PGIM

DC SOLUTIONS

INTO THE UNKNOWN

Best Practices for Return Assumptions in a Financial Plan

DECEMBER 2021
For Professional Investors only. All investments involve risk, including the possible loss of capital.

EXECUTIVE SUMMARY

- **Return assumptions in a financial plan need to reflect realistic expected returns for each forecast period.**
- **Historical long-term average returns likely paint an overly optimistic picture for investors, resulting in lower required savings rates and higher available safe withdrawals, especially for investors with shorter time horizons (e.g., retirees).**
- **PGIM Quantitative Solutions (PGIM Quant) creates two sets of capital market assumptions (CMAs) that are ideally suited as return assumptions in a financial plan: shorter-term estimates (10-year forecasts) that incorporate today's low bond yields and longer-term estimates that are more unconditional in nature (which we call our "steady state").**
- **Expected arithmetic returns should be the input for any type of Monte Carlo simulation, and the geometric return will be the realized return (i.e., output). Expected geometric returns should be used for time-value-of-money calculations.**
- **Returns should incorporate expected fees and expenses, as well as potential investment alpha, and documented accordingly.**

INTO THE UNKNOWN

Future market returns are uncertain; however, estimating expected returns is an essential planning exercise for most investors. Return forecasts, commonly called Capital Market Assumptions (CMAs), impact investors in a variety of ways. The most obvious implication of CMAs has to do with optimal portfolio design. Asset classes and investments with more attractive CMAs should receive higher portfolio weights than those with less attractive CMAs.

CMAs can also impact other financial decisions, such as how much a household has to save for retirement, how much the household can spend in retirement, etc. (i.e., a financial plan). Financial plans for households can exceed 50 years. For example, a 30-year old might plan on retiring at age 65 and then having a retirement that would last until age 95, suggesting a 65-year planning period.The returns used in a financial plan should be the expected returns for investors and can vary as expectations evolve into the future.

While historical long-term average returns are commonly used by financial advisors, this approach can provide an unreasonable estimate of expected returns for investors today, especially fixed income investors. For example, the average yield on 10-year US government bonds from January 1870 to July 2021 has been 4.5%. This is significantly higher than current yields, which are closer to 1.5% as of December 9, 2021.

While it's possible the gap between current and historical yields will narrow in the future, a financial plan whose return assumptions are based purely on long-term averages would imply an investor owning 10-year government bonds (before fees, taxes, and inflation) today could effectively earn a 4.5% return, while in reality the actual expected return, based on today's yields, is likely to be considerably lower.

A number of asset managers create CMAs today, but most of their forecasts tend to be relatively near-term estimates covering roughly the next 10 years. While these nearer-term estimates provide a useful context for more immediate investment expectations, they are not necessarily appropriate for longer-term forecasts, such as a financial plan for a younger family, which can easily exceed 50 years.

PGIM Quantitative Solutions creates two sets of CMAs that are ideally suited for financial plans: a near-term forecast (the next 10-years) and a longer-term forecast (after that 10-year period), which we call steady state. The 10-year CMAs are somewhat conditional in nature and are impacted more by the current market environment. The steady state CMAs are more unconditional in nature, focused on return expectations in equilibrium (i.e., for the long-term). In a forecast, we recommend using our 10-year CMAs for the first 10-years of the projection and the steady state CMAs for the remainder. In this piece we demonstrate that the return assumptions have a significant impact on the output of a financial plan; therefore, it is essential that financial advisors, and the underlying financial planning tools they use for clients, can incorporate varied return expectations into the forecast.

HISTORICAL RETURNS

A common starting place when thinking about potential future returns for investment markets is historical returns, especially long-term historical averages. While relying on historical returns may seem reasonable, and are often favored by compliance professionals, it is important to understand that even historical returns can differ significantly across markets and time.

For example, while US investors commonly rely on historical US returns, few investors realize the significant differences in historical returns across different global markets, an effect we document in Exhibit 1, using historical real (i.e., after inflation) returns for 21 countries from the Dimson, Marsh, and Staunton (2009) dataset from 1900 to 2020.A common starting place when thinking about potential future returns for investment markets is historical returns, especially long-term historical averages. While relying on historical returns may seem reasonable, and are often favored by compliance professionals, it is important to understand that even historical returns can differ significantly across markets and time.

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The long-term average yield on 10-year government bonds from January 1871 to October 2021 is approximately 4.5%. The average increases to 5.0% if the beginning period is moved from 1871 to 1926, which is when the commonly used "Stocks, Bonds, Bills, and Inflation" (SBBI) series commences. The average bond yield increases further to approximately 5.5% if the period ommences in 1950 (after World War II) versus approximately 6.0% since 1970, when a larger subset of indexes, especially international indexes, become available. If only the last 20 years are considered, the average is closer to 3.0%.

This all suggests the entire process of relying on historical returns is somewhat ambiguous because it requires selecting a starting (and ending) point that can significantly affect the resulting values. Often times a financial advisor may use historical data over a particular period given data availability (e.g., for a some set of indexes) and may not realize the return implications of the decision.

Exhibit 1: Historical Real Return and Real Risks for Countries: 1900 to 2020

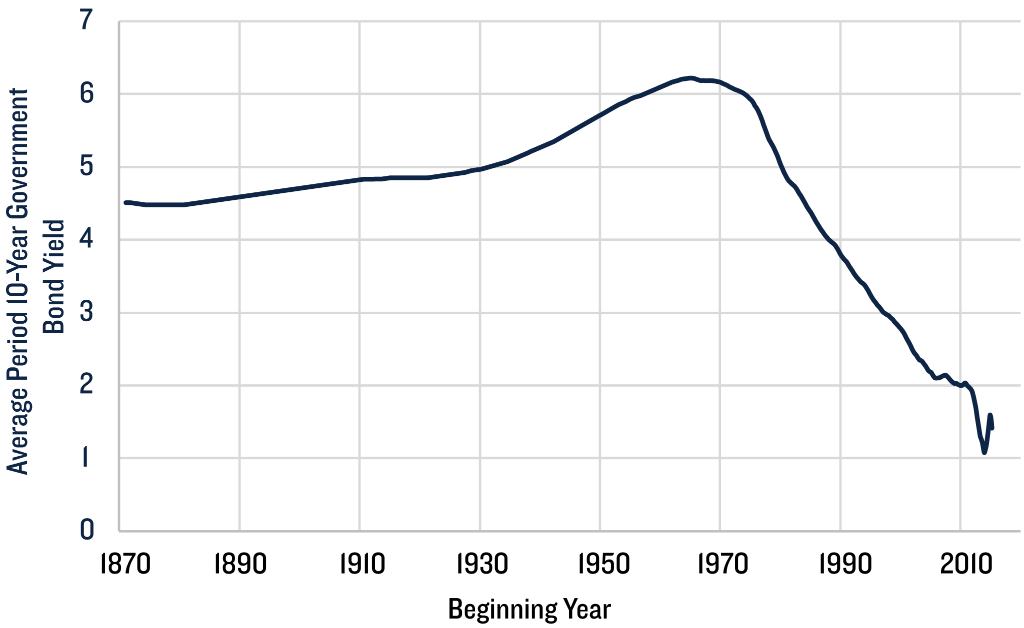
	Real Bond		Real Equity	
County	Return	Standard Deviation	Return	Standard Deviation
Australia	2.75%	13.06%	8.27%	17.36%
Austria	4.71%	53.34%	5.06%	30.53%
Belgium	1.60%	14.93%	5.27%	23.53%
Canada	2.70%	10.25%	6.96%	16.83%
Denmark	3.06%	13.46%	7.24%	20.63%
Finland	1.39%	13.53%	9.19%	29.49%
France	1.17%	12.96%	5.71%	22.81%
Germany	1.33%	15.45%	7.97%	31.29%
Ireland	2.61%	14.84%	6.73%	22.77%
Italy	0.49%	15.11%	5.80%	28.18%
Japan	1.70%	19.32%	8.60%	29.18%
Netherlands	2.23%	9.77%	7.01%	21.11%
New Zealand	2.57%	8.71%	7.93%	19.14%
Norway	2.47%	11.85%	7.17%	26.47%
Portugal	0.09%	18.06%	8.34%	33.90%
South Africa	2.40%	10.37%	9.20%	21.90%
Spain	2.63%	12.47%	5.66%	21.66%
Sweden	3.47%	12.78%	7.89%	20.89%
Switzerland	2.69%	9.29%	6.18%	19.28%
UK	2.68%	13.48%	7.25%	19.58%
US	2.45%	10.30%	8.29%	19.85%
Average	2.25%	14.92%	7.22%	23.64%
Median	2.47%	13.06%	7.24%	21.90%
Maximum	4.71%	53.34%	9.20%	33.90%
Minimum	0.09%	8.71%	5.06%	16.83%
Standard Deviation	0.99%	9.00%	1.22%	4.84%

Source: Morningstar Direct, DMS Return Series

[1]Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Ireland, Italy, Japan, Netherlands, New Zealand, Norway, Portugal, South Africa, Spain, Sweden, Switzerland, the United Kingdom, and the United States.

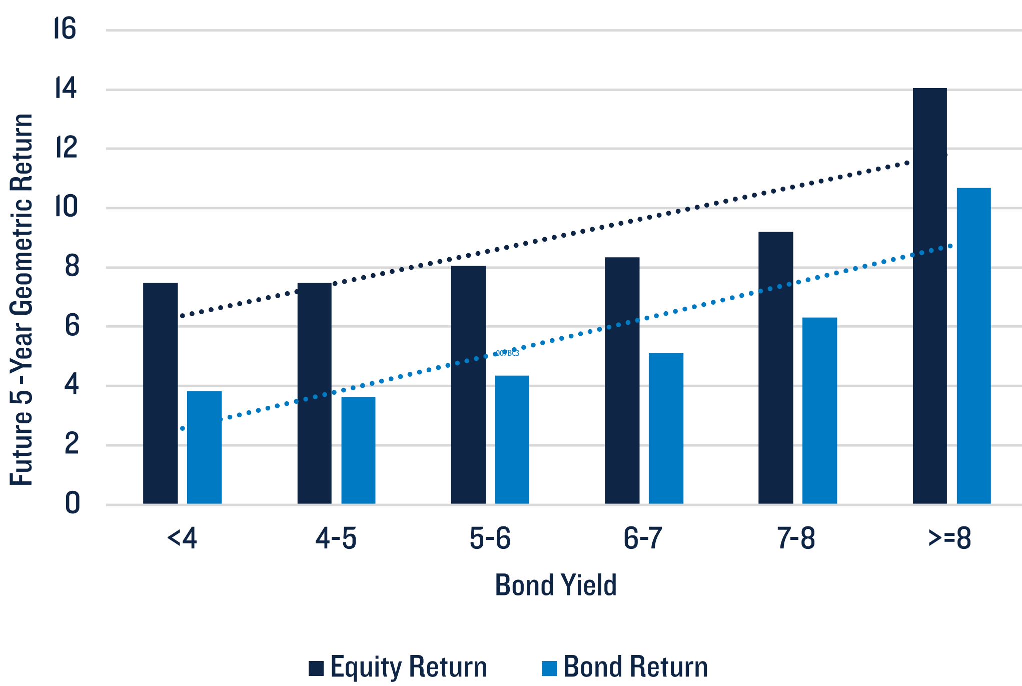
While Exhibit 2 focuses on average historical bond yields, it is worth noting the relatively significant relation between bond yields and future equity returns, an effect demonstrated in Exhibit 3, based on an analysis by Blanchett (2021) relying primarily on the Jordà-Schularick-Taylor Macrohistory database (see Jordà, Schularick, and Taylor (2017) and Jordà et al. (2019) for additional information).

Exhibit 2: Average Bond Yields for Various Historical Rolling Periods



Source: Shiller website. As of August 2021.

Exhibit 3: Bond Yields and Future 5-Year Geometric Equity and Bond Returns



Source: Blanchett (2021)

Clearly lower bond returns have accompanied lower equity returns historically, an effect that has been relatively robust. This is especially important for investors today, given that current bond yields (and general return forecasts) are well below historical long-term averages.

THE IMPACT OF RETURNS ON ADVICE

The Impact of Returns on Advice Returns can have a significant impact on the results of any type of financial plan. For example, in Exhibit 4 we demonstrate how different return assumptions result in different required initial savings amounts for various investment periods and assume rates of return (using simple time-value-of-money calculations).

Exhibit 4: Required Balance to Create $100 at the End of the Investment Period Investment Period (Years)

		Investment Period (Years)							
		5	10	15	20	25	30	35	40
Rate of Return	0%	$100	$100	$100	$100	$100	$100	$100	$100
	1%	$95	$91	$86	$82	$78	$74	$71	$67
	2%	$91	$82	$74	$67	$61	$55	$50	$45
	3%	$86	$74	$64	$55	$48	$41	$36	$31
	4%	$82	$68	$56	$46	$38	$31	$25	$21
	5%	$78	$61	$48	$38	$30	$23	$18	$14
	6%	$75	$56	$42	$31	$23	$17	$13	$10
	7%	$71	$51	$36	$26	$18	$13	$9	$7
	8%	$68	$46	$32	$21	$15	$10	$7	$5
	9%	$65	$42	$27	$18	$12	$8	$5	$3
	10%	$62	$39	$24	$15	$9	$6	$4	$2

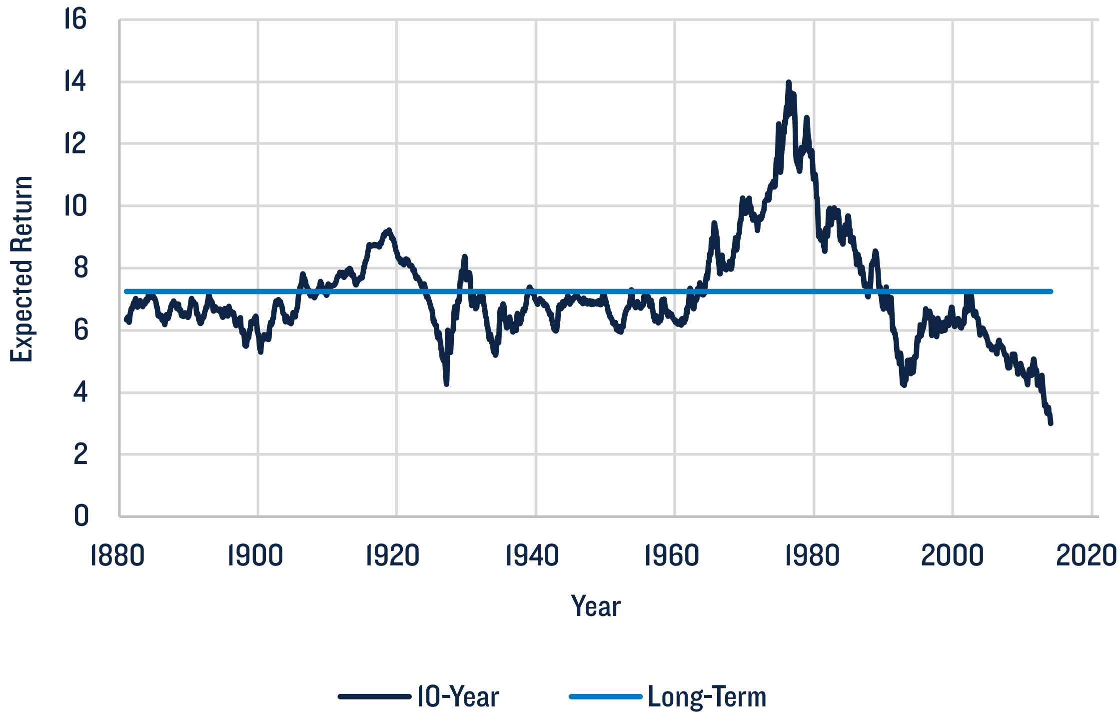
Source: Author's Calculations

For example, an assumed return of 6% would require an initial investment of only $31 to grow to $100 over a 20-year period versus only $15 for a 10% rate of return (10% higher). The differences become even greater over a longer period. For example, the required initial amount would be $10 and $2, respectively, assuming a 40-year investment period. Many financial plans can last 60 years, or longer, and therefore even relatively small differences in returns can result in significant differences in things like required savings rate or optimal spending levels.

An important aspect of any return assumption within a financial plan, though, is that it should match the expected return for the respective period. While many financial planning tools allow for only a single set of return assumptions, this can be a significant weakness and lead to advice that doesn't necessarily reflect expected returns, especially for investors with different investment durations.

For example, if we build a relatively simple forecasting model, where expected 10-year bond returns are based on 10-year government bond yields, and the expected 10-year return on equities is based on the Shiller CAPE Ratio (15-.25(CAPE)), which is the price earnings ratio based on average inflation-adjusted earnings from the previous 10 years, we can demonstrate how the expected 10-year return of a 50/50 portfolio has evolved over time and compare that to the implied long-term average return, which we do in Exhibit 5.

Exhibit 5: Potential Shorter-term and Longer-term Return Expectations for a Balanced Portfolio

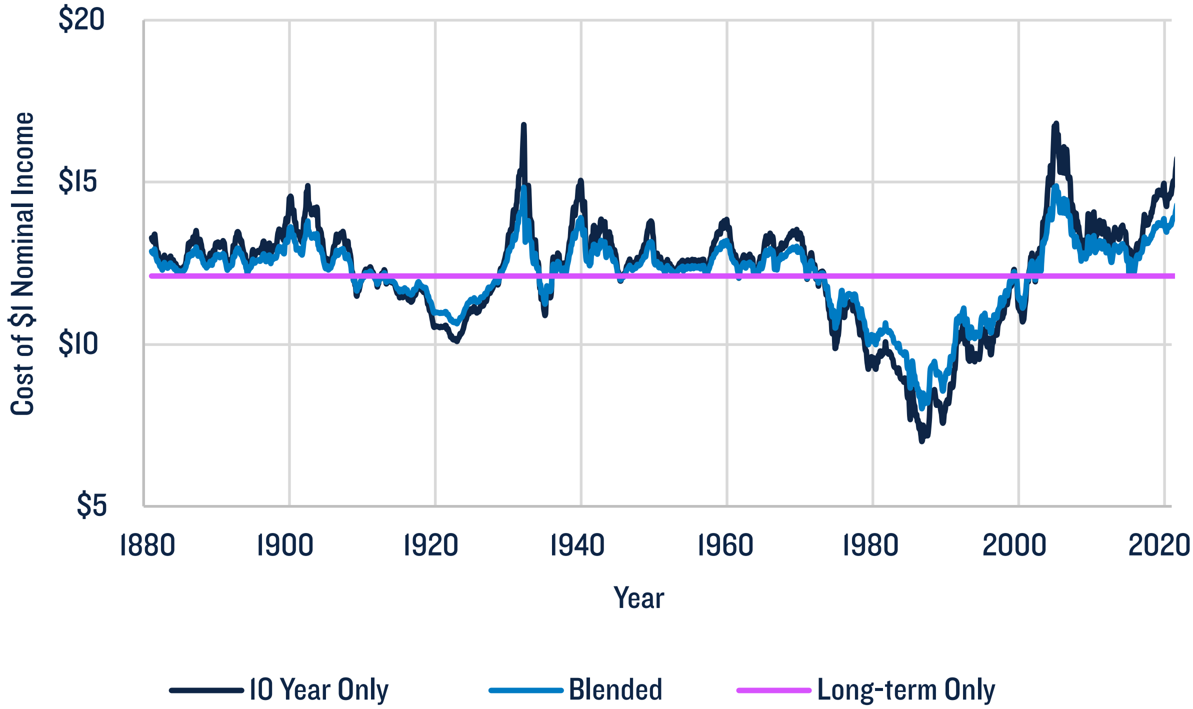


Source: Shiller website, Author's Calculations. As of August 2021.

There have been times when the expected short-term return is significantly different than the long-term average. For example, expected returns today using this model are well below average (the lowest they've been), and would be lower based simply on a constant equity risk premium model using the data in Exhibit 3.

Based on how this is incorporated into a financial plan it can have a significant impact on the expected cost of income during retirement. For example, using the expected returns from Exhibit 5, it's possible to estimate how the cost of $1 of nominal income would have evolved historically for a 30-year retirement period. Three different calculations are performed. The first is based entirely on 10-year return expectations. The second is based on a blended approach, using the 10-year returns for the first 10-years of the projection and long-term thereafter. The third is based on long-term average returns. The results are included in Exhibit 6.

Exhibit 6: The Cost of $1 of Nominal Income Over Time with Varying Return Assumptions



Source: Shiller website, Author's Calculations. As of August 2021.

The cost of income has varied significantly over the period based on the return assumptions. For example, using only 10-year returns would result in estimates ranging from $7.02 to $19.64 (effectively the cost today). This is a wider spread than the blended returns, ranging from $8.02 to $16.28, while the long-term estimate is a constant $12.10.

Given the notable rise in the current cost of income, which is driven primarily by the current low yield environment, incorporating time-varying return assumptions is likely increasingly important, because whether an advisor believes the recent drop in bond yields is temporary (suggesting the blended returns) or permanent (suggesting the10-year only returns), the cost of retirement income is significantly higher now than it has been historically.

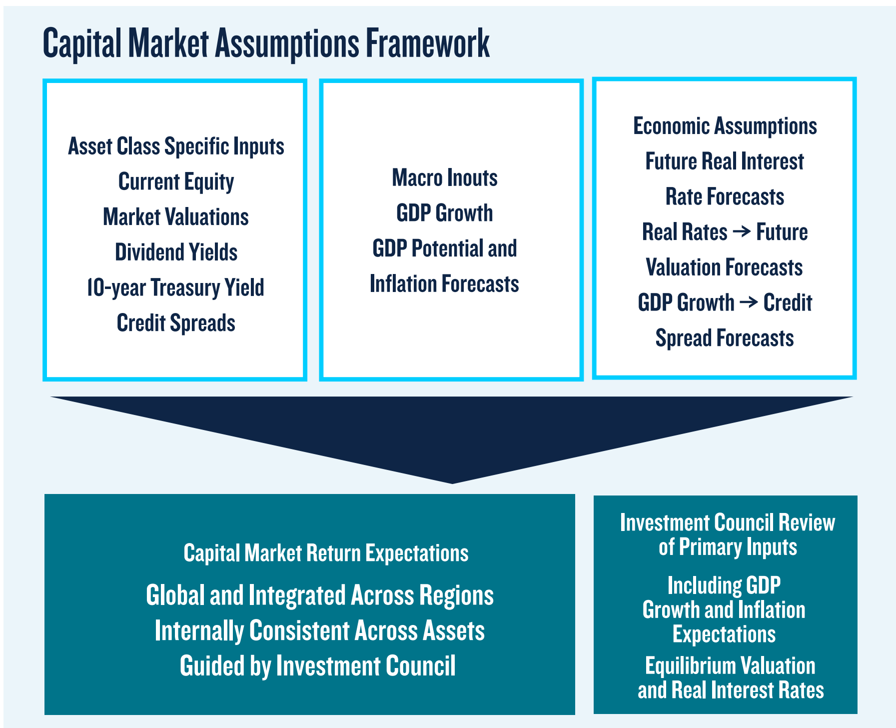
PGIM Quantitative Solutions releases CMAs quarterly, which can be used by advisors in financial planning forecasts. We summarize in the next section, then we explore the implications of using different return assumptions within a Monte Carlo setting.

PGIM QUANTITATIVE SOLUTION'S APPROACH TO FORECASTING RETURNS

In this section we provide an overview of how PGIM's Quantitative Solutions group creates its CMAs. The CMAs underpin the long-run outlook for strategic allocations in the various individual strategies and multi-asset portfolios offered. They are the product of a highly systematic process for generating consistent projections across the capital markets and begin with evolving asset class fundamentals and macroeconomic assumptions at the country level.

Exhibit 7 provides an overview of the framework.

Exhibit 7: PGIM Quantitative Solution's Capital Market Assumptions Framework



Shown for illustrative purposes only. Source: PGIM Quantitative Solutions.

The 10-year return expectations are generated for the most widely held equity, fixed income and non-traditional asset classes, measuring both return and risk, and are updated quarterly. The forecasts are based on building blocks with inherent uncertainty, particularly uncertainty as to the economic environment that will prevail over the next 10 years. Deviations in long-run economic outcomes from the assumed growth and inflation building blocks introduce one form ofuncertainty. Another form of uncertainty introduced by economic outcomes is in short-term asset price returns that exhibit distinctlydifferent distributions in expansionary and recessionary economic environments. To model this economic uncertainty, 10-year forward looking simulations are run, which introduce path-dependent economic expansion and recession regimes.

Through these simulations, we generate a distribution of return outcomes centered on our capital market assumptions, incorporating both long-term economic growth variability as well as shorter-term periods of elevated asset class return volatility. Presented in the following chart are the 25th and 75th percentile ranges for the primary asset classes we forecast.

To build the income component of our long-term equity forecasts, we calculate each country's expected income contribution, based on current and anticipated levels of dividend yield, as well as the expected returns attributable to buyback activity (positive) or net positive share issuance (negative).

For each asset class, we decompose local return expectations into three broad categories: income, growth and valuation adjustment. We also forecast relative currency adjustments for investors in different domiciles to allow for conversion to hedged or unhedged returns. Our core building blocks and final forecasts are reviewed at their component levels by an investment council of our most senior investment professionals.

For longer maturity government bond returns, we forecast each country's expected long-term slope to define a term structure of yields across their respective government yield curves. The forecast slope for each country is a function of forecast and potential real economic growth and will evolve countercyclically. When economic growth is forecast below potential, the slope of the yield curve is expected to be steeper (early cycle), whereas if growth is forecast to be closer to, or above, potential (late cycle), the yield curve is forecast to be flatter

Our bond return forecasts are largely predicated on income and valuation factors. At a given maturity point, the forecast income return for a government bond will consist of the average expected coupon yield over the forecast horizon, as well as proceeds from bonds maturing to lower yields. Changes in yield at a given maturity point over the forecast horizon will determine the necessary valuation adjustment. If yields are forecast to rise (fall) over the next 10 years, the valuation adjustment will be negative (positive).

We calculate the expected returns for fixed income credit indices to include any additional income expected from an average credit spread yield over comparable government bonds, adjusted for expected default and downgrade losses over the forecast horizon. We then calculate the valuation adjustment for expected changes in spreads.

PGIM Quantitative Solutions introduced steady state CMAs in 2021. Steady State CMAs are intended to answer the question of "what will asset returns be after prices have returned to equilibrium and the economies grow at their long-run pace?". To accomplish this, the valuation components and cyclical term from the existing model is removed, anchoring them to an equilibrium level.

Exhibit 8 includes PGIM Quantitative Solutions Q4 2021 Capital Market Assumptions (CMAs). Expected inflation for both the 10-year CMAs and steady state is 2.66%.

Exhibit 8: PGIM Quantitative Solutions Q4 2021 Capital Market Assumptions (CMAs)

	10 -Year		Steady State	
Asset	Arithmetic Return	Standard Deviation	Arithmetic Return	Standard Deviation
Cash	0.46	0.00	1.39	0.00
US Treasury	1.85	4.53	4.66	10.53
US Treasury 1-3Y	0.80	1.81	3.14	4.34
Global Treasury Hedged	1.30	6.52	4.60	15.78
US Aggregate Bond	2.40	5.61	4.83	10.02
NonUS Aggregate Bond Hedged	1.33	5.42	3.80	10.53
US Investment Grade	2.78	6.61	5.81	11.05
US High Yield	3.53	8.47	7.12	12.26
EM Sovereign Dollar Debt	4.58	9.10	10.14	17.68
US TIPS	2.14	5.49	4.81	11.35
US Large Cap	7.24	15.09	9.77	18.09
US Mid Cap	7.78	16.93	10.42	20.17
US Small Cap	8.52	19.58	11.31	23.09
NonUS Equities Unhedged	8.55	15.94	7.71	15.04
EM Equities Unhedged	10.53	23.60	14.10	28.08
Global Equities Unhedged	8.55	19.92	10.44	22.31
US REITs	6.68	17.39	9.02	19.13
NonUS REITs Unhedged	7.43	21.58	10.06	23.94
Commodities	3.36	14.54	3.02	18.07
60/40 Portfolio	5.66	12.89	7.28	15.58

Forecasts are not a reliable indicator of future performance. As of 9/30/2021.

RETURN ASSUMPTIONS AND MONTE CARLO FORECASTS

Financial advisors are increasingly relying on Monte Carlo forecasts to provide guidance to clients on optimal savings and spending decisions. Monte Carlo forecasts provide additional context beyond simple time-value-of-money calculations and can be incredibly useful demonstrating different potential outcomes; however, it's especially important to ensure appropriate returns assumptions are used in the projection.

The return input in a Monte Carlo forecast should be the expected arithmetic return of the portfolio or asset classes for the respective period. The arithmetic return is the simple average over a period and doesn't include the impact of volatility. The return realized in the forecast will be the geometric average. You can approximate the geometric return if you subtract half of the variance. For example, an investment with a 10% arithmetic average return and a 20% standard deviation would have approximately an 8% geometric average return [(10% - (20%^2)/2) = 8%].

It's important for an advisor to adjust forecasted returns to include anything that could positively or negatively affect them. This includes fees (e.g., fund expenses and/or advisor fees) as well as any kind of expected investment alpha. For example, if the advisor is charging a 1% fee, then the base assumed asset class returns should be reduced to reflect this fee. If there are additional fees associated with investing (e.g., expense ratios for investment products) these should be considered as well. Additionally, if the advisor believes he or she will be able to generate alpha for the portfolio over time, this could also be included (i.e., returns could be increased), but the change should be documented accordingly.

The assumed returns within a projection may vary over time. For example, an advisor may want to consider using lower returns in the nearerfuture, reflecting the current low bond yield environment, and higher returns further into the forecast if the advisor believes interest rates are going to drift back towards the longer-term values in the future.

In this analysis, we demonstrate how different return assumptions can impact the results of a Monte Carlo forecast.

Two broad portfolios are created: fixed income and equity. The fixed income portfolio is assumed to be allocated 25% cash and 75% aggregate bond, and the equity portfolio is assumed to be allocated 65% US large cap, 10% US small cap, and 25% international.

Exhibit 9 includes information about the returns for the fixed income portfolio (Panel A) and the equity portfolio (Panel B) in both nominal (before inflation) and real (after inflation) terms, as well as the arithmetic average and geometric average (i.e., compounded) for the 10-year CMAs, the steady state CMAS, and the long-term average returns, based on the Ibbotson SBBI dataset (from January 1926- December 2020).

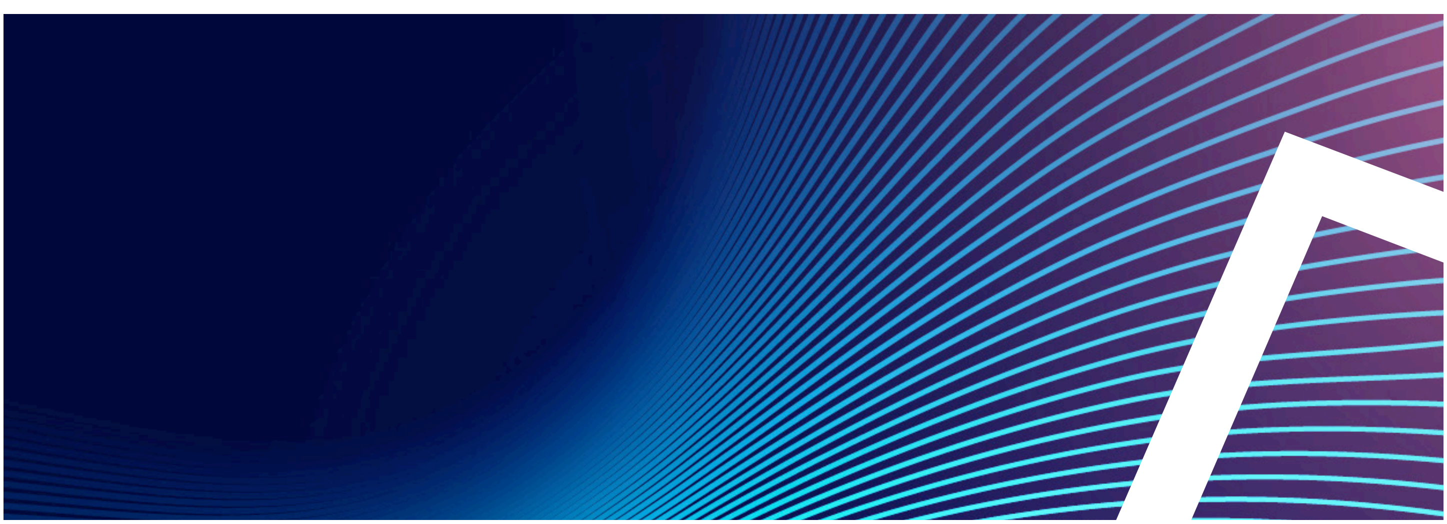
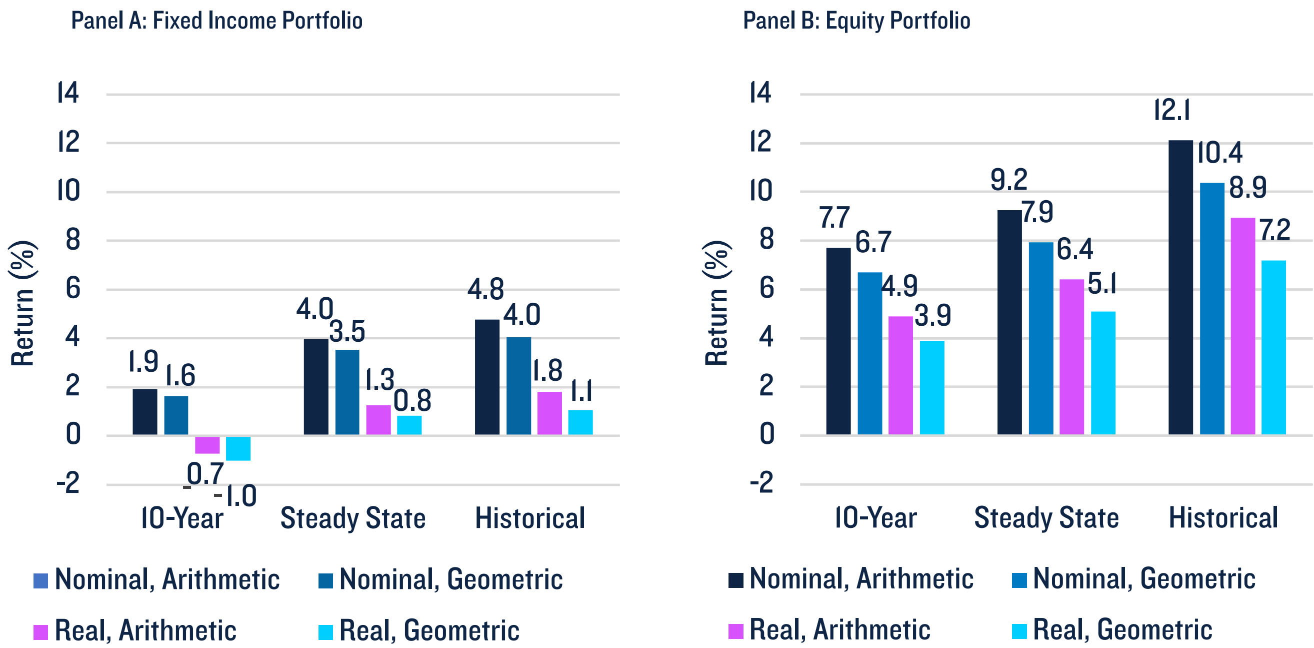


Exhibit 9: Geometric Nominal Annual Portfolio Returns for Various Equity Allocations



Source: PGIM Quantitative Solutions. As of 9/30/2021.

The differences in the returns are relatively significant, especially for equities. For example, the nominal arithmetic 10-year PGIM Quant return assumption is 7.7% versus 12.1% for the long-term average. While the steady state estimate (9.2%) is closer to the long-term average, it is still notably lower.

We assume both static and changing equity allocations as part of the analysis.

For the analysis we consider four different sets of return assumptions:

- 10 Year: PGIM Quant's 10-year CMAs are used for the entire projection, based on Exhibit 9.
- 10 Year / Steady: PGIM Quant's 10-year CMAs are used for the first 10 years of the projection and the steady state returns are used for the remainder.
- Steady: PGIM Quant's steady state CMAs are used for the entire projection, based on Exhibit 9.
- Historical: Historical returns are used for the entire projection, based on Exhibit 9.

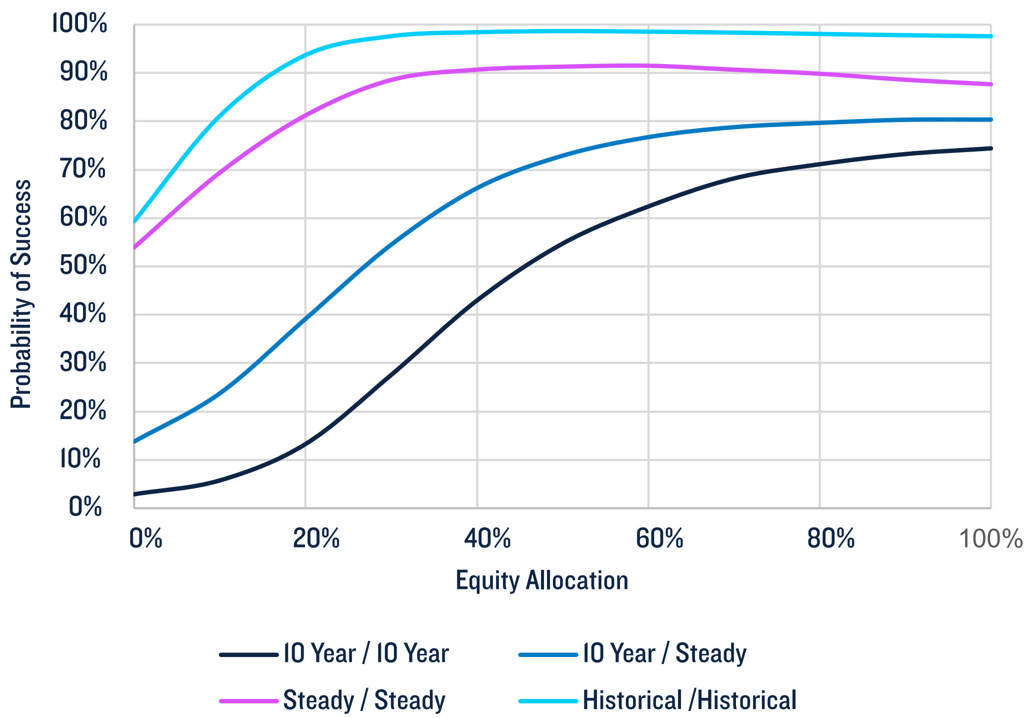
We also include a 50-basis point fee in our analysis, where the assumed portfolio returns are reduced by .50%. These are not reflected in Exhibit 9, which are the gross returns for the respective portfolios.

MONTE CARLO RESULTS

One of the most commonly cited rules of thumb for retirees is the "4% Rule," based on work by Bengen (1994). This research suggests that the safe initial withdrawal from a portfolio is 4%, where the analysis assumes a withdrawal period of 30 years and where the initial withdrawal amount is increased annually by inflation. The initial analysis assumed a balanced portfolio and relied on historical US market returns. Meanwhile, the "4%" really only applies to the initial withdrawal, since subsequent withdrawals are based on that amount increased by inflation.

Exhibit 10 provides context around the probability of success for a 4% initial withdrawal rate for the four potential return assumptions for equity allocations ranging from 0% to 100%, in 10% increments.

Exhibit 10: Probability of Success for a 4% Initial Withdrawal Rate for a 30-Year Retirement Period, Assuming Various Constant Equity Allocations and Returns (~4% Rule)



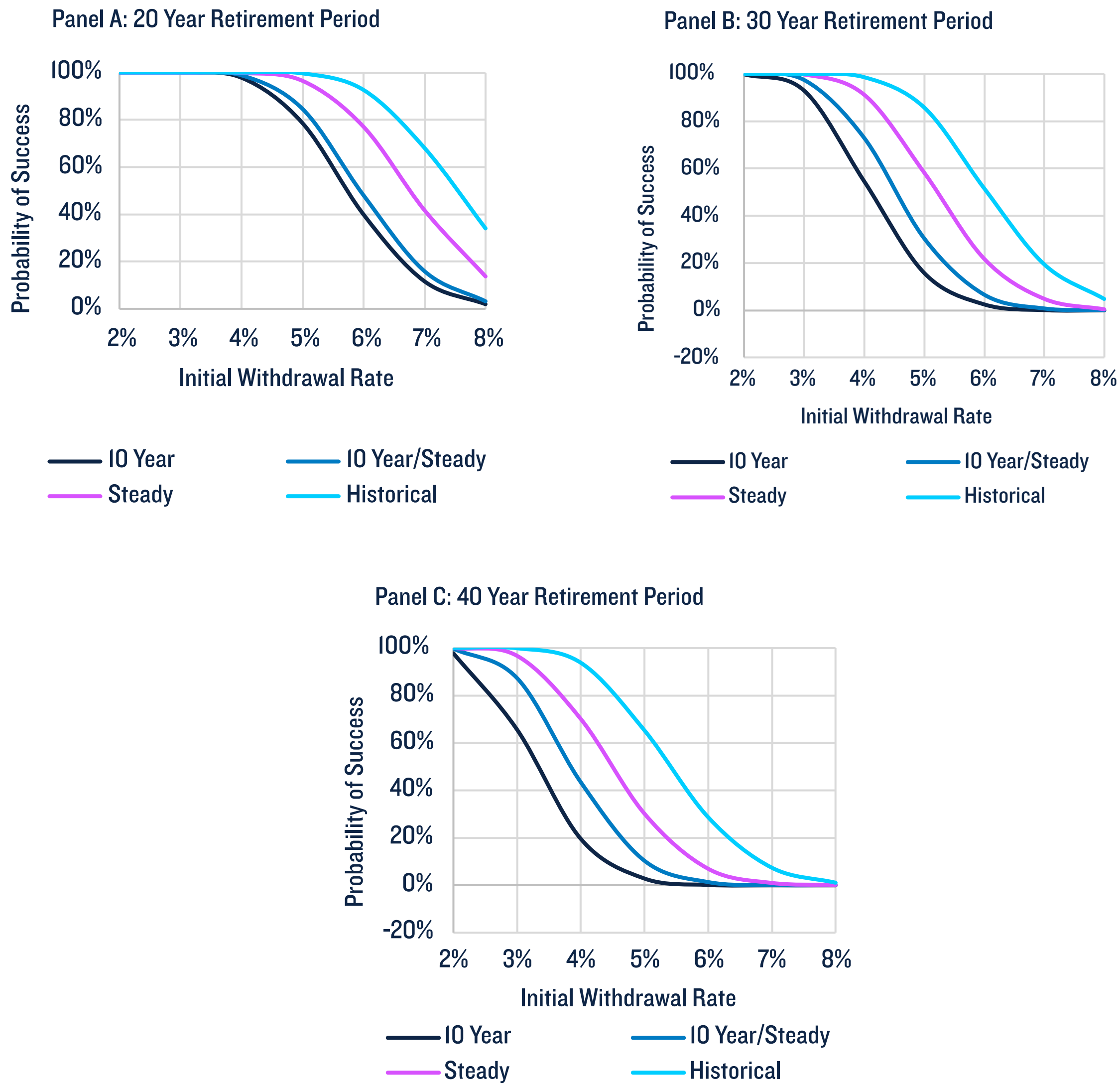
Source: Author's calculations. As of 9/30/2021.

The analysis clearly demonstrates the considerable impact return assumptions can have on the presumed safety of a retirement strategy. Pure historical returns make a 4% initial withdrawal rate appear relatively safe, with a probability of success exceeding 90%. In contrast, using entirely the PGIM Quant 10-Year CMAs the probability of success declines to approximately 50% for a balanced portfolio.

In reality, though, neither pure historical returns nor the 10-year CMAs reflects the true return expectations of PGIM. We believe the 10-year CMAs should apply for the first 10 years of a projection and the steady state thereafter. These results fall in between the pure historical returns and the pure 10-year returns.

In Exhibit 11 we provide additional context around how the probability of success varies for different return assumptions given different initial withdrawal rates assuming a constant 50% equity allocation over a 20 year (Panel A), 30 year (Panel B), and 40 year (Panel C) retirement period.

Exhibit 11: Probability of Success for a 50% Equity Portfolio, Assuming Various Constant Equity Allocations and Returns



Source: Author's calculations. As of 9/30/2021.

The difference in estimated safe initial withdrawal rates obviously varies by the assumed retirement period It also varies significantly by assumed CMAs, and the differences are somewhat stunning.

For example, if you were targeting a 90% success rate over a 30-year retirement period, the safe initial withdrawal rate using pure historical returns would be close to 5%. In contrast, using the 10-year CMAs a 3% initial withdrawal rate would be more appropriate.

MONTE CARLO RESULTS TO PROJECT PORTFOLIO GROWTH

Next, we provide context as to the differences in the growth of $1,000 over a 50-year period, again assuming a 50% equity portfolio. Results included are the respective percentile values. For example, the 5th percentile would be the best 1 in 20 outcomes and the 95th percentile would be the worst in 1 in 20 outcomes.

Exhibit 12: Growth of $1,000 Using Different Return Assumptions for a 50% Equity Portfolio

Source: Author's calculations. As of 9/30/2021.

Again, differences in return assumptions can lead to considerable differences in the results of the Monte Carlo forecast.

CONCLUSION

Future returns are fundamentally uncertain and difficult to predict; however, it is still important to use reasonable assumptions that accurately reflect the return environment in any type of forecast.

As opposed to relying on pure historical long-term averages, which is common, or potentially CMAs that are based on the near future (e.g., the next 10 years), we believe financial advisors, when building long-term forecasts, should use estimates that capture both current market conditions and higher longer-term averages. Using such “steady state” CMAS allow advisors to take into greater account potential scenarios, such as interest rates drifting back towards their longer-term averages.

One potential source for these returns is PGIM Quantitative Solutions, which publishes CMAs quarterly that are publicly available.

Not all software programs allow for different CMAs. In that instance, the CMAs could potentially be adjusted based on the length of the projection, although steady state CMAs would likely be a more appropriate single assumption than the nearer-term estimates (i.e., 10-year returns) or historical long-term averages.

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NOTES TO DISCLOSURE

THE PURSUIT OF OUTPERFORMANCE™

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ABOUT PGIM DC SOLUTIONS[1]

As the retirement solutions providers of PGIM, we plan to deliver innovative defined contribution solutions founded on market-leading research and capabilities. Our highly-experienced team will partner with our clients on customized solutions to solve for retirement income. As of 9/30/2021, PGIM has $214 billion[2] DC assets under management and are the top manager[3] of stable value assets and provider ofin-plan guaranteed lifetime income.

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