PRIVATE ASSETS ARE COMING TO 401(k)s…

but the industry seems unprepared to manage the data challenges ahead.

July 2025

Executive Summary

Private assets are set to make their way into 401(k) plans. Despite a proliferation of products and tie-ups among industry participants, there are many data challenges to be addressed to ensure fiduciaries are acting prudently towards plan participants. Several are highlighted below:

Historical Performance Presentation: Private markets were accustomed to presenting IRRs for drawdown funds, but Evergreens in 401(k)s will present time-weighted returns (TWRs). Fund manager benchmarks or listed proxies can mislead the participant on the relative performance of private assets. The private2000® index, with its monthly index and pricing, is more suitable.

Case for Private Asset Inclusion in 401(k)s: Relies on presenting historical or expected returns, and lower correlations with listed markets. The data used by industry participants can employ smoothed NAVs, listed proxies, or prior period returns. This can misrepresent return potential and diversification benefits. See our report on Capital Markets Assumptions (here).

Returns - Realised vs Unrealised: Evergreen funds' returns are largely unrealised and based on GPs' valuation practices. How can a fiduciary ensure that plan participants' NAV is accurate? Listed private asset investment trusts in the UK trade at material discounts to NAV (~30%). Fiduciaries will need processes and better data to ensure plan participants' assets are appropriately marked. Asset-level private equities data can facilitate this.

Fees: Fee levels are well above those in other asset classes and can approach 300bps per annum. The case for high fees is the superior net returns, but as highlighted above, those returns are largely unrealised and untested in a tradeable market. Further, the private2000 index shows that private equities have underperformed listed markets for 5 of the last 6 years.

Pricing Frequency: Scant details on how higher frequency pricing will be established. Quarterly or monthly NAVs may only be adjusted for capital calls and distributions. Industry will need private assets data that can facilitate more frequent pricing, using now-casting or up to date valuation multiples that reflect current market dynamics.

Multi-strategies: Does a plan participant understand all these private asset strategies? GP and LP-led secondaries, primaries, credit, credit secondaries…how will one benchmark all these assets blended in a sleeve? Using listed proxies is entirely inappropriate to benchmark the private asset sleeves.

Manager/Evergreen Selection: Few details presented to support manager/evergreen selection. Manager dispersion is high in private assets, requiring good benchmarking tools to justify inclusion in investment menu.

Overview

Size of US Retirement Market. The U.S. retirement market is massive, with total assets of $43.4 trillion[1] as of March 31, 2025. Defined Benefit (DB) plans account for $12.1 trillion, split between government ($8.9 trillion) and corporate plans ($3.2 trillion). Defined Contribution (DC plans) are similar in size to the DB market, with $12.2 trillion of assets at the end of Q1 2025 and have gained share at the expense of DB plans. The remainder of the U.S. retirement assets ($16.8 trillion) are held in individual retirement accounts (known as "IRAs"). DB plans have been active investors in private assets for decades, with average holdings in alternative assets of 25%[2]. DC plans, given their size, offer a huge opportunity for alternative asset managers.

401(k)s. Within the DC segment, 401(k) plans are the largest piece, accounting for $8.7 trillion (of $12.2tn). This represents the lion's share of the private sector pension plan market. 403(b) and 457(b) plans account for the remainder of the DC market and represent certain government and non-profit entities' DC plans. The focus of the asset management industry is to push for inclusion of private assets in 401(k) plans. Given the size of the 401(k) plan assets, the inclusion of private assets would add a substantial growth lever for the alternatives managers.

Private Assets. Early movers in the 401(k) space have utilised partnerships with a target date fund provider (TDF) structured as a Collective Investment Trust (CIT). The TDF allocates a sleeve for private assets and invests in an Evergreen (semi-liquid) product offered by an alternative asset manager. A recent example is Apollo's partnership with State Street's target date fund (TDF), which maintains a 10% allocation to private assets. They have chosen Apollo's Apollo Aligned[3] Alternatives (AAA) to manage the private asset sleeve accessed via a CIT[4].

Other DC Markets. Regulators can take cues from countries like Australia, which have a much more developed DC plan system. Specifically, the "Your Future, Your Supers" (YFYS) framework administered by APRA, the prudential supervisor. This imposes mandatory benchmarking for investment products offered through the superannuation system. With very expensive private asset products targeting the 401(k) participant, there needs to be mandated benchmarking and performance evaluation, with consequences for underperformance or excessive fees. Full disclosure on all levels of fees should be provided (mgmt. fees, incentive, fees at underlying fund managers). Good private equities time series data will be required to benchmark performance, assess risk, and justify inclusion. **The privateMetrics® indices can be utilised by fiduciaries to evaluate the private equities sleeve of TDFs or advisor managed accounts.**

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[1] Investment Company Institute and Federal Reserve Board

[2] DCALTA. CEM Benchmarking, 2024.

[3] SSGA and Apollo launch target-date funds

[4] Apollo Aligned Alternatives Collective Investment Trust - Alta Trust

Data and Methods

We utilise the privateMetrics® database to obtain monthly index prices and time series of returns for the private2000 indices (see the index factsheet here). This is achieved by using the privateMetrics Excel Add-In tool (see here on how to use the add-in in Excel), which allows one to pull the data directly into Excel. We can extract a time series of monthly index prices and returns dating back to June 30, 2013, for privateMetrics alongside risk data, including volatility metrics, Sharpe ratios and maximum drawdowns for all indices. This performance data can be directly compared to the monthly return and risk data provided by the semi-liquid vehicles that are offered to 401(k) participants. The performance of the vehicles can be assessed by using the direct alpha approach with the privateMetrics Direct Alpha tool.

Fiduciaries will need good data to justify their decision of including certain fund managers over others. As Larry Fink highlighted on BlackRock's Q2 2025 conference call with respect to litigation in the DC segment, "There's a lot of issues related to the defined contribution business, and this is why the analytics and data are going to be so imperative."

Benchmarking Performance

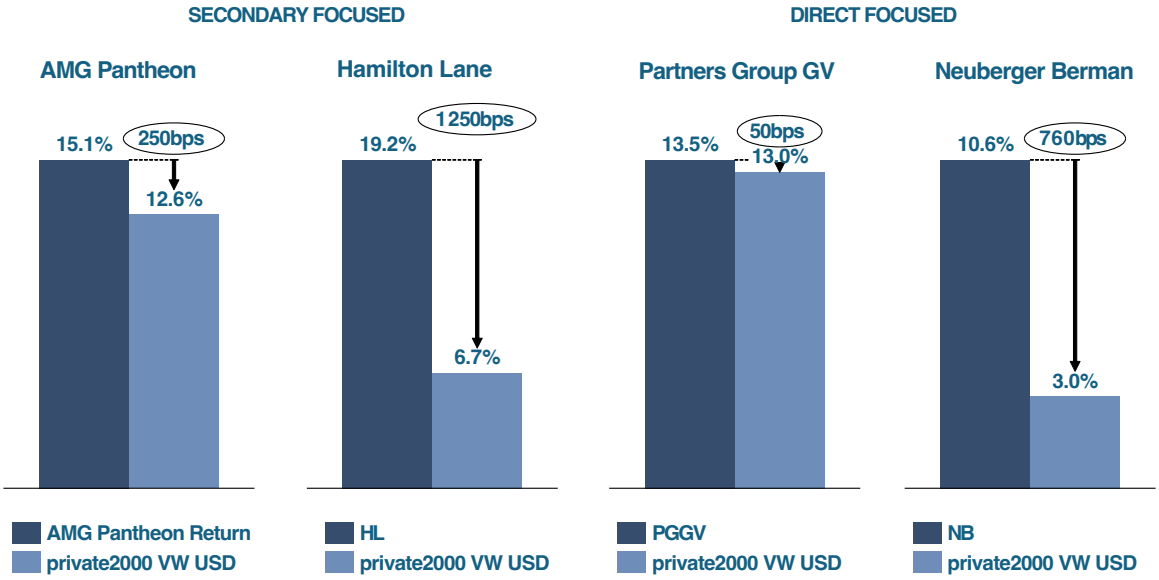
The privateMetrics data can be used to benchmark an Evergreen fund that is offered to DC participants with 401(k) plans. Plan sponsors can use privateMetrics to evaluate the private asset managers and Evergreen funds that are on the investment menu of various recordkeepers (via TDFs). Furthermore, target date fund managers will need to evaluate and justify why they have included a certain private asset manager in their private asset sleeve, and not others. Likewise, plan participants with managed accounts will need to understand why their advisor has selected a particular private asset solution. As we mentioned in our recent report on private equity Evergreens (see report here), long-term drawdown fund IRRs are not comparable in evaluating Evergreen funds' performance.

Importantly, the choice of a private asset manager carries greater importance than the choice of index fund or low-cost mutual fund for the listed equities portion. Whether a TDF uses a Vanguard vs Fidelity index fund, the plan participant will still gain exposure to the same underlying assets at a very similar cost. With private equities, the plan participant will get exposure to the investment choices of a particular private equity manager. That is, they will have different exposure than if the sleeve included another fund manager. This requires good data to evaluate the managers. It should require the TDF manager to justify their decisions. Further, there is some risk that most of the AuM raised will go to a select group of managers. Plan participants may only get exposure to a segment of the private market.

Figure 1 provides an example of how the privateMetrics data, tools, and indices can be leveraged to evaluate private equity vehicles targeting 401(k) plans. Figure 1 details the returns since inception of four Evergreen vehicles. Each fund's performance is benchmarked against similarly timed investments in the private2000 index. The degree of outperformance varies by manager. The more mature vehicles (AMG Pantheon and Partners Group GV SICAV) have been around 10+ years. Both outperformed the index

over the measurement period, by 250bps and 50bps, respectively. More recently formed funds, including Hamilton Lane's private asset fund, has shown greater alpha (1250bps). This reflects their strong returns over the last 4-5 years in a very difficult return environment for private equities. A similar story for Neuberger Berman. Note that index returns were much lower for Hamilton Lane and Neuberger Berman as this covers the 2021-2025 period, a weaker period for private equities returns.

FIGURE 1: DIRECT ALPHA OF EVERGREEN FUNDS SINCE INCEPTION AGAINST PRIVATE2000 VW INDEX



Source: privateMetrics, SIPA calculations. Note: Inception dates for AMG Pantheon (Oct 2015), Hamilton Lane PAF (Sep 2020), Partners Group GV (Jun 2013), Neuberger Berman (Jan 2021). PGGV start date to match start date of private2000 index. Presented as Gross returns vs index. Gross returns estimated by SIPA from net published returns.

Quantifying alpha will be important for fiduciaries given that the fee structures for Evergreen vehicles are much higher than those observed for listed equities. Most Evergreen vehicles charge base management fees of 1.25%-1.50%, based on NAV. Many charge incentive fees on top and can range from 10-15% of returns. The blended fees can approach 3% per annum.

Benchmarking practices in private equity often rely on contributed fund manager returns. These performance metrics are in the form of IRRs and are not comparable to the TWRs used by Evergreen funds. This makes manager selection or benchmarking based on such benchmarks inappropriate for the 401(k) market. Only asset-level benchmarks that provide frequent TWRs can facilitate this.

Finally, reported returns are largely unrealised. They are formed in large part by valuation practices of underlying fund managers, and write-ups of secondary purchases to NAV.

401(k)s Scope and Asset Mix

According to the Investment Company Institute, the broad asset mix for the U.S. 401(k) market as of March 31, 2025, is outlined in Table 1. Mutual funds hold ~61% of total assets across various equity, bond, and cash strategies. A significant portion of the TDFs holding mutual fund assets are in the Hybrid category. The Other Assets category houses TDFs that are held in collective investment trusts. Notably, there is practically no presence of private assets in the DC plans. The asset mix looks very different than in DB plans, which have large allocations to private assets, among other alternative assets.

TABLE 1: US 401(K) ASSETS AS OF MARCH 31, 2025 ($BN)

Asset Class:	**Vanguard DC Plans Mix**	
Mutual Funds	5,341	61.4%
Domestic Equity	2,585	29.7%
World Equity	576	6.6%
Hybrid*	1,423	16.3%
Bond	604	6.9%
Money Market	143	1.8%
Other Assets	3,364	38.6%
Total	8,705	100.0%

Source: Investment Company Institute. Hybrid includes Target Date Funds.
Other Assets includes TDFs that are CITs rather than mutual funds.

We can get more granular by looking at a leading recordkeeper's DC plans asset mix. Table 2 shows Vanguard's DC plan asset mix in 2015 and 2024 (left) and the contribution for the same years. Target Date Funds account for 42% of plan assets as of year-end 2024, up from 26% in 2015. Furthermore, the contributions in 2024 were heavily weighted to TDFs, at 64%. This appears to have come at the expense of diversified equity funds and some cash and bond funds. With a significant portion of incremental capital flowing into TDFs, these have become logical targets for alternative asset managers looking to attract AuM from the 401(k) space.

TABLE 2: VANGUARD DEFINED CONTRIBUTION RETIREMENT PLANS

Asset Class:	Vanguard DC Plans Mix		Vanguard DC Plans Contribution	
	2015	2024	2015	2024
Cash	11%	5%	7%	3%
Bond Funds	8%	6%	6%	4%
Other Balance Funds	6%	3%	5%	2%
Target Date Funds	26%	42%	46%	64%
Diversified Equity Funds	42%	41%	32%	26%
Company Stock	6%	2%	4%	1%
Brokerage	1%	1%	0%	0%
Equity Weighting	*71%*	*75%*	*74%*	*79%*

Source: Vanguard: How Americans Save 2025

401(k) Plan Sponsors and ERISA

Regulated by ERISA, plan sponsors design DC plans conservatively, with ERISA compliance in mind.

Qualified Default Investment Alternatives (QDIAs). Broadly speaking, ERISA offers plan sponsors (as fiduciaries) protection from liability if they offer diversified default options (minimum of 3 asset classes – e.g. equities, fixed income, cash) that bear different risk and return characteristics.[5] For new employees, or those who do not choose an investment option, the plan sponsor can direct their 401(k) contributions to one of the QDIAs without having to worry about liability. The three QDIAs are TDFs, managed accounts, and balanced funds. In 2006, The Pension Plan Act of 2006 was passed that included TDFs as a QDIA, alongside managed accounts and balanced funds. This has led to significant growth in usage of TDFs by plan participants, with nearly all plans now offering TDFs. As it pertains to inclusion of private assets, most fund managers are pursuing solutions through TDFs and advisor-led managed accounts. We touch on both below:

Target Date Funds. TDFs provide a simple solution to a plan participant. As a default option, the participant can allocate to a TDF that will manage asset mix on the participants' behalf, with the equity portion of the portfolio declining as the participant ages. Most of the major recordkeepers and asset managers offer TDFs. According to the Investment Company Institute (ICI), there is approximately $3.75 trillion invested in TDFs[6]. All but $283 billion are held within retirement accounts. The fastest growing segment has been in the target date funds in collective investment trusts.

[5] CFA Institute

[6] quick-facts-tdfs-retirement-plans.pdf

Assets have grown from ~ zero in 2000 to $1.84tn as of June 30, 2024. Target date mutual fund assets accounted for $1.3tn, with IRAs' holdings amounting to $329 billion for the same period. Based on total 401(k) assets of ~$8.7tn, target date funds now make up over 40% of assets. Importantly, younger 401(k) participants have a much higher allocation. According to ICI, for those in their 20s, the percentage of 401(k) plan assets in TDFs is 66% versus 32% for those in their 60s. In theory, TDFs could offer a larger initial private asset sleeve to younger employees given that their overall equity weighting would be higher.

Many recent tie-ups in the industry have involved an alternative asset manager and a target date fund provider. We mentioned the tie up between State Street and Apollo earlier for a target date fund that offers access to Apollo's Evergreen fund. BlackRock and Goldman Sachs have teamed up with Great Gray Trust, a leading player in CITs. Great Gray Trust has established a target date fund series called "Panorix Target Date Series" that will use BlackRock for index equities and private equities, and Goldman Sachs[7] for private credit. Further, BlackRock will manage the glidepath.

Managed Accounts. Managed accounts are offered less frequently as a QDIA within a 401(k) plan but remain popular. Rather than invest assets through a pre-set TDF that manages asset allocation and investment choices over time, a managed account offers more personalised service, for a fee of course. Private assets can be accessed from advisor managed accounts. For example, Partners Group's US Evergreen fund accepts US retirement assets from managed accounts that invest via a CIT. This CIT is structured to provide daily valuation (pricing) and liquidity as required by the 401(k) market. Further, Blue Owl's recent tie up with recordkeeper Voya Financial will develop CITs that will accept assets from advisor-managed accounts on Voya's retirement platform. They will also be available through Voya's TDFs via its investment management platform. Finally, Empower recently announced that it will provide access to 7 alternative asset managers through CITs[8]. The firms include Apollo, Franklin Templeton, Goldman Sachs, Neuberger Berman, PIMCO, Partners Group, and Sagard.

Collective investment trusts vs Mutual Funds. CITs have overtaken mutual funds in market share within the DC space. Like mutual funds, they are pooled investment vehicles. Unlike mutual funds, CITs are not SEC-regulated, but rather subject to banking and trust laws. CITs are only available to qualified retirement plans (not retail accounts) and have the flexibility to incorporate private assets. Many TDFs are structured as CITs. Further, they are often established to facilitate investment in an underlying Evergreen fund, particularly with advisor managed accounts. All the tie-ups mentioned for private assets, either TDFs or advisor managed accounts, utilise CITs.

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[7] GS - Panorix

[8] Empower

Key Players in DC Markets

The 401(k) plans' path to investing in private assets will be very different than DB Plans. Most DB participants invest in private assets through drawdown funds, either primary funds or through funds of funds. Some pursue direct/co-investments in private equities in addition to primary funds. The DB plan often has a direct relationship with the fund manager, performing due diligence and building a portfolio of fund commitments, co-investments, and/or direct investments. A DB plan may use a consultant to assist with constructing a portfolio, selecting managers, or evaluating performance.

401(k) plans introduce a number of new players in the "value-chain", including the plan participant, plan sponsor, recordkeeper, target date fund (most incremental assets), managed account advisors, trust companies, and underlying fund managers. Consultants are also prevalent in developing a plan, target date fund construction, and choosing recordkeepers. Table 3 details the differing approach, sequence and players for DBs and DCs.

TABLE 3: PLAYERS AND SEQUENCE FOR PE INVESTING: DB VS DC

Comparison	DB Plan	DC Plan (401(k)
Capital Source	Sponsor's pooled plan	Individual accounts
Role of Participant	None	Chooses plan from menu or accepts QDIAs (TDF, Balance Fund, or Managed Account)
Role of Sponsor	Has in-house team that constructs private assets portfolios	Selects recordkeeper, provides input on plan design and fund menu
Investment Decision Making	In-house with approval from CIO and Sponsor Board. Either via funds or directs	Pushed to asset manager (TDF manager) and advisor managed account allocate sleeve
Advisory Input	Investment consultants assist with portfolio design and manager selection	Consultant advises on plan design, recordkeeper choice, and fund menu
PE Access	Direct - Sponsor/consultant selects PE GPs (funds, co-invests, directs)	Indirect - TDF or managed account allocates to PE via CIT or another compliant vehicle.
Investment Vehicles	Primary fund, fund of funds, co-investment, SMAs	Target Date Fund (TDF) or managed account → invests in a PE-focused CIT
Fund vs Solution	Tailored. Allocates to individual funds or companies	Default. Allocates to Evergreen that invests across a GP's fund strategies
Structure	LP. Drawdown Fund. Closed End.	Collective Investment Trust
Liquidity	None – Closed End. Liquidity risk managed by LP	CIT offers partial redemptions, cash/ liquids allocation

NAV Frequency	Quarterly	Monthly or even Daily
Reporting	Direct from GP	Indirect Recordkeeper Platform
Fiduciary Oversight	Sponsor or pension board; usually has discretion	Shared among Plan sponsor, trust company (CIT), TDF manager, advisor.
Relationship	Direct LP position	Pooled vehicles

Source: SIPA

Tables 4 and 5 look at some of the major recordkeepers and target date fund providers in the DC segment:

Recordkeepers are chosen by the plan sponsor (private sector company with DC plan) often with help of consultants. Recordkeepers, as the name suggest, handle the administration of the accounts, tasks such as account balances, transactions, obtaining NAVs from fund managers, and reporting. Some recordkeepers are also fund managers (Fidelity, Vanguard, Voya) and offer TDFs. We noted earlier that Empower, the 2nd largest recordkeeper, has made a big push into private assets. Empower has partnered with 7 alternative asset managers to allow its plan participants access to these managers through CITs.

Table 4 shows the largest TDF managers in the US. BlackRock, State Street, and Capital Group have made definitive pushes into the 401(k) space, forming partnerships with trust companies (BlackRock – Great Gray), or alternative asset managers (State Street – Apollo, Capital Group - KKR). Blackstone has also developed a partnership with Vanguard and Wellington.

Though it is still early days in the 401(k) push, most key players are exploring new products to attract AuM from the Plans.

TABLE 4: TOP RECORDKEEPERS BY ASSETS UNDER ADMINISTRATION IN US

Recordkeeper	**Assets ($bn)**	**Participants (Millions)**
Fidelity Investments	4,002	33.4
Empower	1,596	17.8
Alight	1,548	12.0
Vanguard Group	813	6.0
TIAA	785	6.6
Voya Financial	586	7.5
Principal	521	11.6

Source: Pensions & Investments

TABLE 5: TOP TARGET DATE FUND PROVIDERS BY AUM IN US

Manager	TDF Assets ($bn)	Series
Vanguard	900	Target Retirement Funds
Fidelity Investments	600	Freedom Index Series
T.Rowe Price	400	Retirement Blend Funds
BlackRock	350	Lifepath Index
Capital Group	200	Target Date Retirement
J.P. Morgan	150	SmartRetirement
State Street	100-150	Target Retirement/Index Plus

Source: Company websites

Potential Conflicts between DBs vs DCs

Given DB Plans invest as LPs through private equity drawdown funds and DC Plans will invest via Evergreen funds, there are potential conflicts.

The first relates to how new investments are shared between the drawdown fund and the Evergreen fund. Will an Evergreen fund participate in every new deal on a pro-rata basis, or will it only be presented with certain deals? There is potential for gaming depending on the stage of the drawdown fund. For example, if a GP's drawdown fund needs to close one more deal before kicking off fundraising for the next fund (LPA usually provisions this), the GP may have an incentive to allocate it to the drawdown fund and bypass the Evergreen vehicle. Unless there are clear rules, this conflict potential exists. Evergreen investors also risk being treated like LP co-investors, whereby they only see a portion of the deals generated in the GP's various funds. LPs, as co-investors, are aware of this, but an Evergreen fund paying hefty fees may be unaware. LPs who seek co-investment opportunities and consider it part of the rationale in backing a GP, may also be concerned about deals being allocated to the Evergreen funds. Given how removed a DC plan participant is from the underlying manager and asset, these pose real risks. DB plans in drawdown funds can at least negotiate around this in the Limited Partnership Agreement.

A second major risk involves the strategies pursued by the Evergreen funds. Many Evergreen funds pursue sizeable LP-led and GP-led secondary investments and can be said to be providing liquidity to the market. In a sense, the DC market could be a huge source of capital that provides liquidity to the DB plans, which have been struggling to find liquidity through traditional means over the last several years. The nature of Evergreen funds, perpetual capital vehicles with TWRs, incentivises the manager to deploy capital as it comes in. This could make them less price sensitive that drawdown funds, which can wait to deploy. We see some evidence with Evergreen funds paying higher prices (lower discounts) on average for LP-led secondaries relative to drawdown secondary funds[9].

[9] Campbell Lutyens

Conclusion

Alternative asset managers are aggressively pursuing solutions to open the large 401(k) DC plans to private asset strategies. It is still early days but there have been enough meaningful partnerships among major alternative asset managers, target date fund managers, recordkeepers, and trust companies that it seems only likely to continue. Participants are eagerly awaiting a potential executive order[10] from the US administration to advance this. Given the highly litigious nature of the DC retirement market[1112], fiduciaries will need to arm themselves with high quality data and analytics to justify private asset allocations. High fees, limited liquidity, infrequent pricing, unrealised returns, and conflicts of interest within alternative asset managers will need to be addressed.

The current quarterly reporting practices of drawdown fund managers will not be sufficient for the 401(k) plans. Higher frequency pricing of assets and returns will be required to ensure plan participants are treated fairly. Performance of products aimed at the 401(k) market need to be benchmarked, and reasons for inclusion must be backed up with good data. privateMetrics data and analytics tools can help fiduciaries make better choices for inclusion, while providing evidence-based grounds to support their decision making, ensuring regulatory compliance.

[10] Reuters EO

[11] 401(k) Excessive Fee Litigation Spiked to 'Near Record Pace' in '24 | PLANADVISER

[12] Plaintiffs' Lawyers Are Ready to Pounce if Private Equity Pushes Into 401(k) Plans - WSJ

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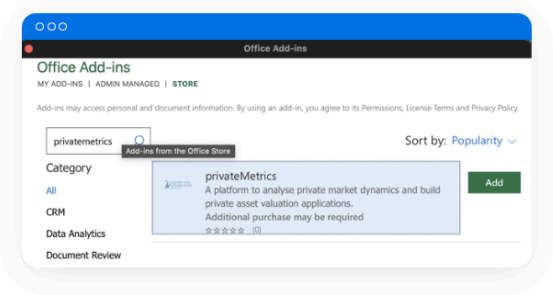

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The privateMetrics® Valuation Model

Our approach to the valuation of private companies is designed to maximise the available transaction and financial data in private markets and provide a standardised and systematic manner to update prices with every observed transaction.

First, we construct a multi-factor model of prices using a sample of observed transactions over time which can infer the unbiased and precise factor prices that investors pay for different characteristics of a private asset. Although every transaction is idiosyncratic or unique, in a large sample of transactions, the individual errors in each transaction price can be diversified away to discern the price attributable to each factor. Factor prices refer to the premium (or discount) that an investor is willing to pay to seek exposure to a specific factor of return in private companies. For example, observing the relationship between size and valuation among reported transactions, it can be inferred how much premium or discount an investor is willing to pay for purchasing a larger private company.

Second, an important and key application of this approach is that, with the estimated factor prices, say for size, it would then be possible to price unlisted private companies whose size information is available, irrespective of whether they are traded or not. This approach provides a more robust estimate for FV and enables the creation of representative indices of private companies.

Our approach's novelty is calibrating the model to newly observed transactions obtaining the factor price evolution over time, which allows us to update the valuation for all tracked unlisted private companies.

Common Risk Factors

If investors trade unlisted private companies from each other in mutually negotiated transactions, there must be some common characteristics that at least partially explain prices. For example, private companies that have higher profits or growth opportunities may be more valuable to investors than those that are not.

To arrive at a potential list of factors, we follow simple criteria that there needs to be an economic rationale for the factor to affect valuation. The factor should also be statistically related to the valuation. Moreover, the factor should also be objectively observable or measurable. With a potential list of factors, our factor selection is the result of a statistical approach, where the factors that can satisfactorily explain the variation in observed transaction valuations are included in the final model while trading off being parsimonious with being able to explain a higher variance in valuation. The privateMetrics asset pricing model uses five key risk factors as below:

- **Size**: Larger companies may be more complex, have higher transaction costs, and be less liquid, all of which can make them trade at a lower valuation per $ of revenue.
- **Growth**: As traditional PE strategies rely on growing the entry multiple, that may involve both increasing its top and bottom lines, i.e., revenue and profits. Thus, companies that can grow faster can be more sought after, making them more valuable.

- **Leverage**: Leverage can make a company riskier as it increases the risk of default. However, there is also a signalling effect of leverage, as companies with stable consistent cash flows can support a higher leverage, and vice versa. Thus, leverage is expected to influence the valuation of a company.
- **Profits**: More profitable companies have more predictable (less risky) future payouts and hence attract a lower risk premium, making them more valuable.
- **Maturity**: Younger companies have fewer track records and face higher information uncertainty. Studies have shown that firms with high uncertainty tend to be overvalued and earn lower future returns. Thus, the maturity negatively affects valuation.
- **Country risk**: Investors may require a high return when investing in a high-risk country, thus depressing the current valuation. In other words, in countries with lower risk, investors may be willing to purchase assets at a higher valuation as government policies may be more predictable with lower macroeconomic risks.

TABLE A1: KEY FACTORS, THEIR EFFECT ON VALUATION, & THE ECONOMIC RATIONALE FOR INCLUDING THEM IN THE MODEL

Factor	Definition (Proxy)	Effect on price	Economic Rationale	References
Size	Revenues	Negative	Larger firms are more illiquid and trade a lower price	Fama & French (1993)
Growth	Change in Revenues	Positive	Companies with higher revenue growth trade at a higher price	Fama & French (1992), Petkova & Zhang (2005)
Leverage	Total debt / Revenues	Positive	Companies that can borrow more have a lower cost of capital and a higher value	Gomes & Schmid (2010), George & Hwang (2010)
Profits	Ebitda Margin	Positive	Companies that have higher profits have a higher value	Novy-Marx (2013), Hou et al. (2015)
Maturity	Years since incorporation	Negative	Companies that are mature exhibit less growth potential and trade a at a lower price	Jiang et al. (2005)
Country Risk	Term Spread	Negative	Companies in high-risk countries face more uncertain prospects	Chen & Tsang (2013)

SOURCE: CALCULATED USING OVER 10K DEALS FROM PITCHBOOK, CAPITALIQ, FACTSET, AND OTHER PRIMARY SOURCES BETWEEN 1999-2022

Our factors have been documented in prior academic studies to be associated with valuation. We also include factors that have been identified as key determinants of valuation from a survey of private equity practitioners that we conducted in 2023. Table A1 summarises the key factors that we use in the model, how they are measured, each factor's effect we document in the data on average, the economic rationale for their inclusion, and citations for the work that underpins their inclusion.

Model Set Up

The privateMetrics asset pricing model uses the Price-to-Sales ratio of observable transactions (the entry price multiple) as the modelled variable. The model is estimated as the linear sum of the product of factor exposures and factor prices. The estimation can then separate the systematic part of the valuation while leaving out "noise" in each valuation.

$$\frac{P}{S} = a + \sum_{k=2}^{K} b_k l_k + e$$

Following standard asset pricing notation, the factor exposure or factor loading is called a beta (β), and the factor premium is called a lambda (l) for the k factors in the model. a is the intercept and e is the noise or idiosyncratic part of the valuation.

Model Calibration

The privateMetrics model uses a carefully curated dataset of more than 10k+ unlisted private company investments going back two decades sourced from a wide variety of datasets including PitchBook, Factset, Capital IQ, fund manager reports, and other publicly available data sources.

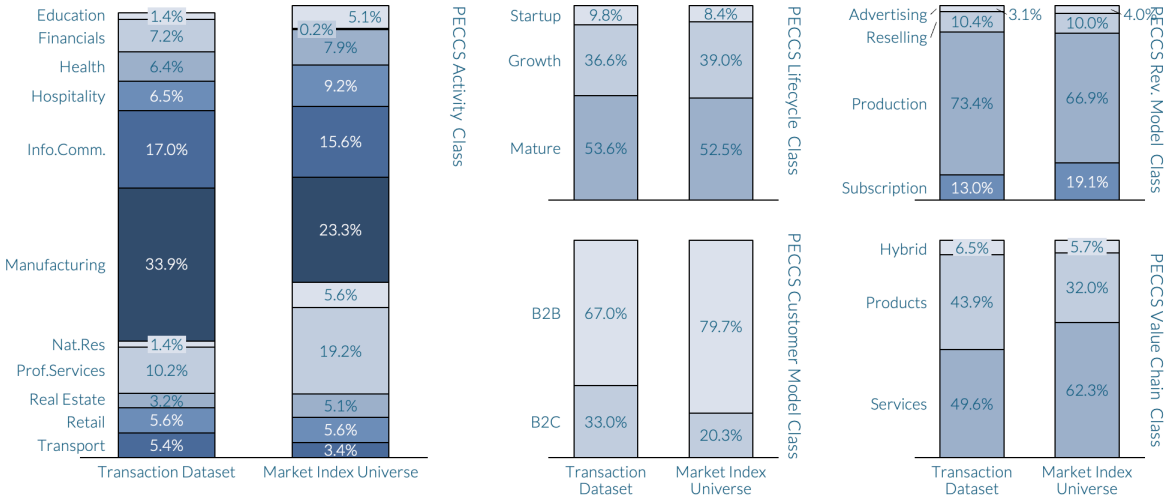
We calibrate this model using new observations monthly to update its estimation of the price of risk of each factor. In other words, each transaction observed is then used to 'update' this model (i.e., obtain new ls) through a dynamic estimation (using a Kalman filter), which retains the memory of past ls while also allowing the new transaction to influence the relationship while keeping the average e close to zero. More details on the implementation of the model are available in our online documentation and Selvam and Whittaker (2024). The dataset covers all key segments of the market as shown in Figure1.

A good application of using the model to value unlisted private companies is to create a representative marked-to-market index of private companies that are regularly valued. The privateMetrics index universe in Figure 1 includes the constituents of the private2000® index constructed by Scientific Infra and Private Assets, which is developed on this shadow pricing idea and captures the performance of private companies in 30 countries globally that are important for private equity investors (read more about the index here).

How Precise are the Predictions across PECCS® Pillars?

To examine how closely the predicted valuations track the raw modelled valuations in transactions, we compute the average estimation errors of the full sample, and also by classes within each PECCS® pillar. What stands out is that although the model by design is expected to have lower estimation errors in the full sample, the within PECCS® class estimation errors are also very small. All the errors are within ±10%, reassuring that the model predictions on average even within each segment of PECCS® are reasonable. The errors are summarised in Table A2.

FIGURE A1: PRIVATEMETRICS TRANSACTION DATASET COMPARED TO THE PRIVATEMETRICS INDEX UNIVERSE BY PECCS PILLAR & CLASS



The most commonly used metric of valuation in private markets is EV/EBITDA as PE owners have the flexibility to alter the capital structure of their holding company and hence are more interested in operational profitability without factoring interest costs. However, our model is based on P/S because P/S is statistically better, stable, and not affected by loss-making companies. Thus, one may be concerned whether our predictions for EV/EBITDA might be biased.

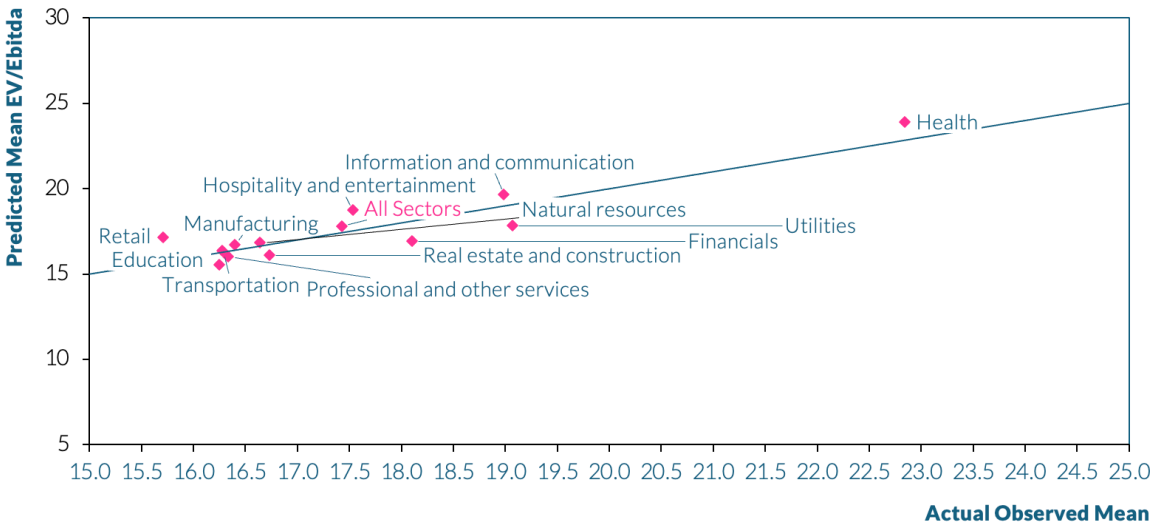
To ensure that is not the case, we compute the EV based on the book value of debt and predicted equity valuation and divide the sum by the EBITDA to get a predicted EV/EBITDA and compare it to transaction implied ratios. Figure A2 presents the average predicted and observed EV/EBITDA by PECCS® activity classes. We find that the predictions are very close to the observed values, thus mitigating this concern.

TABLE A2: AVERAGE ESTIMATION ERRORS ACROSS PECCS® CLASSES, BASED ON THE DIFFERENCE BETWEEN TRANSACTED VALUATIONS AND FACTOR MODEL PREDICTIONS

PECCS Pillar	PECCS Class	Mean Estimation Error	PECCS Class	Mean Estimation Error	PECCS Pillar
PECCS Activity	Education and public	0.9%	Startup	0.1%	PECCS Lifecycle Phase
	Financials	1.8%	Growth	-1.7%	
	Health	2.6%	Mature	2.8%	
	Hospitality and entertainment	-1.1%	Advertising	1.2%	PECCS Revenue Model
	Information and communication	-4.4%	Reselling	4.6%	
	Manufacturing	2.5%	Production	2.9%	
	Natural resources	9.4%	Subscription	-6.9%	
	Professional and other services	3.3%	B2B	1.5%	PECCS Customer Model
	Real estate and construction	1.9%	B2C	0.9%	
	Retail	0.5%	Hybrid	0.6%	PECCS Value Chain
	Transportation	7.2%	Products	1.1%	
Full Sample		**1.1%**	Services	3.4%	

SOURCE: CALCULATED USING OVER 10K DEALS FROM PITCHBOOK, CAPITALIQ, FACTSET, AND OTHER SOURCES BETWEEN 1999-2022

FIGURE A2: PREDICTED VERSUS ACTUAL EV/EBITDA RATIOS BY PECCS® ACTIVITY CLASSES



SOURCE: CALCULATED USING OVER 10K DEALS FROM PITCHBOOK, CAPITALIQ, FACTSET, AND OTHER SOURCES BETWEEN 1999-2022

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Our products come from the cutting-edge R&D of the EDHEC Infrastructure & Private Assets Research Institute, established in 2016 by EDHEC Business School. In 2019, we transformed this academic research into a commercial enterprise, providing services like private market indices, benchmarks, valuation analytics, and climate risk metrics. We take pride in our unique dual identity, bridging scientific research and market applications.

The EDHEC Infrastructure & Private Assets Research Institute (EIPA) continues to advance academic research and innovate with technologies in risk measurement and valuation in private markets, especially utilising artificial intelligence and language processing. Our company, Scientific Infra & Private Assets (SIPA), supplies specialised data to investors in infrastructure and private equity.

Merging academic rigor with practical business applications, our dedicated team excels in integrating quantitative research into private asset investing. Our products, infraMetrics® and privateMetrics®, are unique in the market, stemming from thorough research rather than being ancillary services of larger data providers. We are the Quants of Private Markets, leading with innovation and precision.

Contact Information

London Office

10 Fleet Place,
London EC4M 7RB
United Kingdom
+44 (0)207 332 5600

Singapore Office

One George Street
#15-02
Singapore 049145
+65 66538575

email: sales@scientificinfra.com

web: www.scientificinfra.com

About the Author(s)

Evan Clark
Evan is a Senior Private Market Analyst with EDHEC Infra & Private Assets (EIPA).
Email: evan.clark@sipametrics.com

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