PGIM

INSTITUTIONAL ADVISORY & SOLUTIONS

EXPLORING RASA™ INTERACTIVE

August 2021

AUTHOR

Harsh Parikh, PhD
Principal
PGIM IAS
harsh.parikh@pgim.com
+1 973 558 4355

The PGIM Institutional Advisory & Solutions group advises institutional clients on a variety of asset allocation and portfolio construction topics, and delivers bespoke research based on an institution's specific objectives.

To learn more about PGIM IAS, contact IAS@pgim.com or visit pgim.com/IAS.

***RASA™ Interactive* allows investors to determine if their real asset benchmark is aligned with their objectives, to compare their real assets portfolio to peers, and to conduct "what-if" analysis to modify their current allocations based on their views.**

CIOs can compare various real assets and real asset portfolios based on performance metrics like returns, volatilities, and RASA sensitivities (i.e., correlations or betas to inflation and economic growth and stock and bond returns). These metrics are evaluated at two return horizons (1y and 3y) and over different time periods (1991 – 2020 and 1973 – 2020).

CIOs can use *RASA Interactive* to compare the sensitivities of various real assets to macroeconomic and financial variables and assess the uncertainty of those sensitivities (i.e., having wide confidence intervals). A CIO may prefer selecting real assets with lower estimation uncertainty. To demonstrate the application, we show how a CIO of a public pension plan can select and benchmark a real assets portfolio that helps to achieve a desired degree of inflation exposure.

Finally, CIOs may want to evaluate how real asset sensitivities might change depending on the economic environment such as stagflation or stagnation. Differences in sensitivities suggest different real asset portfolios for different environments allowing a CIO to select real assets based on their economic views.

The growing institutional interest in real assets prompted PGIM IAS to bring its real assets research directly to the CIO's desktop. CIOs can use ***RASA™ Interactive*** to compare and contrast 14 real assets, both public and private, based on their performance metrics like returns, volatilities, and RASA sensitivities like correlations or betas to headline inflation (Consumer Price Index (CPI)) and economic growth (Chicago Fed National Activity Index (CFNAI)) or to the S&P 500 and 10y Treasury.[1] *RASA Interactive* can help CIOs determine the right mix of real assets to meet specific investment objectives like inflation-protection, low-growth protection, or diversification from traditional asset classes.

Besides the **Homepage**, *RASA Interactive* has three *dashboards*, each for a particular type of investment analysis:

[1] For details on the definitions and methodologies underlying RASA sensitivities see H. Parikh, "Institutional Gold!" PGIM IAS, November 2019.

1. **Asset-Level RASA Statistics** dashboard: Investors can compare real assets based on performance metrics (returns and volatility) and RASA statistics (betas and correlations to macroeconomic and financial market variables) over different time-periods and return horizons.

2. **Portfolio-Level RASA Statistics** dashboard: Investors can:

   a. Construct a real assets benchmark;

   b. Conduct peer group portfolio comparisons;

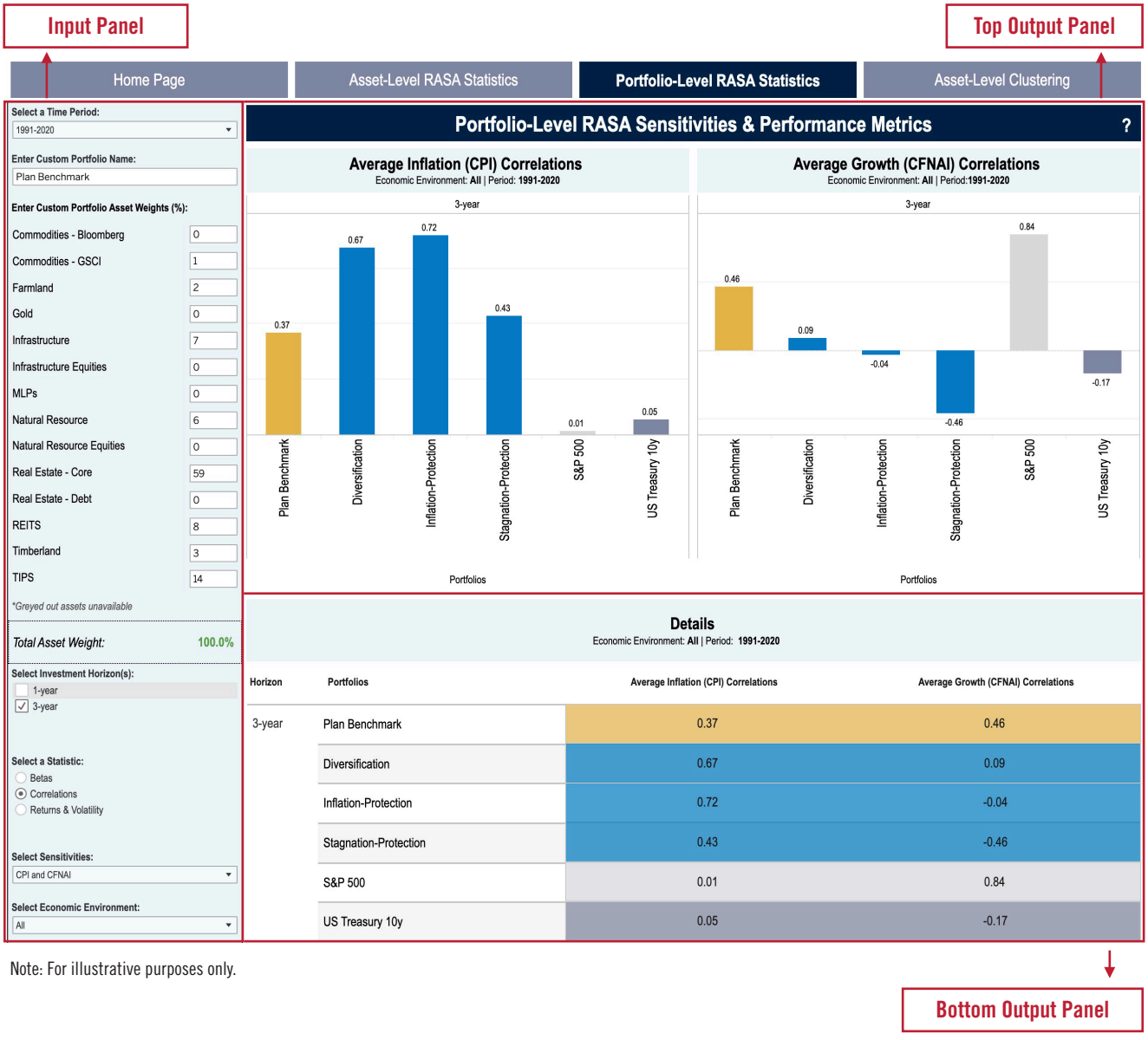
   c. Compare their real assets portfolio to traditional assets like stocks and bonds and to some objective-oriented real assets portfolios; and

   d. Perform "what-if" analysis to modify their current portfolio to be better aligned with the investor's objectives or views.

3. **Asset-Level Clustering** dashboard: Using cluster analysis, investors can assess how real assets and real assets portfolios compare in terms of their RASA sensitivities.

The top bar of *RASA Interactive* gives the investor access to the homepage and to each dashboard (Figure 1). Each dashboard is, in turn, divided into three panels: an investor input panel and two output panels (Figure 1).

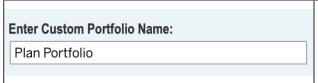
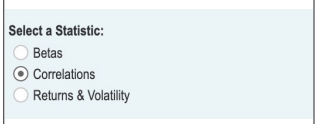
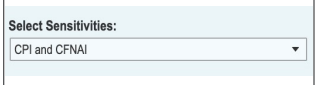
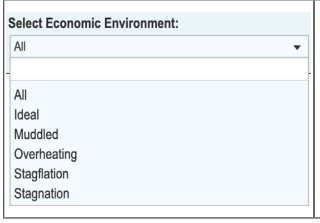
Figure 1: RASA Interactive Dashboard



Note: For illustrative purposes only.

An optimal portfolio of real assets depends on the CIO's investment objective and investment horizon, the amount of estimation uncertainty the CIO is willing to tolerate, and the economic environment the CIO is most concerned about hedging. The ***input panel*** allows the CIO to specify their preferences (Figure 2).

Figure 2: The CIO Input Panel

CIO Selections	Action	Description
	Select historical time period from two available choices: (1) 1991 – 2020 and (2) 1973 - 2021	Depending on the selection, the RASA statistics are estimated either using 30y or 48y of data, respectively.[2]
	Specify your portfolio name to identify in the ***output panel***	Please provide a name that describes your portfolio and can be compared with other "what-if" portfolios that you may analyze.
	Enter the weights for each of the real assets in the desired custom portfolio.	A CIO can enter weights for various portfolios like a benchmark, peer-average or current portfolio and compare them to traditional assets like stocks and bonds and to various objective-oriented real assets portfolios like Inflation-Protection or Stagnation-Protection.[3]
	Select either 1y, 3y or both investment horizons.	The ***output panel*** will display statistics estimated at the selected horizon (i.e., return frequency). Selecting both horizons will shrink the display to show statistics for both horizons.
	Select from three options (a) Betas, (b) Correlations or (c) Returns & Volatility	Based on the selected statistics average values are displayed. The **Asset-Level RASA Statistics** dashboard displays the 90th percentile confidence interval.
	Select (a) CPI and CFNAI (i.e., inflation and economic growth macroeconomic variables) or (b) S&P 500 and TSY (financial market variables)	Choice of sensitivities determines which betas and correlation statistics are displayed. For example, if beta statistics are selected and CPI and CFNAI sensitivities are selected, the ***output panel*** displays inflation (CPI) and growth (CFNAI) betas
	Select an Economic Environment from the six available options. "All" choice shows the average statistics across all economic environments.[4]	See how the metrics differ depending on the environment selected. A CIO may be specifically interested in the allocations to real assets that do better in Stagflation i.e., when inflation is high and economic growth is low, so may want to review statistics in that economic environment.

Note: For illustrative purposes only.

[2] The 1973 – 2020 time-period has limited data availability, so the analysis is provided for only seven of the 14 real assets.

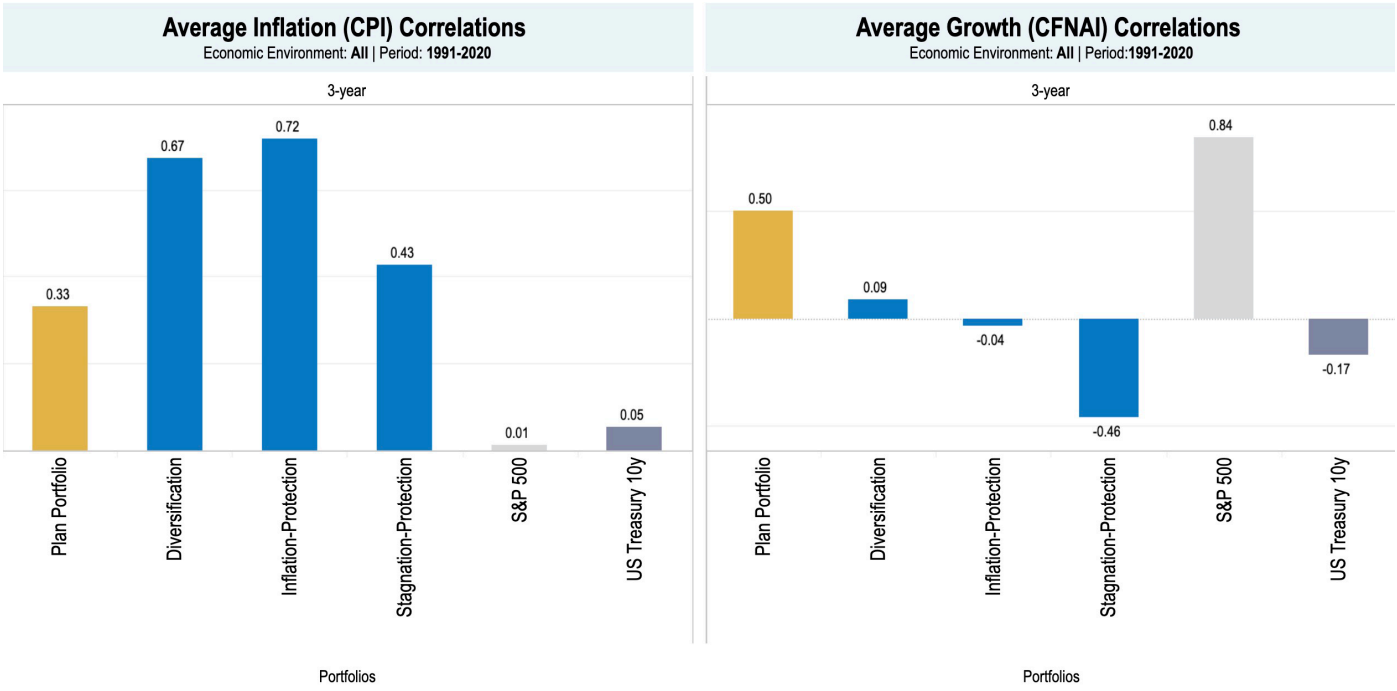
[3] For the construction of objective-oriented real assets strategy portfolios – Diversification, Inflation-Protection and Stagnation-Protection see H. Parikh and W. Zhang, "The Diversity of Real Assets: Portfolio Construction for Institutional Investors," PGIM IAS, April 2020.

[4] In addition to "All," the five economic environments classify the simulated data for the given "Period" based on the average CPI and CFNAI. "Ideal" environment includes periods with low CFNAI and high CPI values; "Overheating" environment includes periods with high CFNAI and high CPI; "Stagnation" includes periods with low CFNAI and low CPI; "Stagflation" includes periods with low CFNAI and high CPI and "Muddled" includes the remainder of the periods. For the simulation methodology see "Institutional Gold!" PGIM IAS, November 2019.

To illustrate using *RASA Interactive*, we compare a hypothetical public DB plan's real assets portfolio to a real assets benchmark. We assume that the benchmark is a representative portfolio across a peer group of large DB public pension plans.[5] Suppose the CIO wishes to change their portfolio mix to increase its sensitivity to inflation relative to the benchmark? Alternatively, how might the CIO change the portfolio mix if the CIO is specifically concerned about a future stagflation economic environment?

In the ***input panel*** for the **Portfolio-Level RASA Statistics** and **Asset-Level Clustering** dashboards, the CIO can enter weights for 14 different public and private real assets for their plan's real asset portfolio ("Plan Portfolio" – weights see Figure 2) and the benchmark ("Plan Benchmark" – weights see Figure 1).

Figure 3: Portfolio-Level Correlations for the Plan Portfolio (Portfolio-Level RASA Statistics Dashboard)



Note: For illustrative purposes only.

Before selecting potential real assets for the portfolio, the CIO may first wish to compare various real assets depending on their RASA statistics like correlations or betas. To do this, the CIO can use the "Asset-Level RASA Statistics" dashboard (Figure A1). Once the CIO has identified a potential set of real assets and portfolio weights, the CIO can analyze the real assets or the custom portfolio in the ***output panel***. The ***output panel*** differs depending on the dashboard:

Asset-Level RASA Statistics: The ***top output panel*** shows the real assets selected by the CIO, averages and the 90th percentile confidence interval bands for the selected statistic (Figure 4). In the ***bottom output panel***, a scatter chart is plotted comparing real assets based on average statistical values. For example, if Betas (statistic) and CPI and CFNAI (sensitivities) are selected the scatter chart shows the average CFNAI Beta on the x-axis and the average CPI Beta on the y-axis.

Portfolio-Level RASA Statistics: The ***top output panel*** shows the CIO's custom portfolio compared to the three objective-oriented real assets portfolios and traditional assets (stocks and bonds) based on the average value of the selected statistic. In the ***bottom output panel***, average values of the statistic are displayed for the custom and other portfolios (e.g., see Figure 1).

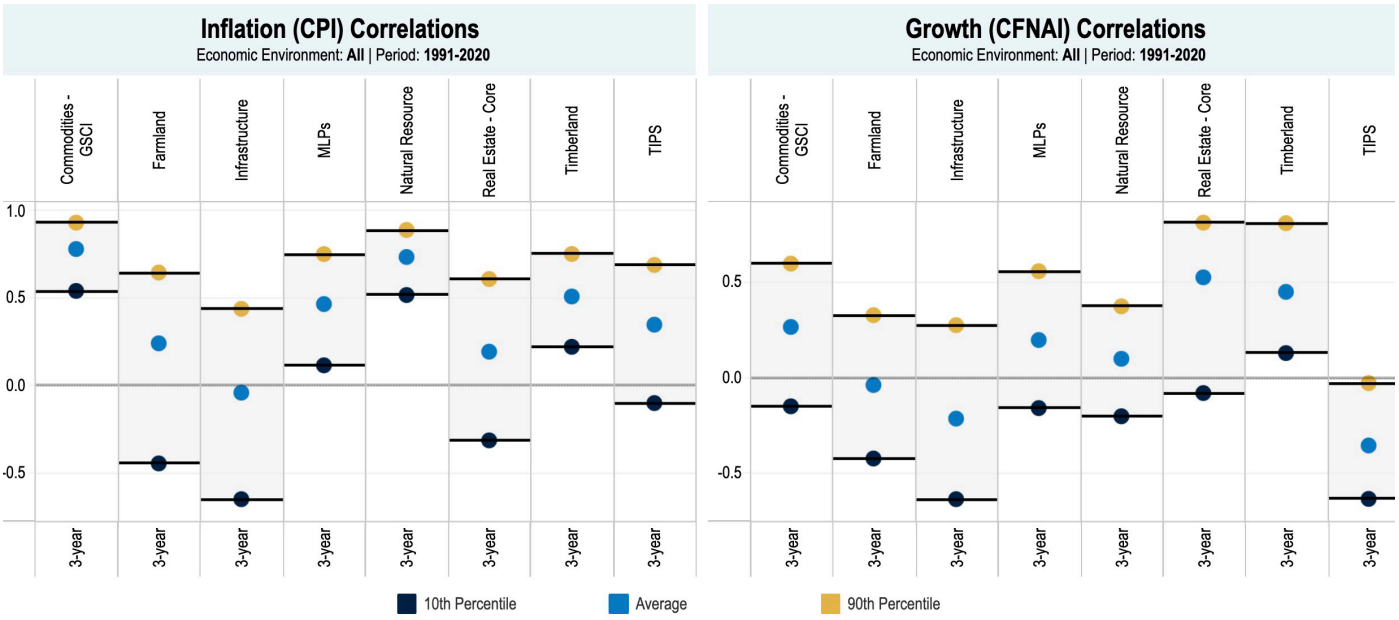
Asset-Level Clustering: The scatter chart displayed in the ***top output panel*** depends on the choice of statistics made using **Select Cluster Chart Type** selection. Real assets with the same color belong to a common cluster. The ***bottom output panel*** displays cluster-level average statistics (Figure 6).

[5] Instead of using a representative peer group portfolio, a CIO may use other benchmarks such as the Bloomberg Commodity Index. Some portfolios use CPI + 4% as a benchmark, here an implicit assumption is correlation of 1 to inflation (CPI). Using the application, a CIO may construct a portfolio with high correlation to CPI.

Comparing correlation values of the benchmark and plan portfolio in Figures 1 & 3, we find that the plan portfolio has lower average 3y inflation (CPI) correlation value than the benchmark (0.33 vs. 0.37). In contrast, the plan's real assets portfolio has higher average 3y growth (CFNAI) correlation than the benchmark (0.5 vs. 0.46). ***What if the DB sponsor wants to increase their portfolio's inflation exposure?***

The CIO can use the **Asset-Level RASA Statistics** dashboard to look for real assets with higher correlation to inflation. Commodities, natural resource, and MLPs each have high average 3y correlation to inflation (Figure 4). In addition, to match the benchmark's exposure to growth, the CIO may consider including real assets with low average 3y correlations to growth such as TIPS, infrastructure, and farmland.

Figure 4: Asset-Level Correlations (Asset-Level RASA Statistics Dashboard)



Note: For illustrative purposes only.

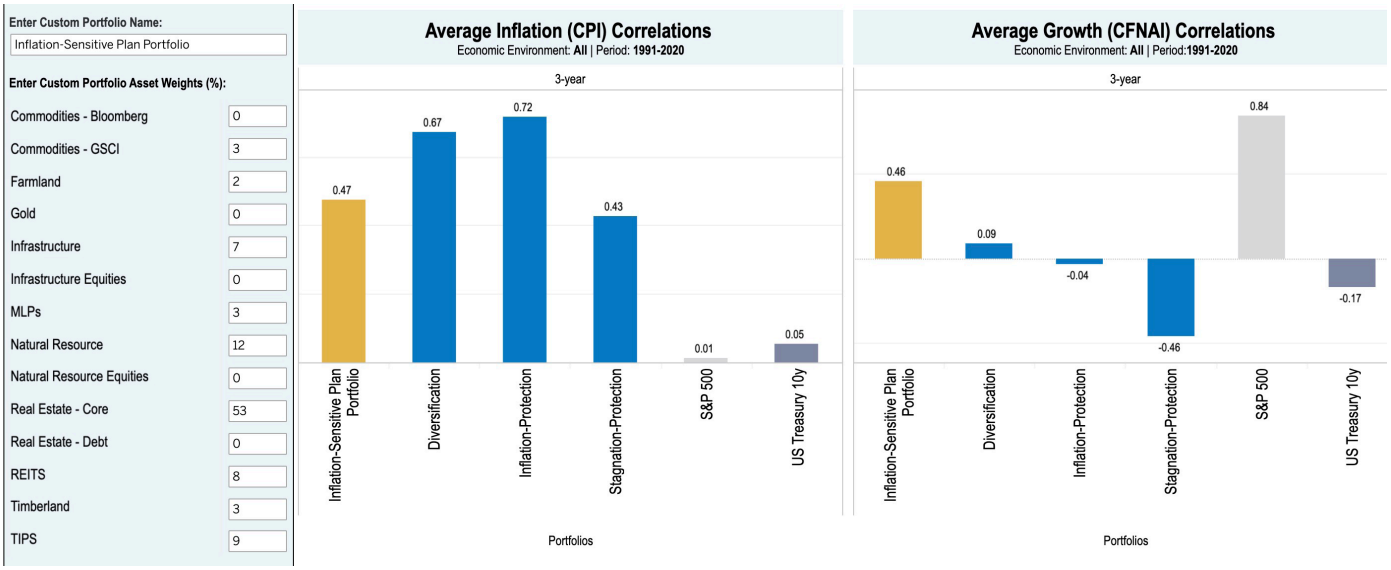
Once the CIO identifies the potential set of real assets for their portfolio, the CIO can create a "what-if" custom portfolio (labeled "Inflation-Sensitive Plan Portfolio") using the **Portfolio-Level RASA Statistics** dashboard. The CIO may choose portfolio weights similar to the benchmark but with a tilt to those identified real assets with high inflation exposures like natural resource, commodities, and MLPs. Compared to the benchmark, the CIO's new portfolio has a higher correlation to inflation (0.47 vs. 0.37) while correlation to growth remains the same (0.46) (Figure 5). These allocation tilts can be incorporated either tactically or strategically. Based on these new allocations, the CIO can construct an inflation-sensitive custom benchmark for an active manager to manage against. Alternatively, the CIO can reallocate capital across their specialty managers and overweight those assets with higher inflation beta.

A CIO interested in constructing a portfolio for a specific economic environment can select, for example, "Stagflation" in the **Select Economic Environment** box on the **Asset-Level RASA Statistics** dashboard. Those real assets with high average inflation (CPI) betas and low growth (CFNAI) betas in stagflation environment (such as farmland, infrastructure, natural resource and TIPS) may be of relevance to the CIO (Figure A5).

Once the CIO identifies the potential set of real assets for their portfolio, the CIO can create a "what-if" custom portfolio (labeled "Inflation-Sensitive Plan Portfolio") using the **Portfolio-Level RASA Statistics** dashboard. The CIO may choose portfolio weights similar to the benchmark but with a tilt to those identified real assets with high inflation exposures like natural resource, commodities, and MLPs. Compared to the benchmark, the CIO's new portfolio has a higher correlation to inflation (0.47 vs. 0.37) while correlation to growth remains the same (0.46) (Figure 5). These allocation tilts can be incorporated either tactically or strategically. Based on these new allocations, the CIO can construct an inflation-sensitive custom benchmark for an active manager to manage against. Alternatively, the CIO can reallocate capital across their specialty managers and overweight those assets with higher inflation beta.

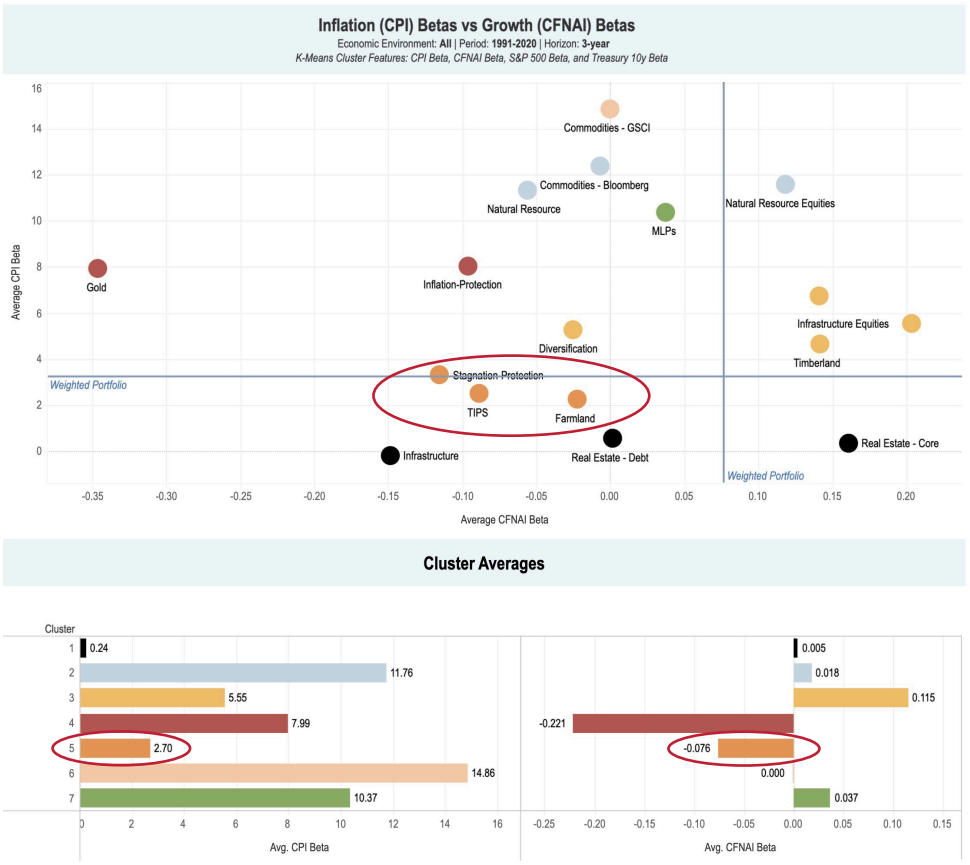
A CIO interested in constructing a portfolio for a specific economic environment can select, for example, "Stagflation" in the **Select Economic Environment** box on the **Asset-Level RASA Statistics** dashboard. Those real assets with high average inflation (CPI) betas and low growth (CFNAI) betas in stagflation environment (such as farmland, infrastructure, natural resource and TIPS) may be of relevance to the CIO (Figure A5).

Figure 5: Portfolio-Level Correlations for the Inflation-Sensitive Plan Portfolio (Portfolio-Level RASA Statistics Dashboard)



Note: For illustrative purposes only.

Figure 6: Asset-Level Clusters (Asset-Level Clustering Dashboard)



Note: For illustrative purposes only.

Using the **Asset-Level Clustering** dashboard, the CIO can discover any similarity across different real assets based on the RASA sensitivities to CPI, CFNAI, S&P 500 and 10y Treasuries (Figure 6). For example, Cluster 5 contains two real assets (TIPS and farmland) and the Stagnation-Protection portfolio. Assets and portfolios in this cluster share, on average, negative betas to growth (-0.076) and positive betas to inflation (2.7).[6]

While this is just one illustration for a CIO seeking high inflation exposure, other CIOs, say of a corporate pension plan, may be less concerned with inflation sensitivity and instead seek real assets that have low-growth exposure and offer diversification from traditional stocks and bonds. Or a DC plan-sponsor may wish to construct a custom real assets portfolio with higher equity exposure for early-year target date funds and with higher bond exposure for near-retirement target date funds.

Equipped with this analysis, the plan CIO may further engage with IAS for a bespoke analysis to evaluate real asset sectors or to optimally construct real assets portfolio or benchmark that accounts for estimation uncertainty, economic environment or multiple objectives like high inflation and low growth, etc.

Acknowledgments

Special thanks to PGIM Innovation group (Christian Clark, James Kallo, Nicholas Roach, Abhinai Pothireddy, and Peter So) for developing and implementing RASA™ Interactive as a web application. Many thanks also to Roben Dunkin, PGIM Chief Innovation Officer, and Dr. Taimur Hyat, PGIM Chief Operating Officer, for their project sponsorship.

[6] From the home page dashboard, CIOs can also download their analysis in the dashboards as a report in ".pdf" file format. For instructions to download click here.

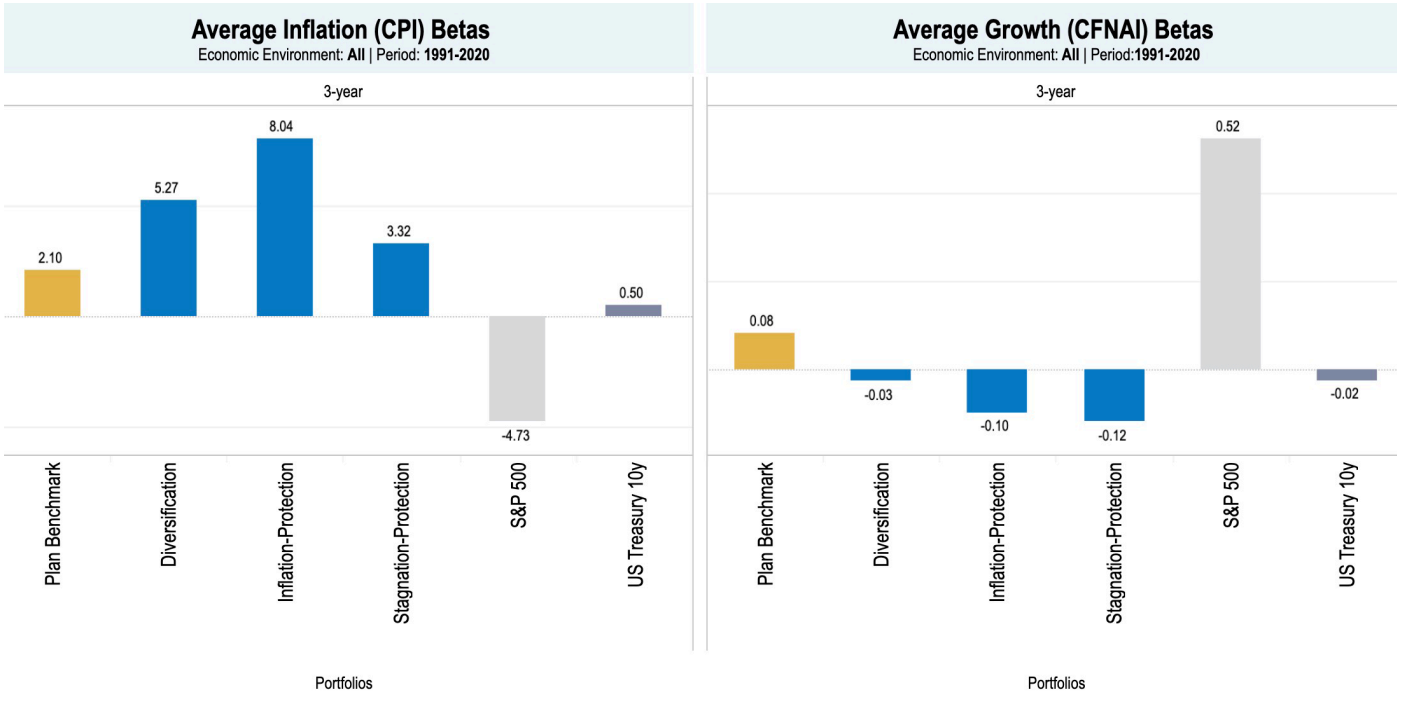
APPENDIX

Figure A1: CIO Input Panel (Asset-Level RASA Statistics Dashboard)

CIO Selections	Action	Description
Select Assets: ☐ (All) ☐ Commodities - Bloomberg ☑ Commodities - GSCI ☑ Farmland ☐ Gold ☑ Infrastructure ☐ Infrastructure Equities ☑ MLPs ☑ Natural Resource ☐ Natural Resource Equities ☑ Real Estate - Core ☐ Real Estate - Debt ☐ REITS ☑ Timberland Cancel Apply	Select the assets to compare based on the RASA statistics.	A CIO can compare 14 public and private real assets based on their RASA statistics such as betas or correlations. The CIO can also select traditional assets such as S&P 500 and 10y Treasury to compare.

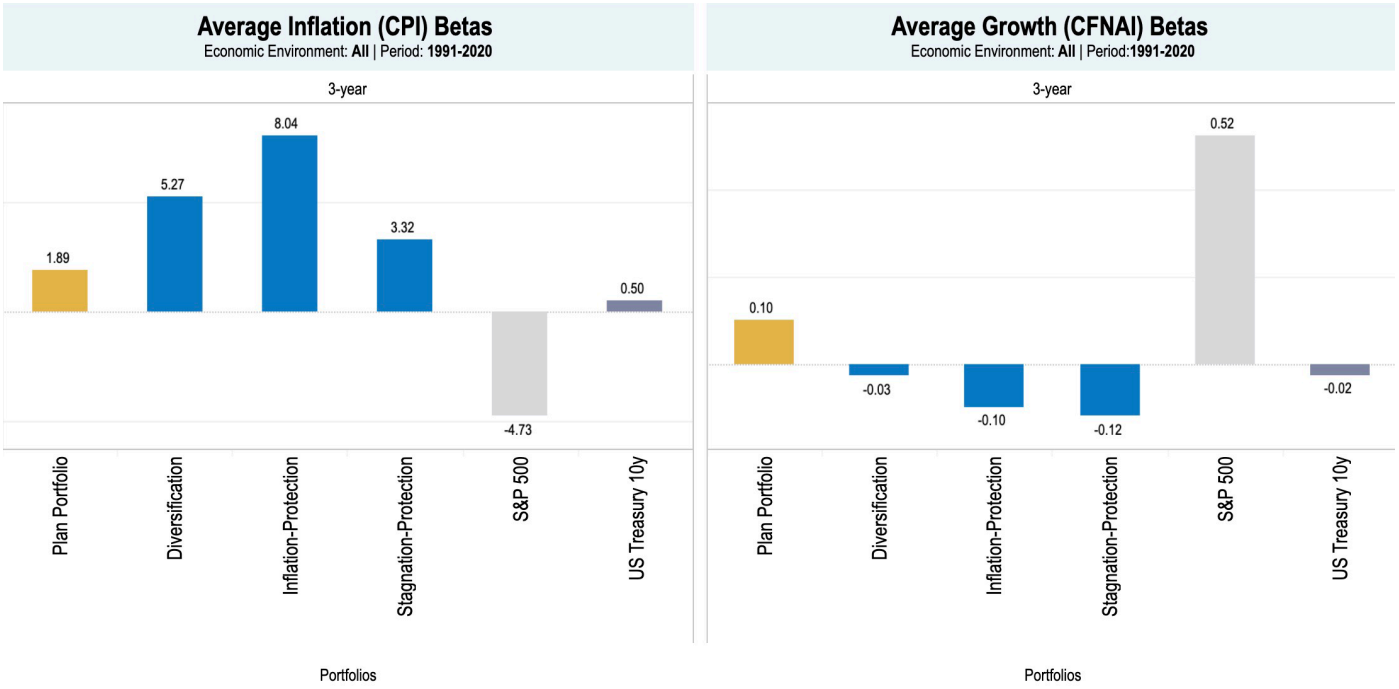
Note: For illustrative purposes only.

Figure A2: Portfolio-Level Betas for the Plan Benchmark



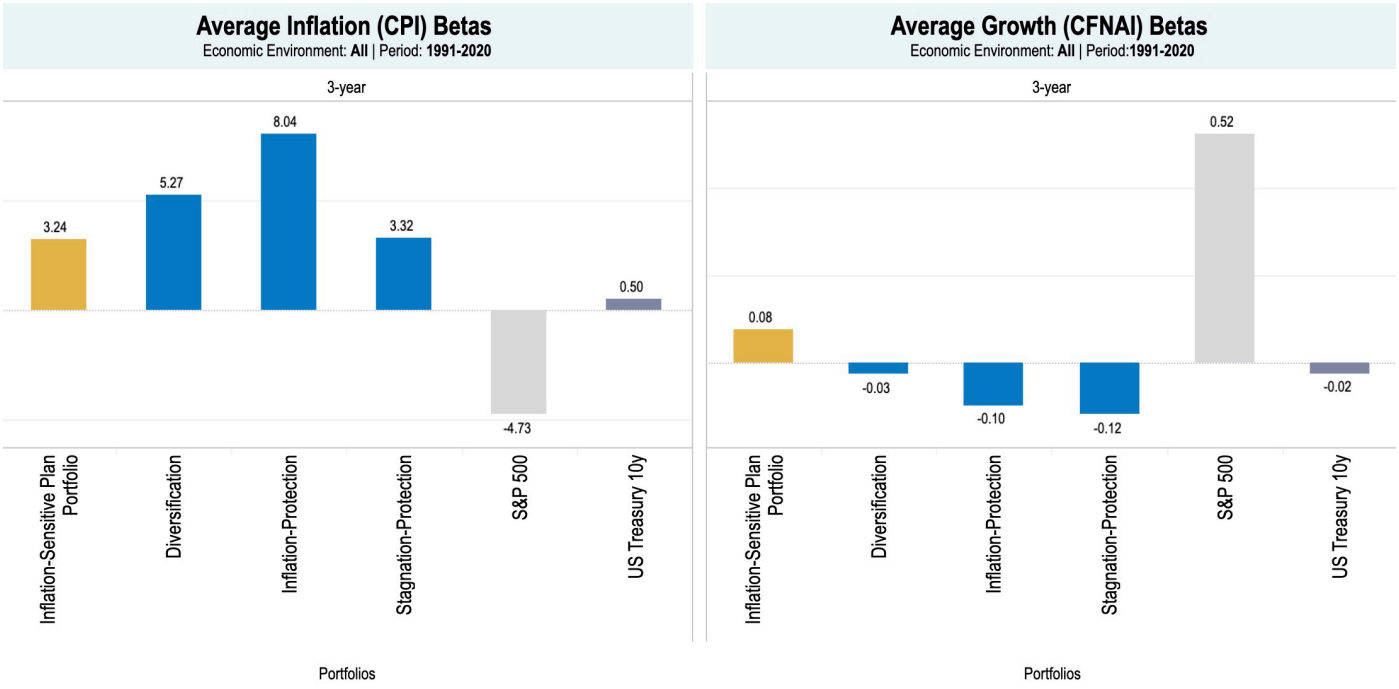
Note: For illustrative purposes only.

Figure A3: Portfolio-Level Betas for the Plan Portfolio



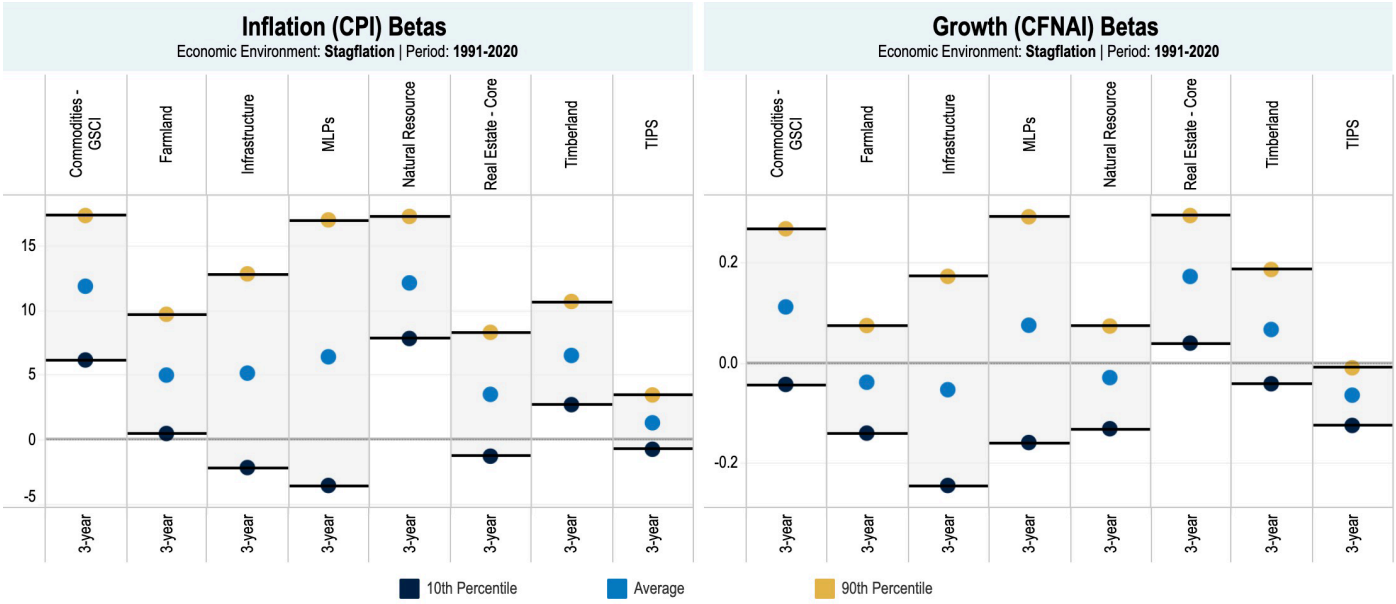
Note: For illustrative purposes only.

Figure A4: Portfolio-Level Betas for the Inflation-Sensitive Plan Portfolio



Note: For illustrative purposes only.

Figure A5: Asset-Level Betas for Real Assets in Stagflation Environment



Note: For illustrative purposes only.

IMPORTANT INFORMATION

For Professional Investors Only. Past performance is no guarantee or reliable indicator of future results. All investments involve risk, including the possible loss of capital. These materials are for informational or educational purposes only. In providing these materials, It is acknowledged and agreed that PGIM is not acting as a fiduciary in providing any recommendations, information or other communications contemplated by this arrangement (including without limitation asset allocation recommendations), and that such recommendations, information and communications (including without limitation any asset allocation recommendations) are not intended to serve, and will not serve, as a primary basis for your investment decisions.

Alternative investments are speculative, typically highly illiquid and include a high degree of risk. Investors could lose all or a substantial amount of their investment. Alternative investments are suitable only for long-term investors willing to forego liquidity and put capital at risk for an indefinite period of time. Equities may decline in value due to both real and perceived general market, economic and industry conditions. Investing in the bond market is subject to risks, including market, interest rate, issuer, credit, inflation risk and liquidity risk. Commodities contain heightened risk, including market, political, regulatory and natural conditions and may not be suitable for all investors. The use of models to evaluate securities or securities markets based on certain assumptions concerning the interplay of market factors, may not adequately take into account certain factors and may result in a decline in the value of an investment, which could be substantial.

The analysis in the paper is based on hypothetical modeling. There is no guarantee, and no representation is being made, that an investor will or is likely to achieve profits, losses or results similar to those shown. Hypothetical or simulated performance results are provided for illustrative purposes only and have several inherent limitations. Unlike an actual performance record, simulated results do not represent actual performance and are generally prepared through the retroactive application of a model designed with the benefit of hindsight. There are frequently sharp differences between simulated results and actual results. In addition, since trades have not actually been executed, simulated results cannot account for the impact of certain market risks such as lack of liquidity. There are several other factors related to the markets in general or the implementation of any specific investment strategy, which cannot be fully accounted for in the preparation of simulated results and all of which can adversely affect actual results.

All charts contained herein were created as of the date of this presentation, unless otherwise noted. Performance results for certain charts and graphs may be limited by date ranges, as stated on the charts and graphs. Different time periods may produce different results. Charts and figures are provided for illustrative purposes and are not an indication of past or future performance of any PGIM product.

These materials represent the views, opinions and recommendations of the author(s) regarding the economic conditions, asset classes, securities, issuers or financial instruments referenced herein, and are subject to change without notice. Certain information contained herein has been obtained from sources that PGIM believes to be reliable; however, PGIM cannot guarantee the accuracy of such information, assure its completeness, or warrant such information will not be changed. The information contained herein is current as of the date of issuance (or such earlier date as referenced herein) and is subject to change without notice. PGIM has no obligation to update any or all of such information; nor do we make any express or implied warranties or representations as to the completeness or accuracy or accept responsibility for errors. Any forecasts, estimates and certain information contained herein are based upon proprietary research and should not be considered as investment advice or a recommendation of any particular security, strategy or investment product. These materials are not intended as an offer or solicitation with respect to the purchase or sale of any security or other financial instrument or any investment management services and should not be used as the basis for any investment decision. No liability whatsoever is accepted for any loss (whether direct, indirect, or consequential) that may arise from any use of the information contained in or derived from this report. PGIM and its affiliates may make investment decisions that are inconsistent with the recommendations or views expressed herein, including for proprietary accounts of PGIM or its affiliates. The opinions and recommendations herein do not take into account individual client circumstances, objectives, or needs and are not intended as recommendations of particular securities, financial instruments or strategies to particular clients or prospects. No determination has been made regarding the suitability of any securities, financial instruments or strategies for particular clients or prospects. For any securities or financial instruments mentioned herein, the recipient(s) of this report must make its own independent decisions.

An investment cannot be made directly in an unmanaged index. The Bloomberg Commodity Index (BCOM) is a broadly diversified commodity price index distributed by Bloomberg Indexes. The index was originally launched in 1998 as the Dow Jones-AIG Commodity Index (DJ-AIGCI) and renamed to Dow Jones-UBS Commodity Index (DJ-UBSCI) in 2009, when UBS acquired the index from AIG.

The S&P 500 Index, or the Standard & Poor's 500 Index, is a market-capitalization-weighted index of the 500 largest U.S. publicly traded companies. The S&P is a float-weighted index, meaning company market capitalizations are adjusted by the number of shares available for public trading.

The information contained herein is provided by PGIM, Inc., the principal asset management business of Prudential Financial, Inc. (PFI), and an investment adviser registered with the US Securities and Exchange Commission. In the United Kingdom and various European Economic Area jurisdictions, information is issued by PGIM Limited with registered office: Grand Buildings, 1-3 Strand, Trafalgar Square, London, WC2N 5HR. PGIM Limited is authorised and regulated by the Financial Conduct Authority of the United Kingdom (registration number 193418) and duly passported in various jurisdictions in the EEA. Prudential Financial, Inc. of the United States is not affiliated with Prudential plc, incorporated in the United Kingdom or with Prudential Assurance Company, a subsidiary of M&G plc, incorporated in the United Kingdom. These materials are issued by PGIM Limited to persons who are professional clients or eligible counterparties as defined in Directive 2014/65/EU (MiFID II), investing for their own account, for fund of funds, or discretionary clients. In certain countries in Asia, information is presented by PGIM (Singapore) Pte. Ltd., a Singapore investment manager registered with and licensed by the Monetary Authority of Singapore. In Japan, information is presented by PGIM Japan Co. Ltd., registered investment adviser with the Japanese Financial Services Agency. In South Korea, information is presented by PGIM, Inc., which is licensed to provide discretionary investment management services directly to South Korean investors. In Hong Kong, information is provided by PGIM (Hong Kong) Limited, a regulated entity with the Securities & Futures Commission in Hong Kong to professional investors as defined in Section 1 of Part 1 of Schedule 1 (paragraph (a) to (i) of the Securities and Futures Ordinance (Cap.571). In Australia, this information is presented by PGIM (Australia) Pty Ltd. ("PGIM Australia") for the general information of its "wholesale" customers (as defined in the Corporations Act 2001). PGIM Australia is a representative of PGIM Limited, which is exempt from the requirement to hold an Australian Financial Services License under the Australian Corporations Act 2001 in respect of financial services. PGIM Limited is exempt by virtue of its regulation by the Financial Conduct Authority (Reg: 193418) under the laws of the United Kingdom and the application of ASIC Class Order 03/1099. The laws of the United Kingdom differ from Australian laws. Pursuant to the international adviser registration exemption in National Instrument 31-103, PGIM, Inc. is informing you of that: (1) PGIM, Inc. is not registered in Canada and relies upon an exemption from the adviser registration requirement under National Instrument 31-103; (2) PGIM, Inc.'s jurisdiction of residence is New Jersey, U.S.A.; (3) there may be difficulty enforcing legal rights against PGIM, Inc. because it is resident outside of Canada and all or substantially all of its assets may be situated outside of Canada; and (4) the name and address of the agent for service of process of PGIM, Inc. in the applicable Provinces of Canada are as follows: in Québec: Borden Ladner Gervais LLP, 1000 de La Gauchetière Street West, Suite 900 Montréal, QC H3B 5H4; in British Columbia: Borden Ladner Gervais LLP, 1200 Waterfront Centre, 200 Burrard Street, Vancouver, BC V7X 1T2; in Ontario: Borden Ladner Gervais LLP, 22 Adelaide Street West, Suite 3400, Toronto, ON M5H 4E3; in Nova Scotia: Cox & Palmer, Q.C., 1100 Purdy's Wharf Tower One, 1959 Upper Water Street, P.O. Box 2380 - Stn Central RPO, Halifax, NS B3J 3E5; in Alberta: Borden Ladner Gervais LLP, 530 Third Avenue S.W., Calgary, AB T2P R3.

IAS 0708-100