Mechanics of fund diversification

Maximizing alpha while smoothing capital calls

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1. Welcome

Professional investors are in the business of taking cash – the fundamental building block of all multi-asset portfolios – and investing it in a diversified portfolio of financial products. Investors with alternative or illiquid investments face cash management challenges, including commitment-based asset classes. Managers draw down investors' capital (again, cash) over periods of 5 years or more, and there are significant penalties for missing a capital call.

This makes the effective and efficient management of cash critical for professional investors' success. And the key challenge facing investors is estimating the amount of cash needed in a given period to fund capital calls and cover uncalled commitments. Pacing models, which seek to bring structure and predictability to these uncertain domains, can help meet these challenges. An effective pacing plan provides expectations for cash needs, with probabilities to help investors make informed decisions about how much capital can be committed without putting the organization at risk of missing a call.

2. NTK

Here's what you "need to know" from this brief.

- **Scenario Planning:** Rather than viewing pacing models as a convenient way to forecast a single amount of cash to hold in reserve, investors should see them as presenting a range of potential cash-need outcomes. Said differently,

investors' commitments to funds—and the associated liabilities—behave similarly to assets in terms of returns and volatility.

- **Fund Diversification:** Increasing the number of funds held reduces the volatility of liabilities and enables smaller cash buffers. Particularly when an investor moves from one to two or two to three funds, the benefits can be significant. Investing in three to six commitment-based funds[1] can strike an optimal balance between reducing cash drag while not over-diversifying away greater alpha potential.
- **Over-diversification:** Over-diversification to illiquid funds is common among institutions, as CIOs seek to construct portfolios that perfectly smooth capital calls. This portfolio approach to managing capital call risk is very expensive: it leads to lower fund performance (too many funds to drive the desired alpha), higher fees (smaller commitments preventing leverage in negotiations) and less contact with GPs (lower investment amounts, which reduces influence).

In short, getting the balance of funds right—achieving a "Goldilocks" level of diversification by building sophisticated analytics around pacing—is a key to successful private market portfolios.

3. Significance

An investment in a private equity or venture capital fund takes the form of a "commitment," which signifies that an investor (limited partner or LP) commits to have cash ready for the manager (general partner or GP) to invest over a time period. Generally, the manager can call this cash at any time during the period, so the investor is obligated to stay ready to provide that cash when it is called.

The simplest way to manage this type of cash liability would be to set aside the total amount of the commitment from the time it's made, but this would lead to substantial cash drag on the portfolio. By that, we mean that the return on cash is often much lower than the return on the asset being invested in, so holding cash is an expensive way to manage the liability.

[1] The vintages of funds held will impact analysis. Analysis shown is based on holding vintage year constant. Contact us for sensitivity analysis on simulations across vintages.

To address this problem, investors use pacing models, which provide guidelines or guardrails around the levels of cash required to meet unfunded (i.e., not-yet-called) commitments. This is done by setting expected cash contribution amounts as well as providing a confidence band around those expectations. Intelligent pacing can help an investor plan not only for cash reserves, but also make ongoing allocations, and size investments correctly.

A sophisticated pacing model has the potential to deliver meaningful outperformance. It isn't by luck that the most commonly used pacing model for alternatives was invented by Yale's endowment team. In order to effectively run the Yale Model, which represents a highly illiquid and alternatives-heavy portfolio, the team had to invent smarter ways of planning for cash needs (see Takahashi and Alexander, 2002). Moreover, as increasing numbers of investors follow Yale into alternative and illiquid assets, the importance of these models has skyrocketed.

This ARB offers fresh insights into creating smart cash-flow diversification and pacing models. Most organizations we observed are looking to Monte Carlo simulations to assess whether their cash reserves are sufficient, but we do not see this approach as sufficiently tailored to the specific needs of an individual investor. This brief shines light into this black box by connecting portfolio composition to confidence intervals.

4. Context

Before moving forward, let's take a quick detour and discuss a few important concepts related to commitment-based asset classes, such as private equity or venture capital:

- **Pacing Model:** An estimate of the time needed to implement a portfolio mandate or deploy capital into a fund. The pacing reflects the time it takes for a fund to call an investor's capital and put it to work.
- **Cash Buffer:** The amount of cash investors earmark for a specific purpose at a specific time, which in turn can be broken down into two categories: 1) median expected cash needs; and 2) some additional amount to reflect the uncertainty of future cash needs.
- **Cash Drag:** The negative impact of investment returns from over-reserving cash in order to manage liquidity risks arising from unfunded commitments to illiquid asset classes.

- **Diversification:** Asset diversification is a foundational concept in modern portfolio theory. Harry Markowitz (1964) won the Nobel Prize for showing that by combining a set of non-perfectly correlated assets, an investor can improve their risk-reward profile. This concept holds true for any time series and applies to both portfolios of assets and of liabilities. For private assets, diversification offers a useful way to manage liquidity risks and the challenges of meeting capital calls related to pacing. As we combine a set of unfunded commitments, the dispersion in potential capital calls decreases, meaning that the risk of being hit with large, unexpected capital calls decreases, allowing investors to be more comfortable holding a smaller buffer of cash to fund their future commitments.

- **Over-diversification:** Relying exclusively on fund diversification as a means of managing liquidity risks associated with capital pacing is pervasive, but it's suboptimal and costly. Commitment based assets, such as PE or VC, are often costly and bespoke: LPs often pay different fees to the same GPs, depending on the size and nature of their commitment. As this implies, diluting commitments across too many funds will increase fees paid and reduce the alignment with GPs. In addition, funds are pooled investment vehicles, which means they already offer diversified exposure to the underlying assets driving performance. By diversifying further to manage risks related to funds, an investor may over-diversify their exposure to the actual investments (i.e., the fund's portfolio companies). This can mean paying high alpha fees for beta exposure to an asset class.

- **Confidence Intervals:** When dealing with uncertainty, it's helpful to create models and do statistical analysis to help give an idea of the likelihood of potential future events. In this ARB, we rely on confidence intervals or the likelihood that a future event will fall within some range of potential outcomes. A 90% confidence interval suggests that the amount of a future capital call will likely fall within that range of outcomes 9 out of 10 times.

5. Approach

Advanced data analysis can help investors better understand unfunded commitments and commitment risks, potentially reducing the need for a big cash buffer, decreasing the cash drag on the portfolio and delivering appropriate diversification of funds with intelligent pacing. To develop better pacing models, we studied a large universe of contributions data. We pulled 93,486 capital call data points from Preqin[2] across 5,999 funds, spanning vintages from 1980–2021 with the most prevalent year being 2017. Geographically, roughly 75% of the funds in this dataset are based in North America. The funds' most prevalent strategies were private equity, venture capital and real estate, which together accounted for over 80% of total funds included in the analysis.[3]

The capital call risk in various sized portfolios was calculated using simulations built upon the Preqin dataset. For private capital fund portfolios of between one and eight assets, we created 10,000 unique portfolios made up of randomly selected and equally weighted sets of funds. We used Preqin's capital call curve data to exhibit each of these portfolios' capital call curves, and when aggregated, were able to pull sample mean and standard deviations for each portfolio size. The results of this analysis are shown in Figures 3 and 4, with additional details of this analysis available in the Appendix.

Key assumptions include:

- Cash flow values are net of fees.
- Cumulative contribution curves are non-decreasing.
- The start date of each fund is July 1st of the vintage year (unless there's evidence that it was earlier in the year).

Dispersion calculations between the 75th and 25th percentile (as shown in Figure 1), as well as median capital call curves across various private capital categories (Figure 2), were created using the aforementioned Preqin data. Meanwhile, the average number of alternatives held by high-net-worth (HNW) individuals was calculated by looking at Addepar's proprietary platform with its $3.5 trillion in assets. Please also note that this analysis doesn't take into consideration cash distributions from private capital (this will be forthcoming in a future brief). A detailed list of our assumptions can be found in the Appendix.

[2] Preqin provides data, analytics and insights in the alternatives space.
[3] Data from the Preqin database was primarily sourced via the Freedom of Information Act. Please see the Appendix for additional details.

Approach to Performance Analysis

We began with the same Preqin dataset used for our commitments analysis. We first corrected the data to ensure that all cumulative distributions and contributions were monotonically increasing and decreasing, respectively. We then calculated performance to take into consideration both realized and unrealized returns as shown below:

$$Performance = \frac{Distributions_t}{(Valuation_{t-1} + Contributions_t)} + \frac{Valuation_t}{(Valuation_{t-1} + Contributions_t)}$$

For each vintage for which we had data on 35 or more funds, we randomly chose *n* number of funds, with replacement, to create 500 unique, equally weighted synthetic portfolios, from which we derived sample statistics.

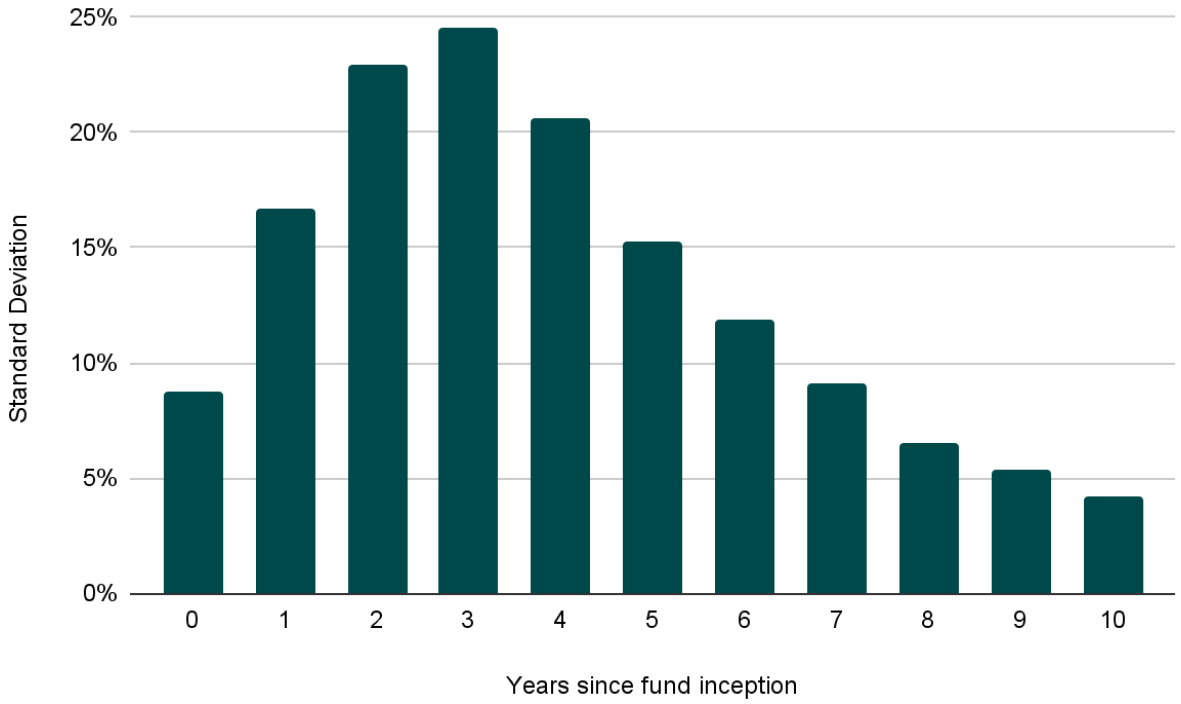
6. Findings

Looking at historical Preqin data, we found that the uncertainty in cash needs reaches its maximum level two to three years after fund launch. Uncertainty then decreases over time before mostly leveling off seven years after the fund's start date.

Figure 1

Standard Deviation Across the Sample Set

Standard deviation of cumulative cash contributions across entire sample set



Source: Preqin

Median Capital Call Curve

For the most part, the median capital call curve is consistent for both private equity and venture capital.[4] This is because capital calls are driven by the investment opportunities of the fund's manager, and many of these investments in the major strategies have similar characteristics in

[4] This is not necessarily true across vintages, which will be the topic of a future ARB.

aggregate.[5] However, as can be seen in Figure 2, we found that private debt and real estate funds tend to call capital more aggressively than the average fund, while fund-of-fund managers call for capital contributions at a slower rate than other fund types.

Figure 2

Range of Expected Cash Contributions Depending on Strategy

Median cash contribution curves across all assets, the fastest and the slowest capital call curves

Source: Preqin

Average Alternatives Held by HNW Individuals:

As shown in Figures A.5 and A.6 (see Appendix), family offices and investment advisors that invest in private capital markets tend to only hold one or two funds. There can be many reasons for holding fewer private capital funds, particularly for smaller investors who face large investment minimums (relative to their wealth). But for those that can expand their holdings—given that a little diversification leads to a large measure of liquidity risk benefits (as detailed in the next

[5] See the Appendix for a graphical representation of median capital call curves in private equity and venture capital.

section)—investing in a few additional funds can significantly improve investors' cash management around private capital commitments.

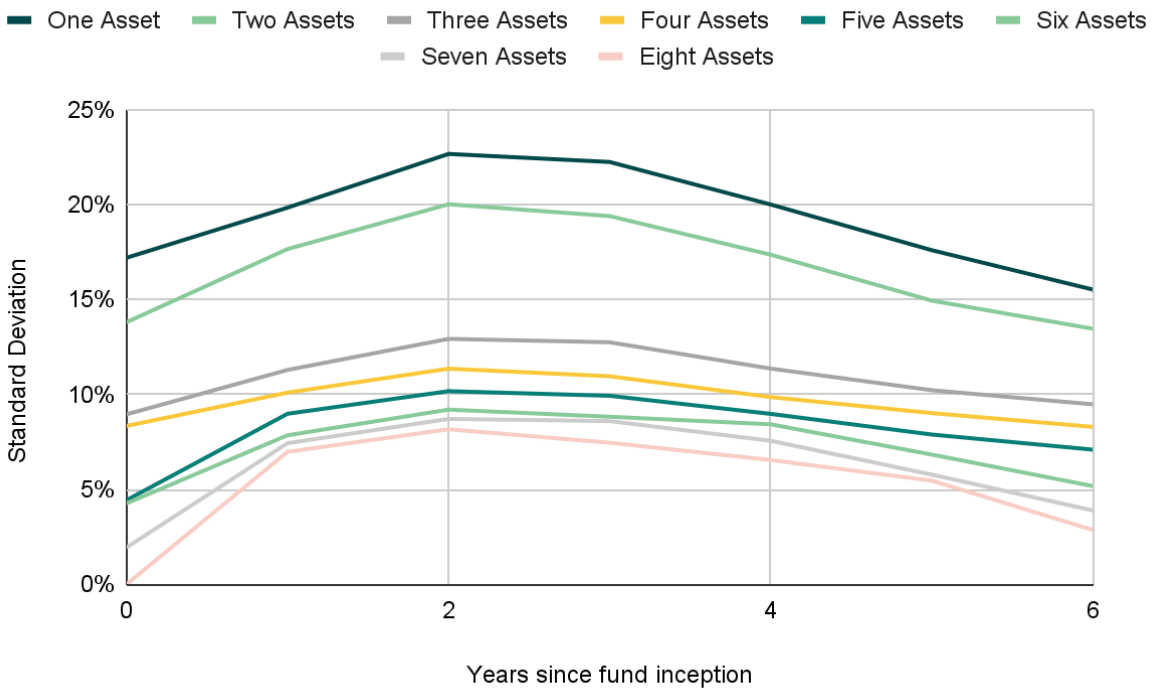
Capital Call Risk Benefits of Larger Private Capital Portfolios:

Investing in several private capital funds leads to a more consistent liability stream and allows for a smaller cash buffer compared to investing in a single private capital fund. To more clearly illustrate this, we created sets of equally weighted cash contribution streams that held anywhere from two to eight combined funds. We found that—without exception—as the number of funds in the portfolio increased, with the associated liabilities linked to unfunded commitments, the standard deviation of cash contributions decreased from the vintage year through year six. This suggests that an investor can reduce their capital call risk by increasing the amount of private capital funds held. Said differently, fund diversification across capital call curves can allow an investor to hold less cash, while maintaining the same cash risk as an investor who holds fewer funds.

Figure 3

Capital Call Risk Decreases Across all Time Periods as Portfolio Size Increases

Standard deviations of various sized portfolios from the time of initial capital commitment



Source: Preqin

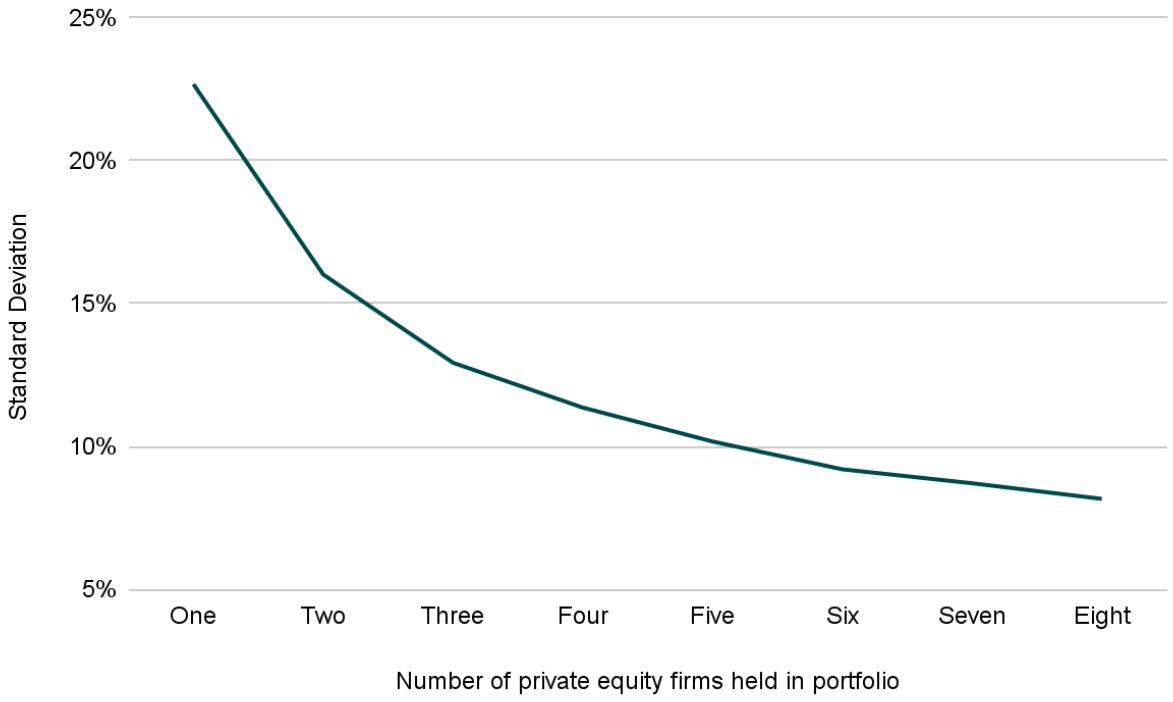
Importantly, note from Figure 3 that the vast majority of the benefits comes from fund diversification. That is, investors can nearly halve their capital call risk by increasing private capital fund holdings from one to three funds. As this suggests, the benefits of diversification from adding the sixth (or even a 10th fund from an institutional perspective) will likely not deliver sufficient risk mitigation to justify the cost and effort required to manage an increasingly diversified portfolio.

To see these issues more clearly, Figure 4 presents a closer view of the two-year point from Figure 3. As the size of the portfolio increases, the amount of capital call risk (as measured by volatility) decreases. These diversification benefits are largest when increasing the portfolio size from one to three assets. The decreases in risk allow investors to set aside a smaller cash buffer earmarked for potential capital calls.

Figure 4

Capital Call Risk Decreases as Portfolio Size Increases

Standard deviation two years after initial commitment



Source: Preqin

Over-diversification Starts at Four to Six Funds:

While increasing the number of fund investments generates a more predictable call schedule (which subsequently allows investors to reduce cash drag), the increase in funds held also has the effect of diversifying idiosyncratic risk and reducing the potential for achieving excess alpha returns. To illustrate the point, we provide the dispersion in performance for *n*-sized portfolios of equally-weighted private capital funds[6].

Figure 5

Alpha Potential Decreases as Portfolio Size Increases

Dispersion of annualized cumulative performance across portfolio sizes five years after vintage date

Source: Preqin

The dispersion across simulated portfolios drops rapidly as the number of funds increases. Said differently, if you're creating a portfolio with three investments, the chances of you picking funds that earn you 5% or more annually above benchmark is 20%. If you pick 10 investments for your portfolio the chances of you earning 5% above benchmark decreases to 10%.

[6] We calculated dispersion by dividing the 85th–15th interquartile range by 2. This is approximately equivalent to one standard deviation, which helps to better deal with this non-standard distribution.

7. The ARB-itrage

Undeployed cash can generate significant drag on a private equity portfolio. A minimal number of fund positions, say three or more, structurally diversifies future cash flows, which reduces cash flow volatility and ultimately means reduced cash buffers and less drag.

However, increasing the number of funds held can also have the potentially adverse effect of over-diversifying fund returns. For investors seeking to identify high-performing managers and funds that provide excess alpha returns, diversification reduces the chances of being able to capture alpha, while increasing complexity and the operational burden of managing the portfolio. Portfolios of six or more fund positions run the risk of being over-diversified.

Here's the key insight from this ARB: Investing in three to six commitment-based funds[7] for a given portfolio objective strikes the right balance between diversifying your future cash flows enough to reduce the cash drag on your returns, while not over-diversifying away your potential of achieving alpha. Put another way, choosing a small number of great investments is the key to a great portfolio. Investors really don't need that many investments to maximize alpha potential while smoothing capital calls.

8. Coda

Cash management planning for future capital calls should be analyzed in two steps. First, clearly understand the expected capital call in each time period. This can be affected by the fund's strategy, but all of the main strategies tend to have similar curves. Then decide how much capital call risk you're willing to take on. You can mitigate this risk and hold smaller cash buffers by diversifying your private capital portfolio across vintages and over time. You can also gain considerable benefit through very little diversification. This is important because over-diversification can have detrimental effects on achieving your portfolio's key objectives. We will touch on that idea in a future Addepar Research Brief.

[7] The vintages of funds held will impact analysis. Analysis shown is based on holding vintage year constant. Contact us for sensitivity analysis on simulations across vintages.

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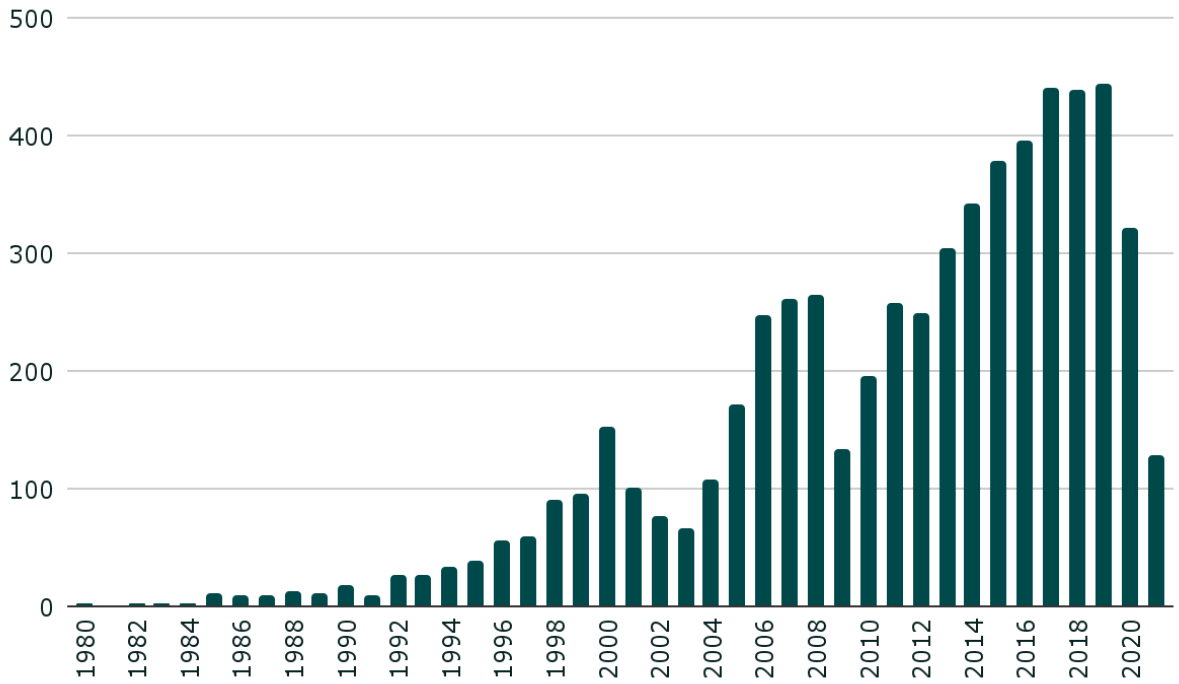
Appendix

Dataset Details

Figure A.1

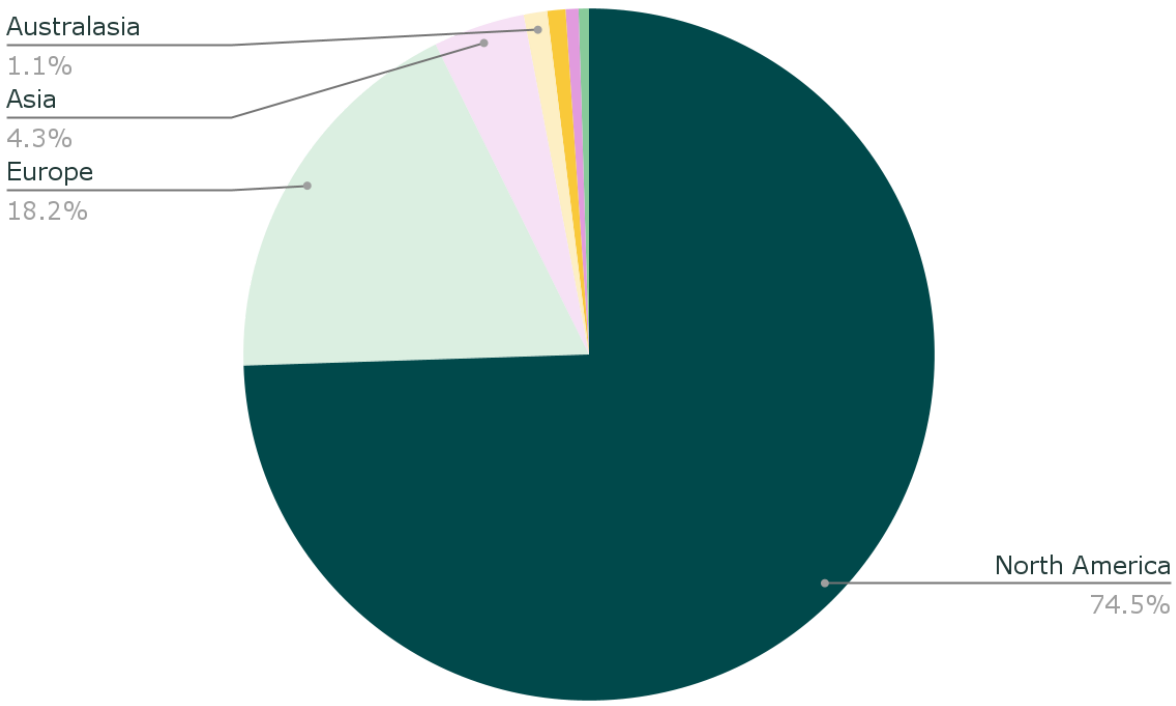
Number of Funds in Dataset by Vintage



Source: Preqin

Figure A.2

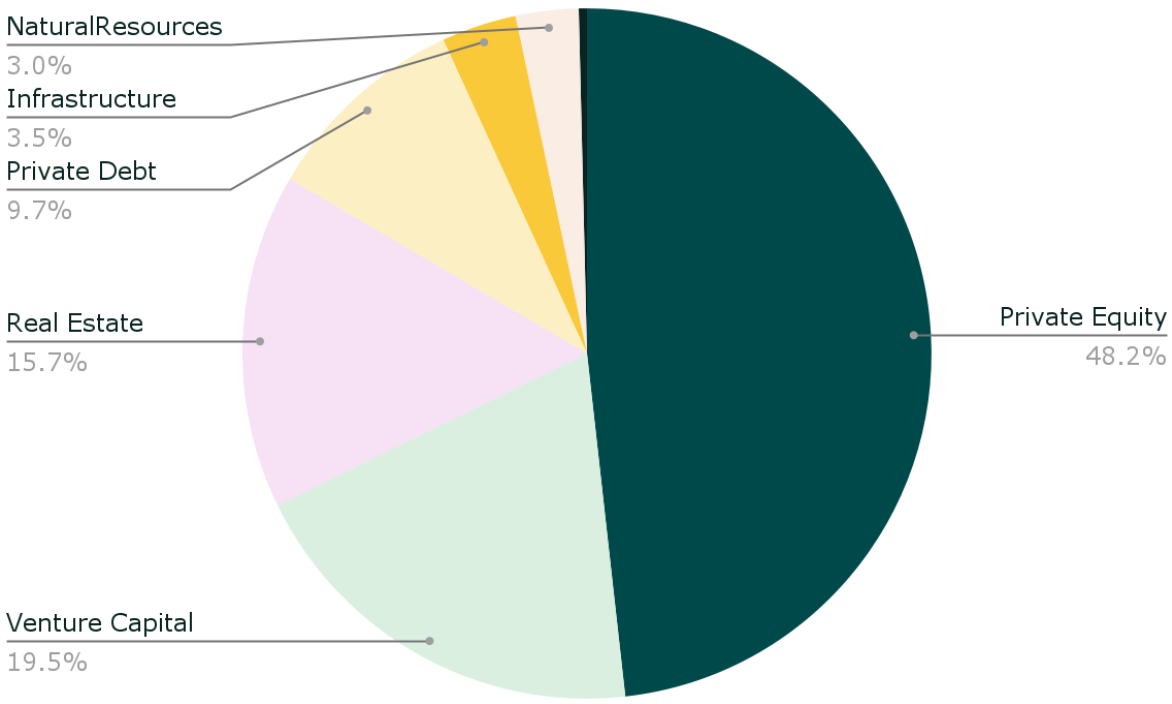
Distribution of Funds in Dataset by Region



Source: Preqin

Figure A.3

Distribution of Funds in Dataset by Strategy



Source: Preqin

Methodology Assumptions

The following assumptions were made:

1. Contributions are rebased to $10 million in committed capital.
2. For each fund, cumulative contribution curves are calculated for each cash flow date.
3. Cash flow values are net of fees.
4. The start date of the fund is assumed to be July 1 of the fund's vintage year unless either the first capital call or the fund's launch date occurred before July 1. In those cases, the start date is assumed to be January 1.
5. Cash flows are binned in 0.5-year increments. The date of each cash flow is subtracted from the fund's start date and rounded to the nearest half-year. If there's more than one cash flow for a fund within a 0.5-year increment, the max of the cash flows is taken.

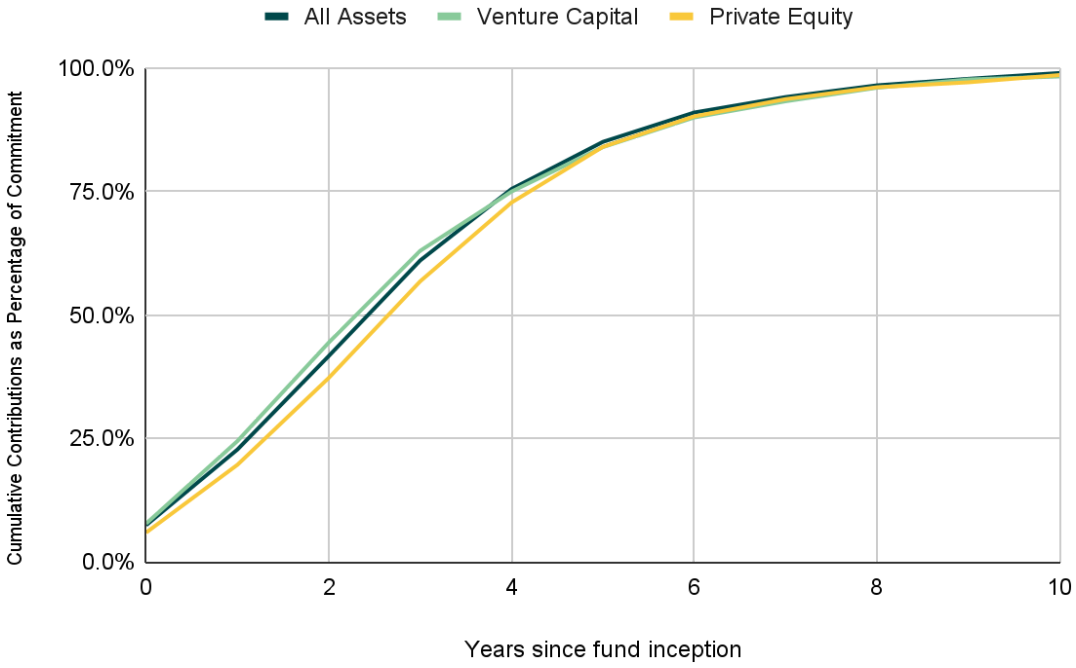
6. Buyout funds are grouped by target size (in $m) based on Preqin logic:
    a. Small: <200 prior to 1997, <300 prior to 2005, <500 after 2005
    b. Mid: <500 prior to 1997, <750 prior to 2005, <1500 after 2005
    c. Large: >500 prior to 1997, <2000 prior to 2005, <4500 after 2005
    d. Mega: >2000 prior to 2005, >4500 after 2005
7. For each combination of geography, asset class and strategy, we calculate quartiles by age of fund.
8. The maximums of a data point and the previous one are taken for each quartile curve to ensure cumulative curves are not decreasing.
9. Definitions for fund strategies are here.

Cumulative Cash Contribution Curves for Venture Capital and Private Equity

Figure A.4:

Cumulative Cash Contributions are Roughly Equivalent in the Main Strategies

Cumulative cash contributions in venture capital and private equity over time versus sample set median



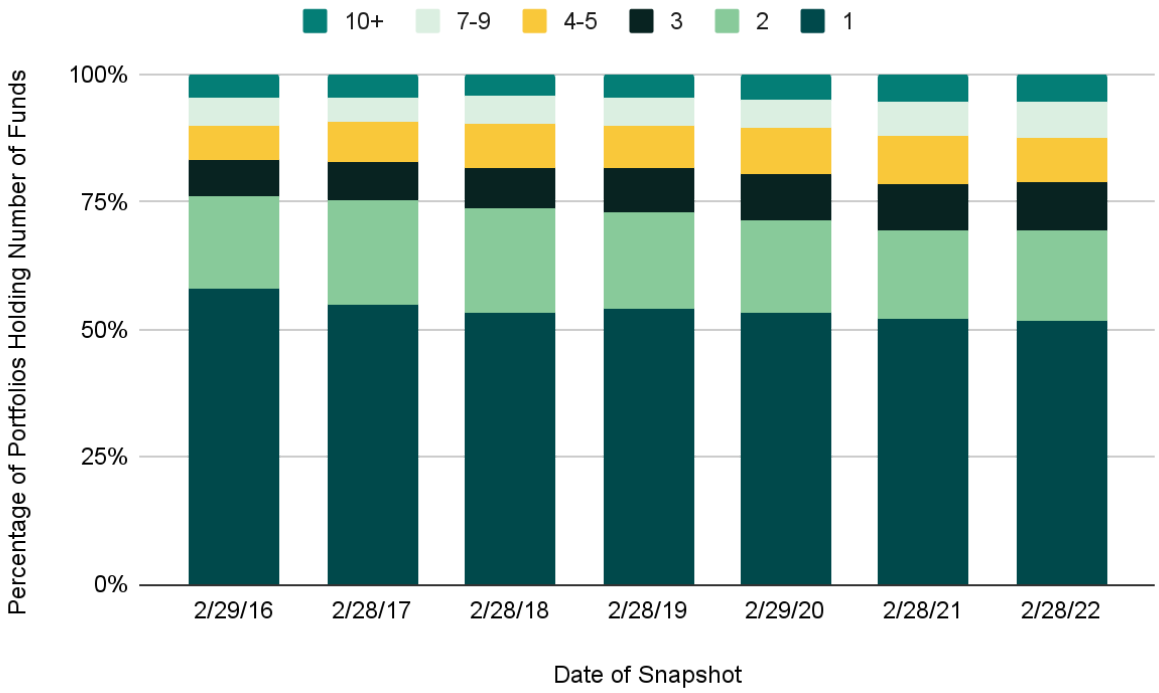
Source: Preqin

Number of Alternatives Held by Investors over Time

Figure A.5

Investors Hold Less than an Ideal Amount of Funds in their Private Capital Portfolios

Percentage of investors who invest in private capital funds with a given portfolio size



Source: Addepar

Figure A.6

Mean and Median Private Equity and Venture Capital Funds Held by Investors

As of March 31, 2022 for home offices and advisors that have at least one private capital investment (Source: Addepar)

	Median	Mean
0–1mm	1	2.1
1mm–3mm	1	2.2
3mm–10mm	1	2.3
10mm–30mm	2	3.5
30mm–100mm	3	5.6
100mm+	6	12.0

Details of Point-in-Time Diversification Scenarios

In Python, we constructed 10,000 portfolios that held *n* assets where *n* = [2,8]. We created these portfolios by assigning a random number to each of the 5,999 funds in our sample set and using a random number generator to select *n* random, distinct funds. We chose 10,000 distinct sets of funds for each of n = [2, 8].

With our sample set of investments in hand, we then assumed that the investor would buy into an equal amount of each of the *n* assets in their portfolio. That is, if the investor held a portfolio of five funds, they would invest 20% of their overall portfolio into each fund.

Once we had a picture of what and how much each portfolio held, we simply multiplied each of the asset-specific capital contribution streams to their individual asset weightings and summed these together to calculate one portfolio-level capital contribution stream for each of the 10,000 portfolios of size *n*. This formed the basis for the data points utilized to calculate expected values and standard deviations in this study.

Details of Over-Time Diversification Scenarios

In Python, we assumed 1,000 investors for every annual year *t* = [2000, 2018], leading to the creation of 19,000 total investors. Each of these investors held one portfolio, which invested in private capital funds over time from year *t* through 2021. That is, an investor from cohort *t* = 2005 would have invested in funds beginning in 2005 and would have continued investing through 2021.

We created three flavors of investors. The first were aggressive investors who committed cash to one new private capital fund per year. (This is the *every-year* group.) The second were moderately aggressive investors who committed cash to one new private capital fund every two years (the *every-two-years* group). And finally were the least aggressive investors who committed cash *every three years*. Note that there were 19,000 of each of these flavors of investors in the form described above.

We allowed a random number generator to decide which asset an investor committed capital to. Much like in our previous simulation, we assigned a random number to each fund, with the additional caveat that we also tracked each fund's vintages. We created a dictionary of vintages mapping to the random numbers assigned to each of the funds that shared a specific vintage. For

each portfolio, the random number generator chose a fund from each vintage and assigned that as a set of over-time investments. For example, an investor in the *every-year* group from t = 2010 would have been assigned a random fund with vintage = 2010, another with vintage = 2011, and so on.

We assumed that each investor ramped up their investments in private capital over time. If their total allocation toward alternatives would have been 100%, they would spread out that allocation across seven years as they built their alternatives portfolio. This assumption follows from the finding that on average, nearly all capital commitments are called within seven years of opening a fund.

How this played out from a practical perspective was that for the *every-year* group, investors would invest 1/7th of their allocated capital in year 1, then another 1/7th in year 2 and so on until they were fully invested by year 7. In year 8, they would again invest 1/7th of their allocated capital, building off of the assumption that they were rolling the proceeds of their original investment into a new fund.

For the *every-two-year* group, investors would invest 2/7th of their allocated capital in year 1, they wouldn't invest in year 2 and then they would invest another 2/7th of their allocated capital in year 3. This pattern would continue over time. For the *every-three-year* group, investors would invest 3/7th of their allocated capital in year 1. They wouldn't invest in years 2 or 3 and then they would invest another 3/7th in year 4. You get the idea.

Therefore, with random funds for each appropriate vintage in hand along with the group-specific weightings, we were able to construct a portfolio-level liability stream based on calendar year dates. For example, for an *every-two-years* investor with t = 2012, we would take the asset with vintage *2012* and multiply its capital contribution stream by (2/7th). We would then add that by calendar year to the investor's 2014 investment multiplied by 2/7th. Explicitly then, we would have only one asset-level capital contribution at the 2012 and 2013 data points, but there would be two at the 2014 and 2015 data points, and so on.

Finally, we normalized all of this data such that the first year of each investor's portfolio was set to be t = 0, providing us a rich sample set of 19,000 randomized portfolios of private fund investments in each group to complete our analysis.

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