PitchBook®

Allocator Solutions

CASH FLOW FORECASTING AND COMMITMENT PACING

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Click here for PitchBook's report methodologies.

Introduction

Private market investments have become an integral part of the allocator's playbook over the last few decades since the popularization of the endowment model pioneered by David Swensen at Yale. Private equity (PE), venture capital (VC), and other illiquid limited partnership fund strategies can represent a key source of differentiated returns. As we have shown in prior research, introducing a 20% allocation of PE funds to a simple 60/40 portfolio can generate an excess annualized return upwards of 1.0% with lower portfolio volatility.

The prospect for boosted returns is enticing, but the practical implications of introducing private fund structures to a portfolio can leave even sophisticated allocators scratching their heads. Investors will need to ask seemingly basic questions, such as:

- How much should we commit to reach our allocation targets?
- When can we expect to see our commitments deployed?
- What do we do with in-waiting uncalled commitments?
- How do we stay at target as funds wind down and give our capital back?

In this report, we provide a breakdown of the challenges that fund limited partners (LPs) face. We then introduce Allocator Solutions: Cash Flow Forecasting and Commitment Pacing, which leverages our historical data on fund cash flows to build probabilistic forecasting and scenario analysis models for private fund portfolios. Finally, our appendix includes additional datasets available for clients that wish to use historical cash flow data as parameters for their own models. Additional historical case study analysis and a back test of our cash flow modeling methodology will be available in forthcoming research.

If you are a PitchBook client and would like to leverage our Allocator Solutions: Cash Flow Forecasting and Commitment Pacing toolkit or learn more about our offering, please reach out to your account manager or pbinstitutionalresearch@pitchbook.com. Non-PitchBook clients can contact info@pitchbook.com to learn more about PitchBook's entire suite of product, research, and data tools.

Limited partner challenges

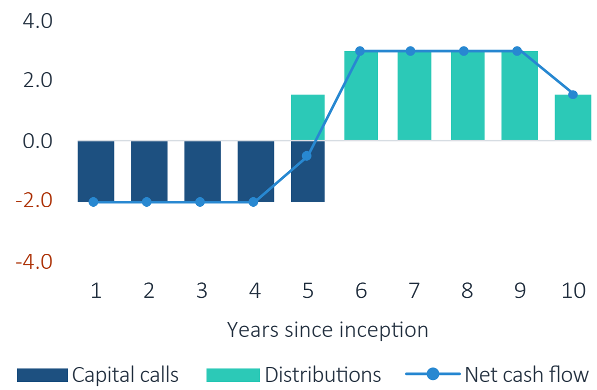
Managing a private market allocation introduces unique complexities to a portfolio. An investor must consider allocation targets, unpredictable cash calls and distributions, liquidity needs, managing re-ups, manager selection, negotiating and understanding fee arrangements, capital risks, and more. Each of these items represents a complex task and should be undertaken carefully.

At a basic level, the traditional PE fund structure is not complicated. An LP makes a commitment to a general partner's (GP's) new fund, which is called down over a predetermined period (usually five to seven years), to finance investments made by the fund. As the fund sells those investments, it will distribute capital back to the fund's LPs with the goal of providing strong returns on invested capital within the fund's limited lifetime (typically 10-12 years). A naïve cash flow profile assuming a 1.5x return on a $10.0 million commitment may look like the example in figure 1A, with the cumulative net cash flow profile in figure 1B, which gives us a visual of the "J-curve."

Expressing our naïve profile as a percent of the total commitment allows us to compare it to historical data—funds in the 2010 vintage year in this example. We can see in figure 2 that the simple model lacks the nuance to adequately describe the variation in the J-curve experienced by actual PE funds. For an LP, that can represent real liquidity risk if they are not properly budgeting for potential outsized capital calls or not properly planning for the reallocation of large distributions.

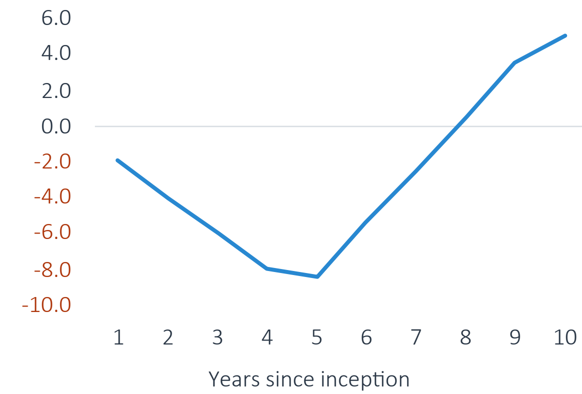
Given the nature of closed-end fund cash flows, achieving and maintaining a private market allocation of a certain size becomes much more difficult than publicly traded assets. If an allocator wants to introduce a $10.0 million allocation to public equities, they can work with an equity fund manager or brokerage to put that capital to work nearly instantly. By contrast, building a $10.0 million allocation in private markets is a multiyear process that can easily result in a different outcome than anticipated.

Figure 1A. **A basic naïve PE cash flow profile ($M)**



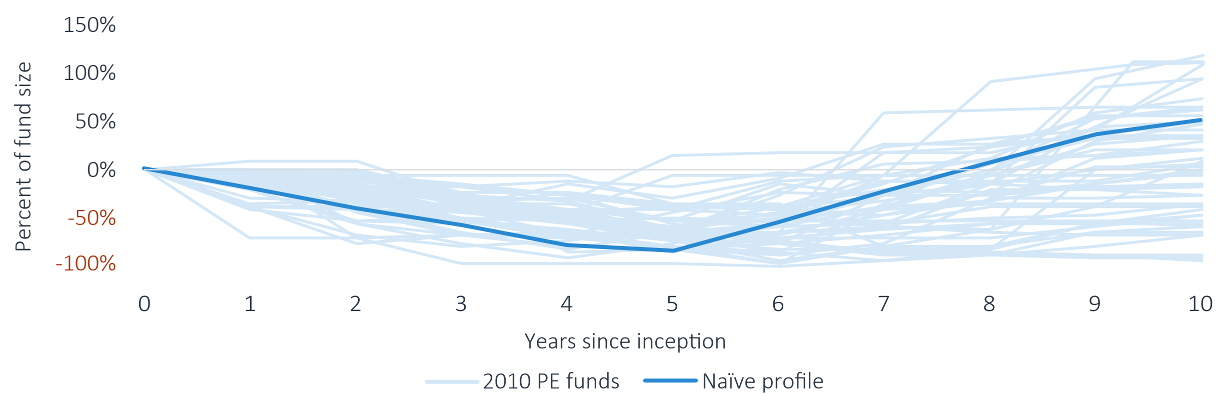
Source: PitchBook
For illustrative purposes only

Figure 1B. **The "J-curve" of a basic naïve PE cash flow profile ($M)**



Source: PitchBook
For illustrative purposes only

Figure 2. **Naïve cumulative net cash flow profile compared to actual PE funds from 2010 vintage year**



Source: PitchBook | **Geography:** Global
For illustrative purposes only

A commitment made to a closed-end fund typically takes several years to be called down and put to work, and that pace can vary greatly. This waiting game represents significant opportunity cost for the LP, as they may be sacrificing returns by parking uncalled capital into lower-returning asset classes. The fund's net asset value (NAV) will grow as the portfolio of investments is built, but distributions and investment performance can work against an allocator's desired allocation target. Figure 3 shows the NAV path of a hypothetical $10.0 million committed to various 2010 vintage PE funds. We see that the NAV profile looks materially different depending on the fund chosen. Unfortunately, the path is unknowable at the time of the commitment.

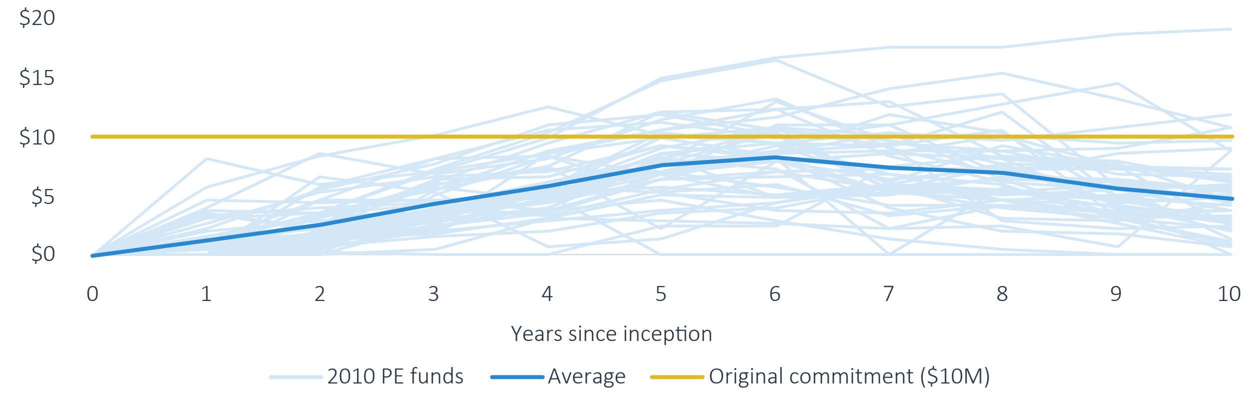
Variation in fund performance is a blessing and a curse for allocators investing in these vehicles. The wide range of potential outcomes means that fortunate LPs that allocate to top funds will see substantial outsized gains relative to peers. However, outperformance can complicate allocation targeting assumptions because a few funds with large NAVs relative to the initial commitment can inflate an LP's overall allocation to the asset class compared to their target. While this can also be true of public market investments, rebalancing is a much simpler task with liquid assets. Conversely, lower-than-expected NAV growth will leave the LP with a shortfall relative to their allocation targets if alterations to the portfolio are not made. Even a mature, diversified portfolio must consider the disparate profiles of funds that sit at different points in their life cycles, making these challenges pervasive for new and seasoned private market allocators alike.

There are some tools available for LPs that attempt to create models that more closely resemble the reality of cash flow and NAV profiles. The most famous is the "Yale model," developed by Dean Takahashi and Seth Alexander, which employs simple parameters to create a non-probabilistic model of cash flows.[1] Manipulating the inputs—notably, the "bow" factor—allows an allocator to adjust the expected forecasts for funds they would like to model. The results and analysis are well-documented, and many LPs have their own versions of the model that they use. Its simplicity is enticing, and its theoretical underpinnings are sound. However, it has several limitations as outlined by Peter Cornelius et al.,[2] including:

- Only one range of capital call and distribution forecasts is generated per set of input parameters.
- Volatility of actual cash flows is not explicitly considered, so measuring liquidity risk is a challenge.
- Deviations from real fund cash flows and NAV growth can be substantial.

1: "Illiquid Alternative Asset Fund Modeling," Yale International Center for Finance, Dean Takahashi and Seth Alexander, January 2001.
2: "Mastering Illiquidity: Risk Management for Portfolios of Limited Partnership Funds," John Wiley & Sons, Peter Cornelius et al., 2013.

Figure 3. **NAV of a hypothetical $10.0 million commitment in 2010 vintage year PE funds**



Source: PitchBook | **Geography**: Global
For illustrative purposes only

These issues are complicated by the characteristics unique to specific fund strategies. For example, debt funds tend to call capital and distribute capital materially quicker than VC funds, and their returns can be somewhat more predictable relative to the home-run-or-bust model of venture investing. Funds of funds can take several years to fully ramp up and have longer average fund horizons than other strategies. The economic cycle can also bend and twist the cash flow and performance profile of funds, a phenomenon we have researched in detail. To help navigate these challenges, we have created a new framework employing PitchBook's robust fund cash flow datasets.

Cash flow and NAV risks aside, allocators face other challenges outside the scope of this report, such as manager selection, fund performance benchmarking, navigating complicated fund terms, and ESG/impact investing. For more on these topics, see our prior research listed below:

- PitchBook Benchmarks
- Primer on Private Market Access Points
- The Fine Print: Unraveling Fund Fees and Terms
- ESG and the Private Markets

Cash flow forecasting and commitment pacing

Overview

To address the obstacles faced by LPs, PitchBook has developed frameworks for cash flow forecasting and commitment pacing that leverage our extensive fund cash flow data to create an empirically based, fund-level model and scenario builder for forecasting the cash flows and NAV of a private fund portfolio. Because the experience of every allocator investing in private markets is unique, we have built a tailored, highly flexible solution that can take into account the characteristics of each fund in a portfolio and produce a baseline cash flow and NAV forecast. We also provide a dynamic commitment pacing model that uses the NAV forecasts as inputs—along with overall portfolio attributes and targets—to arrive at a suggested commitment schedule across strategies. Finally, the framework allows for the combination of the current portfolio forecasts with the commitment schedule to provide more holistic portfolio forecasts.

In the following sections, we will detail our methodology, showing the data sets and metrics we use to develop the portfolio forecasts. We will demonstrate the flexibility of inputs that allow users to tune the forecast profiles to even more exact specifications.

The methodologies and analyses we outline are the culmination of years of historical case studies and analyses published in several research reports. Previous publications are available on the back cover. In addition, PitchBook clients have access to a robust Excel template and PitchBook analysts who can help tailor the output to a real portfolio of funds.

Cash flow forecasting

Building blocks

To begin our framework, we start with PitchBook's historical fund cash flow and performance datasets. With well over 5,000 closed-end, private capital funds with comprehensive cash flow data, we have the advantage of being able to build empirically derived, probabilistic models.

We first start by building the baseline cash flow profiles for each fund class:

- PE
- VC
- Real estate
- Real assets
- Private debt
- Funds of funds
- Secondaries

To do so, we aggregate historical funds' return data across vintage years.[3] We proceed with the following steps for the capital call and distribution profiles:

1) Identify the historical funds that will be used for modeling capital calls and distributions

Capital calls: Funds must have had at least 90% of their fund size (total commitments) called down or be at least seven years old to qualify for inclusion in the capital call profile buildout. We max out the profiles at 15 years since inception, and longer-dated cash flows are removed to eliminate the impact of abnormally delayed cash flows.

Distributions: Funds must have distributed at least some capital back to LPs and be at least 10 years old to qualify for inclusion in the distribution profile buildout. As with capital calls, we max out the profiles at 15 years since inception, and longer-dated cash flows are removed to eliminate the impact of abnormally long-dated funds.

A 15-year horizon may seem like an odd choice given the traditional 10-year PE fund life (plus one or two extensions), but our historical data and industry trends suggest that a high proportion of funds extend beyond the 10+2 heuristic. We use 15-years to have more data at our disposal to accommodate longer-life vehicles and will make further adjustments to accomodate various expected fund terms.

3: Our starting dataset for cash flow modeling first goes through an extensive data cleaning and normalization process employed for our Global Benchmarks report. We pick up our methodology outline here after that process is already completed.

2) Create normalized cash flow profiles from the historical funds

For each fund that qualifies in the respective cash flow series, we normalize the fund's capital call (distribution) profile to cumulatively total 100% as a percentage of the aggregate capital calls (distributions) through the fund life, again up to 15 years. Each quarterly cash flow (capital call or distribution) is denoted for each fund i as $CF_{i,t}$ such that the *Normalized* $CF_{i,t}$ is defined as a weighted percentage of the total cumulative cash flows through either the fund's life T_i or first 15 years, whichever is less.

$$\text{Normalized } CF_{i,t} = \frac{CF_{i,t}}{\sum_{t=0}^{\min(T,15)} CF_{i,t}}$$

The resulting normalized cash flow series for the funds in a particular fund class are then averaged on a three-quarter rolling basis, including values from the prior and next quarters. This process is done to account for the fact that any observed cash flow has practically the same chance of occurring in the prior or next quarter and to smooth out data lumpiness. As an example, for the average capital call at the fourth quarter of fund life (one year since inception), we will include the capital calls at the fourth (*t*=4), third (*t*-1), and fifth (*t*+1) quarters in the rolling average. The consequent cash flow profiles are then re-normalized to ensure the cumulative profile reaches 100%. Figures 4 and 5 show the resulting capital call and distribution profiles, respectively. These curves are a view of all funds as if they started at the same time.

Modeling a fund from inception

With our baseline cash flow profiles, it will now be possible to introduce unique specifications. An allocator may want to set parameters for expected performance, fund length, investment period, and more to align expectations with the forecasts. Put simply, if a new fund commitment is expected to liquidate by year 10, then it won't make sense to have the base cash flow profile extend out 15 years.

We accommodate this need for flexibility by rescaling the cash flow profiles based on a series of required inputs. Table 1 provides an example set of those parameters. Our example "New PE Fund" is a PE fund (primary fund access point), with a $1.0 million commitment and a base case expected

Figure 4. **Baseline profiles for cumulative capital calls by strategy**

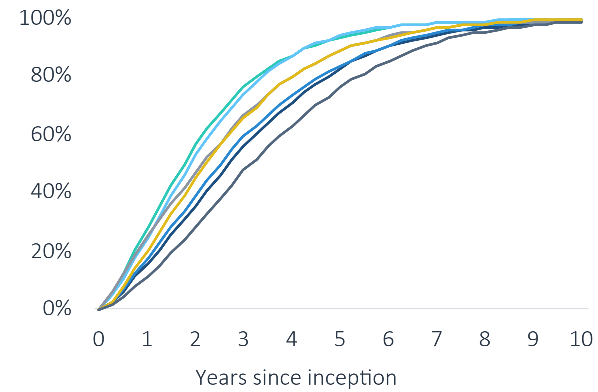
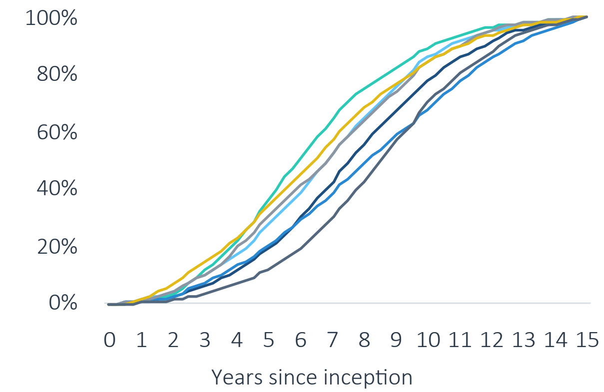


Figure 5. **Baseline profiles for cumulative distributions by strategy**



Private equity | Private debt | Venture capital | Real estate | Real assets | Fund of funds | Secondaries

Source: PitchBook | **Geography**: Global

Source: PitchBook | **Geography**: Global

Table 1. **Example PE fund inputs (New PE Fund)**

Fund name	New PE Fund
Strategy	Private equity
Access point	Primary
Total commitments	$1,000,000
Fund length	12 years
Investment period	6 years
Base case TVPI forecast	1.50x

Source: PitchBook
For illustrative purposes only

total-value-to-paid-in-capital (TVPI) of 1.50x at the end of the fund life.[4] The fund will be expected to liquidate after 12 years and has an investment period where capital is called down in the first six years. Using these inputs we will construct a cash flow profile for this fund, re-scaling our baseline PE profiles created above.

To model the cash flows, we employ the average cash flow percentage for any given quarter. Beginning with the capital call profile, we scale the normalized, baseline profile in each time ***t*** (quarter since inception) such that the cumulative capital called by the end of the investment period (24 quarters) is 100% of the total commitment size. Multiplying the resulting incremental percentages by the commitment size of -$1.0 million gives us a negative dollar figure for each forecast quarterly capital call (negative to represent that it is an outflow for the LP).

$$\textit{New PE Fund capital call}_t = \frac{\textit{Normalized capital call}_t}{\sum_{t=0}^{T=24} \textit{Normalized capital call}_t} \; (-\$1{,}000{,}000)$$

A similar process is employed for the distribution profile, instead using the 12-year fund length parameter and multiplying the total paid-in capital of $1.0 million by the expected return multiple of 1.50x. The resulting output is a series of forecast distributions at each quarter t such that the cumulative distributions reach $1.5 million at the end of the expected fund life (48 quarters). Figures 6A and 6B depict the resulting quarterly and cumulative cash flow profile.

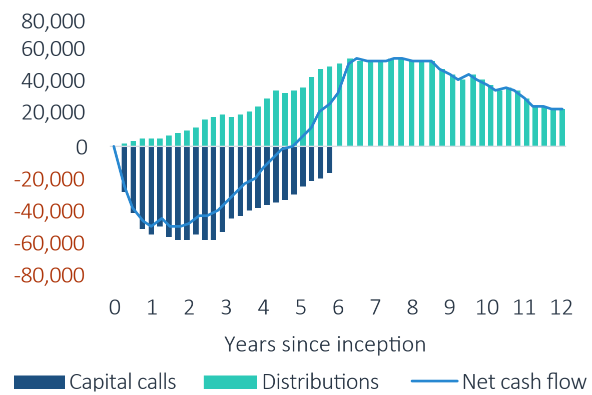
$$\textit{New PE Fund distribution}_t = \frac{\textit{Normalized distribution}_t}{\sum_{t=0}^{T=48} \textit{Normalized distribution}_t} \; (\$1{,}000{,}000) \times (1.50)$$

Modeling a fund mid-life

Alternatively, we can rescale the normalized profiles for a fund that has already experienced cash flows. We introduce additional inputs for the current amount already called, the current amount that has been distributed, and the current age of the fund (rounded to quarter-end). In table 2, our example “Old PE Fund” will be three years old, have had 80% of its $1.0 million commitment called down, and have seen $250,000 in distributions so far. We will keep the same inputs for the expected TVPI, fund length, and investment period.

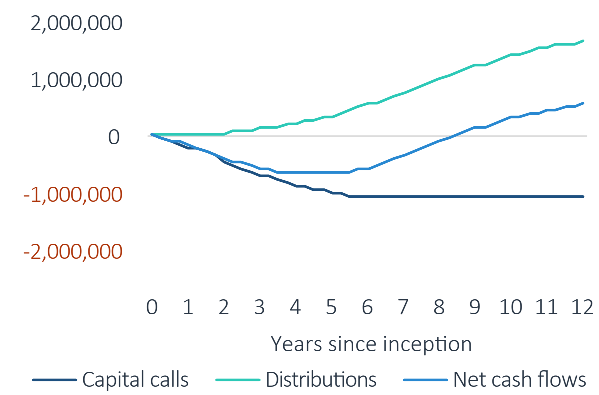
4: All multiples are net of fees and carry.

Figure 6A. **Example New PE Fund cash flow forecast**



Source: PitchBook
For illustrative purposes only

Figure 6B. **Example New PE Fund cumulative cash flow forecast**



Source: PitchBook
For illustrative purposes only

Table 2. **Example PE fund inputs (Old PE Fund)**

Fund name	**Old PE Fund**
Strategy	Private equity
Access point	Primary
Total commitments	$1,000,000
Fund length	12 years
Investment period	6 years
Current age	**3 years**
Current called	**$800,000**
Current distributed	**$250,000**
Base case TVPI forecast	1.50x

Source: PitchBook
For illustrative purposes only

For the capital call profile, we will need to forecast beyond year three, so starting in quarter 13 since inception we estimate the capital call profile through the end of the six-year investment period. Instead of using the $1.0 million commitment as the multiplier, we will use the remaining uncalled capital: $200,000.

$$\textit{Old PE Fund capital call}_t = \frac{\textit{Normalized capital call}_t}{\sum_{t=13}^{T=24} \textit{Normalized capital call}_t} (-\$200{,}000)$$

Similarly, the distribution profile will be scaled such that the cumulative distributions will reach our $1.5 million target but factoring in the $250,000 of distributions that have already occurred (that is, $1.25 million in distributions will be forecast).

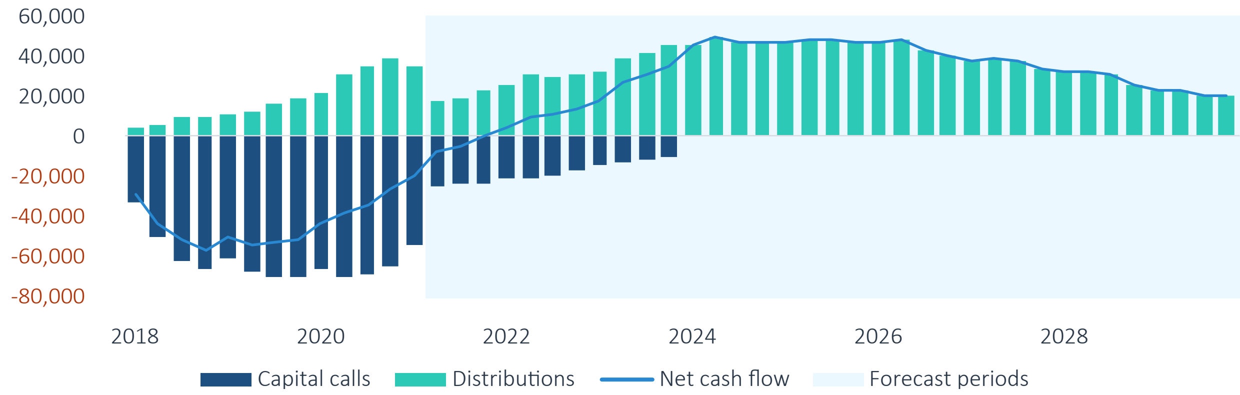
$$\textit{Old PE Fund distribution}_t = \frac{\textit{Normalized distribution}_t}{\sum_{t=13}^{T=48} \textit{Normalized distribution}_t} (\$1{,}000{,}000 \times 1.50 - \$250{,}000)$$

With that, our baseline normalized cash flow profiles are rescaled to account for where cash flow values currently stand for the Old PE Fund and where the values are expected to end up, resulting in figure 7.

Fine Tuning

On top of the customization outlined above, our methodologies have the added flexibility of being able to manually adjust any of the forecast cash flows. For example, if the baseline cash flow forecast expects the New PE Fund to have a $25,000 capital call based on current specifications of the rescaled normalized profiles, but a user has knowledge from that specific fund's GP that the capital call will actually be $75,000, we can adjust the ensuing forecasts. We will again rescale the cash flow forecasts to account for the $75,000 capital call and readjust the subsequent forecasts so as to not overshoot our cumulative capital calls of $1.0 million.

Figure 7. **Old PE Fund cash flow forecast**



Source: PitchBook
For illustrative purposes only

Similarly, we can easily rescale the capital call profile if a fund is expected to have recallable capital commitments—the capital call forecasts will adjust upwards to make up the difference. The same process can be applied to the distribution profiles. The model will take into account any user-provided data and rescale the cash flows back to our base case TVPI forecast in the subsequent periods.

Additionally, for funds that are expected to live beyond our baseline fifteen-year profile, we apply a remaining-expected-life adjustment to match the forecast period to an equivalent point on the fifteen-year baseline profile. This has the effect of stretching out the cash flow profile with smaller forecast amounts after rescaling to reach the TVPI assumption.

Rolling Up

Once we have the cashflow forecasts for the individual funds with varying inception dates, we roll them up into a portfolio-level view of cash flows. For simplicity, we assume the Old PE Fund started on December 31, 2018, and the New PE Fund—which has yet to see a cash flow—began on December 31, 2021. That makes our initial forecast period the first quarter of 2022. Figures 8A and 8B provide the resulting cash flow forecast.

Once the process above has been completed for each fund in the portfolio, we add the values across all cash flow characteristics to arrive at an aggregate cash flow forecast. This can be done at the portfolio, strategy, or any custom grouping level because each fund cash flow profile is calculated independently. Providing this level of granularity allows users to easily track down the source of anomalous values or show the strategy breakdown of forecast cash flow amounts.

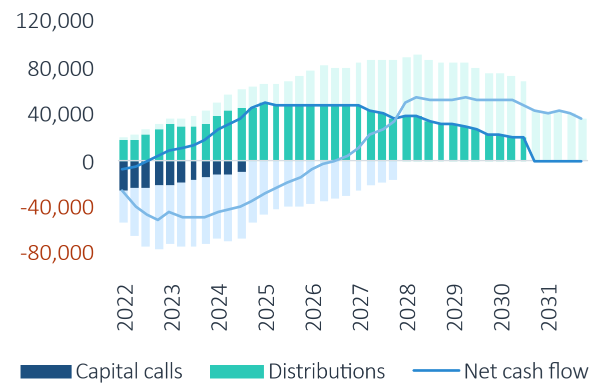
The probability problem

A common issue with portfolio forecasting is that it produces a single output for a given set of input parameters. That single output will often be quite different from reality, especially when the portfolio contains only a handful of fund commitments (that is, idiosyncratic risk is high). Our model is not immune to this difficulty, as the baseline output is a single forecast. However, to supplement our cash flow forecasts we employ a Monte Carlo-style simulation to provide detail on the potential variability of cash flows for the portfolio or sub-strategies. These simulations also allow us to approximate "worst-case" scenarios for capital call events via our capital-call-at-risk (CCaR) metrics. With probability-based estimates of outsized liquidity needs, we can arm allocators with better tools to make cash management decisions.

To build the simulations, we begin by collecting the necessary data points to establish our statistical "norms." We reach into PitchBook's historical fund cash flow datasets once again, using the same inclusion criteria as established in the previous section. The additional components needed for the cash flow simulations are:

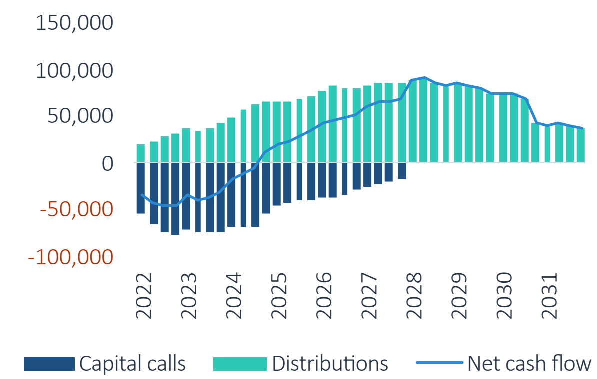
- Probability, in each quarter since inception, of a cash flow occurring by strategy (figures 9 and 10).
- The average cash flow, conditional on a cash flow occurring (figures 11 and 12).
- The standard deviation of the cash flows that occur (figures 13 and 14).

Figure 8A. **Cash flow forecast by fund***



Source: PitchBook
For illustrative purposes only
**Darker color: Old PE Fund; Lighter: New PE Fund*

Figure 8B. **Aggregate cash flow forecast***



Source: PitchBook
For illustrative purposes only
**Total (Old PE Fund plus New PE Fund)*

Figure 9. **Probability of a capital call quarterly**

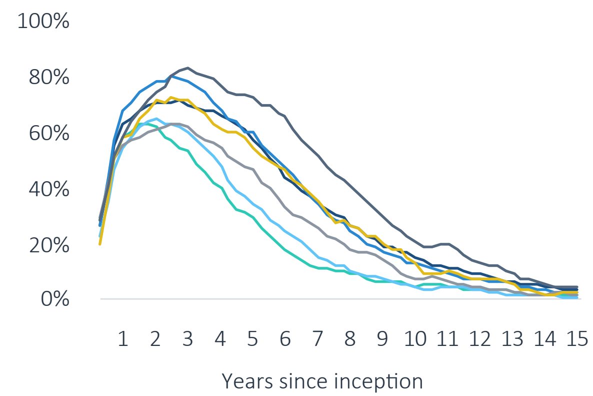
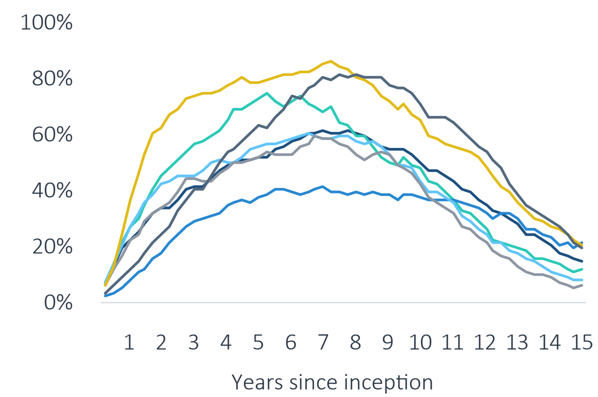


Figure 10. **Probability of a distribution quarterly**



Source: PitchBook | **Geography:** Global

Source: PitchBook | **Geography:** Global

Each of the capital call and distribution cash flow metrics are determined independently, and we employ the same three-quarter rolling periods used in building the base cash flow profiles.

Referencing the data points above, we can estimate a simulation of any given fund cash flow profile by combining the probability of the cash flow occurring with the implied cash flow from a normal distribution that assumes the average and standard deviation profiles. We proceed with the following steps:

1. Using capital calls as an example, a random number between 0 and 100% is first generated and compared to the probability of a capital call occurring based on the historical data series.
2. If the number chosen falls outside the probability of a capital call determined by the strategy and time since inception (figure 9), then the simulator will return a capital call of zero.
3. On the other hand, if the random number falls inside the probability, a capital call is generated by selecting a second random number to represent a point on the normal distribution curve.
4. Taking the average and standard deviation profiles, using the normal distribution, and scaling up to the expected cumulative capital calls then provides us with a nominal figure for the simulated cash flow. It is important to note that we force the randomly generated point on the normal distribution to result in a positive (non-zero) cash flow.

This process results in one simulated cash flow for a single fund at a particular quarter since inception in the forecast period. We build upon that for each of the future time periods for each fund in the portfolio to create a full timeline of the portfolio forecast while also applying the same methodology for the distribution data. Additional parameters are set to ensure the simulations created are internally consistent:

- A distribution cannot occur if no capital calls have occurred historically and in the capital call simulation up to that point in time.
- The total capital calls must add up to the expected capital calls (total commitments + possible recallable capital). If a particular simulation results in a capital call profile that does not reach the total expected calls, the periods with the non-zero capital calls will scale up to fill in the missing delta. If there are no non-zero capital calls in the simulation, a single lump sum totaling the remaining uncalled commitment will be added to the final quarter of the investment period.
- The same will apply to the distribution profile, with the added layer of using the TVPI forecast to estimate the cumulative distributions reached at the end of the fund life.

Figure 11. **Average of non-zero quarterly capital calls as proportion of total capital calls**

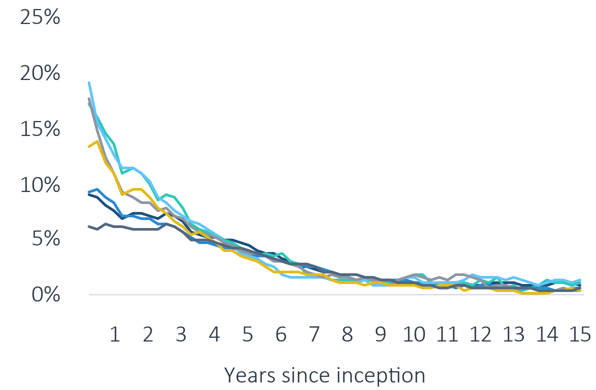
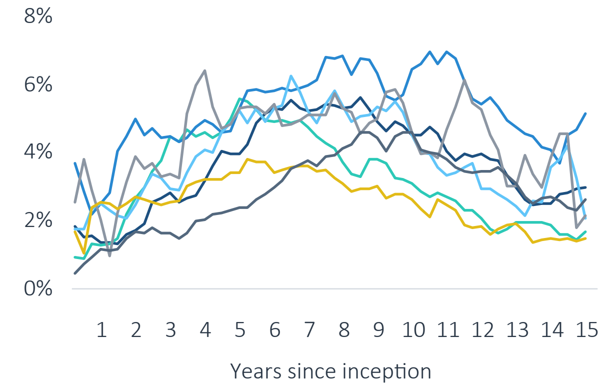


Figure 12. **Average of non-zero quarterly distributions as proportion of total distributions**



Source: PitchBook | **Geography**: Global

Source: PitchBook | **Geography**: Global

Figure 13. **Standard deviation of non-zero quarterly capital calls**

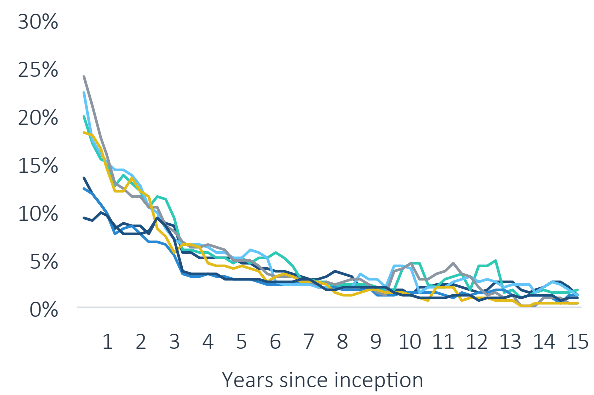
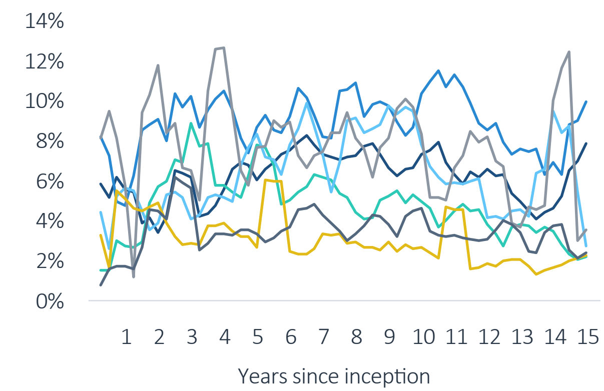


Figure 14. **Standard deviation of non-zero quarterly distributions**



Source: PitchBook | **Geography**: Global

Source: PitchBook | **Geography**: Global

- A fund can call down capital completely before the investment period is over (this is more accurate according to historical data, as many funds will not take the full contracted investment period to deploy commitments).
- The same will apply to distributions; once the TVPI forecast is reached, no more distributions will be forecast, which can result in an overall fund length that is shorter than originally input (for example, 10 years simulated instead of the 12 years expected fund-length parameter).

One additional wrinkle we can introduce to the process is to provide a range of TVPI forecasts, that is, a "bad" and "good" case around the base case TVPI expectation. Any user can input their own TVPI parameters for the fund-level models. The simulator will use the TVPI range between the bad and good case to randomly generate a performance figure in each iteration for each fund.

Let's take, for example, the Old PE Fund from the previous section and create a simulation of potential cash flows in the the remainder of the fund life. We include some hypothetical cash flows in the historical periods (that is, before its current age of three years) to round out a full cash flow profile for the fund. Running the simulation dozens of times with a randomly generated TVPI forecast between 1.25x (bad case) and 1.75x (good case) provides us a range of potential outcomes to consider for this single fund, as shown in figure 15.[5]

As we can see, the simulation process provides the user with probabilistic expectations for the range of outcomes they can reasonably anticipate from their current portfolio. This additional feature is crucial for allocators to assess risk associated with their portfolio.

CCaR

When it comes to cash flow management, the biggest risk for an LP is missing a capital call, a so-called "default" on the contractual obligation to provide capital when required by the GP. Though rare, the reputational and financial damage can be consequential and can result in a forfeiture of the LP's interest in the fund and denial of access to future funds. To avoid the situation, LPs can seek to liquidate their fund interest in the secondary market, or they may be forced to sell other assets in the portfolio. Both of those options can be painful during periods of financial market distress. Allocators, especially those with mature portfolios, may expect to have the distributions from older funds satisfy

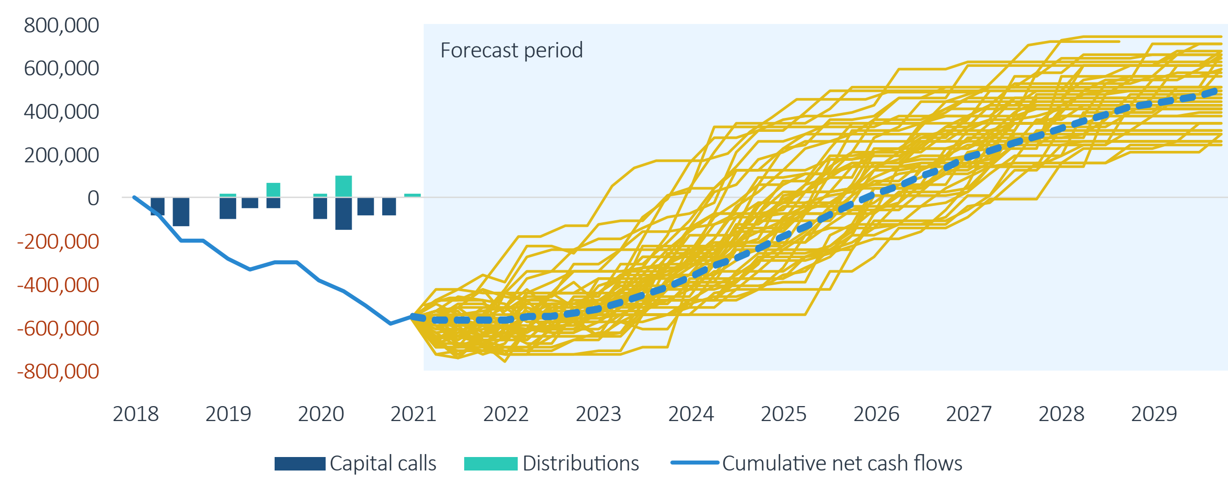
5: Our default is to run 100 simulations, but for visual aesthetics we decided to show 50 in this example. Incremental capital call and distributions in the forecast period are not shown for the same reason.

Table 3. **Updated inputs for Old PE Fund to include "bad" and "good" case TVPI forecasts**

Fund name	Old PE Fund
Strategy	Private equity
Access point	Primary
Total commitments	$1,000,000
Fund length	12 years
Investment period	6 years
Current age	3 years
Current called	$800,000
Current distributed	$250,000
Bad case TVPI forecast	**1.25x**
Base case TVPI forecast	1.50x
Good case TVPI forecast	**1.75x**

Source: PitchBook
For illustrative purposes only

Figure 15. **Simulated cash flow profiles for Old PE Fund**



Source: PitchBook
Note: The dotted blue net cash flow line is the baseline forecast
For illustrative purposes only

the capital calls of more recent vintages. However, we have seen in periods of market turmoil that the likelihood and size of distributions can fall precipitously more than capital calls.

To prevent those worst-case scenarios, LPs will often hold some percentage of their uncalled commitments in relatively safe, liquid assets that will be easily accessible when the GP comes calling. This has opportunity costs, of course, as the capital sitting in safe assets for an extended period will create a drag on the overall portfolio's performance. Too much cash and the portfolio returns can suffer materially. Too little in safe assets and the problems of an unexpectedly large capital call at an inopportune time can be acutely painful. Striking a balance is as much art as is it is science.

Adding a bit more science to the mix, our framework includes a series of metrics called "capital call at risk," or CCaR, that are inspired by the popular value-at-risk (VaR) framework. We use the simulations run in the previous set of steps to aggregate all the simulated cash flows for each fund in a portfolio to build a portfolio-level view. With a collection of simulations built, we can calculate statistics for each point in time simulated in the forecast periods (for example, average total capital calls, standard deviation of calls, and percentile rankings).

Like traditional VaR, our metrics allow an LP to set a confidence threshold (90% or 95%, typically) to help answer the question, "What is the most capital I can reasonably expect to have called in the next quarter with a probability of 90% or 95%?" For example, a CCaR of $10.0 million at 90% confidence implies that there is a 10% probability that the portfolio will experience a capital call of $10.0 million or more in the next quarter. Alternatively, the nominal amounts can be presented as a percentage of remaining uncalled commitments. We have three variations of the metric as outlined below:

1. Percentile CCaR: The simplest of the three, the percentile CCaR takes the simulated capital calls and determines the X percentile capital call in each quarter of all the simulations. A 90th percentile CCaR will find the tenth-largest capital call simulated out of 100 simulations, for example.

2. Conditional CCaR: The conditional CCaR goes a step further and finds the average capital call of all simulations in the X percentile. So, a 90th percentile conditional CCaR will find the average of the 10 largest capital calls simulated out of 100 simulations.

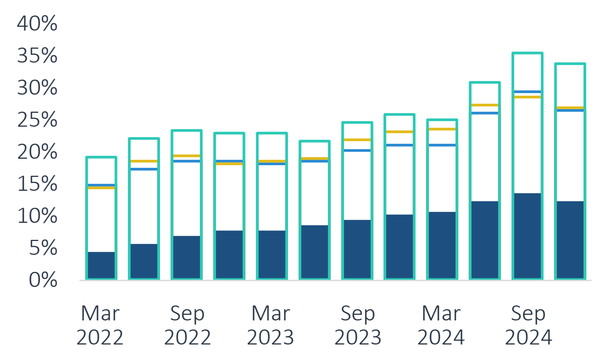
3. Parametric CCaR: The parametric CCaR takes the statistical characteristics of the simulations and assumes a normal distribution. The average capital call and standard deviation are used to determine an implied nominal value of an X percentile capital call given the normal distribution curve.

The CCaR metrics derived are based on only the capital call forecasts. In actuality, LPs will be able to use distributions that occur to finance some portion of capital calls, netting out the impact. Therefore, we can also provide a "net" CCaR that takes into account estimated distributions.

Combining our New PE Fund with the Old PE Fund in our hypothetical portfolio, we use the simulation generator to calculate the CCaR metrics for the near-term quarters, displaying the results in figure 16 along with the original baseline capital call forecasts—all as percentages of estimated uncalled commitments. The percentages shown rise as the remaining uncalled commitments (the denominator) are expected to fall, but the nominal CCaR values fall steadily as the investment periods of both funds move forward, as shown in figure 17.

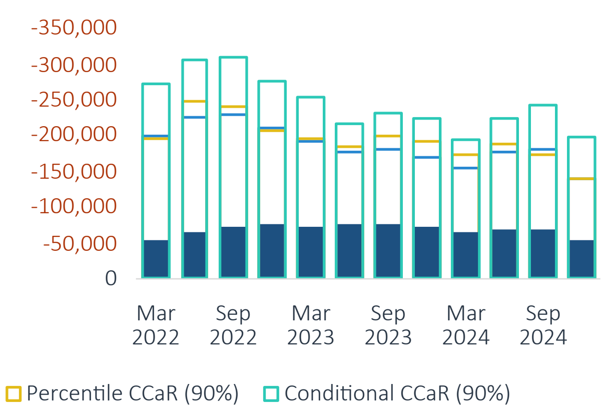
One particularly important consideration is that the CCaR and baseline cash flow estimates can and will change as new actual cash flow data is added to the datasets. If in Q1 2022 (our first forecast period) the actual experienced capital call is materially larger than our baseline forecast, rerunning the simulations will likely result in a lower CCaR in subsequent quarters since there will be fewer uncalled commitments available. Therefore, it is important to revisit this analysis as new information is gathered.

Figure 16. **CCaR as a proportion of expected uncalled commitments**



Source: PitchBook
For illustrative purposes only

Figure 17. **Nominal CCaR estimates**



Source: PitchBook
For illustrative purposes only

Modeling the fund NAV

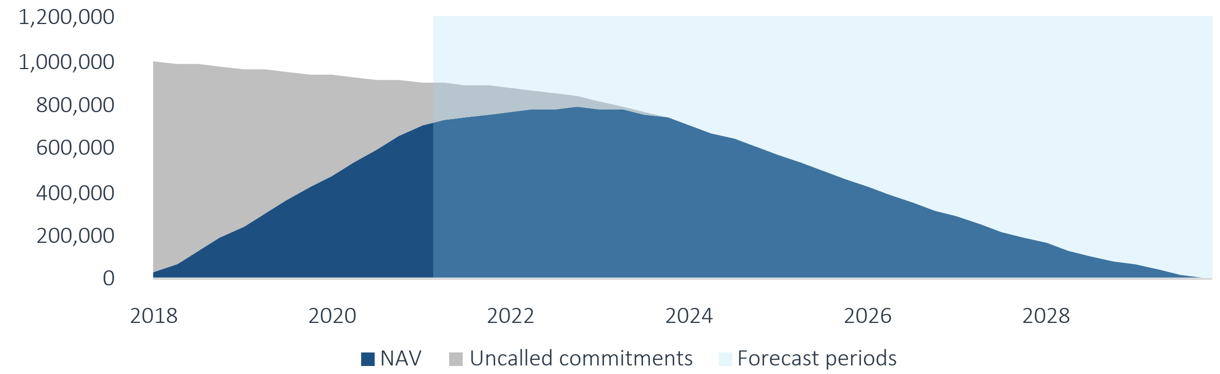
Inseparable from the cash flow profiles, the NAV profiles of the in-ground funds are an important aspect of forecasting and will be an input for commitment pacing in the next section. The NAV forecasts for each in-ground fund (*i*) throughout our future periods (*t*) is a function of the cash flows, previous NAV, and a quarterly NAV growth rate (*g*).

As capital is called, NAV will be expected to rise, and as distributions occur the NAV will be expected to fall (as the unrealized value becomes realized). Implicit in the mathematical relationship is the assumption that the NAV must justify the expected distributions.[6] Here we can turn to established procedures in the Yale model, creating a NAV profile for each fund.

$$\text{In-ground } NAV_{i,t} = \text{In-ground } NAV_{i,t-1} \times (1 + g_i) + C_{i,t} - D_{i,t}$$

Put in words, each quarterly NAV amount is a function of the previous quarter's NAV, grown at some fixed quarterly rate g_i, plus contributions from capital calls ($C_{i,t}$) minus distributions ($D_{i,t}$). Implicit in the simple model is that the cash flows occur at the end of the quarter, which is why the growth rates are not applied to those inputs. We use a gradient descent optimization function to solve for the quarterly growth rate to satisfy the assumption that the NAV at the end of the fund life reaches exactly zero, meaning the NAV growth justifies the expected distributions based on the TVPI forecast used. The resulting NAV profile is depicted for Old PE Fund in figure 18, along with an uncalled commitment forecast for additional color. We add in an additional input that the current NAV of the fund at the start of the forecast is $700,000.

Figure 18. **Forecast NAV profile for Old PE Fund**



Source: PitchBook
For illustrative purposes only

Table 4. **Updated inputs for Old PE Fund to include current NAV**

Fund name	Old PE Fund
Strategy	Private equity
Access point	Primary
Total commitments	$1,000,000
Fund length	12 years
Investment period	6 years
Current age	3 years
Current called	$800,000
Current distributed	$250,000
Current NAV	$700,000
Base case TVPI forecast	1.50x

Source: PitchBook
For illustrative purposes only

6: This is not always true in a practical setting. Distributions can outpace expectations if an exit of a portfolio asset is larger than the NAV booked for the asset, for example. For our modeling, we will ignore this empirical truth and focus on the theoretical.

Commitment pacing

Building blocks

So far, we have focused on modeling the future cash flows and NAV of funds in an active portfolio. Just as important, and highly interrelated, is the plan for future commitments that allocators implement to build and maintain their target allocations to private market strategies. They must strike a balance between timing expectations for reaching and maintaining the target, vintage year diversification, and setting a realistic target allocation that moves the needle on performance/risk but does not lead to undue cash management stress from capital calls and illiquidity.

Setting the commitment schedule is a complicated process, even with historical data and empirically determined input parameters. Once the LP determines the size of commitment they want to make, the GP is in control of calling down the capital, creating value, and returning capital back to the LP. Despite the LP's lack of control, setting the commitment pace diligently is an important process for any LP that wants to reach their allocation targets.

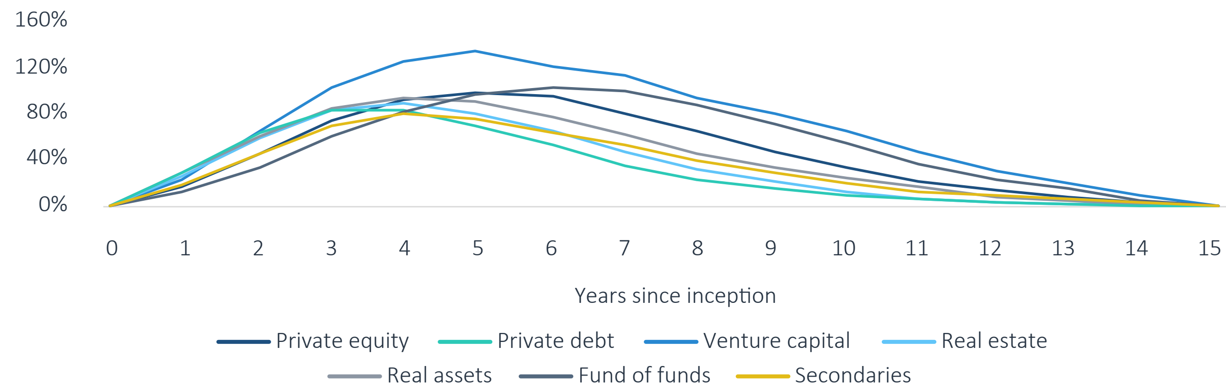
A common approach is to apply an overcommitment ratio, which has an allocator commit more capital than the target allocation, with the drawdown time and early distributions acting as a buffer for funding risk concerns. Determining what that ratio should be is a challenge. Too high, and funding and overallocation risks arise. Too little, and the LP may never hit their allocation targets. Our approach turns the question into an exploration for how fund NAV behaves over time. If we can answer that question, we can back into a commitment schedule that accounts for the NAV glide path and achieves the allocation target at a pre-specified time, layering in commitments in the forecast periods that maintain the target into the future.

We'll once again turn to PitchBook's historical fund return dataset to bring an empirical analysis to the commitment pacing problem to answer two basic questions:

1. What does historical data tell us about the NAV profile's shape for a given fund strategy?
2. When and how high does NAV typically peak in a closed-end, finite life fund?

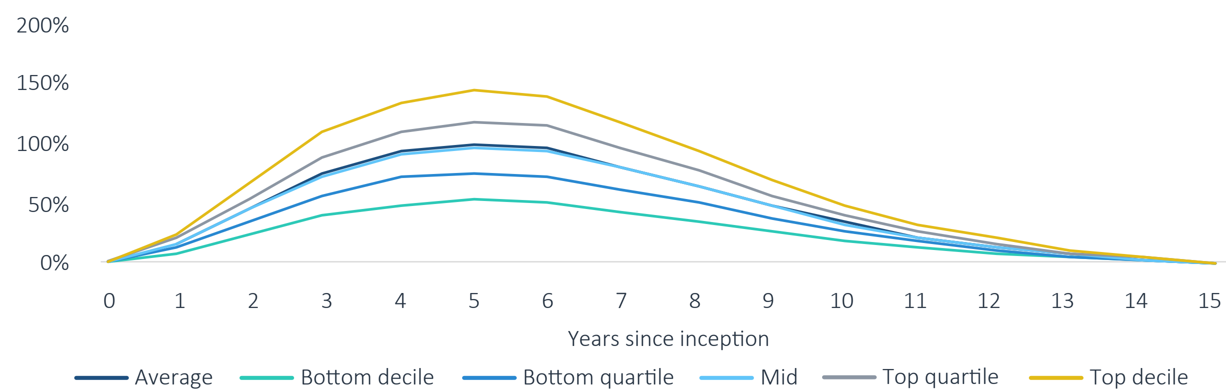
To compile the data set for each strategy, we first create the NAV profile over time. Funds that are at least 10 years old will qualify for inclusion in the NAV profile buildout. While some funds have varying time horizons, we create default profiles that are 15 years in length. Figure 19 shows the resulting average NAV profile by fund strategy. We also create percentile NAV peaks to depict greater variation useful for testing different commitment pacing scenarios. Figure 20 shows several profiles for the PE fund strategy as an example.

Figure 19. **Average NAV profile as a proportion of total commitments**



Source: PitchBook | **Geography**: Global

Figure 20. **Average and percentile breakouts for the PE fund NAV profile as a proportion of total commitments**



Source: PitchBook | **Geography**: Global

Allocation parameters

With NAV profiles in hand, the next piece the allocator will need to consider is the goals of the portfolio. Allocation decisions will need to be taken with a multiyear horizon, especially when an objective is to grow the alternative market allocation substantially from a small or nonexistent base. To set the commitment schedule, an allocator will first need to look at some basic parameters:

- The current (t=0) allocation ($\textit{In-ground NAV}_{h,0}$) of each fund strategy (h)
- The current total portfolio value of all asset classes $\textit{Assets}_0$ (public, private, cash, etc.) to calculate the allocation percentage
- The target allocation (TA_h) of each fund strategy (h) as a percentage of portfolio assets
- An assumed total portfolio growth rate (g_p)
- The amount of time desired to achieve the allocation target, known as the ramp period (T)

The ramp period input users can provide, but we can also apply PitchBook data to implement a suggested time period. Historical data shows peak NAV is reached around the 5 to 7 year mark on average for most strategies. Setting a ramp period that is too quick (2-3 years) can lead to overshooting the target allocation after the ramp period ends as early commitments are still making their way up the NAV profile.

Using these five data points we can estimate an implied $\textit{Ramp NAV}_{i,T}$ at the end of the ramp period T which provides the desired target allocation percentage (TA_h) given the expected growth in total portfolio assets (g_p).

$$\textit{Ramp NAV}_{h,T} = (\textit{Assets}_0)\,(1 + g_p)^T\,(TA_h)$$

It is important to also account for the current allocation of the strategy ($\textit{In-ground NAV}_{h,t}$) by determining what the expected value of the in-ground funds is expected to be throughout our future periods (t). The NAV of the existing portfolio will net out some of the commitments needed to reach the overall $\textit{Ramp NAV}_{h,T}$. To estimate the $\textit{In-ground NAV}_{h,t}$ at different points in the future, we will turn back to our cash flow forecasts established in the "Modeling the fund NAV" section and calculate a NAV profile given the cash flows expected for each fund (i). After calculating the forecast NAV profiles, we can aggregate the $\textit{In-ground NAV}_{i,t}$ of all current funds (N) in the strategy (h) at each forecast period (t).

$$\textit{In-ground NAV}_{h,t} = \sum_{i=1}^{N} \textit{In-ground NAV}_{i,t}$$

Generating a commitment schedule

With the input parameters described in the previous steps, we'll be able to create a commitment pacing schedule for the LP fund portfolio. For simplicity, we'll turn back to a portfolio consisting of a single fund, the Old PE Fund, introduced in the cash flow forecasting section.

Next, in table 5 we'll add in some parameters for a hypothetical allocator looking to build their PE allocation.

Table 5. **Hypothetical LP allocation parameters**

Strategy	Private equity
Current total assets	$50,000,000
Expected asset growth rate	7.0%
Allocation target (%)	8.0%
Years to achieve target	7 years
Current NAV (Old PE Fund)	$700,000

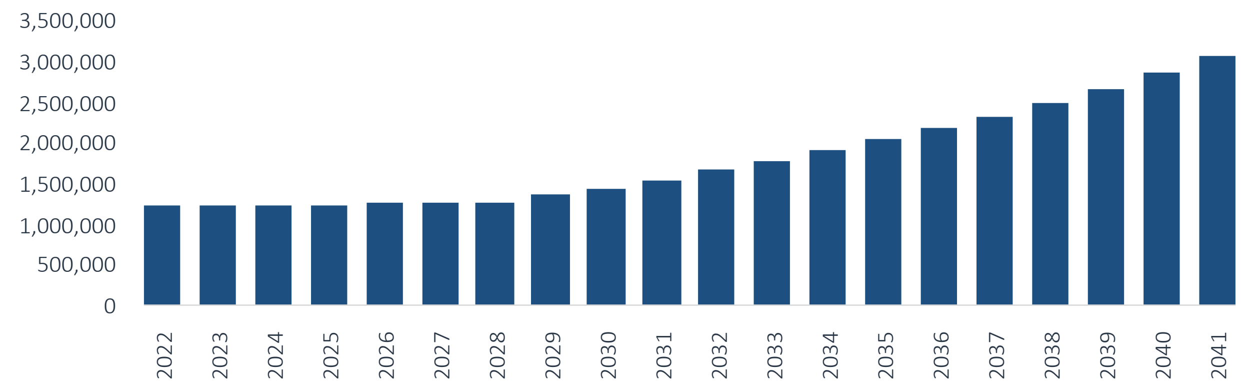
Source: PitchBook
For illustrative purposes only

The parameters above describe a $50.0 million portfolio (all assets) growing at an expected rate of 7.0% per year. This means that achieving an 8.0% allocation to PE in seven years requires a NAV for all PE funds to be approximately $6.4 million, seven years in the future. That will be the target we'll try to reach with an annual commitment schedule, netting out the expected NAV of the current in-ground fund. To set the commitment pacing schedule we proceed with the following steps.

1. Set an initial commitment amount for year one.
2. Set a growth rate for the ramp period (first seven years) to grow the commitment sizing.
3. Set the "steady state" to grow commitment sizes as the same rate of the total portfolio assets (7.0% in this case).
4. Set the NAV profiles assumed for each future commitment (we'll use the average profile for PE funds for simplicity, but one can introduce different assumptions as desired).

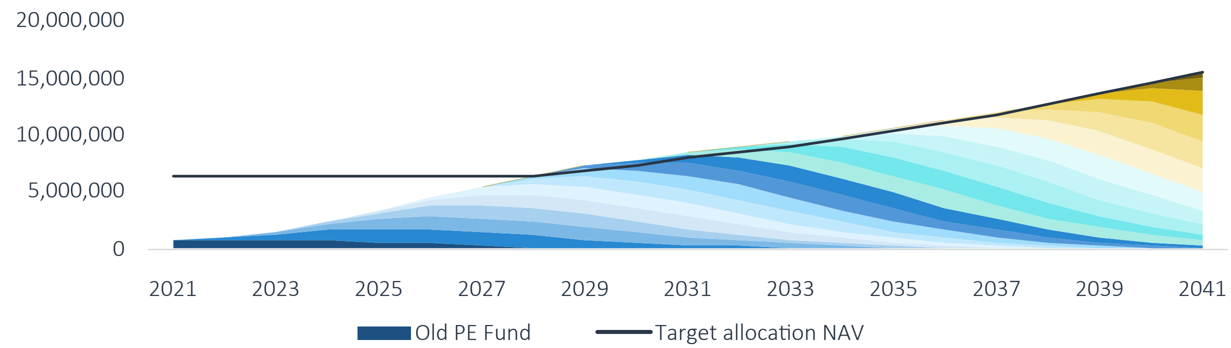
The NAV profiles used for each commitment are key to determining the forecast path of the capital active as NAV each year. We will once again use the Goal Seek functionality to achieve dual objectives: reach the NAV target of $6.4 million at the end of seven years and maintain the 8.0% allocation in the steady-state period. The initial commitment is set as a percentage of the future NAV target (first Goal Seek operation) and a ramp period commitment size growth rate is applied (second Goal Seek operation). The resulting commitment schedule and NAV glide path of the in-ground and future fund commitments are depicted in figures 22 and 23, respectively.

Figure 22. **PE fund strategy commitment schedule**



Source: PitchBook
For illustrative purposes only

Figure 23. **PE fund strategy estimated NAV, both in-ground and future vintage years***



Source: PitchBook
For illustrative purposes only
**Note: Each color shading is the NAV profile for the future vintage years' commitment amounts.*

Bringing it together

With a commitment pacing schedule generated, an allocator will want to recalibrate the expected cash flow profile of the overall private fund portfolio incorporating the future commitments. We can do exactly that by implementing additional fund models in our portfolio forecast. Our commitment pacing schedule can be used to time an estimated commitment size at incremental points in the future. For example, we will use the next 10 years of the commitment schedule shown in figure 22 to add new fund-level profiles, with the inputs shown in table 6.

Each additional fund commitment receives the same assumptions as the Old PE Fund for fund length and performance. That is, each fund is assumed to have a 12-year life and six-year investment period along with bad, case, good case TVPI forecasts of 1.25x, 1.50x, and 1.75x, respectively. Just as in the case of the in-ground fund models, the fund cash flow profiles and assumptions used for these future commitments can be altered to a higher degree of specification.[7]

The resulting cash flow forecasts for each fund are then aggregated, along with the original forecast for Old PE Fund, to create a full cash flow profile of the portfolio. The output provides an allocator with a view of the liquidity needs expected for the ramp-up in fund commitments. The aggregated baseline cash flow forecasts are shown in figure 24.

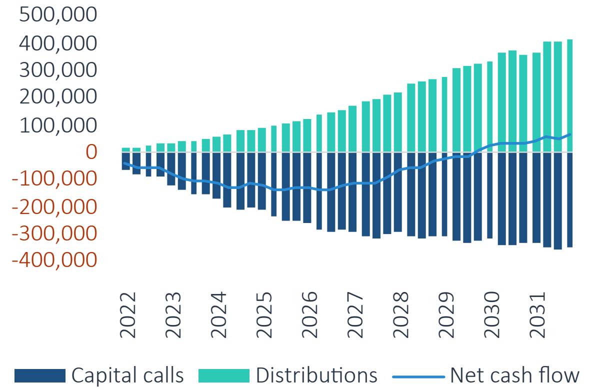
Additionally, we can update our fund cash flow simulations to determine an estimated range of outcomes. This allows the user to estimate potential break-even points on the quarterly cash flow profiles (that is, determine when distributions from older funds start to outweigh the capital calls of new commitments). The range of quarterly net cash flows for the simulated portfolios is juxtaposed with the baseline forecast in figure 25. Looking at just the capital calls side of the ledger allows us to update the CCaR estimates as well (figure 26).

Table 6. **Adding future fund commitments to the Old PE Fund**

Fund name	Commitment size	Inception date (quarter end)
Old PE Fund	$1,000,000	December 31, 2018
Future PE Fund 1	**$1,222,435**	**March 31, 2022**
Future PE Fund 2	**$1,230,839**	**March 31, 2023**
Future PE Fund 3	**$1,239,301**	**March 31, 2024**
Future PE Fund 4	**$1,274,821**	**March 31, 2025**
Future PE Fund 5	**$1,256,400**	**March 31, 2026**
Future PE Fund 6	**$1,265,038**	**March 31, 2027**
Future PE Fund 7	**$1,273,735**	**March 31, 2028**
Future PE Fund 8	**$1,362,897**	**March 31, 2029**
Future PE Fund 9	**$1,458,299**	**March 31, 2030**
Future PE Fund 10	**$1,560,380**	**March 31, 2031**

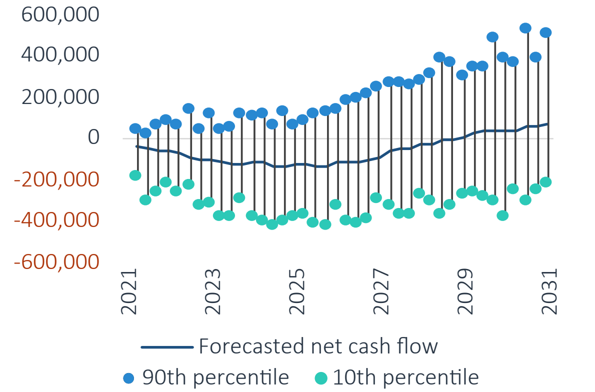
Source: PitchBook
For illustrative purposes only

Figure 24. **Aggregate cash flow forecast**



Source: PitchBook
For illustrative purposes only

Figure 25. **Simulated net cash flow ranges**



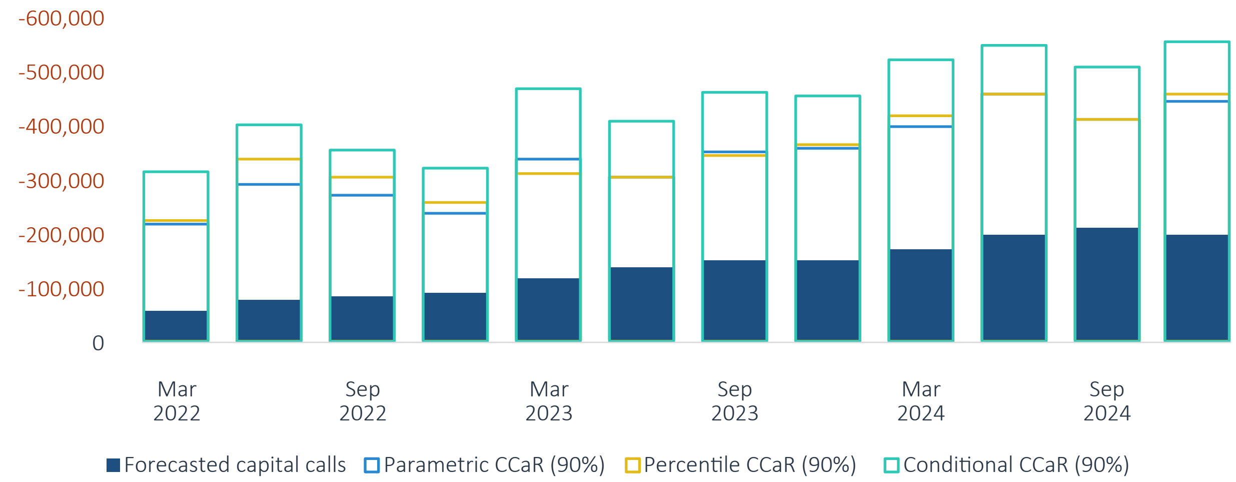
Source: PitchBook
For illustrative purposes only

7: Note that the inputs used for these additional future commitments can lead to different aggregate NAV forecasts compared to the commitment pacing schedule's forecast for the allocation.

Alternatively, we can view the simulated cumulative cash flow profiles aggregated over time, as shown in figure 27.

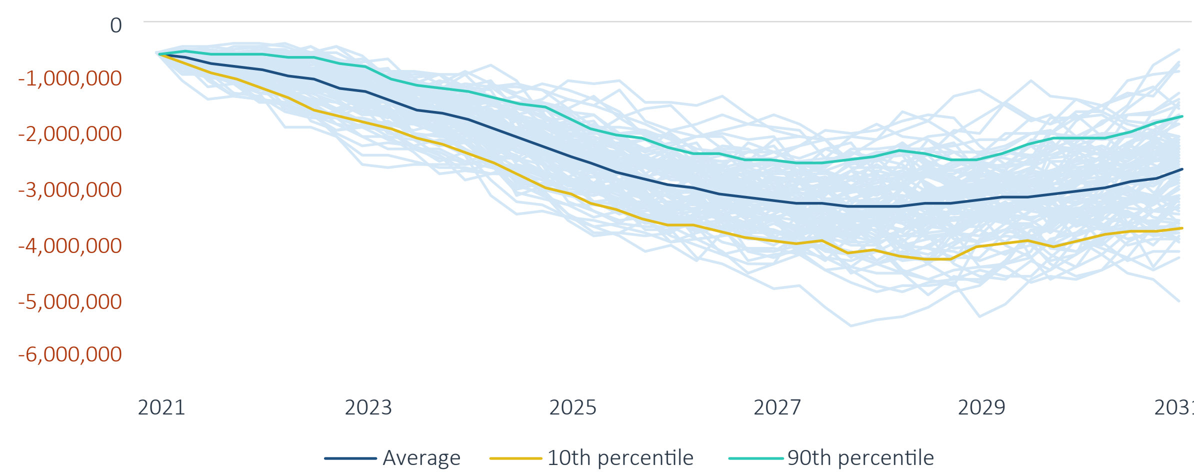
It's also important to note that this example is a very young program, thus the cash flow profiles are negatively skewed for several years as the commitments are put to work. An older, more established portfolio will produce a much different outcome and will likely show self-funding at an earlier stage. More layers can be added if other strategies are included in the portfolio, allowing users to customize fund characteristics, allocation targets, and data analysis by individual strategy (PE, VC, real estate, etc.) or as an aggregate of all private fund types. We plan to continue adding features in the coming quarters, so all questions and feedback are welcome.

Figure 26. **Updated CCaR metrics**



Source: PitchBook
For illustrative purposes only

Figure 27. **Simulated cumulative net cash flow profiles**



Source: PitchBook
For illustrative purposes only

Additional considerations

PitchBook's Allocator Solutions: Cash Flow Modeling and Commitment Pacing offers users a unique, data-driven approach to planning for liquidity and making allocation decisions. However, there are certain limitations that are worth pointing out for a potential user of the toolkit. The key points are outlined below:

- The base cash flow profiles are aggregated across vintage years within each strategy; this forces the assumption that the historical data will be representative of future cash flow profiles.
- Prior analysis of fund cash flow characteristics suggests there is cyclicality to fund performance and cash flow profiles based on prevailing market conditions. Cyclicality is not explicitly applied in our methodologies, although there are workarounds for creating adjustments with different sets of inputs.
- More granular fund profiles are not included in the default model, although there is evidence to show that fund size, sub-strategy, and geographic preferences can lead to different cash flow and performance profiles.
- The simulated cash flows assume no correlation from period to period, with the exception that each simulation is forced to achieve the expected capital call or distribution amounts in aggregate. For example, a very large capital call amount may be systematically less likely to be followed by another large capital call, but our simulations do not implement this constraint.
- Our historical fund cash flow data and forecast estimates are quarterly figures and assume that the cash flows occur at quarter-end for simplicity. More granular timelines are unavailable without additional data manipulation.

Despite these assumptions and limitations, the outputs created improve upon the existing off-the-shelf models available today. Our methodologies outlined will continue to improve with updates and new versions as we collect more data and add additional analyses. One area we are currently exploring is creating macro-variable inputs that will be derived from the empirical impact that economic and financial market conditions have on private fund cash flows. This will allow a user to incorporate macroeconomic scenarios into the analysis. Additionally, our Quantitative Research team is working extensively with our Product teams to bring our solutions to scale within the PitchBook platform, allowing users to have a more seamless software experience.

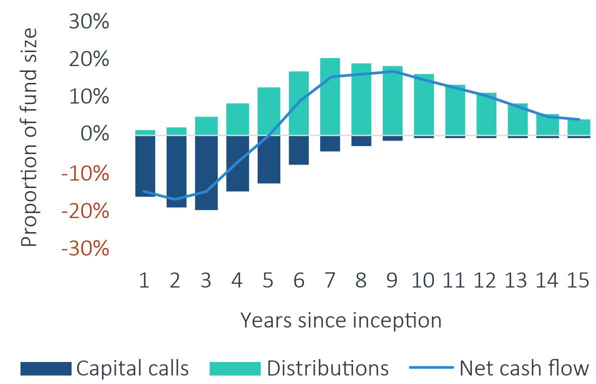
The previously mentioned improvements to our current cash flow modeling framework will be the result of additional research yet to come. Our current versioning is the product of working with dozens of clients on their portfolio forecasting needs, which has provided valuable feedback that we will continue to leverage. As we make incremental improvements, we will continue to provide PitchBook clients with our latest developments.

If you are a PitchBook client and would like to leverage our Allocator Solutions: Cash Flow Forecasting and Commitment Pacing toolkit or learn more about our offering, please reach out to your account manager or pbinstitutionalresearch@pitchbook.com. Non-PitchBook clients can contact info@pitchbook.com to learn more about PitchBook's entire suite of product, research, and data tools.

Appendix

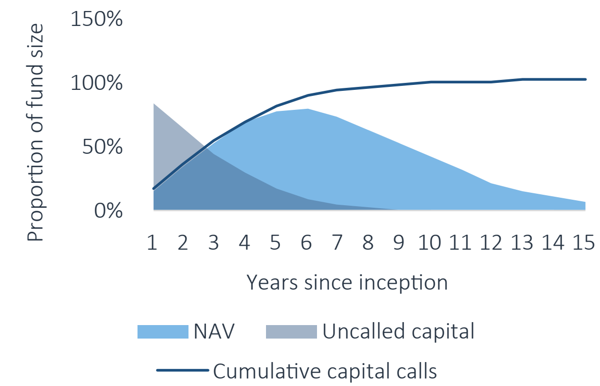
In addition to PitchBook's Allocator Solutions toolkit, PitchBook clients have access to underlying datasets of fund cash flow history for use as input parameters in their own internal models. Pace of capital calls, distribution profiles, historical performance, etc., are all aggregated at the strategy-level for convenience. The ensuing visuals for PE provide some highlights from the Excel summary available in our Research Center. Additional customizations can be requested by contacting support@pitchbook.com or your account manager. Keep in mind that these are datasets that do not employ the same normalization and filtration process described in this report.

Figure 28. **Average PE cash flow profile**



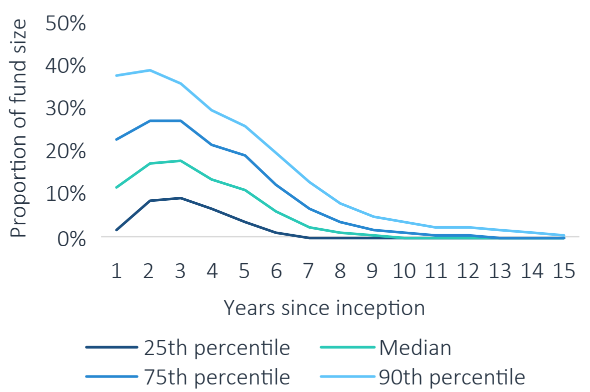
Source: PitchBook | **Geography:** Global

Figure 29. **Average PE NAV profile**



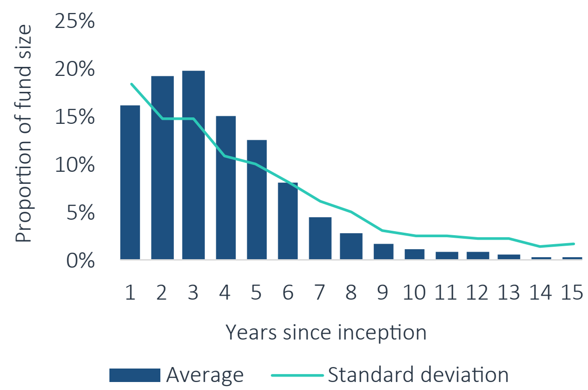
Source: PitchBook | **Geography:** Global

Figure 30. **Yearly capital calls for PE funds**



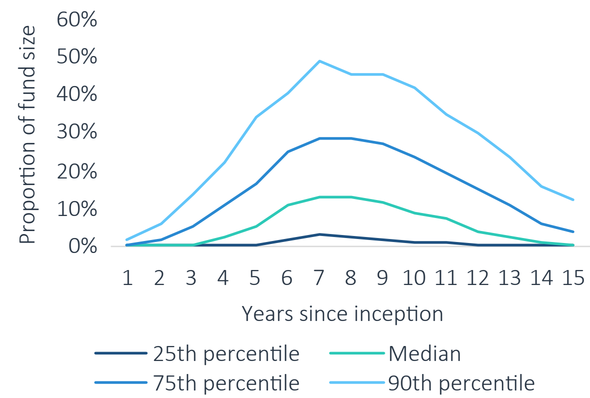
Source: PitchBook | **Geography:** Global

Figure 31. **Average and standard deviation of capital calls for PE funds**



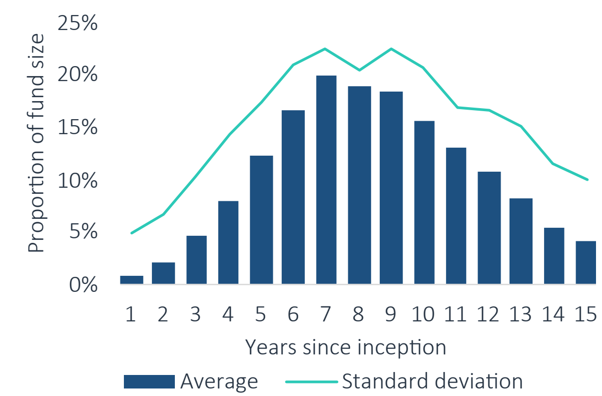
Source: PitchBook | **Geography:** Global

Figure 32. **Yearly distributions for PE funds**



Source: PitchBook | **Geography:** Global

Figure 33. **Average and standard deviation of distributions for PE funds**



Source: PitchBook | **Geography:** Global

Additional research

PitchBook Benchmarks

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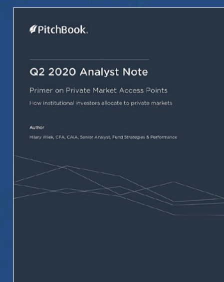

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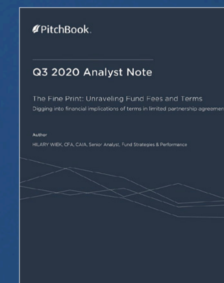

Analyst Note: The Fine Print: Unraveling Fund Fees and Terms

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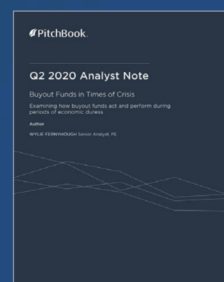

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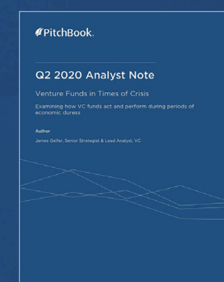

Analyst Note: Venture Funds in Times of Crisis

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