INSTITUTIONAL ADVISORY & SOLUTIONS

HARNESSING THE POTENTIAL OF PRIVATE ASSETS

A Framework For Institutional Portfolio Construction

June 2021

AUTHORS

Junying Shen
Vice President, PGIM IAS
junying.shen@pgim.com
+1 973 508 4538

Michelle (Yu) Teng, PhD, CFA, CAIA
Vice President, PGIM IAS
michelle.teng@pgim.com
+1 973 367 6947

Ding Li
Senior Vice President, GIC
liding@gic.com.sg
+65 6889 8233

Grace (Tiantian) Qiu, PhD
Senior Vice President, GIC
graceqiu@gic.com.sg
+65 6889 8223

This research is a collaboration between GIC TPS and PGIM IAS. The Total Portfolio Strategy division (TPS) of GIC's Economics & Investment Strategy department (EIS) works closely with the Group Executive Committee to set the Total Portfolio's strategic asset allocation, define factor and asset class opportunity sets and benchmarks, and target optimal internal active strategy exposure. The PGIM Institutional Advisory & Solutions (IAS) group provides objective, data-informed analysis to help Chief Investment Officers and Investment Committees manage their portfolios.

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

Institutional portfolios are increasing allocations to illiquid private assets seeking better returns and diversification. However, as allocations increase, a portfolio's liquidity structure changes, sometimes abruptly. How can a CIO increase their confidence with private asset allocations and unlock their potential?

Using a corporate defined benefit pension plan as our example, we present and illustrate a practical framework (OASIS™) that can help CIOs analyze how their top-down asset allocation and their bottom-up private investing activity interact to affect their portfolio's ability to respond to liquidity demands in a multi-asset, multi-period setting. This is exactly what a CIO needs to know.

Besides scheduled benefit payments, corporate pension plans have many unexpected liquidity demands which should be accounted for when evaluating liquidity risk. For example, a plan should be able to rebalance when market movements cause allocations to exceed risk limits. A plan also needs liquidity to meet unexpected capital calls and be prepared for exogenous cash flow events driven by corporate actions (*e.g.*, pension risk transfers, corporate contributions, and merger and acquisition activities). Many plans also have asset allocation glide paths, conditional on the plan's funding ratio, that present additional liquidity strains as it may be difficult to sell illiquid assets to satisfy new allocation targets.

The CIO's challenge is to maximize expected portfolio performance while keeping liquidity risk under control. By measuring the potential tradeoff between asset allocation, portfolio performance and multiple dimensions of liquidity risk, the OASIS framework can help CIOs make more informed portfolio management decisions.

Institutional portfolios are increasing allocations to illiquid private assets in the search for higher returns and better diversification. However, this comes at the cost of decreasing portfolio liquidity as private assets are not easily sold to meet portfolio liquidity demands. Also, private assets generate their own unpredictable liquidity demands when general partners make capital calls stemming from prior commitments. Investors need a strong understanding of how private assets might impact the liquidity characteristics of their portfolios.

For CIOs, liquidity risk is one of the most critical, but least quantified, risk dimensions in portfolio construction. Traditional portfolio construction techniques, including mean-variance optimization or risk parity, focus heavily on return variability and return drawdowns, but treat liquidity risk as a secondary consideration. Unlike fluctuations in returns, which tend to be transitory, liquidity availability can be a matter of survival. For example, pension plans with periodic beneficiary obligations need to ensure that their asset allocation does not unduly risk failing to meet these and other obligations (*e.g.*, capital calls). Even CIOs without explicit obligations may have critical and unexpected liquidity needs such as rebalancing the portfolio to manage risk or having enough dry powder to take advantage of opportunities during periods of market dislocation.

Much has been published separately on the two topics covered by this paper: private asset cash flow modeling and portfolio construction with public and private assets. For many institutional investors, the former is well understood by their private asset deal teams and is often modeled on a bottom-up, deal-by-deal basis or at the aggregate strategy/vintage level, while the latter is conducted by the team responsible for top-down asset allocation. The limitation of such an arrangement is that portfolio asset allocation decisions often do not consider the bottom-up cash flow information and, likewise, the deal teams usually do not formulate their commitment strategies in a top-down, total portfolio context. Consequently, the portfolio liquidity implications of the *combined* decisions of the two groups are rarely explicitly considered. *But in our view, this is exactly what the CIO needs to know.*

PGIM's asset allocation framework (OASIS™ – **O**ptimal **As**set Allocation with **I**lliquid Asset**s**) can help CIOs analyze how their allocations to liquid public and illiquid private assets, in combination with their private asset commitment strategies, may affect their portfolio's ability to respond to liquidity demands.[1] OASIS explicitly incorporates certain characteristics of private assets, such as the delay and uncertainty of capital calls, lumpy and high transaction costs and high idiosyncratic risk, to examine if a portfolio can meet its liquidity demands across different market environments while keeping the risk of a debilitating liquidity event at a level acceptable to the CIO.

OASIS links private asset cash flow modeling with asset allocation analysis. Private asset cash flows are consistently modeled together with expected public asset returns and risk that drive the portfolio construction process. By doing so, liquidity measurement and cash flow management can be formally integrated into a multi-asset, multi-period portfolio construction process. In addition, private asset commitment strategies, even custom ones, are incorporated to reveal the portfolio's overall liquidity characteristics.

Constructing a portfolio that can respond to liqudity demands has implications for the portfolio's asset allocation and, hence, its expected return. At one extreme, while a portfolio of cash gives the CIO full flexibility to meet unexpected liquidity demands, such an asset allocation likely hurts long-term performance. At the other extreme, while a portfolio of private assets might have high expected long-term returns, this allocation gives the CIO little room to meet short-term liquidity demands and may eventually hurt performance if these assets must be urgently sold, often at a discount, to raise cash. Ultimately, it is the CIO's decision on how to structure the portfolio to maximize expected portfolio performance while keeping liquidity risk under control. However, to meet this challenge the CIO needs a way to address several important questions:

1. How to formulate a **private asset commitment strategy** to manage private asset exposure and the uncertainty in timing and magnitude of their cash flows?
2. How to design the **asset allocation glide path** (*i.e.*, allocation to liability hedging assets *vs.* growth assets, and illiquid assets *vs.* liquid assets) towards the goal of a higher funding ratio and reduced funding ratio variability?
3. How might **changes** to the plan (*e.g.*, increased corporate contributions) or the CIO's own capabilities (*e.g.*, superior **fund-selection skill**) impact the portfolio's liquidity and performance?

OASIS is a cash flow-driven asset allocation framework that can help CIOs answer these questions. To illustrate the framework, we consider a US corporate defined benefit (DB) plan portfolio with scheduled benefit payment obligations.[2] It is crucial that these cash flow obligations are met when due. In addition to benefit payments, such a plan has other cash flow needs. The plan should be able to rebalance its asset allocation when market movements cause allocations to deviate outside of established boundaries. The plan also needs liquidity to meet capital calls. Finally, the plan should be prepared for exogenous cash flow events driven by corporate actions: pension risk transfer (PRT) transactions, new (or delayed) corporate contributions, corporate merger and acquisition activities and a decision to close the plan to new participants.[3]

1 OASIS can incorporate multiple types of private assets, such as private equity, real estate, and private debt. See J. Shen, *et al.*, "Asset Allocation and Private Market Investing," *Journal of Portfolio Management*, 2021, for details on private asset cash flow modeling. See M. Teng, W. Zhang and J. Kohana, "A Cash Flow Model for Private Core+ Real Estate Debt Funds," PGIM IAS, (forthcoming, 2021), for details on core+ real estate debt modeling.

2 Although not discussed here, longevity risk can be incorporated as well. For details see M. Teng and J. Shen (2019).

3 Although we illustrate OASIS in the context of a US corporate DB plan, OASIS can be used for many types of institutional portfolios such as sovereign wealth funds, public pension plans and endowments that may have either explicit or implicit cash flow obligations.

Corporate DB plans also have endogenous liquidity demands which should be accounted for when evaluating liquidity risk. For example, CIOs closely monitor their plan's **funding ratio** (*i.e.*, market value of assets divided by the present value of liabilities). A strong funding ratio helps minimize required contributions and any PBGC premiums to meet regulatory requirements.[4] To control funding ratio risk, many CIOs have asset allocation **glide paths** that adjust the plan's asset allocation as certain funding ratio targets are reached. Typically, as the funding ratio improves, CIOs de-risk the plan's asset allocation (*i.e.*, more hedging and less growth assets). These glide paths impose further liquidity requirements as it may be difficult to sell illiquid private assets to satisfy new allocation targets. Other sources of liquidity risk may be cash margin flows arising from derivatives positions. All in all, the CIO has a challenging task to identify all the possible sources of liquidity demands.

To properly assess the tradeoff between expected performance and liquidity risk the CIO needs to be able to assess the potential interaction between liquidity demands and portfolio asset allocation **across different market environments**. In addition, the CIO needs to conduct "what-if" analysis to see how liquidity risk might change if, for example: longevity increases; the company does a large PRT transaction; or the glide path is altered to increase the allocation to illiquid assets. By measuring the potential tradeoff between portfolio performance and liquidity risk (along with other concerns such as funding ratio variability), OASIS can help CIOs make more informed portfolio management decisions.

OASIS Asset Allocation Framework

Figure 1 presents the three components of OASIS. The first generates public returns based on the CIO's capital market assumptions and asset allocation. The second component produces private asset cash flows and valuations based on public returns and the CIO's fund-selection skill, commitment strategy and views on private asset performance. The interaction of the returns and private cash flows with the plan's liquidity demands (the third component) produces the portfolio's tradeoff between liquidity risk and expected performance. We briefly describe the three components and their interactions.[5]

Market Simulation and Private Asset Cash Flows

We use simulation to model the risk and return of the public asset portfolio (*e.g.*, liquid public stocks and bonds). These assets are assumed to be readily liquidated for cash, after paying transaction costs which depend on the asset and market conditions. To capture private equity cash flows we use the cash flow model developed by Takahashi and Alexander (2002) which is a deterministic model that captures the stylized pattern of limited partner (LP) capital contributions, distributions, and net asset values (NAVs).[6] We calibrate the TA model to capture the empirical relationship between private cash flows and public market performance. A cash flow model that is consistent and responsive to the underlying capital market environment allows investors to perform stress tests and tailor their liquidity analysis to forward-looking scenarios.

Private Asset Commitment Strategies

A **private asset commitment strategy** is crucial to balance several investment objectives including performance, risk and liquidity. While there are many possible commitment strategies, we discuss two strategies based on common CIO private asset investment goals – either try to net out the periodic cash flows from private asset investing to minimize portfolio disruption **(Cash Flow Matching)**, or try to target a NAV percentage of the entire portfolio over time **(Target NAV)**.

Cash Flow Matching (CFM)

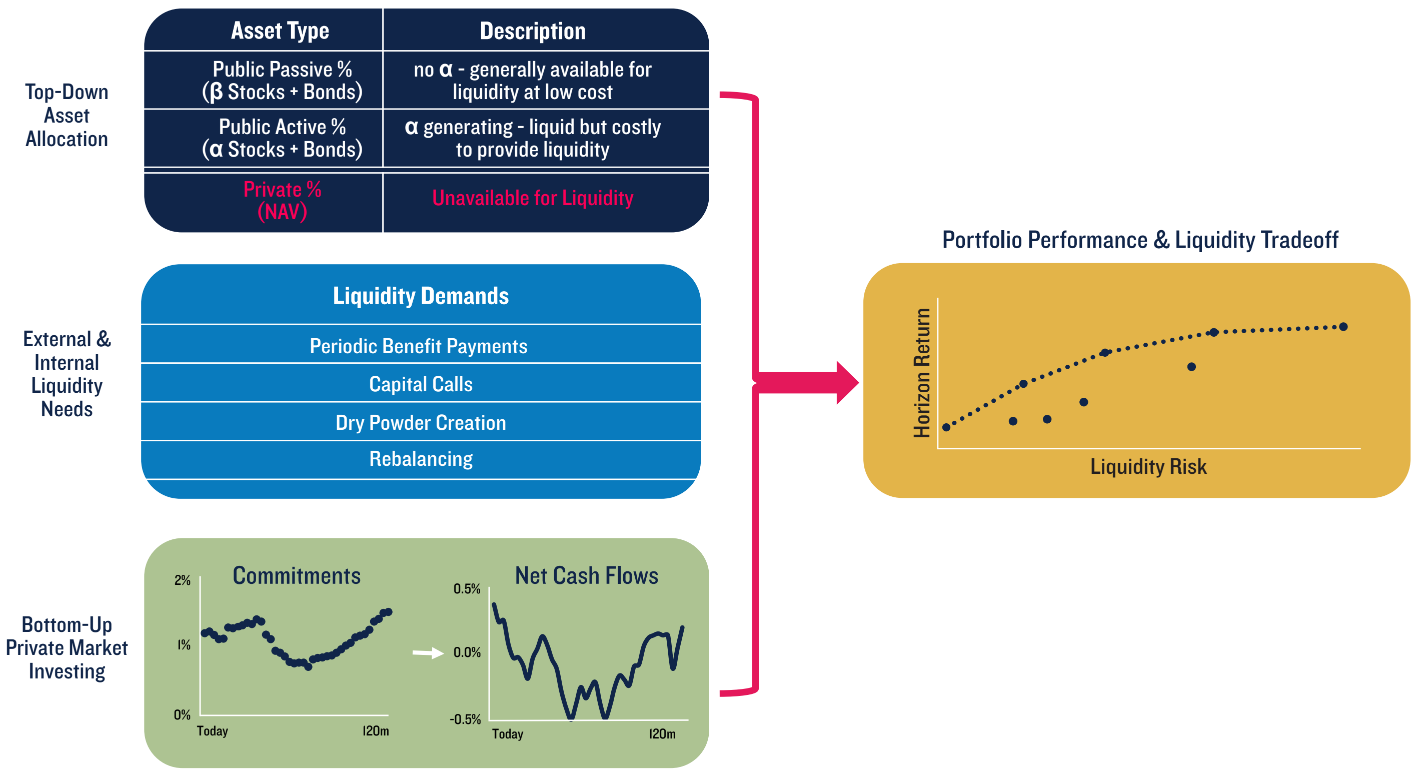
The CFM commitment strategy aims to build a private asset portfolio whose periodic cash flows (contributions and distributions) net close to zero. In other words, all distributions received in the previous quarter should fund all capital calls in the current quarter. Such a strategy can help insulate the rest of the portfolio from the private asset investment activity. The commitment amount at the beginning of each quarter is determined so that the projected net cash flow (distributions minus capital calls) two quarters ahead (based on reported NAV at the end of last quarter) is expected to be zero.

4 ERISA (Employee Retirement Income Security Act of 1974) specified funding rules for single-employer defined benefit (DB) pension plans. Since ERISA, Congress has periodically modified the funding rules. The Pension Protection Act of 2006 (PPA) was the most recent major legislation to affect pension plan funding. It defined new pension funding standards for single-employer DB plans that require plans to become 100% funded over a certain period. Since PPA was enacted, at times, legislation has provided funding relief. For example, the American Rescue Plan Act of 2021 (ARPA) provides extended amortization periods and modification of the interest rate stabilization rules for single-employer plans. See "Single-Employer Defined Benefit Pension Plans: Funding Relief and Modifications to Funding Rules," Congressional Research Service, (May 2020), and https://www.pbgc.gov/american-rescue-plan-act-of-2021#:~:text=The%20American%20Rescue%20Plan%20Act,sum%20payment%20to%20eligible%20multiemployer.

5 Details for each component can be found in the Appendix to J. Shen, *et al.*, (2021).

6 For other private assets (*e.g.*, real estate and private debt) we model them as income-generating assets with quarterly distributions with limited liquidity (*i.e.*, annual rebalancing). See Appendix for details. See also M. Teng, *et al.*, (forthcoming, 2021).

Figure I: OASIS Structure



Source: GIC TPS & PGIM IAS. Provided for illustrative purposes only.

The CFM commitment strategy has a few limitations: 1) The strategy can lead to a volatile commitment pattern over time and may skip commitments over multiple periods – which may be undesirable for maintaining vintage diversification; 2) The strategy cannot control how NAV will grow as a percentage of the overall portfolio; and 3) For a private capital investment program with no prior commitments and NAV, cash flow matching is not possible until distributions start to arrive.

Target NAV

The Target NAV strategy tries to achieve and maintain a target NAV as a percentage of the overall portfolio (NAV%). It is useful to think of three distinct pools of capital associated with private asset investing: 1) capital that is **"in the ground"** also known as the **NAV**; 2) **"committed, but uncalled" capital** which is committed capital that has not yet been called; and 3) **"uncommitted" capital** which is any remaining uncommitted capital initially allocated to private assets plus distributions subsequently received from prior commitments that have not yet been committed.

The commitment amount at the beginning of each quarter is determined as a fixed fraction ***(f)*** of the uncommitted capital at the end of the prior period. Uncommitted capital is continuously replenished by distributions from prior commitments. A NAV% can be achieved by selecting the appropriate *f* value.[1] A drawback of this strategy is that it may require frequent buying and selling of other parts of the portfolio to absorb or free up capital for private market-related activities.

If a CIO wishes to maintain an existing private asset allocation or build up the allocation to a target level, then the Target NAV strategy may be suitable. In addition, Target NAV's quarterly commitment amounts are smoother compared to CFM's. However, if portfolio liquidity is a major concern then CFM may be preferable as it tries to have zero periodic net cash flows across different market environments. CFM may help avoid liquidity events during bad market environments when CIOs most need liquidity.[2]

7 The difference between CFM and Target NAV in determining commitment amounts is that CFM requires forecasting *ex ante* cash flows consistent with the CIO's views so that expected periodic net cash flow equal zero, while Target NAV adjusts *f* according to how the average of *ex post* simulated NAV% compares to a target 10YE NAV%.

8 See J. Shen, *et al.*, (2021) for a detailed comparison between Target NAV and Cash Flow Matching commitment strategies.

Portfolio Structure, Liquidity and Rebalancing

To simplify, we classify portfolio assets into three types: two liquid and one illiquid (Figure 2). The two liquid asset types include *liquid passive* public assets representing beta-type investments in equity and fixed income assets not expected to earn an alpha (*e.g.*, an ETF on a broad-based index fund) and *liquid active* public assets that are actively managed to earn an alpha over passive indices (*e.g.*, an actively managed fund or a liquid hedge fund strategy). The *illiquid* private asset type represents all investments in private assets.

Liquidity Demands & Sources, Liquidity Events & Rebalancing Failures[1]

We recognize three main categories of portfolio liquidity demands:

1. **Pension Benefit Payments:** A monthly participant payment that the plan must meet;
2. **Private Capital Calls:** An obligation that a CIO, as an LP, must fulfill based on total initial committed capital amounts, but the timing and amount of these calls are not under the CIO's control; and
3. **Rebalancing:** A need to shift portfolio allocation, perhaps monthly, between asset classes (*e.g.*, growth *vs.* LDI (or, liability hedging) assets, public equity *vs.* public bonds) to maintain policy or target weights.

Other, more strategic, liquidity demands can also be considered, such as a PRT transaction which can expose a portfolio to higher liquidity risk after execution.

We assume CIOs can rank portfolio assets according to their "transactability" (*i.e.*, ease and cost of selling to meet a liquidity need). The CIO specifies which asset categories serve as liquidity sources for various liquidity demands and which categories, if any, are considered unavailable (*i.e.,* truly illiquid). The CIO must also specify a rule for sourcing liquidity: First sell assets from the part of the portfolio (or, "highest liquidity level") that would be least disruptive and expensive. If more assets must be sold, then source liquidity from increasingly disruptive and expensive liquidity levels. This ranking and rule form the CIO's liquidity "**waterfall**."

Figure 3 illustrates a liquidity waterfall. Liquid passive and active public assets together serve as "**assured cash**"– assets that the plan is assured can be readily convertible into cash, after transaction costs, whenever asset liquidation is necessary. A **liquidity event** occurs when the CIO must move down the waterfall beyond certain points to raise cash. For example, a liquidity event could occur if cash demands cause the portfolio to breach the CIO's "Early Alert Line" (a pre-defined portion, say, x%, of the portfolio's assured cash). In other words, while the CIO will use the assured cash portion of the portfolio to meet liquidity demands, the CIO may become uneasy if too much assured cash is drained. OASIS can inform the CIO how often their "Early Alert Line" might be breached. Another, more severe, liquidity event might occur if the portfolio also breaches the CIO's "Second Alert Line," say, y%, to meet liquidity demands. A single large liquidity demand could produce a cascade of liquidity events.

OASIS also calculates the probability of **rebalancing failures** over the investment horizon (*i.e.,* when the CIO is unable to rebalance the portfolio – due largely to periods of sharply divergent private and public asset performance – to meet the current target allocation within specified tolerance ranges) and identifies the cause.

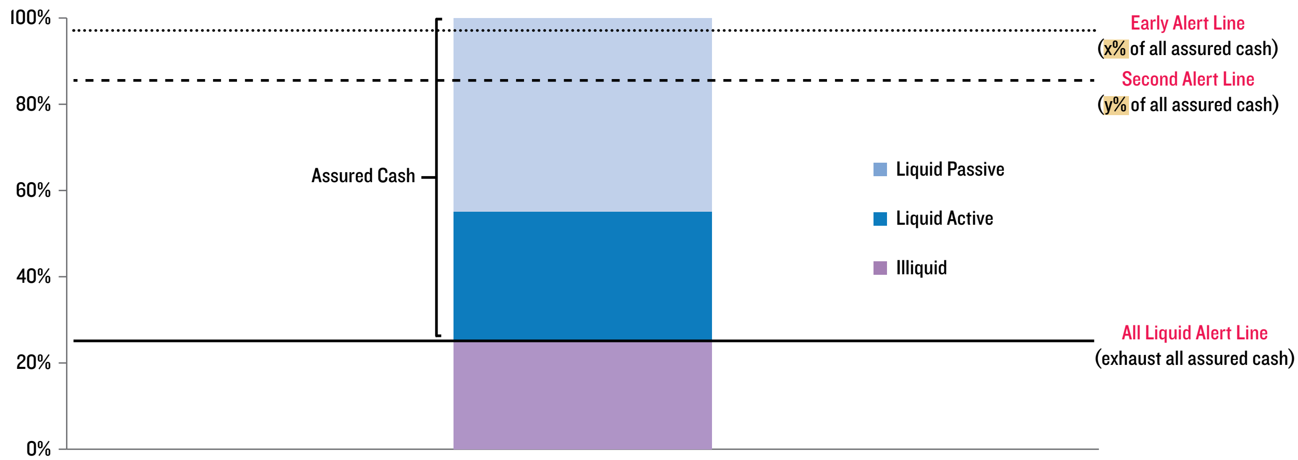
Figure 2: Portfolio Structure & Liquidity Levels

Asset Type	Liquidity Level	Liquidity Level Description	Asset	
(1) Liquid Passive	1A	**Committed, but Uncalled** Reserved for Capital Calls	Stock ETF	Bond ETF
		Uncommitted Reserved for Capital Calls		
	1B	Available for Liquidity	Stock ETF	Bond ETF
(2) Liquid Active	2	Available for Capital Calls if Level (1) is Exhausted	Stock ETF + αS	Bond ETF + αB
(3) Illiquid	3	Unavailable for Liquidity	LP Investments (NAV only)	

Note: αS and αB refer to the expected active return over the passive ETF asset. So, Stock ETF + αS refers to an actively managed stock asset.
Source: GIC TPS & PGIM IAS. Provided for illustrative purposes only.

9 The Appendix contains a detailed description of liquidity sourcing and rebalancing rules used for the example DB portfolio below.

Figure 3: Liquidity (Assured Cash) Waterfall



Note: Yellow field indicates an investor input. Source: GIC TPS & PGIM IAS. Provided for illustrative purposes only.

Liquidity Risk Severity – An Alternative Measure of Portfolio Liquidity Risk

Liquidity events and rebalancing failures, both their frequency and severity, contribute to a portfolio's **liquidity risk**. We therefore can measure a portfolio's overall liquidity risk by assigning a **severity value** to each liquidity event or rebalancing failure. A CIO is likely to consider certain liquidity situations of more concern than others. For example, having to liquidate liquid active strategies to pay pension benefits may be more painful due to transaction and opportunity costs than failing to rebalance the portfolio every month. OASIS allows a CIO to specify subjective severity values to each type of liquidity event and rebalancing failure to ascertain their portfolio's overall **liquidity risk severity score**.

Figure 4 shows examples of liquidity risk severity values for various liquidity events and rebalancing failures, with a higher value representing a subjectively more severe situation. Each simulation run has a severity score that is the sum of severity values for all liquidity events and rebalancing failures over the 10y horizon. For example, if one simulation run encounters two months that the Early Alert Line is breached, and three months during which rebalancing fails, the severity score for this simulation run would be 9 (= (2 × 3) + (3 × 1)). A portfolio's overall liquidity risk severity score is the average of the 5,000 severity scores across all simulation runs. The severity score allows CIOs to compare the liquidity risk of different asset allocations and commitment strategies.

Figure 4: Liquidity Risk Severity Values – Example

Types		CIO's Subjective Severity Value
Rebalancing Failures		1
Assured Cash Drains	> Early Alert Line (only)	3
	> Second Alert Line	4

Note: Yellow field indicates an investor input. Source: GIC TPS & PGIM IAS. Provided for illustrative purposes only.

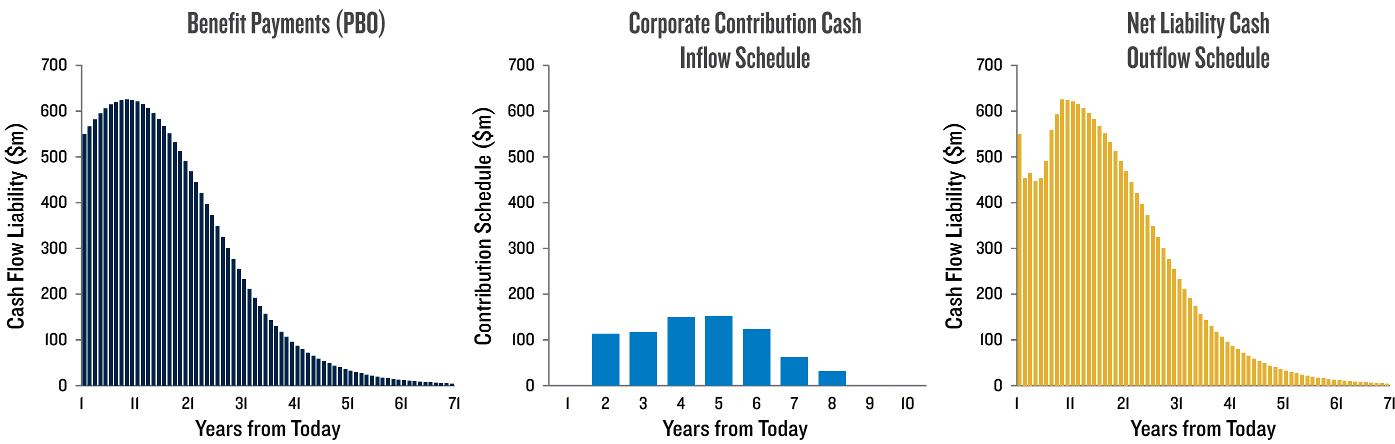
Bringing It All Together

We now illustrate how a DB plan CIO can use OASIS to determine their portfolio's expected performance and liquidity risk tradeoff. We incorporate several *additional* practical considerations that CIOs encounter: concerns about funding ratio variability; glide path requirements; unexpected corporate actions; and drawdown risk.

Baseline Portfolio Assumptions

Figure 5 shows a hypothetical DB plan's liability and corporate contribution schedules. The present value of the liability is $12.2b (with an assumed constant discount rate of 2.4%). We assume the plan's baseline asset portfolio has an initial AUM of $10b, producing an initial funding ratio of 82%.

Figure 5: Hypothetical Corporate Plan Liability and Contribution Schedules



Source: GIC TPS & PGIM IAS. Provided for illustrative purposes only.

The corporation in our example has given the CIO an allocation glide path (GP) to provide "de-risking guidance" for how the plan's target asset allocation should change as the funding ratio improves (Figure 6). As the funding ratio improves, the CIO de-risks the plan (*i.e.,* increases LDI and reduces growth assets) to "lock in" (to some degree) the improved funding ratio. We assume the plan follows a "one-way" glide path, *i.e.*, the target asset allocation will not revert to a previous GP allocation were the funding ratio to subsequently decline.

The plan's current asset allocation (*i.e.,* the "Current-GP0" column) has 50% invested in a liability hedging asset (LDI) whose duration matches the plan's liability duration. The other 50% is allocated as follows: 23% liquid public equity (13% passive and 10% active); 25% illiquid private assets (10% real estate & private debt, 15% private equity (NAV)); and 2% cash. The private equity asset is US buyout funds. The public equity and private assets are, collectively, the portfolio's **"growth assets"** as they alone can help move the funding ratio higher (or, lower).

The funding ratio range serves as the decision marker for each GP state. For example, if the funding ratio were to increase to 88% (from the current 82%), the glide path instructs the CIO to move the portfolio's target asset allocation to GP1.[1] This allocation then stays put until (if) a higher funding ratio triggers a change in the GP state. The GP4 asset allocation – the ending GP state once the funding ratio exceeds 100% – is mostly the LDI asset (85%), along with some growth assets (13%) and cash (2%). Figure 7 shows the target asset allocation evolution in terms of three broad asset categories – LDI, growth assets and cash – following the glide path.

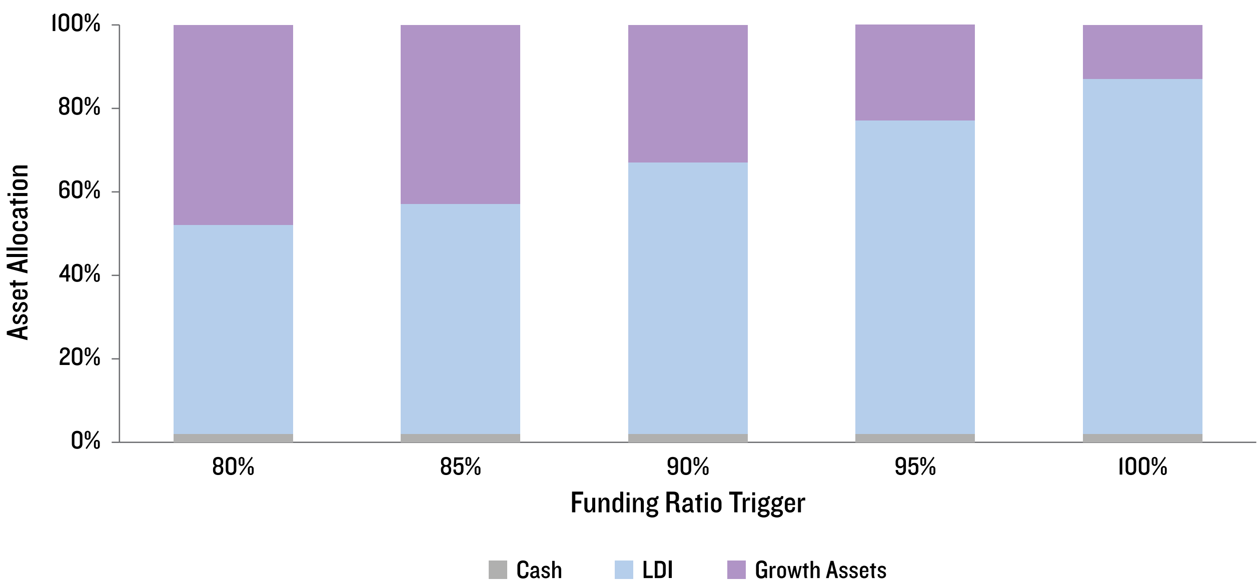
10 Due to the short-term volatile nature of funding ratios we use the average of trailing 12m funding ratios when comparing to the glide path funding ratio trigger. In addition, we allow a 6m transition period to fully migrate to a new target allocation.

Figure 6: Corporate DB Plan Portfolio Structure and Glide Path

		Current – GP0	GP1	GP2	GP3	GP4
Funding Ratio	**Asset**	<85%	[85%, 90%)	[90%, 95%)	[95%, 100%)	≥100%
		Asset Allocation				
Cash	**Cash**	2%	2%	2%	2%	2%
LDI	**LDI**	50%	55%	65%	75%	85%
Growth	**Passive Equity**	13%	11%	8%	4%	3%
	Active Equity	10%	9%	7%	5%	2%
	Real Estate + Private Debt	10%	10%	8%	6%	2%
	Private Equity	15%	13%	10%	8%	6%

Source: GIC TPS & PGIM IAS. Provided for illustrative purposes only.

Figure 7: LDI *vs.* Growth Assets over the Glide Path



Source: GIC TPS & PGIM IAS. Provided for illustrative purposes only.

For the baseline case we assume the CIO follows a Target NAV private asset commitment strategy and has average private equity fund-selection skill (equally likely to pick any PE fund). The capital market assumptions for public and private assets can be found in the Appendix.

Portfolio Analysis

OASIS produces many portfolio performance and risk measures (including traditional risk measures such as volatility) that reveal the performance-risk tradeoff stemming from the CIO's investment decisions. One of the most important performance metrics for a DB plan CIO is the funding ratio. Given our baseline assumptions, the average funding ratio rises gradually from 82% to greater than 100% over the 10y horizon (Figure 8).

Figure 8: Expected Funding Ratio

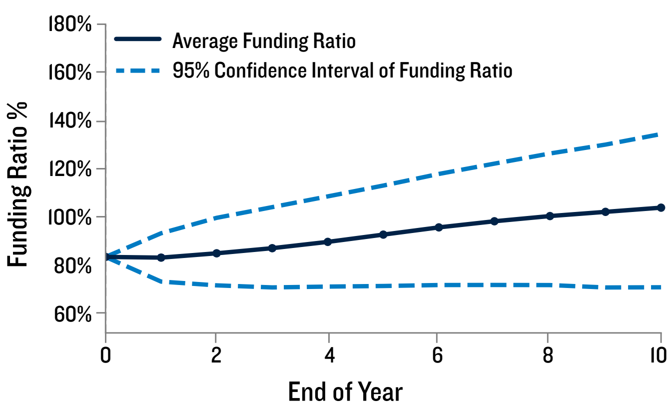
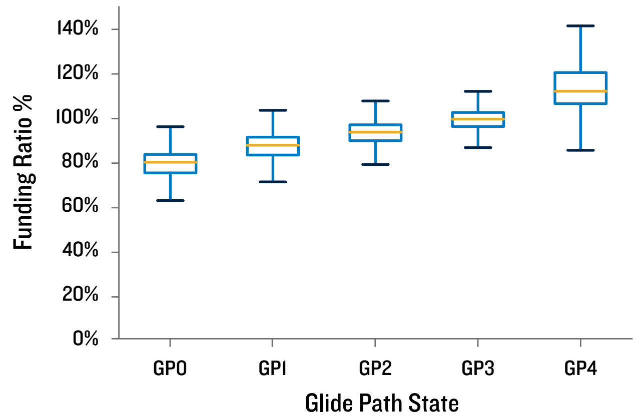


Figure 9: Dispersion of Funding Ratios by GP States

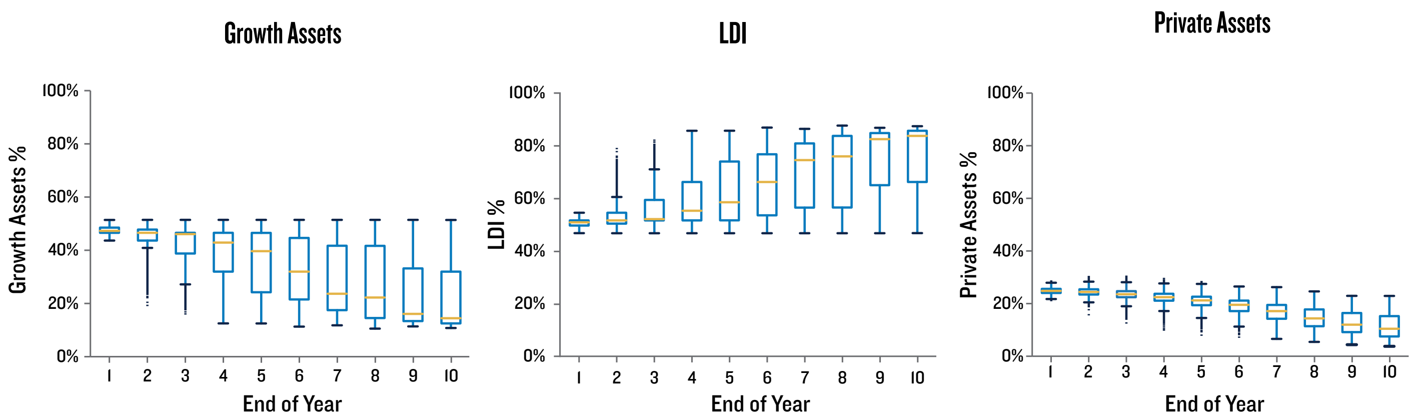


Note: The box extends from the lower to upper quartile values of the data, with a line at the median. The whiskers show the range of the data, *i.e.*, 1.5 × IQR (interquartile range (Q3-Q1)). The upper whisker extends to last datum ≤ Q3 + 1.5 × IQR. Similarly, the lower whisker extends to the first datum ≥ Q1 – 1.5 × IQR. Observations beyond the whiskers are outliers and are shown as individual points. Source: GIC TPS & PGIM IAS. Provided for illustrative purposes only.

As the funding ratio increases, the target allocation shifts from growth assets (*i.e.,* equity and private assets) to LDI. As revealed by Figure 8, the funding ratio is expected to be greater than 100% – in glide path state GP4 – starting from year 8. As the average funding ratio (and GP state) increases, the dispersion in the funding ratio decreases (Figure 9).[11]

Figure 10 shows the range of allocations to growth assets and LDI, across all simulations, at the end of each year. As expected, the allocation to growth assets declines from the initial 48% to approximately 14% by year 10, while the allocation to LDI rises from the initial 50% to about 84%. In addition, private assets, as a percentage of the total portfolio, also declines from the initial 25% allocation to approximately 10% by year 10.

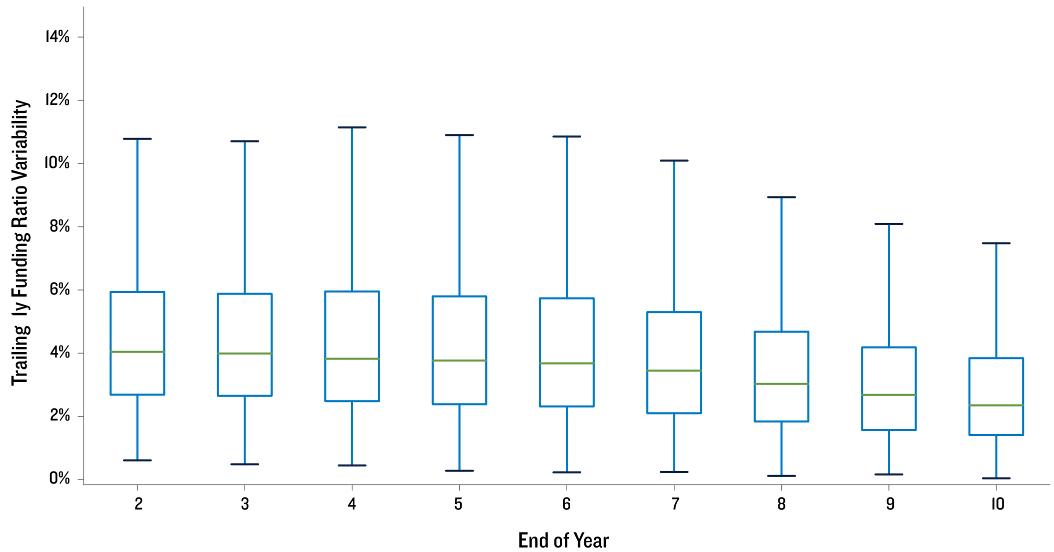
Figure 10: Glide Path Asset Allocation Migration (Broad Asset Categories)



See note to Figure 9. Source: GIC TPS & PGIM IAS. Provided for illustrative purposes only.

11 The funding ratio dispersion at GP4 is relatively high because it is the last GP state whose funding ratio is no longer bounded to the upside, unlike the other GP states.

Figure 11: Funding Ratio Variability, by Year



See note to Figure 9. We calculate the funding ratio YoY change every month. Funding ratio variability by year is then the trailing 12m average of the absolute values of these YoY changes. Source: GIC TPS & PGIM IAS. Provided for illustrative purposes only.

As the allocation to LDI increases, we expect funding ratio variability (*i.e.,* the average absolute value of funding ratio YoY changes) to decline. Figure 11 shows that this is the case, consistent with Figure 9.

OASIS can also inform the CIO of the likelihood that their portfolio will be in any GP state (Figure 12) and the expected arrival month to each state (Figure 13). As shown, the probability of remaining stuck at GP0 falls over time, while the likelihood of residing at higher GP states increases. Notably, the probability of being at GP4 in year 10 is about 59%. It is also noteworthy that states GP1/2/3 are transient states – over time the portfolio moves from GP0, through GP1/2/3, to arrive at GP4. Figure 13 shows how long, on average, it takes to arrive at each GP state, conditional on reaching that state over 10y. For example, it takes roughly 72m to arrive at GP4. The expected arrival time for different GP states can help a CIO evaluate if their glide path is well-designed to de-risk the plan as quickly as desired.

Figure 12: Distribution of Glide Path States

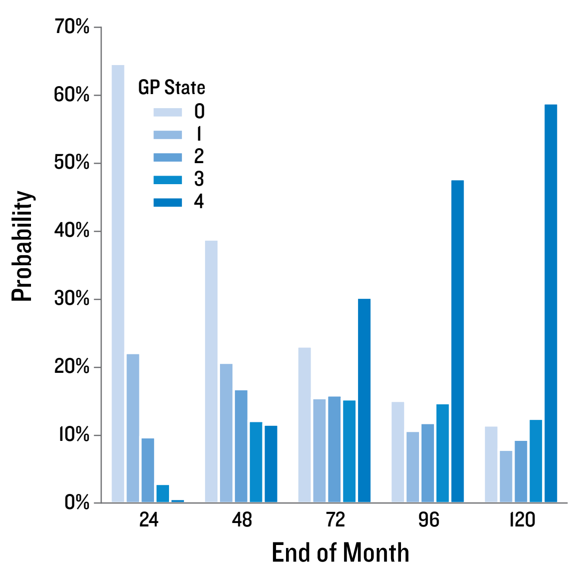
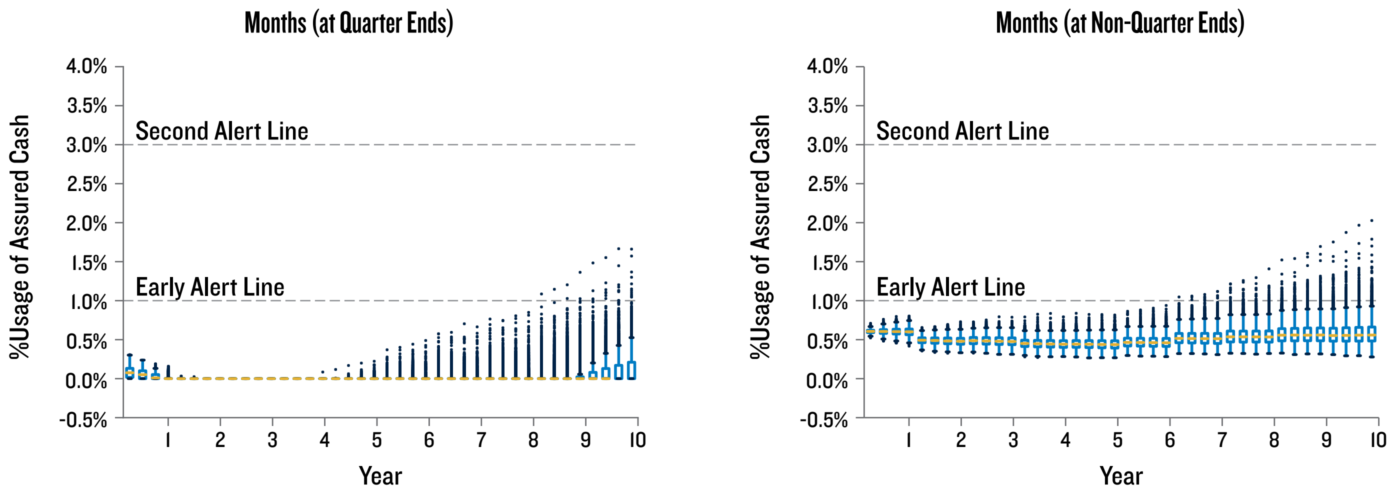


Figure 13: Expected First Month of GP State Arrival

Glide Path State	Expected Arrival Month
GP0	Current
GP1	39
GP2	53
GP3	63
GP4	72

Note: We assume no glide path migration in the first year given the lack of data to calculate a trailing 1y funding ratio average required to trigger GP migration. Source: GIC TPS & PGIM IAS. Provided for illustrative purposes only.

Figure 14: % Usage of Assured Cash



See note to Figure 9. Source: GIC TPS & PGIM IAS. Provided for illustrative purposes only.

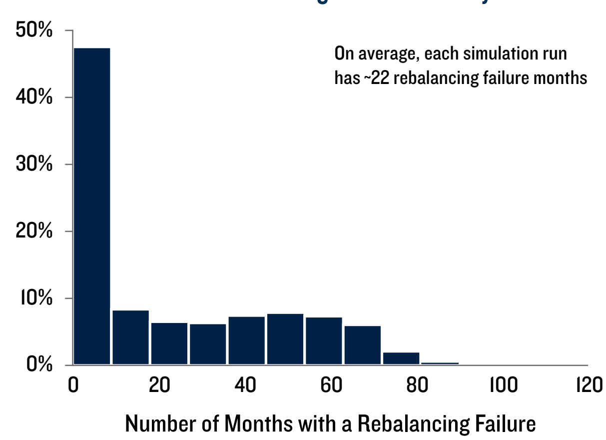
OASIS measures liquidity risk across multiple dimensions – assured cash drain, cumulative drawdowns of assured cash, funding ratio variability, and rebalancing failures. A variety of liquidity risk measures are useful as different CIOs have different sensitivities to various potential liquidity situations. We assume a CIO measures assured cash drain by calculating the fraction of assured cash used for various liquidity needs, and then compares this fraction with their pre-defined liquidity alert lines. Figure 14 shows the monthly **%usage of assured cash** (*i.e.,* liquid assets) for monthly liquidity needs, at quarter ends and non-quarter ends, respectively. At non-quarter ends, the average percentage of assured cash used is stable at about 0.5%.[1] Comparing the %usage of assured cash with the 1% alert line, there is only a 2.7% chance that the alert line will be breached over 10y.

In addition to assured cash drain, OASIS measures the likelihood the CIO will be unable to rebalance the portfolio to the target allocation, within tolerance ranges. Rebalancing failures arise from the limited transactability of private assets which need to be pared down either because the portfolio transitions to higher GP states or when growth assets and LDI have periods of sharply divergent performance.

Figure 15: Rebalancing Tolerance Ranges

Asset Class	Broad Asset Category	Baseline	Rebalancing Frequency
Cash	Cash	0bp	Monthly
LDI	LDI	100bp	Monthly
Passive EQ	Growth	300bp	Monthly
Active EQ			
Real Estate + Private Credit			
PE			

Figure 16: Percentage of Simulation Runs with "X" Rebalancing Failures over 10y



Note: Yellow field indicates an investor input. Source: GIC TPS & PGIM IAS. Provided for illustrative purposes only.

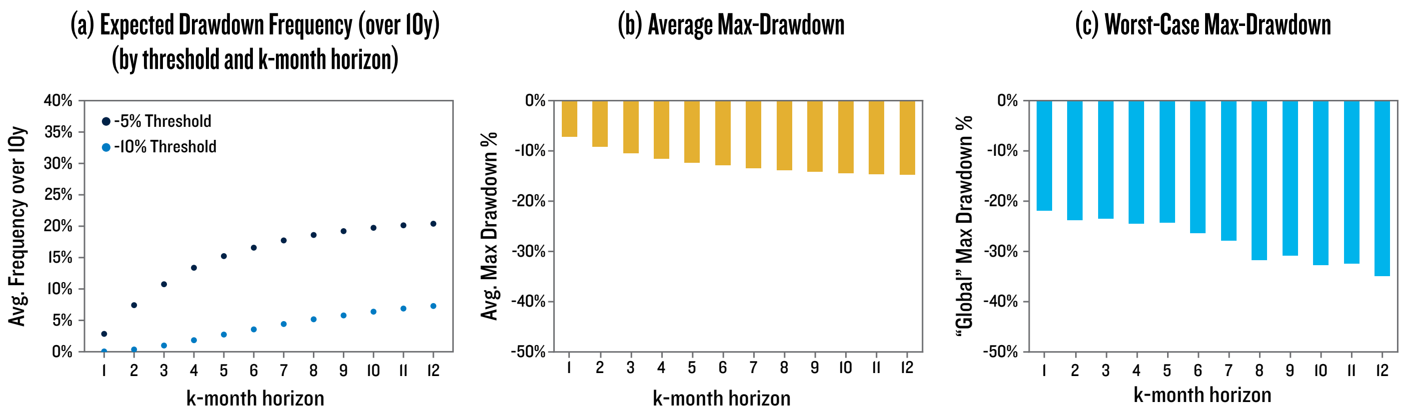
12 The %usage of assured cash is lower at quarter ends than at non-quarter ends because at quarter ends private equity distributions and income from private credit and real estate serve as additional liquidity sources.

CIOs might be more concerned if they cannot keep the desired balance between growth assets and LDI, rather than the balance between liquid and illiquid growth assets, as an imbalance in the former pair is more likely to cause the funding ratio to backslide. Given rebalancing tolerance ranges (Figure 15) for the three broad asset categories, each simulation run of 120m has, on average, around 22 rebalancing failure months (Figure 16). However, note the right skewness of Figure 16 – about 51% of simulation runs has less than 12 rebalancing failure months. Rebalancing failures might be further reduced by widening the rebalancing tolerance ranges. Alternatively, if the glide path migration from growth assets to LDI is slower, occurrences of rebalancing failures might be reduced as less of the portfolio will require rebalancing to absorb performance divergence between growth assets and LDI.

Cumulative drawdown risk is also top-of-mind for CIOs, as it reflects how a prolonged period of poor portfolio performance might lead to a ***sustained assured cash drain*** that affects the portfolio's funding ratio and liquidity risk. Figure 17 illustrates the cumulative drawdown percentage of assured cash: Figure 17(a) shows the expected frequency of a k-month drawdown that exceeds a -5% (or -10%) threshold; Figure 17(b) shows the average max-drawdown of assured cash across all simulation runs; and Figure 17(c) shows the global "worst-case" max-drawdown over the entire 10y horizon and across all simulation runs. For example, the maximum 12m assured cash drawdown is expected to be -15% of the entire assured cash holdings, while, in the worst-case scenario, the maximum 12m assured cash drawdown could be as much as -35%.

Figure 18 brings together the portfolio performance and risk measures using baseline assumptions. We will use Figure 18 to see how the tradeoff between performance and liquidity risk changes as the assumptions move away from the baseline (*i.e.,* "what-if" analysis).

Figure 17: Cumulative Drawdown of Assured Cash (*i.e.*, Liquid Assets)



Note: Cumulative drawdown over a k-month period is the percentage change over the k-month period. Only negative drawdown numbers are included. For each simulation run and for a given k, we calculate 120 k-month drawdowns over 10y. The expected frequency that the drawdown of assured cash over k-months exceeds a given threshold equals the average frequency over the 5,000 simulation runs. The average max-drawdown% of assured cash is the average of 5,000 k-month max-drawdowns, with each k-month drawdown being the maximum for each simulation run. The "worst-case" max-drawdown% of assured cash is the worst k-month max-drawdown over 10y across all simulation runs. Source: GIC TPS & PGIM IAS. Provided for illustrative purposes only.

"What-if" Analysis

We consider three "what-if" scenarios:

1. An alternative corporate plan glide path that more gradually increases LDI;
2. Higher contributions from the corporate sponsor; and
3. Superior CIO private equity fund-selection skill.

Alternative Corporate DB Plan Glide Path

We consider an alternative glide path (Figure 19) where LDI is ramped up more slowly compared to the baseline path (Figure 6). LDI allocation at GP4 is 70% compared to 85% in the baseline. A CIO evaluating this alternative glide path wants to know if the return potential from allocating more to growth assets justifies certain risks such as higher funding ratio variability.

With the alternative glide path, the expected horizon portfolio return (net of benefit payments paid) is 0.6%/y compared to 0.3%/y for the baseline (Figure 30 summarizes all three "what-if" scenarios).

Figure 18: Portfolio Risk & Performance Tradeoff – Using Baseline Assumptions

Performance	
Avg. Horizon "Return" (Net of Benefit Payments)	0.3%/y
Avg. Funding Ratio (YE 10)	103%
% of Simulation Runs Reach GP4 by YE 10	59%
Expected GP4 Arrival Month	72

Risk		
"Assured Cash" Drain	Probability of Hitting "Early Alert Line" (Use up 1% of All Liquid Assets)	2.7%
Rebalancing Failures	% of Simulation Runs with "X" Rebalancing Failures over 10y	22
Funding Ratio Variability	95% Confidence Interval Band (YE 10)	[69%, 134%]
	Avg. Funding Ratio Variability (YE 10)	4.2%
12m Liquid ("Assured Cash") Drawdown	Avg. Frequency of Violation over 10y (-5% threshold)	20.4%
	Avg. Frequency of Violation over 10y (-10% threshold)	7.3%
	Avg. Maximum Drawdown %	-15.0%
	"Global" Worst-case Drawdown %	-34.9%

Source: GIC TPS & PGIM IAS. Provided for illustrative purposes only.

Figure 19: Alternative Corporate DB Plan Portfolio Structure and Glide Path

		Current – GP0	GP1	GP2	GP3	GP4
Funding Ratio	Asset	<85%	[85%, 90%)	[90%, 95%)	[95%, 100%)	≥100%
Asset Allocation						
Cash	Cash	2%	2%	2%	2%	2%
LDI	LDI	50%	55%	60%	65%	70%
Growth	Passive Equity	13%	11%	9%	8%	7%
	Active Equity	10%	9%	7%	7%	6%
	Real Estate + Private Debt	10%	10%	10%	8%	7%
	Private Equity	15%	13%	12%	10%	8%

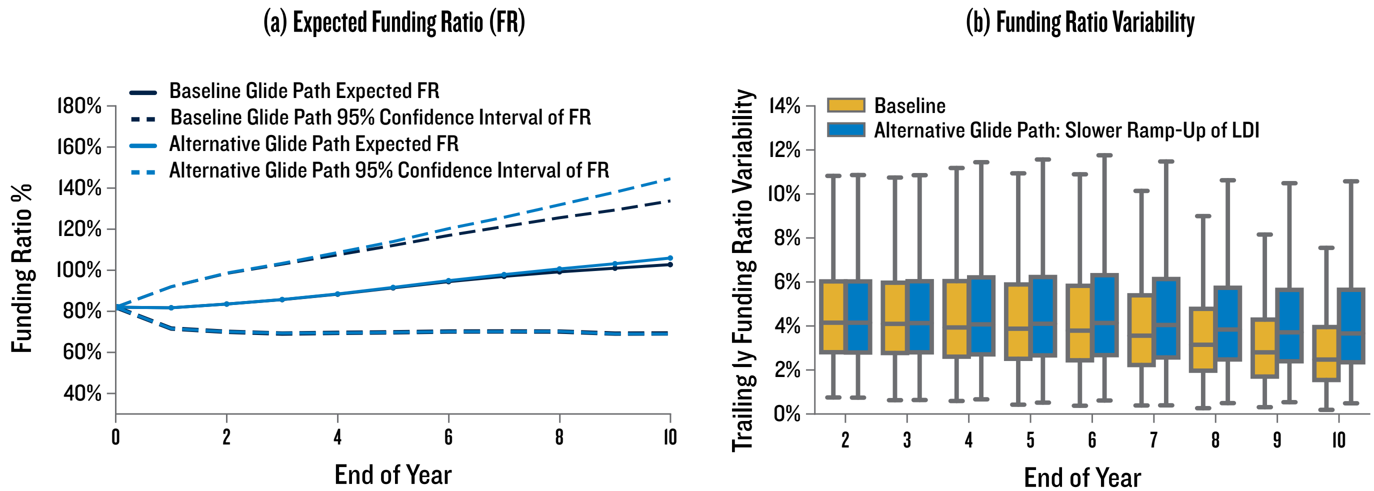
Source: GIC TPS & PGIM IAS. Provided for illustrative purposes only.

Figure 20(a) shows the expected funding ratio and the 95% confidence bands. At the end of the 10y horizon, the expected funding ratio under the alternative glide path is higher than the baseline's due to the higher growth asset allocation. On the other hand, Figure 20(b) shows that the alternative glide path has higher funding ratio variability, especially for the latter half of the period during which the difference in LDI allocation is highest between the two glide paths.

CIOs also monitor their allocation to illiquid private assets in case the sponsor decides to conduct a PRT or close or freeze the plan. In fact, some CIOs wish to keep total illiquid allocations below a certain percentage *over the entire horizon*. Figure 21 compares the illiquid private asset allocation between the baseline and alternative glide paths. Note that once migration begins, the target illiquid allocation at any GP state along the alternative glide path is higher than or equal to the corresponding baseline's allocation, despite both glide paths having the same initial allocations. The illiquid percentage minimum is higher in the alternative glide path compared to baseline while the upper bound is the same.[1] Overall, the alternative path produces a narrower range for the allocation to illiquid private assets.

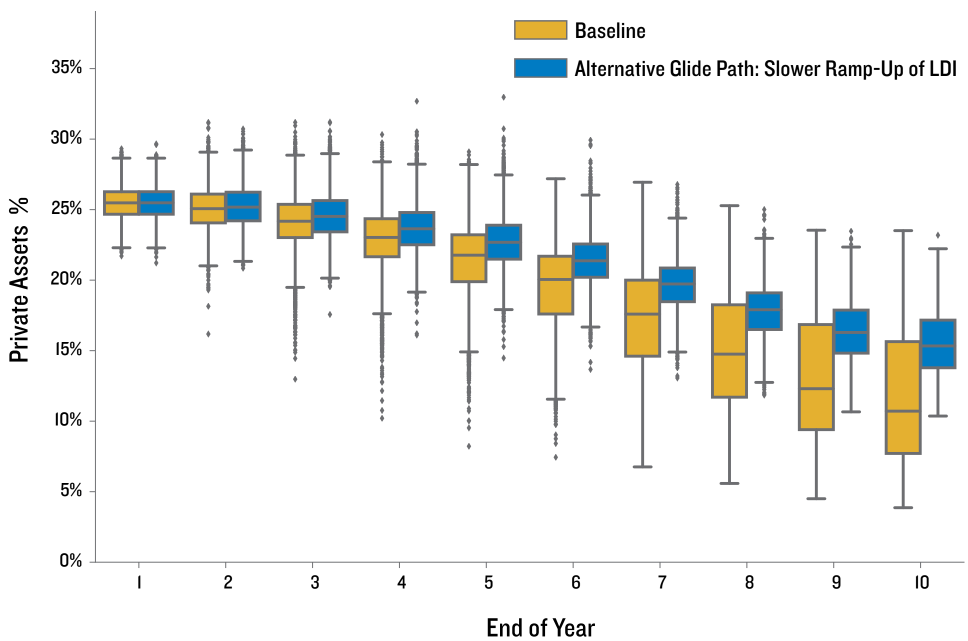
13 The upper bound remains the same under both glide path assumptions because there is a close to 10% chance that the portfolio funding ratio never surpasses 85% and the allocation remains at GP0 (highest allocation to illiquid assets across GP states) over the 10y horizon.

Figure 20



See note to Figure 9. Source: GIC TPS & PGIM IAS. Provided for illustrative purposes only.

Figure 21: Allocation to Illiquid Private Assets – Baseline *vs.* Alternative Glide Paths



See note to Figure 9. Source: GIC TPS & PGIM IAS. Provided for illustrative purposes only.

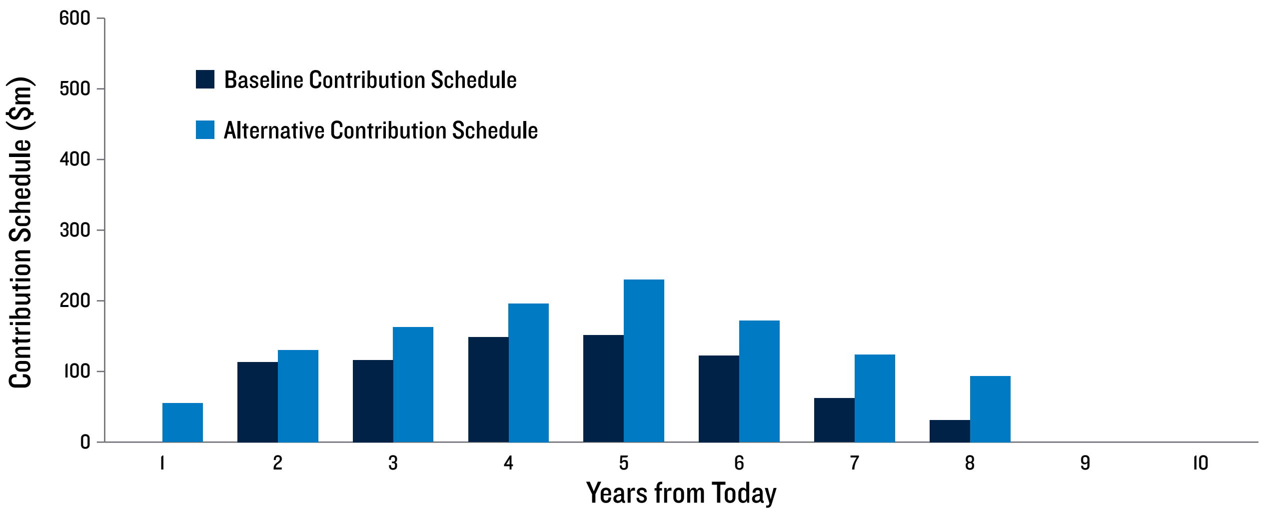
Contributions from Corporate Pension Sponsor

We now consider a "what-if" scenario in which the plan expects more corporate sponsor contributions than in the baseline. Figure 22 shows the two contribution schedule assumptions.

Given the increased contributions, the expected horizon portfolio return, net of benefit payments and other liquidity needs, is 0.7%/y, compared with 0.3%/y in the baseline. The increased contributions also reduces the probability of hitting the Early Alert Line from 2.7% to 1.4% because pension benefit payments are less likely to require liquidation of assets.

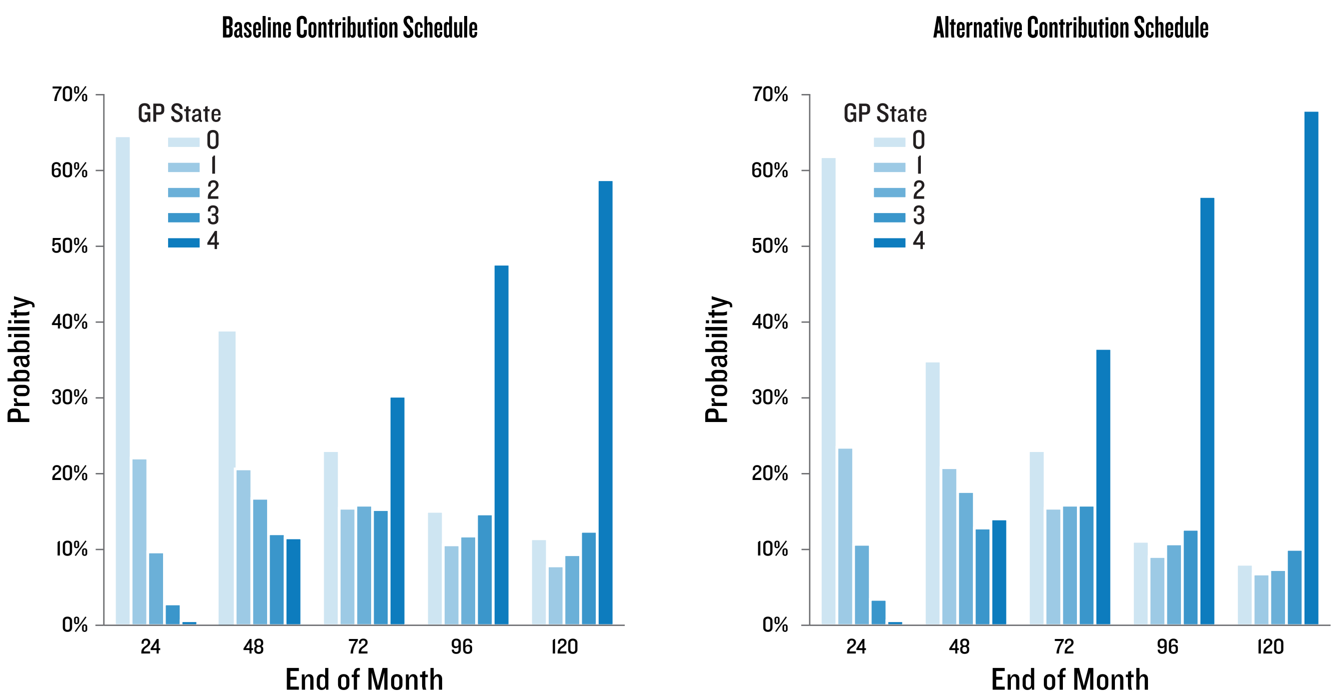
How does the corporate contribution change the distribution of GP states over time? Not surprisingly, with greater contributions the probability of a higher GP state at any time over the horizon is higher (Figure 23). At year 10, there is now a 68% probability (compared to 59% in the baseline scenario) to be at GP4.

Figure 22: Corporate Sponsor Contribution Schedule Comparison



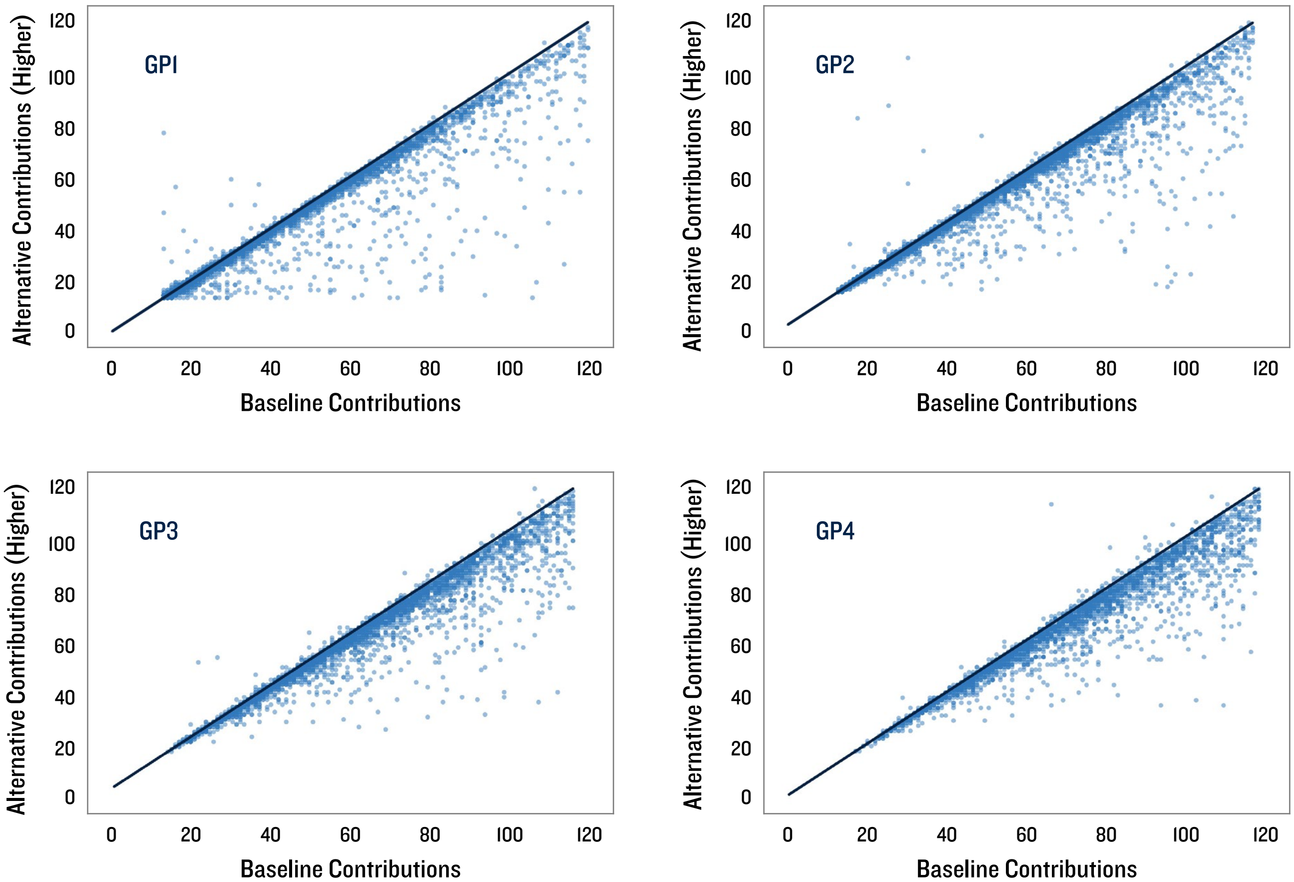
Source: GIC TPS & PGIM IAS. Provided for illustrative purposes only.

Figure 23: Glide Path Distribution Analysis



See note to Figure 12. Source: GIC TPS & PGIM IAS. Provided for illustrative purposes only.

Figure 24: Baseline *vs.* Alternative Contribution Schedule – First Month of GP Arrival, by GP State



See note to Figure 12. Source: GIC TPS & PGIM IAS. Provided for illustrative purposes only.

CIOs, and their corporate CFOs and CEOs, may wish to know how much faster the additional contributions will get the plan to a higher GP state. Figure 24 compares the first arrival month for each GP state depending on the contribution schedule. The scatters largely fall under the 45º line suggesting that the arrival time for each GP state occurs sooner with the higher contribution schedule. Knowing how much faster the increased contributions move the plan to a higher GP state may help corporate executives evaluate the tradeoff between making additional contributions (to avoid paying higher PBGC premiums) and using the capital for corporate growth initiatives.

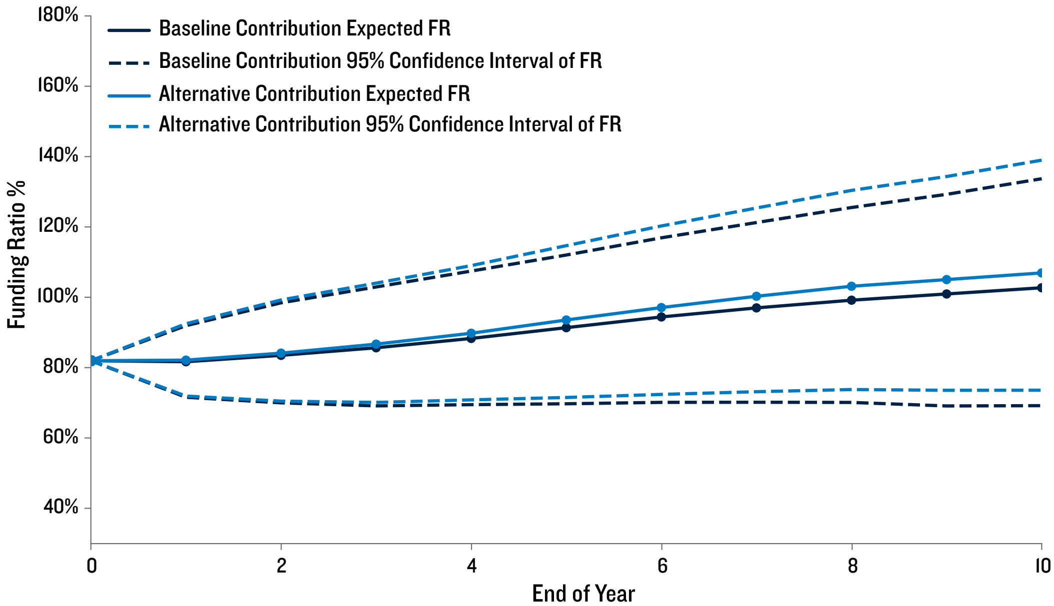
With higher contributions, the funding ratio is likely to reach 100%, 2y sooner, on average. In addition, the expected funding ratio and its confidence interval all shift higher (Figure 25). Note that higher contributions do not noticeably increase funding ratio variability since the underlying asset allocation glide path is unchanged.

Superior CIO Private Equity Fund-Selection Skill

Many CIOs have experience working with general partners and have developed skill in identifying, and have access to, funds that are likely to perform well. Given the relatively high level of idiosyncratic performance across funds, it is important to incorporate CIO fund-level selection skill to better measure private asset return and risk.

We consider a scenario in which the CIO has superior private equity fund-selection skill. To capture fund-selection skill we adjust the probability distribution of picking funds from various performance quartiles. For a CIO with average skill, there is equal probability of picking a fund from all four fund performance quartiles, while a CIO with superior skill is more likely to pick from the top two quartiles (Figure 26). Other measures of skill can be easily incorporated in this framework.

Figure 25: Expected Funding Ratio (FR) – Baseline *vs.* Alternative Contributions



Source: GIC TPS & PGIM IAS. Provided for illustrative purposes only.

Figure 26: Average *vs.* Superior CIO Fund-Selection Skill

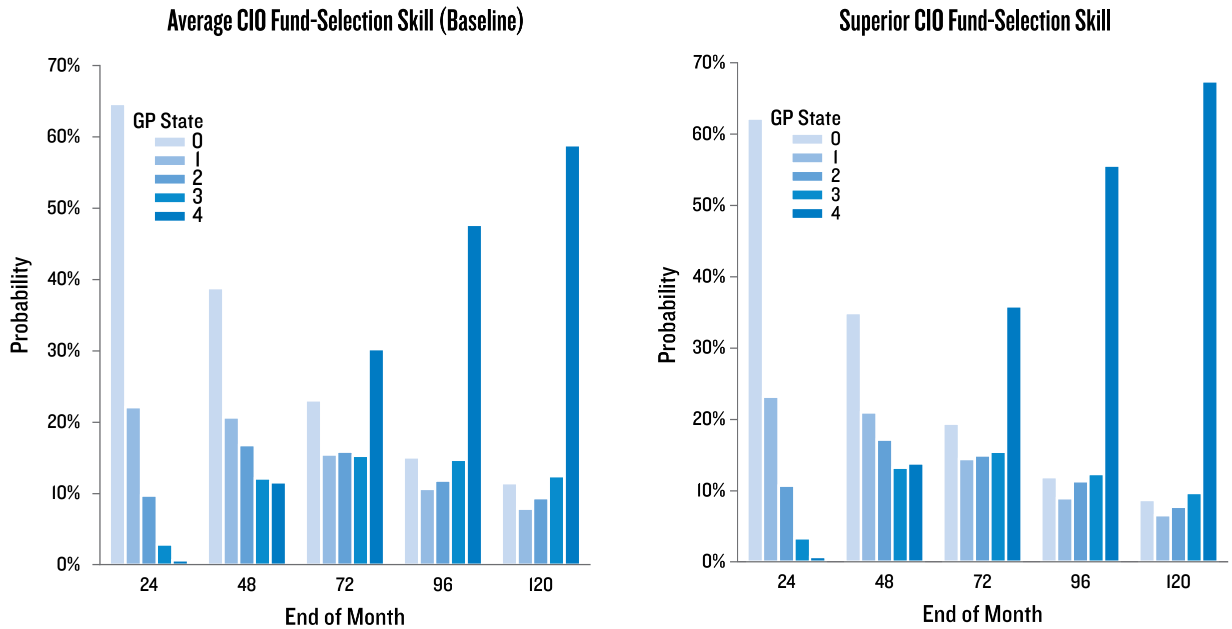
	Probability of Selecting Funds from Quartile	
	Average Fund-Selection Skill (Baseline)	Superior Fund-Selection Skill (Alternative)
Quartile 1 (highest)	25%	40%
Q2	25%	50%
Q3	25%	10%
Quartile 4 (lowest)	25%	0%

Note: Yellow field indicates an investor input. Source: GIC TPS & PGIM IAS. Provided for illustrative purposes only.

With superior fund-selection skill, the expected horizon portfolio return is 0.8%/y, compared with 0.3%/y in the baseline. Fund-selection skill also affects the likelihood of residing at a particular GP state – the probability the portfolio is at higher GP state is significantly higher if the CIO has skill (Figure 27). By year 10, there is 67% probability to be at the GP4 if the CIO is a superior fund selector (59% if average skill).

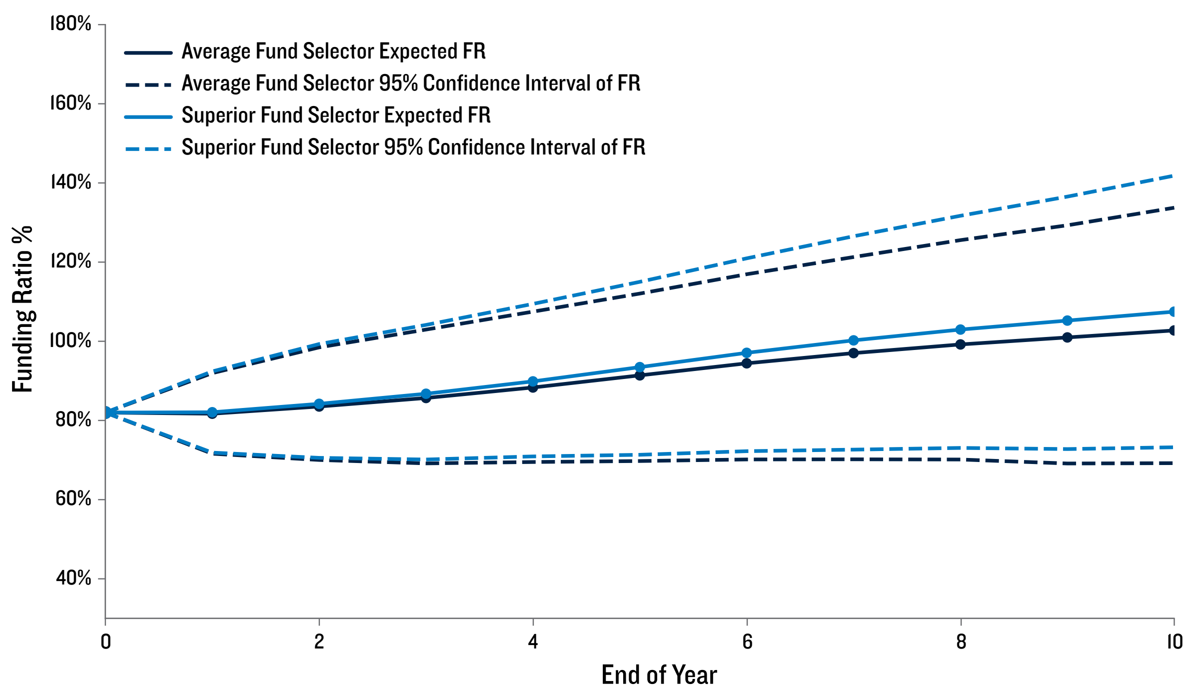
Not unexpectedly, the funding ratio is more likely to reach 100%, on average, 2y sooner. In addition, the expected funding ratio and its confidence intervals all shift higher (Figure 28).

Figure 27: Glide Path Distribution Analysis



See note to Figure 12. Source: GIC TPS & PGIM IAS. Provided for illustrative purposes only.

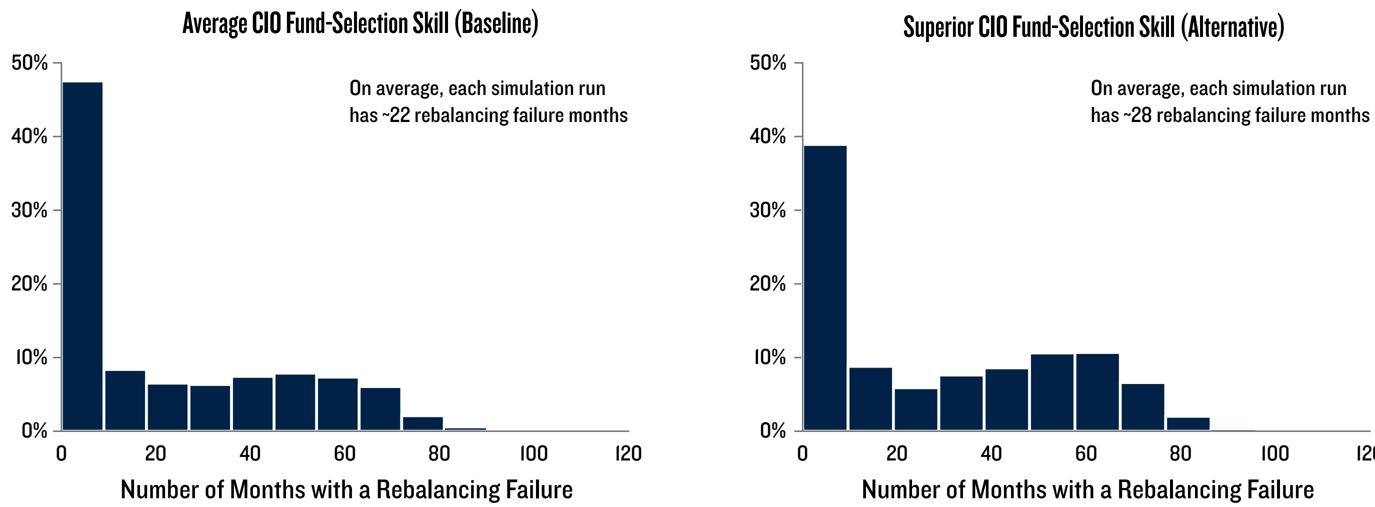
Figure 28: Expected Funding Ratio (FR) – Average (Baseline) *vs.* Superior CIO Fund-Selection Skill



Source: GIC TPS & PGIM IAS. Provided for illustrative purposes only.

Note how the results with superior CIO fund-selection skill resemble those with higher corporate contributions! However, there is a key difference: Additional corporate contributions can help improve portfolio liquidity risk since the probability of hitting the Early Alert Line with higher contributions is lower at 1.4% compared to 1.8% with superior fund-selection skill. Rebalancing failures also increase with superior CIO skill because the relative outperformance of private equity over public assets is amplified, causing overall growth assets to potentially deviate further from the GP target than would be the case with average skill (Figure 29).

Figure 29: Percentage of Simulation Runs with "X" Rebalancing Failures over 10y



Source: GIC TPS & PGIM IAS. Provided for illustrative purposes only.

Portfolio Performance and Risk Tradeoffs

All three "what-if" scenarios produce higher expected funding ratios and portfolio performance. However, they have different portfolio liquidity risks. Figure 30 summarizes the tradeoffs which can help CIOs make investment decisions on asset allocation, private asset commitment strategy and glide path design.

Figure 30: "What-if" Analysis Summary

Performance				
	Baseline	Higher Contributions	Alternative GP (Lower LDI%)	Superior Fund-Selection Skill
Avg. Horizon "Return" (Net of Benefit Payments)	0.3%/y	0.7%/y	0.6%/y	0.8%/y
Avg. Funding Ratio (YE 10)	103%	107%	106%	107%
% of Simulation Runs Reach GP4 by YE 10	59%	68%	61%	67%
Expected GP4 Arrival Month	72	71	72	71

Risk					
		Baseline	Higher Contributions	Alternative GP (Lower LDI%)	Superior Fund-Selection Skill
"Assured Cash" Drain	Probability of Hitting "Early Alert Line" (Use up 1% of All Liquid Assets)	2.7%	1.4%	2.9%	1.8%
Rebalancing Failures	% of Simulation Runs with "X" Rebalancing Failures over 10y	22	24	5	28
Funding Ratio Variability	95% Confidence Interval Band (YE 10)	[69%, 134%]	[74%, 139%]	[70%,145%]	[73%, 142%]
	Avg. Funding Ratio Variability (YE 10)	4.2%	4.3%	4.7%	4.4%
12m Liquid ("Assured Cash") Drawdown	Avg. Frequency of Violation over 10y (-5% threshold)	20.4%	18.7%	20.1%	18.9%
	Avg. Frequency of Violation over 10y (-10% threshold)	7.3%	6.5%	6.8%	6.6%
	Avg. Maximum Drawdown %	-15.0%	-14.7%	-14.6%	-14.7%
	"Global" Worst-case Drawdown %	-34.9%	-34.6%	-35.0%	-34.9%

Source: GIC TPS & PGIM IAS. Provided for illustrative purposes only.

Conclusion

We present an asset allocation framework that captures the interaction of top-down asset allocation decisions with bottom-up private asset investing. The framework formally integrates liquidity measurement and cash flow management into a multi-asset, multi-period portfolio construction process. This and earlier publications provide sufficient information for CIOs to implement the framework.

We apply the framework to a corporate DB plan and examine how the plan's liquidity needs and glide path design interact and what they reveal about expected portfolio performance and risk (liquidity risk, drawdown risk and funding ratio variability).

Through "what-if" scenario analysis, the framework evaluates tradeoffs among key portfolio performance and risk measures and helps the CIO make more informed asset allocation decisions.

The framework is flexible and highly customizable to incorporate CIOs' own liquidity needs, capital market assumptions, views on private asset performance, their fund-selection skill, as well as a variety of commitment strategies. CIOs may also use the framework to conduct sensitivity analysis and stress testing to evaluate how their portfolios might behave in various economic environments.

ACKNOWLEDGMENTS

We wish to thank Dr. Taimur Hyat (PGIM), Mr. Cameron Lochhead (PGIM) and Mr. Howard Nowell (PGIM) for their valuable contributions to this research.

REFERENCES

Jeet, V. (2017). "Endurance of Internal Rate of Return." Working Paper. Burgiss Applied Research.

Jeet, V. (2020). "Modeling Private Investment Cash Flows with Market-sensitive Period Growth." PGIM IAS.

Shen, J., D. Li, G. Qiu, V. Jeet, M. Teng and K.C. Wong (2020). "Building a Better Portfolio: Balancing Performance and Liquidity." PGIM IAS and GIC EIS.

Shen, J., D. Li, G. Qiu, V. Jeet, M. Teng and K.C. Wong (2021). "Asset Allocation and Private Market Investing." *The Journal of Portfolio Management Multi-Asset Special Issue 2021* **47 (4)** 71-82; DOI: https://doi.org/10.3905/jpm.2021.1.211.

Takahashi, D. and S. Alexander (2002). "Illiquid Alternative Asset Fund Modeling." *The Journal of Portfolio Management*. **28 (2)**. 90-100. DOI: https://doi.org/10.3905/jpm.2002.319836.

Teng, M. and J. Shen (2019). "Asset Allocation for "End-State" Portfolios." PGIM IAS.

Teng, M., W. Zhang and J. Kohana (forthcoming, 2021). "A Cash Flow Model for Private Core+ Real Estate Debt Funds." PGIM IAS.

APPENDIX

A1. Capital Market Assumptions

Each simulation run starts with sampling monthly stock and bond market returns.[1] Public passive assets exhibit different return and risk characteristics under different capital market environments (*i.e.*, "good" *vs.* "bad" state of economy). We define a "bad" economy when the monthly moving average (6m, backward-looking) of the S&P 500 simulated cumulative total return experiences a drawdown of more than -15%.

Figure A1 shows capital market assumptions for the two public passive assets in different economic environments. We assume public active equity generates an alpha of 100bp/y over passive equity returns. For private equity, we rely on the Takahashi and Alexander (TA) cash flow model to generate private asset cash flows that empirically depend on public market performance.[2] The expected return (IRR) of private equity based on the public market CMAs is 14%. For real estate and private debt taken together as one assets class, we assume the expected total return is 6.5%, of which there is an income component equal to the floating discount rate +200bp. Every quarter, we distribute the income portion of the quarterly total return to the liquid asset buckets.

Figure A1: Public Passive Asset Return and Risk Assumptions

	Expected Return		
Economic State	**Total**	**Good**	**Bad**
LDI Hedging Portfolio	7.0%/y	5.5%/y	12.0%/y
Liquid Passive Equity	9.4%	9.7%	8.4%
Private Equity	14.0%	-	-
Real Estate + Private Debt	6.5%	-	-
	Annualized Standard Deviation		
Economic State	**Total**	**Good**	**Bad**
LDI Hedging Portfolio	5.8%	5.1%	7.3%
Liquid Passive Equity	15.4%	14.0%	19.5%
	Correlation		
	LDI Hedging Portfolio	**Liquid Passive Equity**	
LDI Hedging Portfolio	1	-	
Liquid Passive Equity	0.27	1	

Note: Yellow field indicates an investor input. Historical average based on monthly data from 1995 to 2020.
Source: Bloomberg-Barclays, GIC TPS & PGIM IAS. Provided for illustrative purposes only.

A2. Liquidity Sourcing and Rebalancing Rules

Every month, we examine the types and the amounts of liquidity demands (including pension benefit payments, private capital calls, and rebalancings assumed in the baseline case study) and follow these three steps to source liquidity from cash and liquid public assets to rebalance the portfolio:

- Step 1 – Calculate available cash generated from private equity and real estate quarterly distributions;
- Step 2 – Determine if cash flow from Step 1 is enough to pay benefits and capital calls. If sufficient, use the cash to pay benefits and capital calls and re-invest any remaining cash *pro rata* into passive liquid assets. If insufficient, first pay benefits and capital calls using the cash, then follow the "waterfall" rule – start selling assets from the least disruptive and expensive buckets. We record the portion of assured cash that is used for liquidity needs;
- Step 3 – Rebalance the portfolio based on glide path target asset allocation and asset-specific tolerance ranges (*e.g.*, Figure 15).

1 See M. Teng and J. Shen (2019) for details on the simulation methodology for public asset returns.
2 See J. Shen, *et al.*, (2021) for details on the private asset cash flow modeling.

MORE PUBLICATIONS FROM PGIM IAS

Publications

- US Stock Bond Correlation: What Are the Macroeconomic Drivers? *(May 2021)*
- Equity Portfolio Manager Active Risk and Information Ratio: How Does the Reward Vary with Active Risk? *(November 2020)*
- Building and Maintaining a Desired Exposure to Private Markets – Commitment Pacing, Cash Flow Modeling and Beyond *(November 2020)*
- Next-Generation Commodity Benchmarks: RASA Benchmarks Designed to Align with CIO Investment Objectives *(November 2020)*
- Modeling Private Investment Cash Flows with Market-Sensitive Periodic Growth *(October2020)*
- Riders in the Storm: How Volatility Events Affect Private Asset Class Performance *(June 2020)*
- The Probability of Recession: A Critique of a New Forecasting Technique *(June 2020)*
- What's in Your Real Asset Portfolio? *(May 2020)*
- Measuring the Value of LP Fund-Selection Skill *(April 2020)*
- Building a Better Portfolio: Balancing Performance and Liquidity *(joint with the GIC - April 2020)*
- What is the Optimal Number of Equity Managers? – A CIO Toolkit for Manager Allocation *(February 2020)*
- Institutional Gold! *(November 2019)*
- A Fair Comparison Framework: Risk and Return in Private & Public Investments *(November 2019)*
- Asset Allocation for "End-State" Portfolios *(September 2019)*
- The Diversity of Real Assets: Portfolio Construction for Institutional Investors *(June 2019)*
- The Tradeoff Between Liquidity and Performance: Private Assets in Institutional Portfolios *(January 2019)*
- Emerging Market Equity Benchmarks for Japanese Investors: Countries, Sectors or Styles? *(October 2018)*
- Forecasting Long-Term Equity Returns: A Comparison of Popular Methodologies *(September 2018)*
- What Can the Markets Tell Us about Future Economic Growth? *(September 2018)*
- How to Measure the Value of Adding a Cross-Sector Manager *(September 2018)*
- Anchor to Windward: Aligning Absolute Return Objectives *(May 2018)*
- When the Dust Flies: How Volatility Events Affect Asset Class Performance *(April 2018)*
- Asset Allocation with Illiquid Private Assets *(February 2018)*
- The Impact of Market Conditions on Active Equity Management *(March 2017)*

Bespoke Client Projects

- Will My Equity Managers Perform as Expected in the Next Downturn?
- How Should We Allocate Capital Across Our Equity Managers?

Case Studies

- Cenland Corporation (II) — The CIO and the Freezing of the DB Plan (December 2020)
- Cenland Corporation (I) —The CIO and the Closing of the DB Plan (December 2019)

Visit us at pgim.com/IAS

THE PURSUIT OF OUTPERFORMANCE