

# 2022 Q1 CAPITAL MARKET ASSUMPTIONS

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All investments involve risk, including the possible loss of capital.



## 2022 Q1 Capital Market Assumptions

### Summary

**Q4 2021 Developments Informing Our Long-Term (10-Year) Forecasts:** U.S. economic growth accelerated in the fourth quarter at an estimated annualized rate of 6.9%, taking growth for the full year to 5.5%, the strongest reading since 1984. That strong rate of economic growth following the pandemic induced recession of 2020 is expected to moderate in 2022 both in the U.S. and globally as the impact of emergency fiscal and monetary policy support is expected to wane. Further hastening a move to expected tighter monetary policy is rising global inflation which in the U.S. reached 7% at the end of 2021. Global equity markets continued to advance in the fourth quarter, despite some hesitation in November on the discovery of the Omicron COVID-19 variant, with the MSCI World Index advancing 7.8% and 21.8% for the fourth quarter and 2021, respectively. The strong economic backdrop also supported commodities in 2021 with the Bloomberg Commodity Index advancing 27.1% for the year, the strongest gain since 2000. Global interest rates rose modestly in the fourth quarter following a significant rise higher earlier in 2021. The U.S. 10-year Treasury yield finished 2021 at 1.51%, a rise of 0.6% from the end of 2020. Our near-term developed and emerging market economic growth and inflation forecasts have decreased modestly from the previous quarter. Evolving policy rates and a moderation in forecast economic growth and inflation have important implications for our long-term asset class forecasts.

**Long-Term Global Economic Outlook:** We expect real economic growth in developed economies to continue to moderate over the next decade, as it has for the last 30 years. This is due to limited growth of the developed labor force, which is constrained by domestic demographics, and to an assumption of no significant offset from improved productivity growth. Inflation in developed markets, in contrast, is anticipated to moderate over the next 10 years, relative to the elevated rates of inflation observed in 2021, though is expected to be somewhat higher than that observed in the period following the Global Financial Crisis of 2008, and prior to the COVID-19 induced recession of 2020. We expect long-run real economic growth and inflation in emerging markets to advance at higher annualized rates. Younger populations and higher rates of return on capital in emerging markets are driving higher rates of nominal economic output compared to developed markets. While our baseline long-term inflation expectations assume a reversion to longer term trends, the nearer term outlook for inflation is highly uncertain. The four-decade trend in falling U.S. inflation has at least temporarily paused with U.S. inflation rising to 7.0% in 2021, and potentially remaining elevated over the next several quarters. While an extreme scenario of 1970s-style, double-digit inflation appears unlikely, the potential for a sustained period average inflation well above central bank targets is a non-trivial risk for investors. We cover these issues at length in a related white paper<sup>1</sup>.

**Equities:** Our 10-year annualized nominal forecast return for global equities is 5.7%, a meaningful decrease from our forecast of 6.6% in the fourth quarter of 2021. The forecast decrease is attributable to moderating expected rates of developed market growth and inflation over the next several quarters from the high levels observed in 2021. The decrease in the global equity forecast is also attributable to less favorable valuations following the 7.8% advance in Global equity markets in the fourth quarter. Our long-term return forecast for U.S. equities is somewhat lower, at 5.1%. Developed market equities outside the U.S. are forecast at 6.6%, with the differential relative to the U.S. largely accounted for by lower historical valuation ratios. Our long-run forecast for emerging market equities is 7.6%, with higher rates of nominal economic growth offset somewhat by comparably lower expected income returns than in developed markets and a negative expected valuation adjustment.

<sup>1</sup> Tokat-Acikel, Campbell, Brundage, Cummings, Ahmed, & Rengarajan, 2021, "Is Inflation About to Revive?"  
PGIM Quantitative Solutions White Paper. <https://www.pgimquantitativesolutions.com/research/inflation-about-to-revive>

## 10-Year Forecast Returns and Volatility



Source: PGIM Quantitative Solutions as of 12/31/2021. Forecasts are not a reliable indicator of future performance.

**Fixed Income:** Global sovereign interest rates rose modestly in the fourth quarter of 2021 following a more significant rise in yields early in 2021 consistent with a broad reflation theme in global markets as both growth and inflation expectations shifted higher to start 2021. With what is still a very low starting point for initial income returns, our long-run forecast for hedged global aggregate bonds is 1.3%, up slightly from our forecast in the fourth quarter. Our long-run forecast for U.S. aggregate bonds is 2.5%, consistent with higher initial yields in the U.S. At the end of our 10-year forecast horizon, we expect the U.S. Federal Reserve's policy rate to be approximately 0.8%, about 70 basis points higher than the midpoint of the near zero policy rate target range at the end of the fourth quarter. Outside the U.S., developed market central banks are forecast to modestly increase policy rates from even lower negative levels in many cases, as longer-run policy normalization is expected. In U.S. credit markets, we are forecasting a rise in average spread levels over the next 10 years, following a large compression in spreads over the past year to below pre-pandemic levels, informing expected returns of 2.7% and 3.4% for U.S. investment grade (IG) and high yield bonds, respectively.

**Real Assets:** "Real assets" are broadly defined to include asset classes that have physical properties or have returns that are highly correlated with inflation. We include commodities, REITs and TIPS as real assets in our Capital Market Assumptions (CMAs).

**Private Assets:** Given the increasingly important role private asset classes play in a growing number of institutional allocations, beginning in the fourth quarter of 2021, PGIM Quantitative Solutions introduced forecasts for U.S. buyout private equity, U.S. venture capital private equity and U.S. mezzanine private debt. Our methodology for forecasting these private assets ties the forecast outcomes of private assets to those of public market assets and assigns a premium consistent with historical empirical outcomes, acknowledging the underlying illiquidity and potential leverage employed in these asset classes relative to public market counterparts. Beginning this quarter, we are also including forecasts for core and opportunistic U.S. Private Real Estate based on inputs from the NCREIF property indices and linkages to forecast economic growth and inflation.

**Currency and Currency Hedging Returns:** Over the next 10 years, we are forecasting a modest decline of the U.S. dollar relative to developed market peers, with annualized gains ranging from 0.0% for the Australian dollar to 1.5% for the Japanese yen. Emerging market currencies, in contrast, are expected to depreciate against the U.S. dollar over the next 10 years. Long-term currency hedging returns against a market weighted basket of developed markets exposures are forecast to be net positive for U.S. investors as short-term interest rates are anticipated to be higher over the long term in the U.S. relative to the Eurozone and Japan.

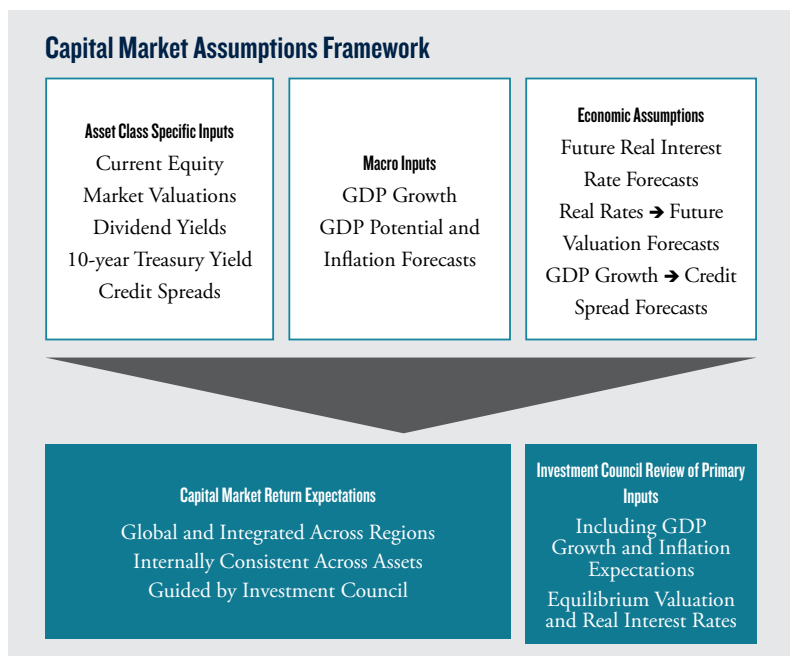
**60/40 Portfolio Return<sup>2</sup>:** Based on our long-term forecasts, a balanced portfolio of 60% Global Equities unhedged and 40% Global Aggregate Bonds hedged is forecast to return 4.4% annually over the next 10 years. This forecast represents a decrease of 0.4% from the fourth quarter attributable to decreases in our global equity forecasts.

<sup>2</sup> For illustrative purposes only. All model portfolios have significant inherent shortcomings and do not consider many real-world frictions. There is no current PGIM Quantitative Solutions client portfolio with this composition of assets. It does not constitute investment advice and should not be used as the basis for any investment decision.

## Overview

PGIM Quantitative Solutions' CMA's underpin the long-run outlook for strategic allocations in our individual strategies and multi-asset portfolios. They are the product of a highly systematic process for generating consistent projections across the capital markets.

CMA's provide 10-year expectations for the most widely held equity, fixed income and non-traditional asset classes, measuring both return and risk. We update our CMA's each quarter. Our investment professionals begin with evolving asset class fundamentals and macroeconomic assumptions at the country level. 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.



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

## Global Economic Outlook

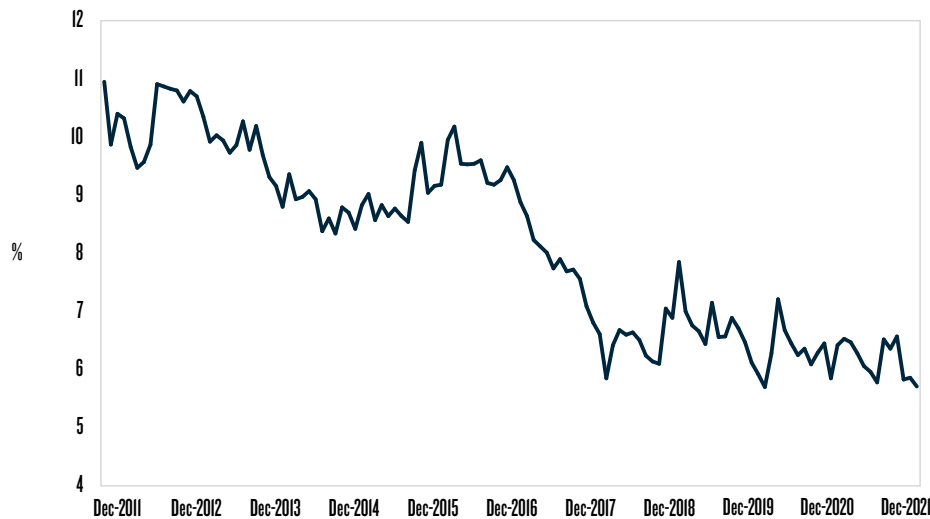
Forward-looking views for economic growth and inflation are some of the most critical building blocks for our CMA's. We currently compile these for 16 nations. Based on our forecasts, long-term real economic growth in the developed economies over the next 10 years is expected to continue to moderate, as it has for the last three decades. This is due to the limited growth of the labor force, which is constrained by domestic demographics, and to an assumption of no significant offset from improved productivity growth. Our forecasts for near-term economic growth have been adjusted lower this quarter as the global economy is forecast to see more moderate rates of growth and inflation than experienced in 2021. We expect longer-term economic growth in developed economies to be led by Australia and other countries with younger populations and more liberal immigration policies. We anticipate growth to be slowest in Japan and parts of Western Europe where the labor force is expected to contract further over the next decade. Inflation in developed markets is anticipated to moderate over the next 10 years, relative to the elevated rates of inflation observed in 2021, though is expected to be somewhat higher than that observed in the period following the Global Financial Crisis of 2008, and prior to the COVID-19 induced recession of 2020. Our 10 year forecasts for developed markets inflation, range from a 2.4% annual rate in the U.S. to a low of 0.9% in Japan. Emerging markets, however, are expected to produce real economic growth and inflation at annualized rates of 4.0% and 2.3%, respectively, driven by younger populations and higher rates of return on capital than in developed markets.<sup>3</sup>

<sup>3</sup>Tokat-Acikel, Campbell, Brundage, Cummings, Ahmed, & Rengarajan, 2021, "Is Inflation About to Revive?" PGIM Quantitative Solutions White Paper. <https://www.pgimquantitativesolutions.com/research/inflation-about-to-revive>

## Evolution of Our Market Outlook

Entering 2020, the U.S. economy had grown for 126 straight months through the end of 2019, beginning at the end of the NBER defined recession coinciding with the Global Financial Crisis in June 2009, as had much of the global economy. That expansion ended abruptly in the first quarter of 2020. Whereas the U.S. expansion that ended in 2020 was the longest in the postwar period, it was also one of the weakest if measured by average real GDP growth. Against this backdrop, equity markets nonetheless performed strongly, with the MSCI World Index delivering annual returns of 11.1% in the 10-year period following the end of the last recession through the end of 2019. U.S. equities fared even better, with the S&P 500 Index advancing at a 14.5% annualized rate. Over the last 10 years, in contrast, our long-term capital market assumptions for global equities have gradually come down. This is consistent with a forecast moderation in developed markets economic growth and richer valuations consequent with the strong performance of equity markets relative to underlying earnings. Our outlook for global equities over the next 10 years is 5.7% a decrease of 0.9% from our forecast in the fourth quarter of 2021.

**PGIM Quantitative Solutions' Expected 10-Year Return for Global Equities**



Source: PGIM Quantitative Solutions as of 12/31/2021. Forecasts are not a reliable indicator of future performance.

Our capital market assumptions for global fixed income assets have also declined broadly over the last 10 years, primarily attributable to historic declines in underlying sovereign interest rates through 2020, resulting in an estimated \$11.3 trillion still remaining in negative-yielding debt, approximating 17% of the Bloomberg Barclays Global Aggregate as of December 31st, 2021. During 2021, however, our hedged Global Aggregate Bond forecast moved noticeably higher following a broad rise in government yields during the year.

**PGIM Quantitative Solutions' Expected 10-Year Return for Hedged Global Aggregate Bonds**



Source: PGIM Quantitative Solutions as of 12/31/2021. Forecasts are not a reliable indicator of future performance.

## Global Fixed Income Markets

Long-term fixed income forecasts begin with our view of 10-year forward policy rates for each of the major developed market central banks. We derive expected policy rates for each central bank jurisdiction as a function of current and future equilibrium real interest rates, the expected GDP output gap over the next 10 years<sup>4</sup> and the expected rate of inflation. Our long-term forecasts for short-term interest rates have moved significantly lower for all the major developed economies from the end of 2019 on account of the policy reset precipitated by the global COVID-19 pandemic and resulting supportive policy actions by central banks. In the first quarter of 2020, the Federal Reserve cut its main policy rate by 1.75% and the European Central Bank pushed policy rates further into negative territory. For the U.S., policy rates in 10 years are expected to be about 70 basis points higher than the 0.13% policy rate prevailing at the end of the third quarter, given the forward view of inflation and growth relative to potential. Other developed market central banks are expected to raise rates modestly, on average, consistent with forecasted inflation rising closer to central bank targets over the next 10 years from very low pre-pandemic levels.

Interest Rates		
Country	Current Short-Term Interest Rates (12/31/2021)	Long-Term Forecast of Short Interest Rates
United States	0.03	0.78
United Kingdom	0.04	0.83
Eurozone	-0.57	0.40
Japan	-0.13	0.43
Australia	0.91	1.51
Canada	0.18	0.89

Source: Bloomberg, PGIM Quantitative Solutions, as of 12/31/2021. Forecasts may not be achieved.

For longer maturity government bond returns, we forecast<sup>5</sup> 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).

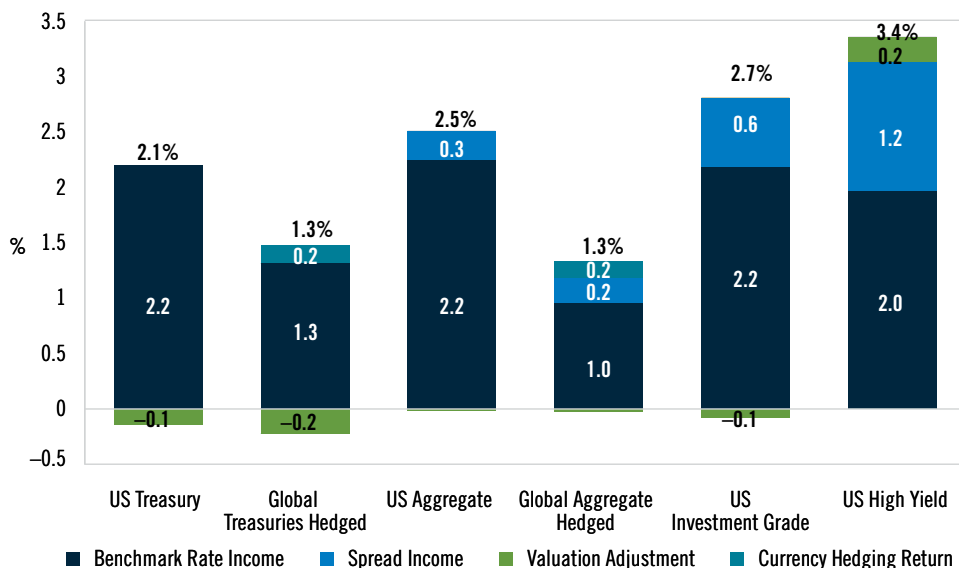
Year to date through the end of fourth quarter, benchmark 10-year U.S. Treasury yields have advanced by 0.6%, closing out 2021 at 1.51%. Looking forward, yields for the Bloomberg U.S. Treasury Index are expected to rise modestly over the next 10 years, resulting in a negative valuation adjustment and an expected return of 2.1%, a rise from a 1.7% forecast last quarter. Developed market government bonds outside the U.S. are forecast to return less over the next decade, given lower initial yields and a negative valuation adjustment, as yields are expected to rise over the forecast horizon. Long-run returns in global developed market government bonds for a U.S. investor are forecast at 1.7% on an unhedged basis and 1.3% on a hedged basis, given the differentials in forecast short-term interest rates.



<sup>4</sup> GDP-weighted Eurozone country average for European Central Bank.

<sup>5</sup> There can be no assurance these forecasts will be achieved.

## Decomposition of Fixed Income Return Forecasts

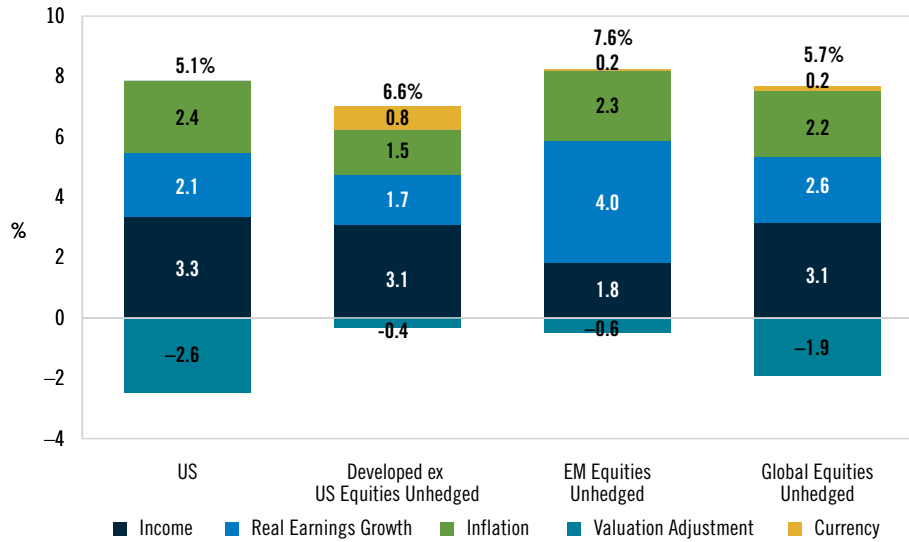


Source: PGIM Quantitative Solutions as of 12/31/2021. For illustrative purposes only. Forecasts are not a reliable indicator of future performance.

Our long-term forecast for U.S. aggregate bonds is 2.5%, which includes an expected spread return of 0.3%. Our forecast for hedged global aggregate bonds from a U.S. investor perspective is 1.3%, given similar assumptions for credit spreads and defaults, as well as the aforementioned lower starting levels for underlying government yields outside the U.S. For both U.S. investment grade and U.S. high yield bonds, spreads at the end of the fourth quarter were somewhat lower than expected averages for the next 10 years.

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. Year to date in 2021, credit spreads have continued to retrace lower following significant moves higher in the first quarter of 2020 as the global economy moved into recession. Improvement in financial conditions in the second half of 2020 and 2021 has reduced our forecast for defaults for the next two years, resulting in a slight improvement in our forecasts for speculative debt. Long-run returns for U.S. investment grade and U.S. high yield bonds are expected to be 2.7% and 3.4%, respectively.

Decomposition of Global Equity Return Forecasts



Source: PGIM Quantitative Solutions as of 12/31/2021. For illustrative purposes only. Forecasts are not a reliable indicator of future performance.

All of our long-term asset class forecasts, including equities, are based on income, growth, and valuation considerations.

Consistent with historical precedent and assuming the continuation of current dividend taxation regimes, the U.S. equity market has a large share of expected income returns coming from share buybacks, equal to about 1.9% in our long-term forecasts. Outside of the U.S., the expected impact of net buybacks in developed economies on long-term income returns is anticipated to be a much more modest 0.2%. For emerging markets, an expected drag on income returns from net share issuance is forecast at 0.6%.

For the growth component of our equity return forecasts, long-term nominal earnings growth for each equity market is expected to approximate the growth in nominal GDP for each country. We calculate this as the combined

annualized rate of expected inflation plus real GDP growth. As noted earlier, our near-term growth and inflation assumptions for the developed and emerging markets have been adjusted higher from the previous quarter as the global economy is forecast to continue its strong rebound from the COVID-19 precipitated downturn of 2020. Our 10-year forecast for U.S. real annualized GDP growth is now 2.1%, with 2.4% for inflation translating to an earnings growth component of 4.5% with more elevated growth and inflation anticipated over the next few quarters before moderating to levels consistent with underlying potential. For developed markets outside the U.S., our 10-year expectation for real GDP growth is 1.7%, while inflation is expected to average 1.5%, providing nominal earnings growth of 3.2%, a decrease of 0.3% from our forecast the previous quarter.

For emerging markets, higher nominal GDP growth relative to developed markets is expected to result in long-run nominal earnings growth of 6.4%.

Among developed markets, the U.S. maintains a negative expected long-term valuation adjustment of -2.4% annually, attributable to still historically elevated valuation ratios. Developed equities outside the U.S., in contrast, are expected to have a negligible valuation repricing, given historical valuation ratios that are in line with long run averages. Emerging markets equity returns are forecast to be 0.4% per year lower on negative valuation adjustments.

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).

## Private Assets

Given the increasingly important role private asset classes play in a growing number of institutional allocations, beginning in the fourth quarter 2021, PGIM Quantitative Solutions began producing forecasts for U.S. buyout private equity, U.S. venture capital private equity and U.S. mezzanine private debt. This quarter we are also providing forecasts for core and opportunistic U.S. private real estate. Our methodology for forecasting private assets outside of real estate ties the forecast outcomes of private assets to those of public market assets and assigns a premium consistent with historical empirical outcomes, acknowledging the underlying illiquidity and potential leverage employed in these asset classes relative to public market counterparts. Our forecasts for private real estate incorporate data from the NCREIF property index to determine yields and relative valuations in addition to linkages to forecast macroeconomic inputs. Investors in private assets must also consider cash flow considerations that may impact other liquid allocations in a multi-asset portfolio. For further reference on these considerations please see Shen et. al (2021)

Private equity funds that take a buyout strategy invest in equity ownership in mature companies that result in a change of control. These are typically large transactions that use leverage. Our current 10-year annualized forecast for U.S. buyout private equity is 6.5% versus a forecast of 5.1% for public U.S. equities.

Venture capital funds seek private equity stakes in startups and small to medium sized companies with strong growth potential. Our current annualized 10 year forecast for U.S. venture capital private equity is 7.8% versus a forecast of 5.6% for public U.S. small cap equities.

Private mezzanine debt invests in loans that are subordinate to other debt in a firm's capital structure and are backed by little to no collateral. Our current annualized forecast for U.S. mezzanine private debt is 4.2% versus a forecast 3.4% for public U.S. high yield debt.

Private real estate funds covered in the NCREIF property index (NPI) for our forecasts include properties that are acquired in place of institutional investors that are exempted from taxes in the fiduciary environment. The property types allowed into the NPI are hotels, office buildings, industrial properties, apartments, and other retail use properties. Allowed properties can be wholly owned or even jointly owned properties. Returns on investment are required to be reported without leverage. From the unlevered initial forecast we then calculate a core real estate forecast to represent funds with 20% leverage and an opportunistic real estate forecast to represent funds with 40% leverage.

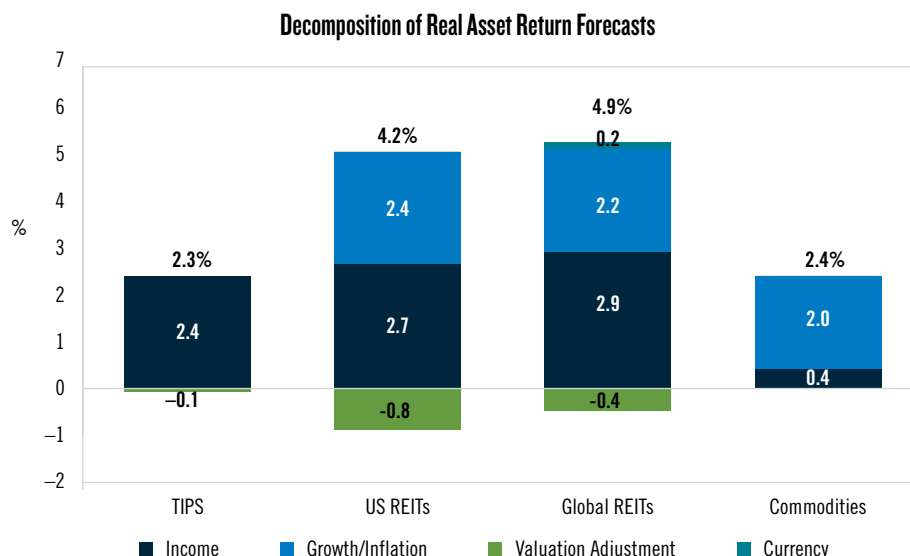
## Real Assets

We include commodities, REITs and TIPS as real assets in our Capital Market Assumptions.

For U.S. TIPS, we assume that expected inflation and break-even inflation converge over time, implying that the inflation risk premia and liquidity risk premia in TIPS offset each other. Under these assumptions, we forecast a long-term return from TIPS of 2.3%, which is somewhat above the expected return to U.S. Treasuries, given the slightly higher duration of U.S. TIPS. This U.S. TIPS forecast is 0.3% higher than the prior quarter's forecast, attributable to an increase in underlying nominal U.S. TIPS yields.

Our forecast returns for U.S. and Global REITs include current and forecast dividend payments, expected appreciation linked to forecast price level changes and a valuation adjustment based on current payout ratios. Our long-run forecasts for U.S. and global REITs are 4.2% and 4.9%, respectively.

Our long-run expected return for commodities is 2.4%, reflecting a return on cash investment of 0.4%, assuming investment through liquid futures, and a growth premium of 2.0%, consistent with historical spot returns over cash and a linkage to forecast inflation. This forecast is a small increase from our forecast from last quarter.



Source: PGIM Quantitative Solutions as of 12/31/2021. For illustrative purposes only. Forecasts are not a reliable indicator of future performance.

<sup>6</sup> Shen et al., (2021), "Harnessing the Potential of Private Assets: A Framework for Institutional Portfolio Construction", PGIM Institutional and Advisory Solutions.

## Currency and Currency Hedging Returns

Our long-term forecasts for currency returns and returns to currency hedging are based on our forward views of local relative price levels and short-term policy rates. These views allow us to provide our long-term forecasts for a range of domiciles outside the U.S. Over the next 10 years, we are forecasting the U.S. dollar to decline modestly relative to developed market peers, with annualized forecast gains ranging from 0.0% for the Australian dollar to 1.5% for the Japanese yen. Emerging market currencies, in contrast, are expected to depreciate against the U.S. dollar over the next 10 years. Long-term currency hedging returns against a market weighted basket of developed markets exposures are forecast to be net positive for U.S. investors as short-term interest rates are anticipated to be higher over the long term in the U.S. relative to the Eurozone and Japan.

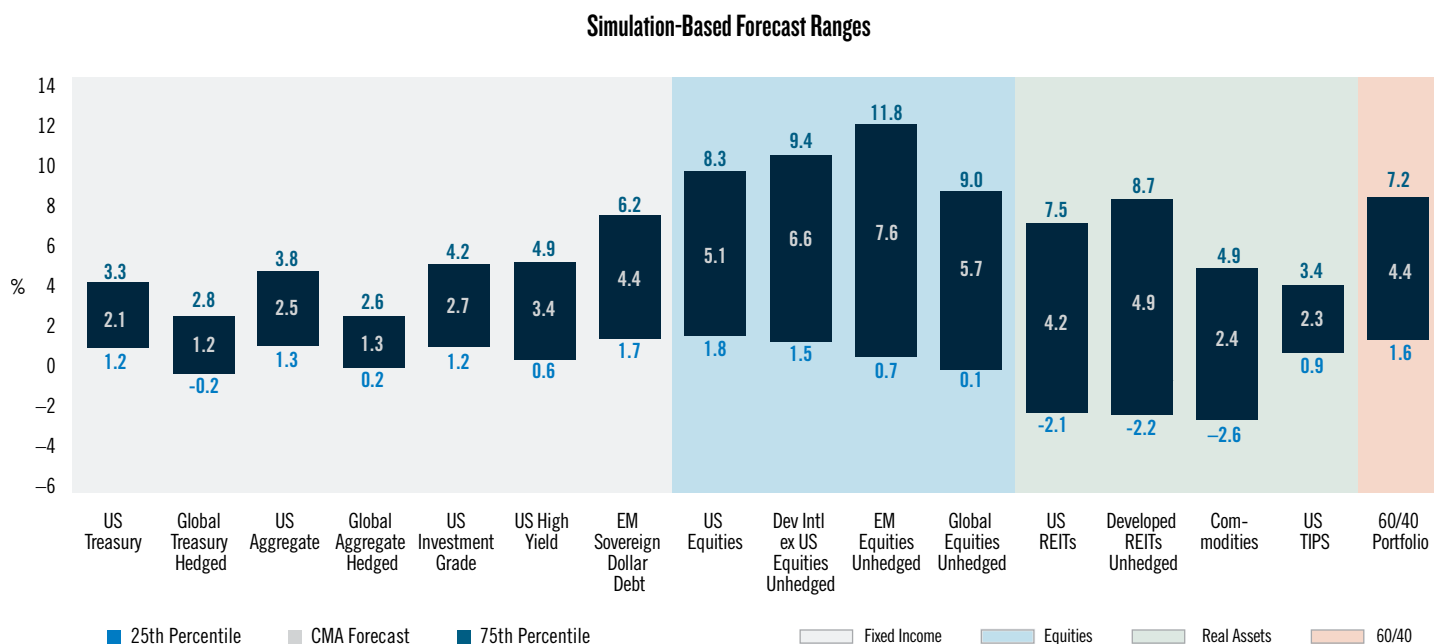
PGIM Quantitative Solutions Q1 2022 10-Year Capital Market Assumptions				
Asset	Expected Geometric Return	Expected Arithmetic Return	Expected Volatility	Expected Sharpe Ratio
Cash	0.41	—	—	—
US Treasury Bonds	2.06	2.16	4.52	0.39
US Long Treasury	1.71	2.23	10.17	0.18
Global Treasury Bonds Hedged	1.26	1.47	6.49	0.16
US Aggregate Bonds	2.50	2.65	5.51	0.41
Global Aggregate Bonds Hedged	1.33	1.48	5.41	0.20
US Investment Grade Bonds	2.73	2.95	6.54	0.39
US High Yield Bonds	3.36	3.71	8.44	0.39
US TIPS	2.29	2.44	5.53	0.37
US Equities	5.10	6.24	15.08	0.39
US Small Cap	5.60	7.51	19.54	0.36
UK Equities Unhedged	6.84	8.47	18.07	0.45
Europe ex UK Equities Unhedged	5.64	7.11	17.15	0.39
Japan Equities Unhedged	7.43	9.55	20.58	0.44
Developed International ex US Equities Unhedged	6.62	7.88	15.88	0.47
EM Equities Unhedged	7.56	10.30	23.41	0.42
Global Equities Unhedged	5.71	7.70	19.97	0.37
US REITs	4.22	5.74	17.44	0.31
Developed REITs Unhedged	4.87	7.19	21.56	0.31
US Private Real Estate - Core	5.60	6.58	13.97	0.44
US Private Real Estate - Opportunistic	6.88	8.57	18.38	0.44
Commodities	2.40	3.46	14.57	0.21
US Private Debt - Mezzanine	4.22	4.80	10.79	0.41
US Private Equity - Buyout	6.53	8.43	19.51	0.41
US Private Equity - Venture Capital	7.80	10.89	24.85	0.42
<b>60/40 Portfolio</b>	<b>4.37</b>	<b>5.21</b>	<b>12.92</b>	<b>0.37</b>

Source: PGIM Quantitative Solutions as of 12/31/2021. Forecasts are not a reliable indicator of future performance.

## Incorporating Economic Uncertainty in Our 10-Year Forecasts

PGIM Quantitative Solutions' 10-year forecasts are based on building blocks with inherent uncertainty, particularly uncertainty as to the economic environment that will prevail over the next 10 years. To model this economic uncertainty, we conduct forward looking simulations incorporating joint distributions of expansionary and recessionary investment environments. In contrast to simulations assuming a single multivariate normal distribution of asset class returns that are inconsistent with observed historical outcomes, our robust simulations consider periods of crisis that result in more pronounced drawdowns than would be captured in static average expected return and covariance forecasts.

Through these simulations we generate a distribution of return outcomes centered on our capital market assumptions. Presented in the following chart are the 25th and 75th percentile ranges for the primary asset classes we forecast.<sup>7</sup>



Source: PGIM Quantitative Solutions as of 12/31/2021. **Forecasts and hypothetical performance are not a guarantee or reliable indicator of future results.** PGIM Quantitative Solutions generates 1,000 potential return paths using the simulation methodology described above. The uncertainty bands represent 25th and 75th percentile of potential return paths from the simulation. Returns paths are hypothetical in nature and do not reflect actual investment results. The information is shown for illustrative purposes only, does not constitute investment advice, and is not indicative of a guarantee of future results. Results from the projected simulation may vary over time and with each use.

<sup>7</sup> Beginning in Q1 2022, PGIM Quantitative Solutions introduced a methodology change in the Economic Uncertainty Simulations that removed the quarterly modeling of deviations from expected economic growth and inflation. The updated monthly asset class based simulations result in wider uncertainty bands than the previous methodology.

## Risk-Based Policy Portfolios<sup>8</sup>

To provide insight into how our evolving CMAs can be used to inform multi-asset portfolios, PGIM Quantitative Solutions produces three representative risk-based policy portfolios every quarter. These policy portfolios are based on public market assets only and meant to mimic three distinct liability profiles from a U.S. investor perspective. Each quarter, suggested portfolios are constructed through constrained optimization based on our evolving risk and return forecasts. Suggested portfolios selected along the efficient frontier will be those with the highest Sharpe ratio with at least the same expected return as the respective policy portfolio they are benchmarked to.

For the first quarter of 2022, starting from the benchmark policy portfolios, intra-equity allocation changes common to all of the policy portfolios were reductions in exposure to U.S. equities and increased allocations to international and emerging equities. Within fixed income, allocations to U.S. Aggregate bonds were decreased in the income portfolio and increased in the balanced and growth portfolios, while allocations to investment grade bonds were generally reduced. Allocations to high yield bonds were increased in the income portfolio while being reduced in the growth portfolio. Within real assets, allocations to REITs were underweight in the income portfolio, while allocations to commodities were increased in the income portfolio and reduced in the balanced and growth portfolios. TIPS allocations were overweight in the income and balanced portfolios. Across broad asset class groups, real asset and equity allocations were higher in the income and balanced portfolios, whereas in the growth portfolio overweight allocations to equities and fixed income were funded from an underweight in real assets.

Q1 Risk Based Policy Portfolios			
	Income Focused	Balanced Income and Growth	Growth Focused
<b>Equities</b>	<b>30.0%</b>	<b>55.0%</b>	<b>70.0%</b>
US Large Cap	20.0%	35.0%	40.0%
US Small Cap	2.0%	3.0%	8.0%
International ex US	5.0%	12.0%	15.0%
Emerging Markets	3.0%	5.0%	7.0%
<b>Fixed Income</b>	<b>60.0%</b>	<b>35.0%</b>	<b>20.0%</b>
US Aggregate	50.0%	30.0%	10.0%
US Investment Grade	8.0%	3.0%	3.0%
US High Yield	2.0%	2.0%	7.0%
<b>Real Assets</b>	<b>10.0%</b>	<b>10.0%</b>	<b>10.0%</b>
TIPS	6.0%	3.0%	2.0%
US REITs	2.0%	4.0%	5.0%
Commodities	2.0%	3.0%	3.0%
<b>Expected Geometric Return</b>	<b>3.8%</b>	<b>4.8%</b>	<b>5.5%</b>
<b>Expected Standard Deviation</b>	<b>7.5%</b>	<b>9.0%</b>	<b>10.7%</b>
<b>Expected Sharpe Ratio</b>	<b>0.63</b>	<b>0.54</b>	<b>0.53</b>

Q1 Optimized Risk Based Policy Portfolios			
	Income Focused	Balanced Income and Growth	Growth Focused
<b>Equities</b>	<b>33.0%</b>	<b>56.0%</b>	<b>71.0%</b>
US Large Cap	17.0%	30.0%	35.0%
US Small Cap	4.0%	5.0%	10.0%
International ex US	7.0%	14.0%	17.0%
Emerging Markets	5.0%	7.0%	9.0%
<b>Fixed Income</b>	<b>55.0%</b>	<b>33.0%</b>	<b>21.0%</b>
US Aggregate	45.0%	32.0%	15.0%
US Investment Grade	6.0%	1.0%	1.0%
US High Yield	4.0%	0.0%	5.0%
<b>Real Assets</b>	<b>12.0%</b>	<b>11.0%</b>	<b>8.0%</b>
TIPS	8.0%	5.0%	2.0%
US REITs	0.0%	4.0%	5.0%
Commodities	4.0%	2.0%	1.0%
<b>Expected Geometric Return</b>	<b>4.0%</b>	<b>5.0%</b>	<b>5.6%</b>
<b>Expected Standard Deviation</b>	<b>7.5%</b>	<b>9.0%</b>	<b>10.6%</b>
<b>Expected Sharpe Ratio</b>	<b>0.52</b>	<b>0.55</b>	<b>0.54</b>

Source: PGIM Quantitative Solutions as of 12/31/2021. For illustrative purposes only. The asset allocations are hypothetical and should not be construed as investment advice. No investment strategy or risk management technique can guarantee returns or eliminate risk in any market environment. **There is no guarantee strategies will be successful. Forecasts are not a reliable indicator of future performance.**

<sup>8</sup> For illustrative purposes only. All risk-based policy portfolios have significant inherent shortcomings and do not consider many real-world frictions. There is no current PGIM Quantitative Solutions client portfolio with this composition of assets. Does not constitute investment advice and should not be used as the basis for any investment decision.

## Innovations in Suggested Allocations from Q4 2021

Changes in our forecasts in the first quarter of 2022 have resulted in a number of innovations in our optimized portfolios from the end of 2021. Common across all the portfolios are reductions to REIT allocations and increases to U.S. equity allocations. In the Income portfolio, an increase in the TIPS allocation was partially funded by a reduced allocation to U.S. Aggregate Bonds. The Balanced portfolio added exposure to commodities funded by a larger reduction in the REITs allocation. In the Growth portfolio, the TIPS allocation was reduced to partially fund an increase in the U.S. Aggregate Bond allocation. Equity allocations were increased across the portfolios, funded by Fixed Income in the Income Portfolio and from Real Assets in the Balanced and Growth portfolios.

Quarter over Quarter Changes in Optimized Risk Based Policy Portfolio Allocations			
	Income Focused	Balanced Income and Growth	Growth Focused
<b>Equities</b>	<b>2.0%</b>	<b>1.0%</b>	<b>2.0%</b>
US Large Cap	2.0%	0.0%	0.0%
US Small Cap	0.0%	1.0%	2.0%
International ex US	0.0%	0.0%	0.0%
Emerging Markets	0.0%	0.0%	0.0%
<b>Fixed Income</b>	<b>-2.0%</b>	<b>0.0%</b>	<b>1.0%</b>
US Aggregate	-2.0%	0.0%	1.0%
US Investment Grade	0.0%	0.0%	0.0%
US High Yield	0.0%	0.0%	0.0%
<b>Real Assets</b>	<b>0.0%</b>	<b>-1.0%</b>	<b>-3.0%</b>
TIPS	1.0%	0.0%	-2.0%
US REITs	-1.0%	-2.0%	-1.0%
Commodities	0.0%	1.0%	0.0%
<b>Expected Geometric Return</b>	<b>-0.2%</b>	<b>-0.5%</b>	<b>-0.5%</b>
<b>Expected Standard Deviation</b>	<b>1.5%</b>	<b>0.2%</b>	<b>-0.2%</b>
<b>Expected Sharpe Ratio</b>	<b>-0.13</b>	<b>-0.06</b>	<b>-0.04</b>

Source: PGIM Quantitative Solutions as of 12/31/2021. Forecasts are not a reliable indicator of future performance. There is no guarantee strategies will be successful. Asset allocations are hypothetical and should not be construed as investment advice for illustrative purposes only.

## PGIM Quantitative Solutions' Steady State CMAs

PGIM Quantitative Solutions is now providing a longer term forecast view beyond a ten-year horizon based on our 'steady state' views for asset classes. We construct long-term CMAs by combining 10-year CMAs and steady state CMAs. Returns are expected to follow the 10-year CMA scenario for the first segment of history and then follow the steady state CMAs thereafter. One motivation for this structure is that cheap (rich) might have better (worse) returns over the near-term horizon. However, the longer an investor's time horizon, the less weight they should place on an asset class being cheap or rich today and the more weight they should place on what happens in the steady state. 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, we remove valuation components and cyclical terms in our existing model, anchoring them to an equilibrium level

CMA volatility estimates are constructed based on historical standard deviations over the long-term. To construct steady state volatility, we rely on the methodology by Cox, Ingersoll, and Ross (1985),<sup>9</sup> whose model links the volatility of interest rates to the square root of interest rates. Higher interest rates are associated with greater volatility in interest rates, just not linearly. In our case, we have volatility estimates over the subsequent 10 years, and want to model how those values would change if the return estimates change. The steady state volatility is calculated by scaling the 10-year volatility by the square root of the ratio of the steady state return to the 10-year return expectation. This approach ensures that if an asset class has a higher return in the steady state, such as would occur due to interest rates rising beyond our typical 10-year horizon, then the volatility is also scaled higher. However, since the scaling uses a square root instead of a linear adjustment, volatility will not increase as much as returns in the steady state. This means that the Sharpe ratio will also increase. (See Tokat-Acikel et al 2021 for details)<sup>10</sup>

Long-Term Capital Market Assumptions				
Asset	Expected Geometric Return	Expected Arithmetic Return	Expected Volatility	Expected Sharpe Ratio
Cash	1.46	1.46	—	—
US Treasury Bonds	4.33	4.54	6.51	0.47
Global Treasury Bonds Hedged	3.56	4.16	10.93	0.25
US Aggregate Bonds	4.66	4.95	7.65	0.46
Global Aggregate Bonds Hedged	3.50	3.88	8.75	0.28
US Investment Grade Bonds	5.47	5.90	9.32	0.48
US High Yield Bonds	6.60	7.31	11.85	0.49
US TIPS	4.34	4.62	7.53	0.42
US Equities	8.95	10.95	19.98	0.48
US Small Cap	9.45	12.68	25.39	0.44
UK Equities Unhedged	8.53	10.56	20.18	0.45
Europe ex UK Equities Unhedged	7.59	9.56	19.88	0.41
Japan Equities Unhedged	6.50	8.36	19.25	0.36
Developed International ex US Equities Unhedged	7.63	9.08	17.05	0.45
EM Equities Unhedged	10.33	14.08	27.38	0.46
Global Equities Unhedged	8.77	11.83	24.76	0.42
US REITs	7.94	10.78	23.85	0.39
Developed REITs Unhedged	7.78	11.50	27.27	0.37
Commodities	2.05	2.96	13.46	0.11
<b>60/40 Portfolio</b>	<b>6.66</b>	<b>7.93</b>	<b>15.93</b>	<b>0.41</b>

Source: PGIM Quantitative Solutions as of 12/31/2021. Forecasts are not a reliable indicator of future performance.

<sup>9</sup> Cox, John C., Jonathan E. Ingersoll, and Stephen Ross. 1985. "A Theory of the Term Structure of Interest Rates." *Econometrica*, 53 (2): 385-407. <https://doi.org/10.2307/1911242>.

<sup>10</sup> Tokat-Acikel, Yesim, Marco Aiolfi, Lorne Johnson, John Hall and Jessica (Yiwen) Jin. 2021. "Top-Down Portfolio Implications of Climate Change" PGIM Quantitative Solutions White Paper. <https://www.pgimquantitativesolutions.com/white-paper/top-down-portfolio-implications-climate-change>

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