,368	812	59.4%	101	11
2017	1,377	820	59.5%	109	12
2018	1,372	823	60.0%	105	12
2019	1,367	828	60.6%	117	13
2020	1,324	798	60.3%	130	22

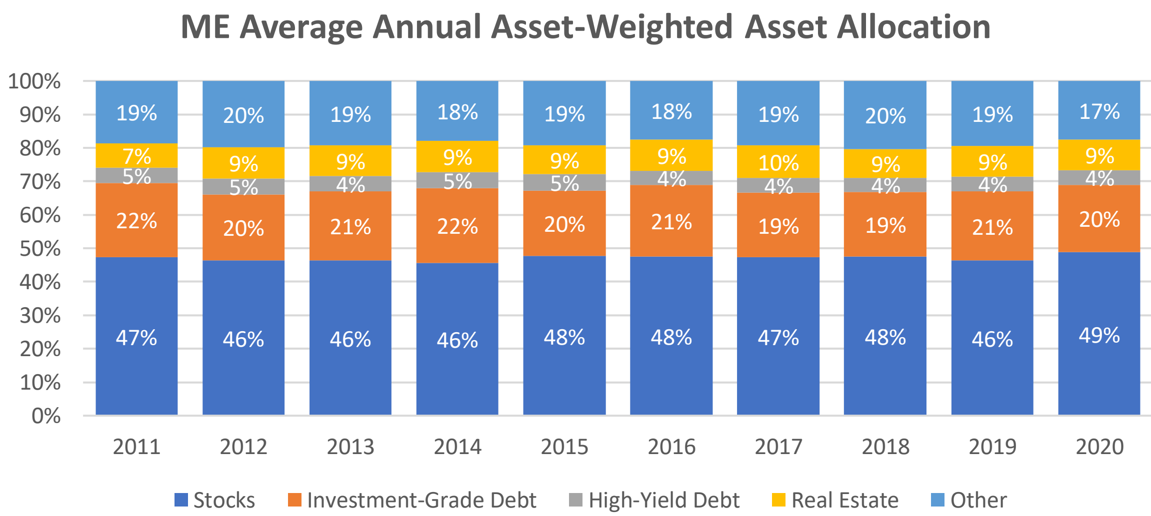
Source: Data from the Schedule R was provided by PBGC; data is from the 2011 through 2020 surveys. Mercer calculated the asset-weighted average asset allocation for Multiemployer plans utilizing plan sponsor responses with both a total market value of plan assets and asset allocation data available.

Approximately 59% of the respondents provided by an asset value and allocation; Table 3 shows that the number of total respondents, along with the percentage of records with complete data did not significantly vary year-over-year. Due to rounding, some allocations totaled +/-0.5% against the mean of 100%. Given we do not believe the rounding will impact overall results, we reallocated the remainder to the stocks allocation.

[33] Schedule R data provided by PBGC; this data may or may not be consistent with data publicly available. https://www.pbgc.gov/prac/data-books?adlt=strict

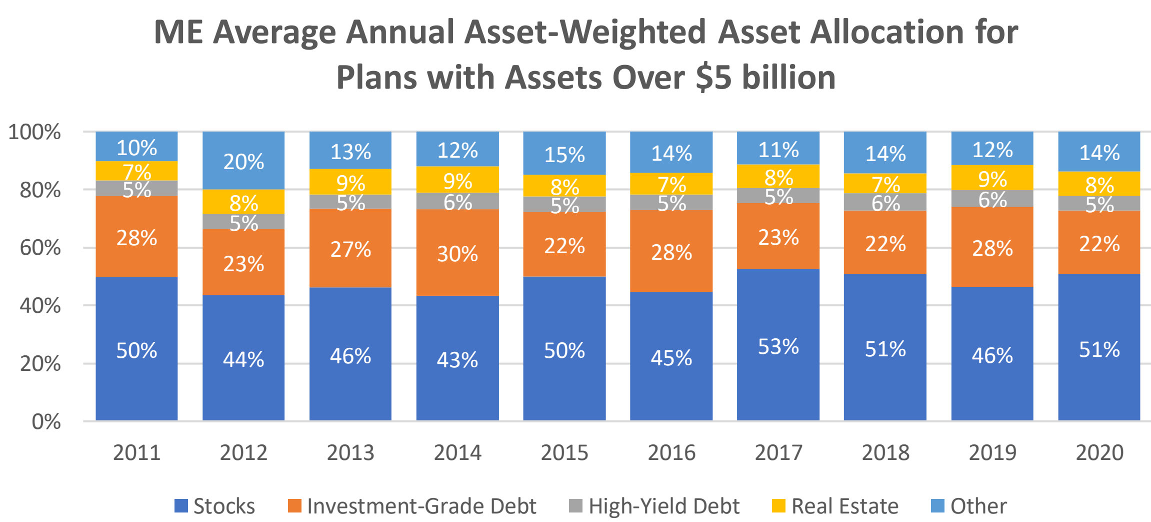
We then examined the asset allocation of the overall ME universe, and then broke down the average asset-weighted allocation based on total assets. Charts 29 and 30 provide a detailed breakdown of asset allocation by year across all plans, and for those larger than $5 billion. For plans over $5 billion in assets, the allocation to the “Other” bucket was between 5-8% lower than the asset-weighted allocation of the entire universe, with the difference being reallocated to primarily investment-grade debt.

Chart 29



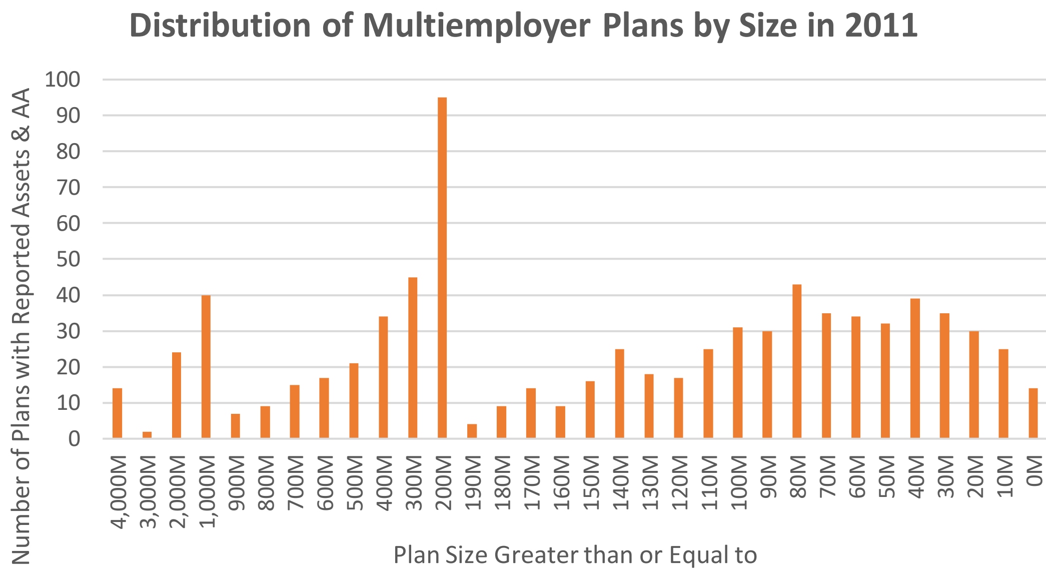
Source: Data from the Schedule R was provided by PBGC; data is from the 2011 through 2020 surveys. Mercer calculated the asset-weighted average asset allocation for Multiemployer plans utilizing plan sponsor responses with both a total market value of plan assets and asset allocation data available.

Chart 30



Source: Data from the Schedule R was provided by PBGC; data is from the 2011 through 2020 surveys. Mercer calculated the asset-weighted average asset allocation for Multiemployer plans utilizing plan sponsor responses with both a total market value of plan assets and asset allocation data available. Data shown above only includes the asset-weighted average asset allocation for those plans with assets above $5 billion in any one given year.

Chart 31



Source: Data from the Schedule R was provided by PBGC; data is from the 2011 through 2020 surveys. Mercer calculated the asset-weighted average asset allocation for Multiemployer plans utilizing plan sponsor responses with both a total market value of plan assets and asset allocation data available. Data shown above only includes the asset-weighted average asset allocation for those plans with assets above $5 billion in any one given year.

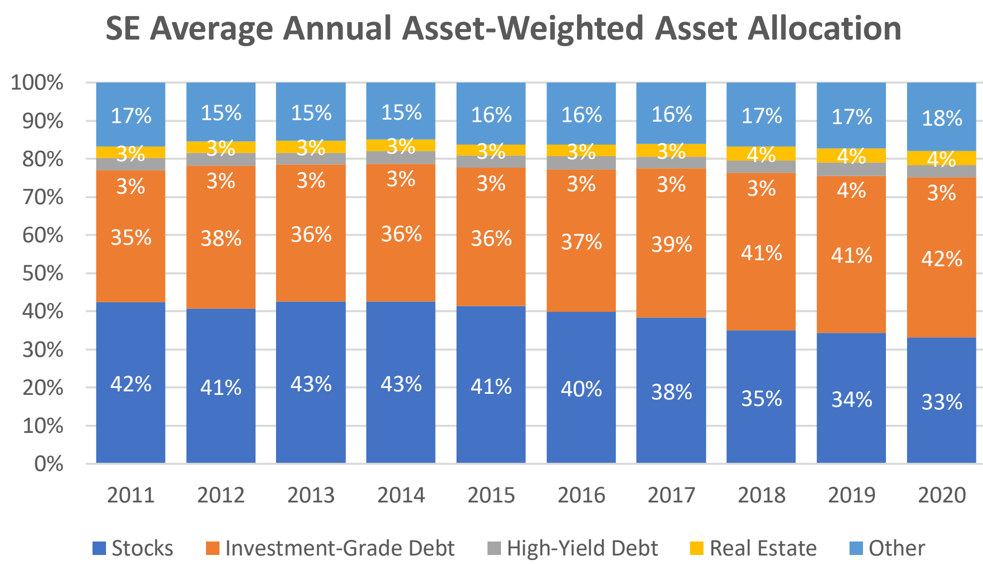
For those respondents with reported assets and asset allocations, close to 60% are over $100 million in assets. We then examined similar characteristics for SE Plans. While there were significantly more SE Plans (and thus responses), the relative number of respondents who provided full information (total market value of assets and asset allocation) is less than that of the ME respondents. Of note, the total number respondents in 2020 fell about 40% from 2011, while average total assets increased by about 50%; we believe the increase in the average amount of plan assets could be attributed to stronger market performance during the time period following the 2008 financial crisis. However, there does not appear to be any significant biases in the data in terms of over- and/or under-representation of a specific subset of plans that we believe would significantly alter the outcome of our analysis.

Table 8: SE Plan Schedule R Data

Year	Total Schedule R Submissions	Total Submissions with Assets and Asset Allocations (AA)	Percent of Data Available for Analysis (by count)	Percent of Plans over $1B (with AA)	Total Assets Available for Assessment in Millions of Dollars
2011	14,143	3,009	21.4%	347	$1,807,679
2012	13,162	2,889	22.0%	358	$1,868,846
2013	12,337	2,920	23.8%	390	$2,077,929
2014	11,539	2,866	24.9%	398	$2,055,126
2015	10,515	2,751	26.4%	426	$1,909,129
2016	10,417	2,642	25.6%	400	$2,035,161
2017	9,964	2,565	26.0%	415	$2,179,348
2018	9,425	2,433	26.1%	448	$2,462,111
2019	8,801	2,272	26.3%	437	$2,068,024
2020	8,851	2,094	23.9%	433	$2,180,785

Source: Data from the Schedule R was provided by PBGC; data is from the 2011 through 2020 surveys. Mercer calculated the asset-weighted average asset allocation for Single-employer plans utilizing plan sponsor responses with both a total market value of plan assets and asset allocation data available.

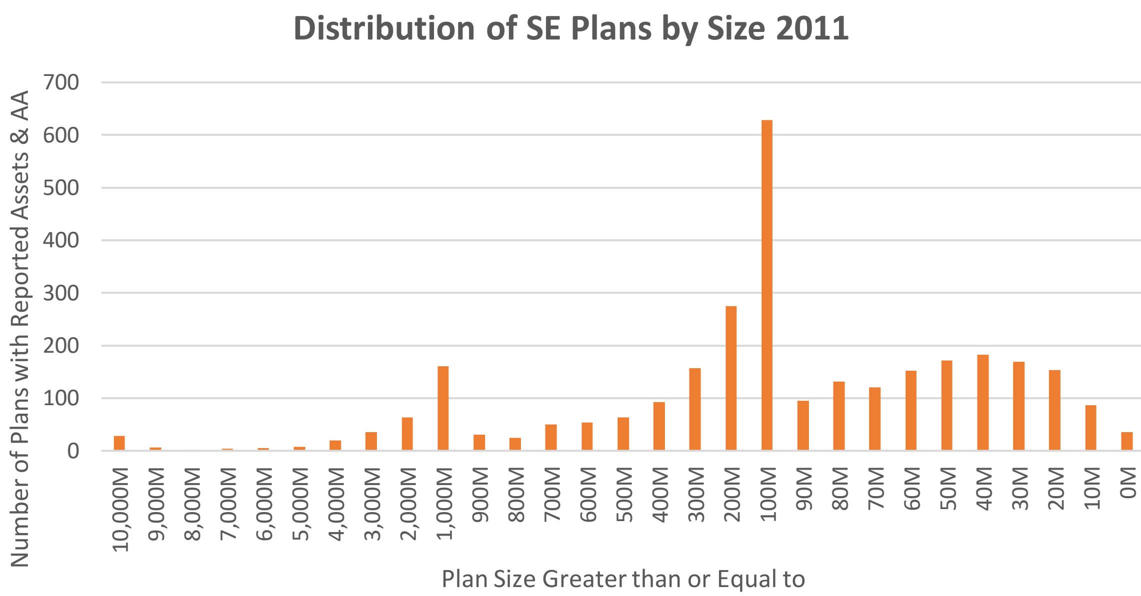
Chart 32



Source: Data from the Schedule R was provided by PBGC; data is from the 2011 through 2020 surveys. Mercer calculated the asset-weighted average asset allocation for Single-employer plans utilizing plan sponsors response with both a total market value of plan assets and asset allocation data available.

When examining asset allocation for all SE Plans with available data (about 24.4% on average across the 10-year period), there appeared to be a shift towards investment-grade fixed income and “other” assets. The asset allocation among larger plans (over $5 billion) did not appear to differ significantly from the overall pool of ME plan respondents. Examining the distribution of asset size, approximately 57% of total plans examined were over $100 million. Chart 33 provides a detailed breakdown SE Plan respondents by asset size. While not all SE plan respondents provide full information in terms of total market value and asset allocation, we do not believe there are any significant biases in the data that would alter our examination in the use of factors to model plan assets overtime. Similar to the universe of ME plans with available data, we do not believe there are any existing biases or irregularities with the data available that would significantly alter our ability to accurately assess the explanatory power of the factor model.

Chart 33



Source: Data from the Schedule R was provided by PBGC; data is from the 2011 through 2020 surveys. Mercer calculated the asset-weighted average asset allocation for Single-employer plans utilizing plan sponsor responses with both a total market value of plan assets and asset allocation data available.

Utilizing the asset allocations provided in Schedule R, we then mapped the allocations to common benchmarks available via Bloomberg. Table 9 summarizes such mapping:

Table 9: Factor Mapping

Factors	Benchmark	Notes
Equity Excess Returns	US: Dow Jones S&P 500 Composite Index; backfill using MSCI USA Index Calculate Equity Excess Return: subtract effective monthly 10-year Treasury Yield	US: Utilized monthly total returns of Dow Jones S&P 500 Composite via Bloomberg from February 1988 through December 2020; returns were backfilled through December 1976 using MSCI USA Index. Equity Excess Return calculation: remove 10-year Treasury yield (effective monthly rate).
Bond Excess Returns	10-Year Treasury returns (Mercer estimate)	Estimated the price of a 10-year Treasury bond by utilizing the Bloomberg 10-year US Treasury Yield (FRED), assuming semi-annual coupon, rolled monthly.
Bond Yields	10-Year Treasury Yields	Utilized 10-year Treasury yields to proxy the risk-free rate; data for 10-year yields via the Federal Reserve Economic Database (FRED) is available from September 1981 through December 2020; data utilized prior was obtained from Shiller.
Monthly Absolute Change in Corporate Spreads	Bloomberg US Long Corporates AA Index Less 10-Year Treasury Yield	Bloomberg US Long Corporates AA Yield minus the 10-Year Treasury Yield to obtain the spread component.

PBGC currently uses the 30-year Treasury yield to model this risk-free rate. While hypothetical, as every investment has some level of risk, shorter duration Treasury bonds are arguably the closest possible to being "risk-free". The US government has never defaulted on this debt obligation; these securities are auctioned at or below par and the government repays at par upon maturity. The large size and liquidity of the Treasury market also contributes to the perception of safety. As such, for the purposes of this analysis, Mercer derived a "risk-free" rate utilizing 10-year Treasury yields, assuming semi-annual coupons.

To capture market and interest rate exposure, Mercer utilized equity and bond risk historical excess returns. Through the use of such "premium" over an established risk-free rate, we can approximate the expected return that is attributed to equity and bond markets, respectively.

Mercer also examined the use of a credit spread as an additional factor not currently implemented in PIMS' ESG. Credit spreads can be used to reflect the expectations on default and recovery and can vary with macroeconomic factors such as economic growth and the equity risk premium. Credit spreads can be thought of as compensation for taking on credit risk. Higher-yielding bond spreads are observed to be closely related to equity market factors, while higher-quality bond spreads show greater dependency to Treasury yields.[34] The addition of the absolute change in spreads introduces a component that cannot be derived from bond returns alone. Duration is the most commonly used measure of interest rate risk in bond investing, and as such captures the risk associated in investing in Treasuries. In regard to the "Other" category in Schedule R, Mercer assumes an equal blend of private equity and hedge funds. To proxy private equity, Mercer beta-adjusted domestic small cap stocks returns (Russell 2000 Index, a public market equivalent) by a factor of 1.2. While such public market equivalents are generally accepted proxies for smaller cap companies typically held by private equity funds, actual returns for private equity allocations may vary significantly due to differences in strategy, vintage, and manager performance. Illiquidity and lower frequency of mark-to-market valuations also contribute to these differences. As a result, the explanatory power of the factors utilized to estimate asset returns for both the ME and SE plans may vary differently on an individual plan level. To proxy hedge funds, Mercer utilized the HFRI Hedge Fund-Weighted Composite Index, which has available data back to 1990.

[34] Bhar, et al. A Multifactor Model of Credit Spreads. January 2008. Asia-Pacific Financial Markets 18(1):105-127 DOI:10.1007/s10690-010-9123-3. https://www.researchgate.net/publication/225789564_A_Multifactor_Model_of_Credit_Spreads

Table 10: Asset Class Mapping of Excess Returns Over the Risk-Free Rate

Asset	Benchmark	Notes
Stocks	US: Dow Jones S&P 500 Composite Index; backfilled using MSCI USA Index Global: Utilized MSCI ACWI Index	Utilized monthly total returns of Dow Jones S&P 500 Composite via Bloomberg from February 1988 through December 2020; returns were backfilled through December 1976 using MSCI USA Index. Global: Utilized MSCI ACWI Index
Investment-Grade Debt	Bloomberg U.S. Corporates Index	Utilized monthly total returns of Bloomberg US Corporates Index via Bloomberg.
High-Yield Debt	Bloomberg U.S. Corporate High Yield Index; backfilled Bloomberg U.S. Corporates Index	Utilized monthly total returns of Bloomberg U.S. Corporate High Yield Index via Bloomberg from August 1983 through December 2020; returns were backfilled through December 1976 via Bloomberg U.S. Corporates Index.
Real Estate	FTSE NAREIT All Equity REITS Total Return Index	Utilized monthly total returns of FTSE NAREIT All Equity REITS Total Return Index via Bloomberg.
Other	Private equity proxied using FTSE Russell 2000 Index * 1.2 beta; hedge funds proxied using HFRI Fund-Weighted Composite Index	Utilized information from the 2020 Willis Towers Watson study[35] to assess the definition of "other"; simplified to a 50/50 allocation to private equity (proxied using Russell 2000 and scaling with a 1.2 beta to adjust for higher volatility) and hedge funds (HFRI Funded-Weighted Composite Index).

The equation below provides a brief overview of the factor model employed by PGBC to model pension insurance assets for both the ME and SE Plans. We assume asset allocations provided in the Schedule R follow a calendar year implementation, with monthly rebalancing back to target. Additionally, no fees were applied, so returns are gross of manager fees and other related expenses.

[35] 2019 Asset Allocations in Fortune 1000 Pension Plans. Willis Towers Watson. Published January 2021. https://www.wtwco.com/en-US/Insights/2021/01/2019-asset-allocations-in-fortune-1000-pension-plans

Factor Model

$$\text{Equation: } E(R_{P,T}) = \alpha + \beta_{S,T} + \beta_{B,T} + \beta_{Y,T} + \beta_{S,T} + \varepsilon$$

where

$E(R_{P,T})$ = the expected return of plan assets at time T

α = intercept term

$\beta_{S,T}$ = factor sensitivity to stock returns excess of the risk-free rate at time T

$\beta_{B,T}$ = factor sensitivity to bond returns excess of the risk-free rate at time T

$\beta_{Y,T}$ = factor sensitivity to bond yields at time T

$\beta_{S,T}$ = factor sensitivity to US Long Corporate AA spreads at time T

ε = error term

In examining the factor model explanatory power, it is important to review the statistical significance of its factors. Regressing monthly returns from 1976 through 2020 for the aforementioned factors, we found the factors' overall ability to explain the returns for each of the asset classes in Schedule R. Of note, the independent and dependent variable for stocks is the S&P 500 Composite Index, so stock returns should be able to accurately predict the equity asset class.

Table 11: Regression Results for PBGC Factors in Explaining Schedule R Asset Classes

Asset Class 2-Factor Regression Analysis, January 1977-June 2022						
Excess Return over the Risk-Free Rate	**US Stocks**	**Global Stocks**	**Investment-Grade Debt**	**High Yield Debt**	**REITS**	**Other**
Intercept	0.0000*	-0.0001	-0.0003	0.0001	0.0026	0.0006
US Equity Excess Return	1.0000*	0.8769*	0.1599*	0.3414*	0.6717*	0.9365*
Bond Excess Return	0.0000*	-0.0296	0.3218*	0.1053*	0.0566	-0.0416
Multiple R	1.0000	0.8924	0.8049	0.6025	0.5969	0.8253
R Square	1.0000	0.7964	0.6479	0.3630	0.3563	0.6810
Adjusted R Square	1.0000	0.7957	0.6466	0.3606	0.3539	0.6799
Standard Error	0.0000	0.0193	0.0119	0.0206	0.0393	0.0279
Observations	546	546	546	546	546	546

Source: Bloomberg, Mercer Calculations. Note: The risk-free rate was calculated by removing the monthly calculated 10-year Treasury Yield. The "" indicates significance at the 5% level.*

Not surprisingly, we can see that asset classes with equity-like characteristics show a greater sensitivity to stock returns (REITS, high yield, and other/alternatives), while fixed income asset classes show stronger sensitivity to bond returns. In the simplest of terms, this shows that a majority of the asset classes held by SE and ME Plans, represented by Schedule R can be explained using only stocks, bonds, and rates. For example, public and private equity returns are likely explained by the average stock market return. Returns on various fixed income strategies can be explained by some mix of yields, bond returns, and equity sensitivity. We would note that the equity sensitivity component of investment-grade debt reflects the relationship between corporate spreads and equity risks (corporate spreads tend to widen when equities decline). However, the actual degree of equity risk may be overstated, and the bond and yield sensitivity may be understated due to low interest rate environment experienced after the financial crisis. Nonetheless, as we will discuss, we think it is appropriate to capture the relationship between credit and equities.

We then extended this analysis to include the absolute change in spread of longer-duration, high quality corporate bonds. From Table 12, we can see that the explanatory power of the model on investment-grade and higher yielding debt increased with the addition of this factor. For pension portfolios, particularly those in hibernation or termination, or are heavily invested in intermediate to longer-duration fixed income, the use of corporate spreads in the factor model may improve the ability of the model to explain asset returns at the plan-level.

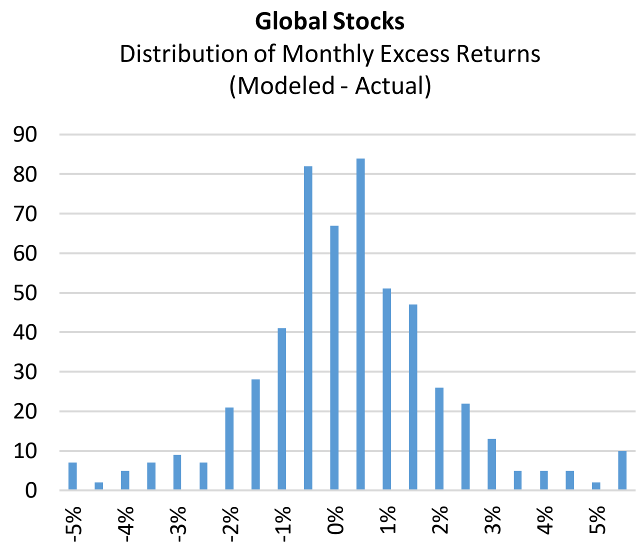
Table 12: Regression Results for PBGC Factors in Explaining Schedule R Asset Classes

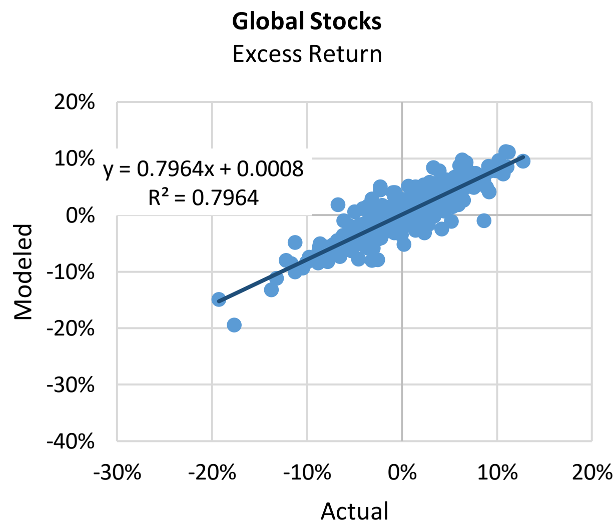
Asset Class 3-Factor Regression Analysis, January 1977-June 2022						
Excess Return over the Risk-Free Rate	**US Stocks**	**Global Stocks**	**Investment-Grade Debt**	**High Yield Debt**	**REITS**	**Other**
Intercept	0.0000*	-0.0001	-0.0002	0.0002	0.0026	0.0006
US Equity Excess Return	1.0000*	0.8766*	0.1311*	0.3078*	0.6385*	0.9331*
Bond Excess Return	0.0000	-0.0283	0.3577*	0.1464*	0.1100*	-0.0397
Corporate Spread	0.0000	-0.0592	-2.3822*	-2.7573*	-3.1680*	-0.2004
Multiple R	1.0000	0.8923	0.8347	0.6339	0.6134	0.8247
R Square	1.0000	0.7961	0.6968	0.4018	0.3762	0.6802
Adjusted R Square	1.0000	0.7950	0.6951	0.3985	0.3728	0.6784
Standard Error	0.0000	0.0193	0.0110	0.0200	0.0388	0.0279
Observations	545	545	545	545	545	545

Source: Bloomberg, Mercer Calculations. Note: The risk-free rate was calculated by removing the monthly calculated 10-year Treasury Yield. The "" indicates significance at the 5% level.*

We then examined the distribution of modeled asset returns against actual or experienced returns at the asset class level. Charts 34 through 38 provides a summary review of these results: the charts on the left show the distribution of the absolute difference between modeled and actual results on a monthly basis; the chart on the right shows a scatter plot modeled vs. actual returns. Because domestic stocks were modeled directly with the US equity excess returns factor, modeled and actual returns do not differ across time.

Chart 34: Global Stocks

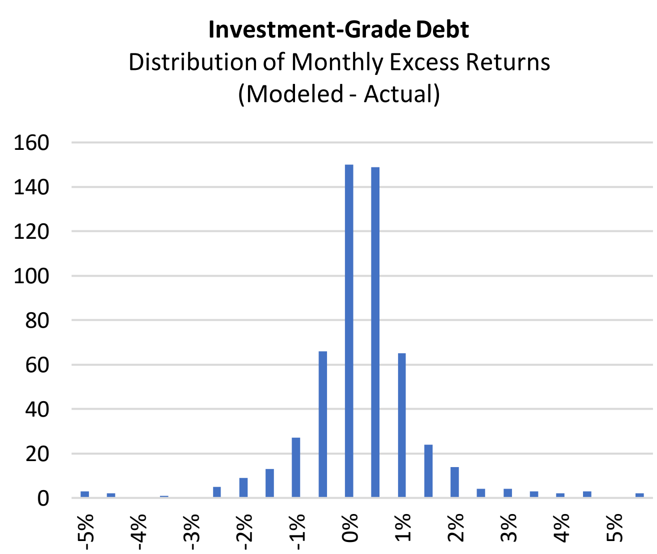


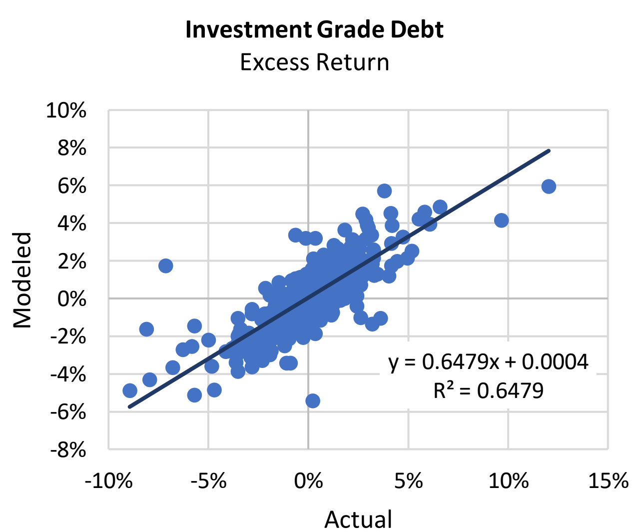


Source: Bloomberg, Mercer calculations; data from January 1977 to June 2022.

The distribution of modeled versus actual global stock returns appear to be normally distributed about the mean, with little skew or kurtosis. The two-factor model appears to explain close to 80% of the monthly returns across the time period examined.

Chart 35: Investment-Grade Debt

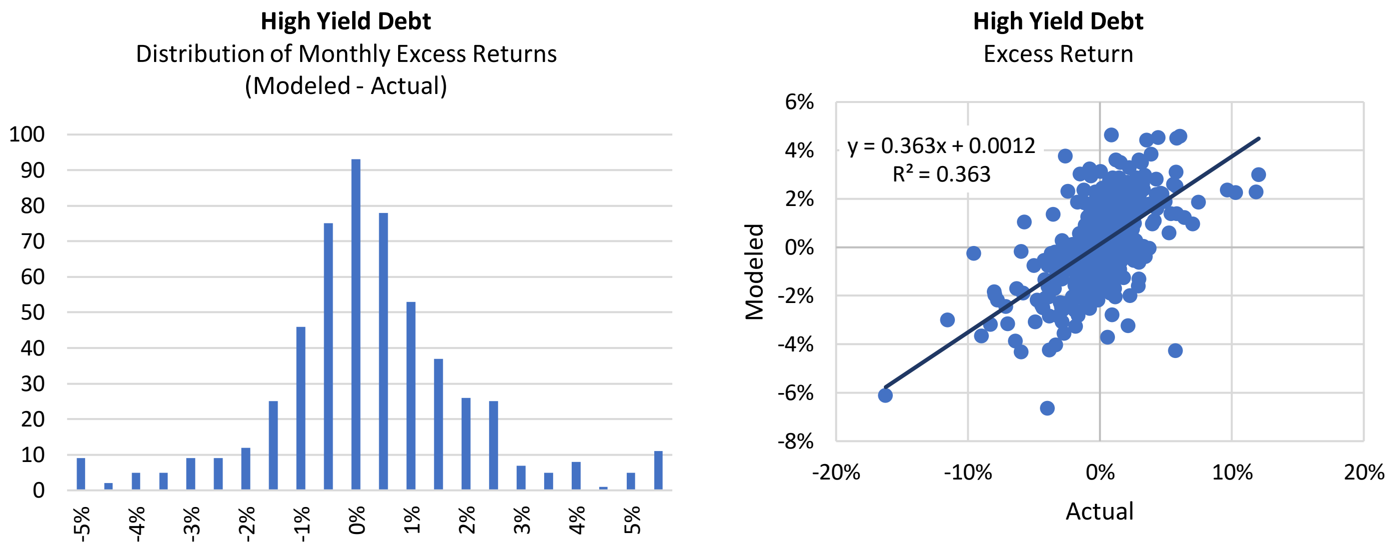




Source: Bloomberg, Mercer calculations; data from January 1977 to June 2022.

The distribution modeled versus actual returns of investment-grade debt appear more tightly distributed across the mean; higher-quality credit has a lower absolute standard deviation versus lower-quality debt. The two-factor model appears to explain approximately 65% of the monthly returns across the time period examined.

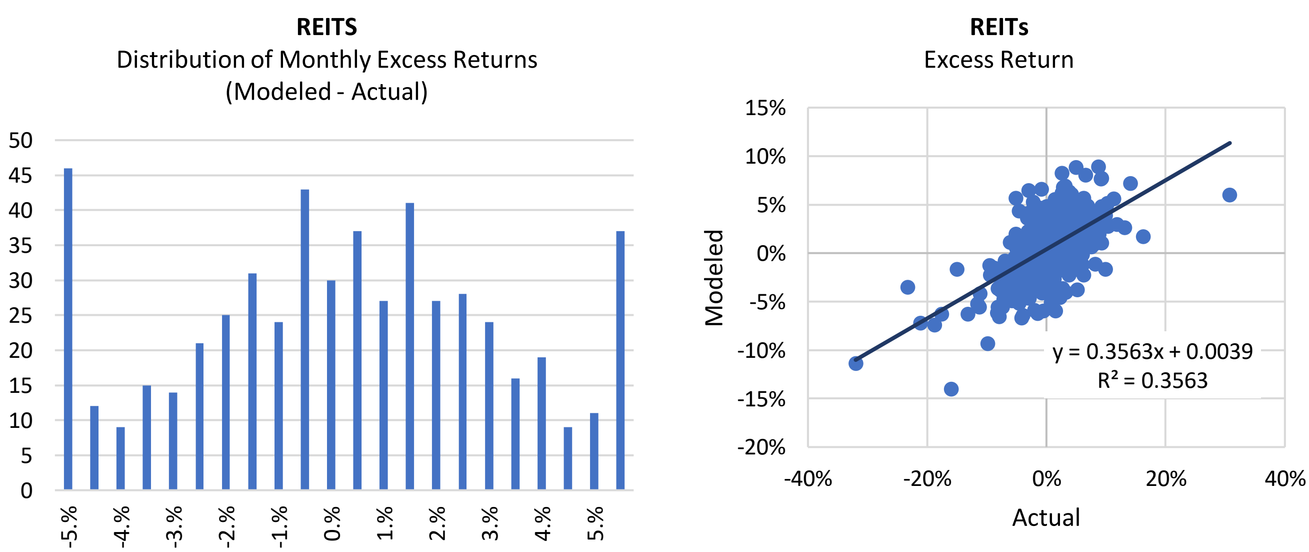
Chart 36: High Yield Debt



Source: Bloomberg, Mercer calculations; data from January 1977 to June 2022.

Compared to investment-grade debt, the distribution of modeled versus actual returns for high yield debt exhibit a wider distribution about the mean, with relatively "fatter" tails on either end of the distribution. While the model appears to only explain about a third of the returns, there appears to be greater discrepancies a market tail events. The occurrence of defaults and other idiosyncratic events not related to market risk may be a contributing factor.

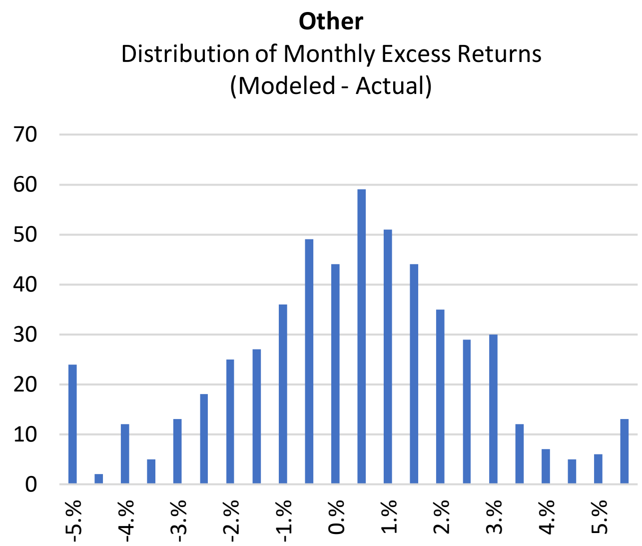
Chart 37: REITS

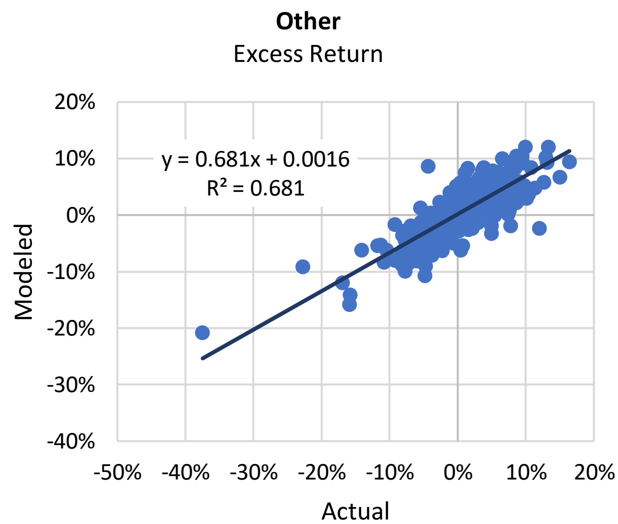


Source: Bloomberg, Mercer calculations; data from January 1977 to June 2022.

REITS generally display equity-like characteristics, however, Chart 37 shows the distribution of modeled versus actual returns exhibit fatter tails; other risk factors beyond traditional equity and interest rate risk contribute to excess returns.

Chart 38: Other Asset Classes





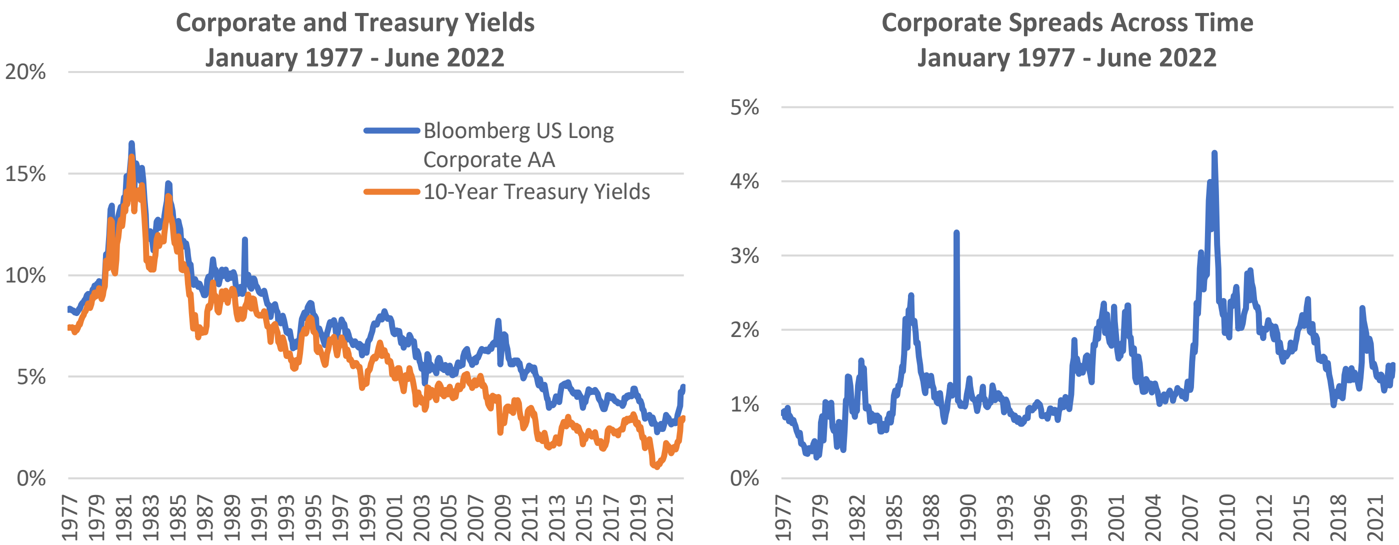
Source: Bloomberg, Mercer calculations; data from January 1977 to June 2022.

Source: Bloomberg. Global Stocks (MSCI World Index), Investment-Grade Debt (Bloomberg US Corporates Index), High Yield Debt (Bloomberg US Corporate High Yield Index), REITS (FTSE NAREIT All Equity REITS Total Return Index), Other (50% private equity proxied using FTSE Russell 2000 Index * 1.2 beta; 50% hedge funds proxied using HFRI Fund-Weighted Composite Index). To calculate the excess return, Mercer removed the 10-year Treasury Yield (yield calculated monthly) from the monthly return.

Examining Chart 38, we can see that non-traditional asset class excess returns, in particular, do not follow a normal distribution: tail events, both good and bad exist and could perhaps be a blind spot in terms of the model's ability to explain these returns. High frequency of relatively large gains and losses suggests high kurtosis in the return distribution. While Mercer modeled the "other" category as both private equity and hedge funds, monthly returns for hedge funds dates back only to the early 1990s; a large portion of the "other" bucket was allocated to private equity, proxied using the Russell 2000 Index, a public market equivalent. In the private markets space, excess return should arguably be heavily influenced by unexplained (or manager) risk in addition to the equity market. While the explanatory power of our regression model shows a relatively high R-squared, the increasing allocation to the "other" category, along with actual implementation of private assets, will likely lead to an overall decrease in the explanatory power of the model.

Chart 39 examines the impact of time on the explanatory power of corporate spreads on both investment grade and high yield debt. It is evident that the relationship between corporate spreads and bond returns is non-stationary: as one truncates the time period, specifically removing the 1980s and 1990s from the examination period, the ability of corporate spreads to determine asset returns in the investment-grade and high-yield market increases dramatically. A contributor to the non-stationary nature for high yield instruments was the rise of "junk bonds" and leveraged buyouts in the 1980s and the subsequent crash of these junk bonds in the 1990s, causing a shift in the relationship between spreads and returns.

Chart 39: Corporate Spreads Over Time



Source: Bloomberg, FRED, Mercer calculations; data from January 1977 to June 2022.

Table 13: Factor Model Explanatory Power Across Time

	R-Squared	1977-2022	2000-2022	Change in Explanatory Power
2-Factor	Investment-Grade Debt	0.648	0.540	-0.108
	High Yield Debt	0.363	0.452	+0.089
3-Factor	Investment-Grade Debt	0.697	0.773	+0.076
	High Yield Debt	0.402	0.584	+0.182

Source: Bloomberg and Mercer Calculation; data from January 1977 to June 2022.

Mercer then conducted the two- and three-factor regression analysis on both the ME and SE Plans; Mercer also assumed allocations to both US stocks only and global stocks; the use of MSCI World Index as a proxy for global stocks assumes a market-weighted allocation to US, international developed and emerging markets. While research[36] suggests US pensions have bias towards domestic stocks, increased globalization, along with improved sophistication and accessibility of investment vehicles with global allocations, could give reason to examine the explanatory power of the aforementioned factors on global stocks.

[36] U.S. Pensions Show Greatest Home Bias in Equities. Northern Trust. Published February 9, 2015. https://www.planadviser.com/u-s-pensions-show-greatest-home-bias-in-equities/?adlt=strict

Table 14: Regression Analysis at the Plan Level Using a Two-Factor Model

2-Factor Regression Analysis, January 1977 - June 2022				
Excess Return over the Risk-Free Rate	Multiemployer US Stocks	Multiemployer Global Stocks	Single-Employer US Stocks	Single-Employer Global Stocks
Intercept	0.0003	0.0002	0.0001	0.0001
US Equity Excess Return	0.7610*	0.7011*	0.6024*	0.5618*
Bond Excess Return	0.0678*	0.0536*	0.1332*	0.1236*
Multiple R	0.9720	0.9152	0.9543	0.9089
R Square	0.9448	0.8376	0.9106	0.8260
Adjusted R Square	0.9446	0.8370	0.9103	0.8254
Standard Error	0.0080	0.0134	0.0084	0.0114
Observations	545	545	545	545

Source: Bloomberg, Mercer Calculations. Note: Plan returns are based on the average asset-weighted asset allocation provided by plan sponsors via Schedule R for 2020. The risk-free rate was calculated by removing the monthly calculated 10-year Treasury Yield. The "" indicates significance at the 5% level.*

Table 15: Regression Analysis at the Plan Level Using a Three-Factor Model

3-Factor Regression Analysis, January 1977 - June 2022				
Excess Return over the Risk-Free Rate	Multiemployer US Stocks	Multiemployer Global Stocks	Single-Employer US Stocks	Single-Employer Global Stocks
Intercept	0.0003	0.0003	0.0001	0.0001
US Equity Excess Return	0.7498*	0.6895*	0.5873*	0.5465*
Bond Excess Return	0.0817*	0.0679*	0.1518*	0.1424*
Corporate Spreads	-0.9274*	-0.9563*	-1.2415*	-1.2611*
Multiple R	0.9734	0.9168	0.9579	0.9129
R Square	0.9474	0.8405	0.9175	0.8335
Adjusted R Square	0.9471	0.8396	0.9171	0.8325
Standard Error	0.0078	0.0133	0.0081	0.0112
Observations	545	545	545	545

Source: Bloomberg, Mercer Calculations. Note: Plan returns are based on the average asset-weighted asset allocation provided by plan sponsors via Schedule R for 2020. The risk-free rate was calculated by removing the monthly calculated 10-year Treasury Yield. The "" indicates significance at the 5% level.*

Examining the results in Tables 14 and 15, one can see that while the two-factor model explains upwards to 90% of the ME and SE Plan returns across the projection period.

Results at the plan level are consistent with that at the asset-level. The additional parameter of corporate spreads improves the ability to explain returns. The three-factor model appears to explain a majority of the historical returns at the total portfolio level, based on the plan's average asset-weighted allocation in Schedule R. For both ME and SE Plans, over 80% of the asset returns at the total plan level could be explained using stocks, bonds, and rates. The addition of the change in corporate spreads appears to have modestly improved results at the plan-level.

Chart 40: Multiemployer Modeled vs. Actual Returns, 2-Factor Model, Data from January 1977 – June 2022

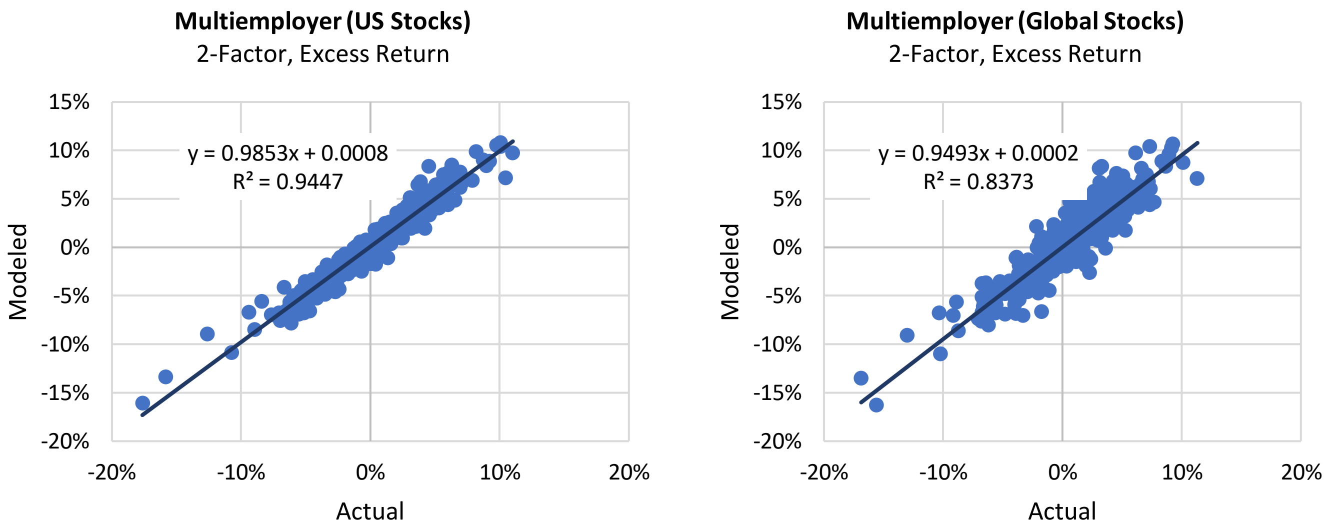
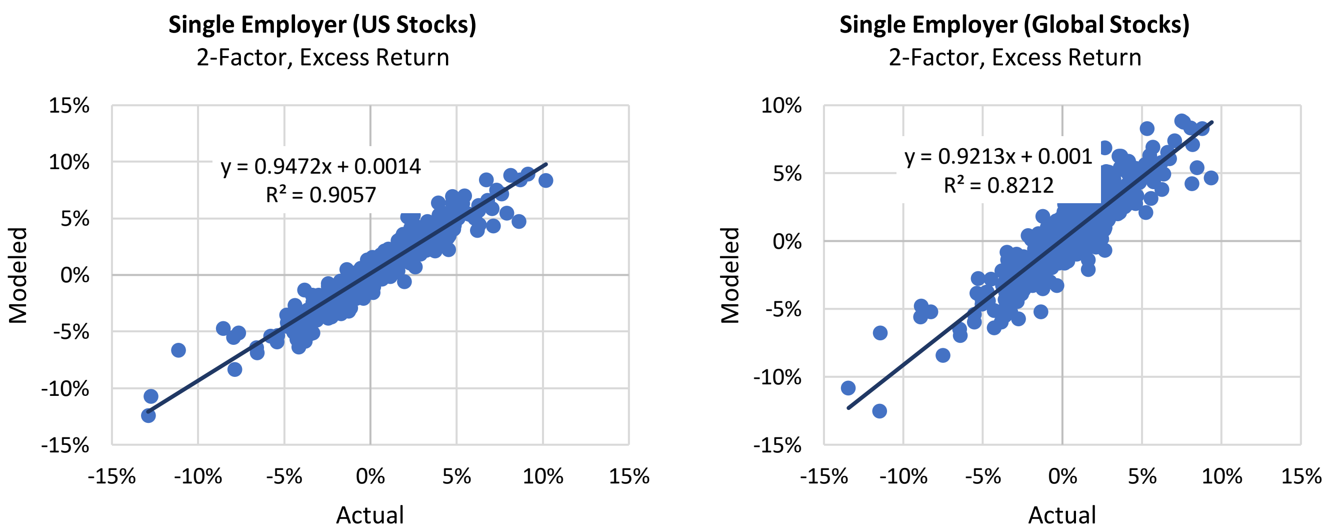


Chart 41: Single-Employer Modeled vs. Actual Returns, 2-Factor Model, Data from January 1977 – June 2022



Source: Bloomberg, Mercer Calculations. Note: Plan returns are based on the average asset-weighted asset allocation provided by plan sponsors via Schedule R for 2020. The risk-free rate was calculated by removing the monthly calculated 10-year Treasury Yield.

Plan Modeling Considerations

As illustrated above, PIMS current factors capture a significant portion of broad index level returns, and while plans allocate to these broad asset classes, the underlying implementation can vary throughout the universe which will introduce additional noise into the modeling exercise. Implementation deviations can stem from a multitude of factors, including geographic biases, active management, or duration positioning. To varying degrees, these differences can be addressed through modeling changes coupled with information aggregation (e.g. Schedule R). For example, general duration positioning is captured by Schedule R. This data could drive changes to the underlying sensitivities of the 30-year Treasury return and yield. As the duration shortens, however, PIMS' flat yield curve assumption can produce discrepancies between current circumstances and the modeling exercise, particularly when the curve is steep or inverted. As such, there is a tradeoff between duration matching and baseline yield, but should PIMS employ greater term structure modeling (discussed in the yield section), these differences could be at least partially mitigated.

Turning to Schedule R asset classes, there are two considerations: 1) What asset allocation data to use from Schedule R and 2) how to allocate to risk factors in order to model the range of potential returns.

As shown in the Charts 29 and 32, the asset allocation of SE and ME Plans has evolved over time. For example, over the last 10 years, the allocation to public equities for SE-Plans decreased by 9% and the allocation to investment grade bonds increased by 7%. We believe this is justifiable given the trend towards de-risking and the use of glide paths within the SE space. We would expect the trend of increased exposure to investment-grade bonds to continue to increase given these dynamics. As a result, we recommend utilizing the latest Schedule R data to compute underlying risk factor weights. The use of the most recent set of asset allocation data for both SE and ME plans should improve plan universe modeling.

The second issue relates to what PIMS risk factor weights to use for each Schedule R asset class. Below, we show the PIMS risk factor weights assigned by PBGC. Our assessment is that the asset class sensitivities below are reasonable and are consistent with the regression data show in Table 15. There are, however, some potential considerations. For example, as discussed earlier, we would suggest adding in an equity factor weight for corporate bonds (core bonds) if the three-factor model (two-factor above) is maintained. This could be accomplished by slightly reducing exposure to the yield component. While we anticipate these factor weights may vary over time, a long historical period should establish relatively robust relationships and justification for fixed weights over the full simulation. We would still suggest a periodic review to ensure their accuracy.

Table 16

	PIMs Risk Factor Weights		
Asset Class	**Equity**	**30-Year Return**	**30-Year Yield**
Core Bonds	--	0.40	0.60
Equities	1.00	--	--
HY Bonds	0.50	0.20	0.30
Real Estate	0.50	0.30	0.20
Private Equity	1.00	--	--
Hedge Funds	0.60	--	0.40
Cash	--	--	1.00

Source: PIMS, PBGC.

Table 17: Regression Analysis of various fixed income assets

Excess Return over the Risk-Free Rate	Corporates	High Yield	Treasuries
Intercept	-0.0003	0.0001	-0.0002
US Equity Excess Return	0.1601*	0.3413*	0.0248*
Bond Excess Return	0.3221*	0.1052*	0.3172*
Multiple R	0.8041	0.6011	0.9547
R Square	0.6465	0.3614	0.9114
Adjusted R Square	0.6452	0.3590	0.9110
Standard Error	0.0119	0.0206	0.0045
Observations	545	545	545

Source: Bloomberg, Mercer calculations; data from January 1977 to June 2022.

Overall, our view that is that by using the latest Schedule R allocation data, making slight reversions to the factor weights, and potentially adding a spread factor would improve the forecast of the overall model.

A final point of discussion around the use of risk factors versus asset classes when developing the model. Many ESGs utilize asset classes, while PIMS simulates risk factors and then assigns asset classes to those risk factors. Ultimately, as shown in the report, asset class returns can ultimately be explained by risk factors. As a result, the modeling output is unlikely to differ significantly based on whether one models asset classes or factors. The process of translating asset classes to factors can increase the complexity in communication. As such, many models use asset classes which investors are familiar with and, of course, Schedule R requests asset allocation information. At first glance, this would suggest asset class modeling would improve the ability of PBGC to communicate to stakeholders. A shift to using asset classes; however, does not completely remove communication and translation challenges. This is because PBGC does not have complete transparency into all plan holdings nor does Schedule R list all potential asset classes investors utilize. Furthermore, it might be burdensome and difficult to list every potential asset class in the investable universe. As a result, there will always be assumptions applied to the weighting process. Taking this a step further, if PIMS does not model all the asset classes shown in Schedule R, there would be still be a translation issues whereby asset classes not modeled need to be allocated to those that are. As a result, since both an asset allocation and risk factor model produce similar results from a modeling standpoint, the decision focuses on the ease of communication with internal and external stakeholders. We note, of course, that most models utilize asset classes because that is what investors and the broad public are most familiar with.

Table 18: Examination of the Current Asset Allocation and Factor Exposures

FY2021 Projections Report: Representation of Plan Asset Allocation			
	S&P 500 Return	30-Year Treasury Return	30-Year Treasury Yield
SE-PIMS	48%	22%	30%

Source: Factors were calculated using the aforementioned two-factor regression analysis on SE and ME plan returns, based on the average asset-weighted allocations from Schedule R in 2020. Results reflect an implementation to global equities.

Section 4: Special Financial Assistance Considerations

The American Rescue Plan Act of 2021 (ARP) created a new Special Financial Assistance (SFA) Program under which PBGC will provide one-time payments to troubled multiemployer pension plans that meet statutory eligibility requirements. ARP and the regulations thereunder impose investment restrictions on the SFA funds provided to eligible multiemployer plans and, as a result, ME-PIMS must account for separate asset allocations for the two pools of plan assets – non-SFA and SFA.

The analysis herein includes a review of PBGC's existing modeling techniques related to projecting the performance and balances of the SFA current regulations mandate that that SFA assets must invest a minimum of 67% in investment-grade fixed income and a maximum of 33% in growth-oriented assets, primarily equities. The current ME-PIMS model assumes plans that receive SFA assets will allocate to the maximum allowable range for growth assets (33%) and will invest the remainder in investment-grade fixed income (67%). This approach appears reasonable based on Mercer's discussions and experience consulting with respect to ME plans. Because the legislation is new and ME plans are first receiving their funds[37], ample evidence does not exist to document how ME plan sponsors will allocate the funds. We recommend that PBGC consider stress-testing the model by running different permutations of the equity and fixed income asset allocation combinations. For example, one could project the net position of pension assets assuming a 0% allocation to growth (equity) assets and 100% investment grade fixed income, 10% allocation to growth (equity) assets and 90% investment-grade fixed income, etc. This would enable PBGC to better understand the sensitivity of results to changes in the assumption regarding plan allocation. However, assuming current information, we believe this is a lower priority recommendation; Mercer believes there are other enhancements to the model that might be more critical.

Adjustment to asset allocation for Plans with SFA

The current ME-PIMS assumes Plans that receive SFA will use such assets for immediate benefit administration over non-SFA assets. In essence, ME Plans receiving SFA will revert to their policy allocation within a few years of first receiving the assistance. The ME-PIMS representation using three economic variables is then modified to represent this adjusted allocation of assets. This modification of the ME-PIMS representation of asset allocation is done each year in the projection until the plan has depleted all its SFA funds, which are assumed to be used as soon as possible.

The assumed policy allocation for plans with SFA, based on data from the latest Form 5500, is shown below.

Table 19

ME-PIMS Allocation	
Policy Allocation to Equities	45%
Policy Allocation to Other Return Seeking Assets	35%
Policy Allocation to Investment Grade Fixed Income	20%

The combined SFA and non-SFA assets are assigned as closely as possible to the allocation above, assuming the restriction on non-SFA assets. Once the full portfolio is allocated to the three asset classes above, the asset allocations are assigned to the PIMS risk factors as shown below.

[37] As of September 28, 2022, 30 ME plans had been approved for SFA funds: https://www.pbgc.gov/arp-sfa/sfa-applications

Table 20: PIMS Risk Factors

Policy Allocation	S&P 500	30-Year Treasury Return	30-Year Treasury Yield (risk free rate)
Equities	100%	--	--
Other Return Seeking Assets	50%	14%	36%
Investment Grade Fixed Income	--	28%	72%

The actual allocation will, of course, vary by plan, as the dollar amount received and the needed re-allocation of non-SFA assets. Plans that receive a “low” amount of SFA assets will have to make fewer adjustments, while those that receive a “high” amount of SFA assets will have to make larger adjustment to their non-SFA asset pool. ME-plans are modeled individually, but for the purposes of projecting the financial status of the ME program, PIMS utilizes the assumptions show above.

There are three aspects of the assumption to address. The first relates to the reallocation concept. The second relates to what specific allocation the plans receiving SFA reallocate towards. The third relates to depletion policy. We have addressed each item in turn.

On the issue of reallocating non-SFA assets back to a “policy” allocation, this approach appears to be reasonable based on our discussions and experience consulting to ME Plans. As indicated above, given the legislation is new, we do not know in practice how ME Plans will reallocate, and there is no data yet available to support any specific claims. In the absence of data, support for the assumption relies on experience and common-sense. PBGC could run the model under different permutations of how non-SFA assets are reallocated. For example, re-run the model assuming a reallocation 25% back to “policy,” 50% back to “policy,” etc. This would enable PBGC to better understand the sensitivity of results to changes in this assumption. The argument in favor of a potential change in policy is that an infusion of SFA assets improves plan solvency and funded status, which, in turn, could lead to a re-assessment of the appropriate policy. On the other hand, since SFA assets are expected to depleted first, plan sponsors may elect to return to their pre-SFA policy. This is especially true as most ME plans remain open and continue to accrue additional liabilities.

The second issue relates to the “policy” allocation itself. The PBGC assumes that plans revert back to the policy shown in the above table, which, in turn, is allocation to the three factors. To test this hypothesis, PBGC assumes three hypothetical portfolios based on SFA usage as a percentage of assets (low, medium, and high). The ability to get to policy varies based on the amount of SFA assets received as well as the pre-SFA policy with the overall conclusion being that the universe of ME plans will be able to return to policy and that the overall average allocation shown in Form 5500 remains appropriate. We agree with the approach to determining this policy allocation. However, given the SFA program is still its infancy, we cannot assess the actual behavior of plan sponsors. As such, the PBGC should establish a process of verifying this assumption and testing whether policy allocations will or will not change in response to SFA assets.

The third issue relates to depletion policy. The current model assumes SFA assets are spent down first. We agree conceptually with this approach. Similar to the above, we recommend PBGC consider monitoring the situation and observe in practice what is done and adjust the model accordingly. Moreover, PBGC may also want to consider testing different depletion policies to understand the materiality of the assumption.

Determination of SFA amounts

The current PBGC approach calculates a distribution of SFA amounts using the ME-PIMS stochastic model, with the exception of the Central States plan[38]. For this plan, the interim requested amount of $35.1 billion is used across all the simulation runs.

More specifically, the FY 2021 ME-PIMS valuation assumes that all plans that become eligible for SFA by the 2022 plan year will apply for it. Plans that are very close to meeting the eligibility criteria under ERISA section 4262(b) may take action(s) to become eligible for SFA (e.g., modify their actuarial assumptions). To account for this plan behavior, ME-PIMS uses modified eligibility criteria:

- For purposes of determining a plan's zone status for SFA eligibility:
    - Projected contributions are reduced by 5% per year for the first two years.
    - The solvency threshold for determining critical and declining status is changed to 25 years instead of 20 years.
    - The threshold for modified funding percentage is changed to 45% instead of 40%.

Due to the high degree of uncertainty related to application timing, ME-PIMS uses a simplified assumption: plans in the first four priority application groups under PBGC's final rule are assumed to be paid SFA in 2022, plans in the remaining priority application groups are assumed to be paid SFA in 2023, and all other plans are assumed to be paid SFA in 2024 and 2025. All SFA applications are assumed to be approved in the first filing.

ME-PIMS is programmed to replicate a plan's SFA application in each model scenario under which the plan is projected to be eligible for SFA. The initial data used as the basis for the application's SFA calculation is based on the ME-PIMS stochastic projection to the application date. The SFA is then calculated using a deterministic projection based on assumptions as follows:

- Interest Rates:
    - For non-SFA assets, the lesser of 5.3% or the interest rate shown on the most recent Schedule MB. The 5.3% rate is an estimate of the third segment rate as of December 31, 2021, plus 200 basis points per ERISA section 4262(e)(3).
    - For SFA assets, the lesser of 2.9% or the interest rate shown on the most recent Schedule MB. The 2.9% rate is an estimate of the average of first, second and third segment rates as of December 31, 2021, plus 67 basis points (per the SFA final rule).
- CBU decline after the measurement date: 2% per year for the first 10 years, 1% per year thereafter.
- Contribution rate increases after measurement date: none.
- Mortality: the same mortality assumption used for other ME-PIMS valuation purposes.
- Administrative expenses: the same administrative expenses assumption used for other ME-PIMS valuation purposes.
- Withdrawal liability payments: same as the standard ME-PIMS assumptions. This is consistent with the conditions placed on withdrawal liability calculations under PBGC's final rule, which limits the impact of SFA on future withdrawals. It is consistent with the assumed CBU decline noted above (i.e., moderate CBU decline rates are consistent with a low level of employer withdrawals).
- Other assumptions: no changes from the assumptions used for other ME-PIMS valuation purposes.
- To determine cash flows, ME-PIMS utilizes these assumptions:

[38] See footnote 17 (page 12) from PBGC 2021 Projections Report: https://www.pbgc.gov/sites/default/files/documents/fy-2021-projections-report.pdf

- Proportion of population assumed to be male: 75%.
- Age difference: females three years younger than their male spouses.
- Proportion of active population assumed to elect a joint and survivor payment form: 60%.
- Proportion of current retirees assumed to be receiving a joint and survivor payment form: 30%.
- Proportion of terminated vested participants assumed to elect a joint and survivor payment form: 35%.
- Joint and survivor payment form: joint and 50% survivor benefit.
- Proportion of participants assumed married for pre-retirement death benefit: 80%.
- Conversion factors based on PBGC rates for the joint and 50% survivor benefit: 0.9150 for both male and female participants.

The current methodology and assumptions are not unreasonable for the 2021 report, given how the SFA legislation is structured and what we observe in ME SFA request filings. However, additional lan information, obtainable from 2021 Form 5500 filings, should be used as soon as available in order to better project plan eligibility. In addition, specific plan determinations of SFA are increasingly becoming available as applications are filed. We recommend PBGC incorporate all requested SFA amounts as stated in applications as soon as the data in the applications is processed. The SFA requests may contain errors but will nevertheless be more accurate than estimates the PBGC could hope to make from earlier information. Accordingly, we see no value in refining the estimation of SFA amounts because the need to do so will quickly become obsolete.

Other considerations

Plans that receive SFA are subject to certain conditions imposed under ERISA Section 4262(m). The conditions include restrictions on benefit improvements, contribution reductions, asset allocation, and withdrawal liability. We understand these restrictions are not explicitly modeled in ME-PIMS.

We understand, however, that these considerations are designed to preclude plan actions that might impair benefit security and the solvency of the program. Not modeling these conditions is therefore reasonable, since the primary purpose of the restrictions is to prevent unacceptable new behaviors that are not currently taking place. Accordingly, we do not believe it is imperative to incorporate these considerations into the model.

Section 5: Defined Benefit Investment Trends

As of August 31, 2022 single-employer defined benefit pension plans in the S&P 1500 were close to their highest funded status in nearly 15 years[39]. The rise in funded status, coupled with a general attitude among plan sponsors to de-risk their pension plans[40], has accelerated several key investment trends, which we describe below. At the same time, certain multiemployer plans are eligible under PBGC's Special Financial Assistance (SFA) program which was enacted as part of the American Rescue Plan in March 2021. The SFA represents a major trend, in part investment-related, and is addressed specifically in another part of this report.

Note, other non-investment trends outside the scope of this review include, but are not limited to: increased appetite on behalf of plan sponsors to terminate pension plans (single-employer specific), changes in contribution strategy (single-employer specific), and increases in flexible retirement arrangements and hybrid retirement plan designs. For the below, unless stated otherwise, assume the trend is applicable for both single-employer and multiemployer pension plans.

Increased allocations to long duration government and corporate bonds (i.e., "liability driven investment approach" or "LDI"; single-employer specific)

These instruments are natural hedges for most corporate defined benefit plans' liability profiles which tend to exhibit similar properties. NEPC's 2022 Defined Benefit Plan Trends Survey[41] shows only 9% of plan sponsors had LDI allocations above 50% in 2011. In 2021, 42% had LDI allocations greater than 50%. NEPC also notes, of their survey respondents, 92% of frozen plans, 60% of closed plans, and 48% of active plans use LDI. Moreover, NEPC states that, of plans with a funded ratio of greater than 90%, 77% utilize LDI. This observation is particularly relevant in today's environment where, as we've cited above, the funded status of corporate plans is generally at its highest level in over a decade.

Mercer has observed increasing allocations to fixed income over the past 15 years, triggered to some extent, with the passing of the Pension Protection Act[42]. This is consistent with the observed data from Schedule R (see asset allocation section). One of the key provisions of the Act was the use of corporate bond yields to calculate pension liabilities used to determine funding requirements. This was a major change in view as prior legislation generally allowed the use of the expected rate of return on plan assets as the discount rate[43]. The law change incentivized plan sponsors to use LDI investments to better control their funding requirements. Our expectation is that plan sponsors will continue to increase their allocations to LDI strategies over time as several factors, including desire to de-risk, improving funded status, higher interest rates, etc. appear structural.

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[39] S&P 1500 Pension Funded Status Decreased by 1 percent in August. Mercer. Published September 8, 2022. https://www.mercer.us/newsroom/s-p-1500-pension-funded-status-decreased-by-1-percent-in-august.html. Other snapshots of funded status show the same phenomenon. For example, see Milliman's August 2022 funded status update: https://www.milliman.com/en/insight/pension-funding-index-september-2022#:~:text=As%20of%20August%2031%2C%20the,of%20August's%202.47%25%20investment%20loss.

[40] See, for example, Mercer 2021 CFO Survey, which documents action to liquidate plans either in full or in tranches; https://www.mercer.us/our-thinking/wealth/cfo-research-survey-transferring-risk.html . Mercer's survey had 201 respondents.

[41] A Decade in Review: The 2021 Defined Benefit Trends Survey. NEPC. Published January 31, 2022. https://www.nepc.com/institutional/a-decade-in-review-the-2021-defined-benefit-trends-survey/

[42] Pension Protection Act (PPA). U.S. Department of Labor: Employee Benefits Security Administration. Accessed October 21, 2022. https://www.dol.gov/agencies/ebsa/laws-and-regulations/laws/pension-protection-act. The act was passed in 2006 and generally became effective in 2008.

[43] We are intentionally glossing over many of the technical details behind the law to draw out the key conceptual feature that influenced single-employer pension sponsors to reconsider their investment strategy.

PBGC potential modeling implication

Asset allocation for all plans is represented by a combination of three economic variables available in SE-PIMS (S&P 500 return, 30-Year Treasury return, and 30-Year Treasury yield). The SE-PIMS allocation is based on an internal study of historical asset returns among large plans that estimated the mixture of the three available economic variables that best fit those historical returns, with returns adjusted down by 2.5 basis points. The current asset allocation is expressed via a 48% weight to S&P 500 returns, a 22% weight to 30-Year Treasury Returns and a 30% weight to 30-Year Treasury Yields[44].

We recommend PBGC test model allocations using Schedule R data to a) determine if changing asset mixes exhibiting the trend above manifests in the reported data, and b) assess whether the changes materially impact the factor loadings described above (discussed in the asset allocation section). PBGC should also c) reevaluate the 2.5 basis points downward adjustment in light of increases in expected returns given the increase in bond yields equity valuation declines through September 2022, which both impact the estimation of future expected returns. Lastly, PBGC may want to d) consider modeling different allocations based on plan type (for example, open plans vs closed plans versus frozen plans), funded status, and/or plan design (cash balance, traditional, or hybrid). A cluster analysis could be performed to group similar plans and asset allocations together. Taken to the limit, each plan would have its own unique allocation modeled.

Adoption of glide path asset allocations (single-employer specific)

The idea of a glide path is that asset allocation shifts from return-seeking to liability-hedging as the funded status of the plan changes. Glide paths may also be designed to be responsive to changing market conditions (for example, changes in interest rate levels). According to Mercer's 2021 CFO Survey[45], 90%+ of plan sponsors have a glide path or are considering one. NEPC's 2022 Defined Benefit Plan Trends Survey notes, of their 76 survey respondents, 65% of frozen plans, 55% of closed plans, and 32% of open plans use a glide path. Furthermore, of those plans greater than 90% funded, 55% utilize glide path investment strategies. We expect continued adoption of glide paths in response to increases in funded status, as more plans close/freeze, and as the approach continues to permeate throughout the pension community.

PBGC potential modeling implication

PBGC does not currently reflect dynamic asset allocation policies in its modeling. We recommend PBGC consider building this feature into the T-PIMS model. It may be possible to glean from the Form 5500 Auditor's report if a glide path is currently in place and what the glide path might look like. By observing changes in Schedule R data over time, it is also possible to support the claim that sponsors have been shifting to liability hedging strategies as funded status has improved. One might possibly also implement a model trend, under which a past clear trend toward increased hedging is assumed to continue.

Increased use of alternative investment and inflation hedging strategies

We define alternatives as any investment strategy other than traditional stocks and fixed income. Based on the respondents in NEPC's 2021 survey, the average asset allocation to alternatives is 15%. The weight is broadly consistent across different plan types surveyed. NEPC also shows a modest 5% increase in the allocation to alternatives over the past two years. This is consistent with data from Schedule R, which showed an 18% allocation to alternatives in 2020, with exposure broadly unchanged in recent years.

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[44] PBGC FY2021 Projections Report. Pension Benefit Guaranty Corporation. Published September 9, 2022. Pages 39 and 40. [FY 2021 Projection Report (pbgc.gov)]

[45] Mercer CFO Research Survey Transferring Risk. Mercer. Published 2021. https://www.mercer.us/our-thinking/wealth/cfo-research-survey-transferring-risk.html

Mercer observes increased use of illiquid investments such as hedge funds, private equity and private credit. Private equity use has been primarily for its expected return advantages over public equity, and for its smoothing properties with respect to its lack of mark-to-market reporting. Private credit use has been primarily for its additional yield and potential liability hedging qualities. Hedge funds may be utilized to diversify away from equity and interest rate risk.

While inflation is a major topic in 2022, we have not yet observed increased allocations to inflation hedging strategies such as: commodities (either as direct investments or via commodity-linked equities), gold, private real estate, TIPS, trend-following/global macro strategies, etc. As inflation is normally associated with increasing nominal interest rates, the impact on pension plans can be positive because of the resulting reduction in plan liabilities, all else equal.

The future trend towards increased use of alternative strategies is mixed. On the one hand, 2022 has shown how traditionally allocated portfolios are not necessarily robust to environments outside those categorized by growth and mild inflation. This suggests allocations to alternatives may continue to increase. On the other hand, as expected returns on traditional investments improve, and as plans increase their funded position and look to terminate, the need and desire for alternative investments wanes. Moreover, as SE-plans close and engage in risk transfer, the need to allocate towards alternatives may decline as focus on simplification.

PBGC potential modeling implication

Using Schedule R data, we can validate the increased use of alternative investment strategies. We can also tested these strategies impacts the weights across the three risk premia currently used to model plan asset allocation. Many alternative strategies may share similar properties with traditional equity and bond/rate risk premia; in some sense they are simply a package of redundant factors[46]. Overall, as discussed in the asset allocation section, alternative investments can be allocated to risk factors using the current approach with a high degree of fit.

Increased adoption of passive investment strategies displacing active investment strategies

Retail and institutional investors, including defined benefit plan sponsors, have embraced passive investment strategies[47]. At first blush this may seem inconsistent with the trend noted above related to alternative investment strategies which can generally only be accessed in active management formats. However, many sponsors have chosen to use passive investment strategies in efficient asset classes/risk premia like large capitalization domestic equities, and instead use their active management fee budget in areas where they believe active management has a reasonable chance of outperforming standard index replication. Active management also tends to be used for fixed income hedging strategies, of which single-employer pension plans have sizeable and increasing allocations.

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[46] Ennis, R. Richard Ennis' Insights: The Fairy Tale of Alternative Investing. The Journal of Investing. Published 2022. 31 (4) 11-16; DOI: https://doi.org/10.3905/joi.2022.31.4.011

[47] Seemingly simple words like "passive" and "active" investing are debatable in the literature and do not have uniformly accepted definitions. We define "passive" as an investment strategy that seeks to replicate in an index. An "active" strategy is one that tries to outperform, on a return basis or risk-adjusted return basis, the performance of the index. For example, a strategy that seeks to replicate the performance of the S&P500 is "passive" even though the decisions around how to construct the S&P 500 performance is active and decided by the S&P Index Committee. A strategy that seeks to outperform the index would be active. Source: S&P 500: The Gauge of the Market Economy. S&P Dow Jones Indices. Accessed October 21, 2022. https://www.spglobal.com/spdji/en/documents/additional-material/sp-500-brochure.pdf

PBGC potential modeling implication

Because PBGC is modeling at the asset class/risk premia level we don't believe any modeling changes need to be accommodated on account of the broad shift from active to passive management. One could argue the expected returns and standard deviations of the various asset classes/risk premia could be adjusted for expectations around index outperformance. Based on Mercer's active/passive guidance, and the broad asset allocations and trends for single-employer defined benefit plans, we do not consider any changes on account of this trend to be significant enough to warrant modifications to the model.

Increased discussion related to environmental, social and governance (ESG) issues

Environmental, social and governance (ESG) factors are an increasingly important and valid consideration for defined benefit plan sponsors and investors. They have moved well beyond values-based considerations into critical investment consideration. For DB plan sponsors, previous Department of Labor (DOL) guidance has presented a significant hurdle to considering any factors that lacked a well-defined and explicit impact on expected returns. While the spirit of the guidance has always been to protect beneficiaries, the strict language prevented investors from incorporating many considerations that may have lacked specificity but that could reasonably be considered significant with regard to long-term results.

As of autumn 2021, the DOL has released draft guidelines that provide more flexibility to include such considerations in investment decisions. This would be an important adjustment for investors, allowing them to incorporate the consideration of events and outcomes that may have an uncertain probability but a significant impact.

We typically see four ways single-employer defined benefit sponsors are incorporating ESG into their investment practices:

- Consider the quality of the ESG investment process adopted by potential managers in selection decisions, and/or the ESG characteristics of current funds.
- Monitor managers for the implementation of their ESG, investment processes and/or the ESG characteristics of their portfolios.
- Monitor investment managers' voting and engagement activity, particularly on controversial ESG issues.
- Seek investment managers who incorporate diversity within their organizations.

PBGC potential modeling implication

We do not see the interest in ESG as a material investment trend for SE plans requiring additional modeling in the SE-PIMS system. If, however, clear evidence emerges that an ESG investment process results in systematic changes to returns or portfolio risk, then an adjustment to future modeling in recognition of an ESG policy might be warranted. The situation should be monitored.

Increased discussion related to climate change and its impact on portfolios[48]

For many years, Mercer has held the investment belief that climate change is a "systemic risk," and investors are therefore encouraged to consider the potential financial impacts of both the associated transition to a low-carbon economy and the physical impacts under different climate outcomes. Financial regulators, particularly for pension funds, are also increasingly asking investors to consider the materiality of climate-related risks and manage them accordingly, consistent with their fiduciary duties. We believe it may be valuable to reflect climate change considerations in setting strategic asset allocation and portfolio construction decisions, which then inform mandate creation and, ultimately, exposures.

[48] Investing in a Time of Climate Change. Mercer. Published 2019. Accessed October 21, 2022. https://www.mercer.com/content/dam/mercer/attachments/private/nurture-cycle/gl-2019-wealth-climate-change-the-sequel-summary.pdf

PBGC potential modeling implication

We see the adoption of climate related modeling and impacts as important but not yet something that is materially impacting asset allocations of plan sponsors. As a result, we do not recommend any changes to the SE-PIMS; rather the situation should be monitored. One concern in how climate change considerations might eventually be modeled is that the economic impacts of investments that consider climate change might be significant but outside the time frame of the model.