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TOTAL PORTFOLIO APPROACH & PRIVATE ASSETS

PART II

The Reference Portfolio as a Governance Mechanism

The second in a three-part series on the Total Portfolio Approach (TPA) — governance, the reference portfolio, the risk budget, and the delineation of roles between the Board of Directors and Management.

This paper is the second in a three-part series on the Total Portfolio Approach (TPA). In this paper, we discuss Governance under a TPA framework and the role of the reference portfolio in establishing a risk budget and delineating the roles between the Board of Directors and Management. In the next paper, we will utilise privateMetrics and infraMetrics to quantify economic risk exposure across private asset classes, and style factors within asset classes. This can then be used to aid in constructing a multi-asset portfolio with targeted exposures.

A PEI GROUP COMPANY

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SIPA is a private market index provider, part of the PEI group of companies. This paper was written independently using SIPA's data, by Evan Clarke of the EDHEC Infrastructure & Private Assets Research Institute (EIPA), an academic team based at EDHEC Business School. Contact frederic.blanc-brude@pei.group for more information.

Executive Summary

Reference Portfolio and Fund Governance. The reference portfolio is a simple portfolio of listed equities and bonds that establishes a risk tolerance level from the Board of Directors. Rather than start with a comprehensive set of capital market assumptions to form asset allocation targets or bands, the approved risk budget acts as a governance mechanism and clarifies responsibilities. The Board of Directors approves a risk budget, consistent with the objectives and constraints of the fund. Management is then responsible for allocating the risk budget across investment opportunities, desired risk factors, or asset classes. A potential blind spot, which we will discuss in the paper, is how private asset allocations get translated back into a risk exposure that is consistent with what was approved by the Board. In other words, can the Board have confidence that the actual portfolio has a similar risk profile to the reference portfolio?

TPA Continuum. The scope of the challenge with TPA depends on both the exposure to private assets and the use of targeted economic or macro risk factors in allocating across opportunities. Allocations to private assets need to be funded from the reference portfolio, creating the need for a proxy in listed assets. Perhaps as important, the reported returns of the private asset portfolio will show different risk and return characteristics to that the listed equivalent, changing the overall risk exposure of the fund. Moving from the reference portfolio to a more diversified portfolio that includes private assets is expected to improve risk adjusted returns. However, some of this improvement may be due to valuation frequency differences between listed and private assets, creating illusory Sharpe ratio improvements, and understated total fund risk.

Key Objectives. In this paper, we will use examples of how institutions employing the TPA define the reference portfolio and use it to establish a risk budget. From there, we show how privateMetrics® and infraMetrics® can be used to quantify active risk and return measures for private assets, leading to reasonable outcomes for total fund risk and risk adjusted performance. More importantly, it shows that risk remains similar to the reference portfolio. Finally, we discuss several challenges with categorising private assets exposure into economic risk factor exposures derived largely from listed assets. This will provide a good segway into the third paper, which will evaluate these exposures and how they interact in a multi-asset portfolio.

Data and Methods

Drawing on data from infraMetrics® and privateMetrics®, this second paper illustrates how market-based private asset data can be used to translate risk exposures in private assets back to a reference portfolio, allowing for improved governance.

Both infraMetrics® and privateMetrics® databases can be used to download monthly index prices and risk metrics for private infrastructure equities, private infrastructure debt, and private equities. The flagship indices, infra300 and private2000, represent broad market indices diversified by sector, geography, and risk profile, best capturing the systematic risk of their respective markets. Both represent excellent starting points for capturing systematic risk and returns in their respective markets, private equity and infrastructure. Find infraMetrics indices (here) and privateMetrics indices (here). Further, our MSExcel Add-in allows for seamless download of the index data (see here).

A brief description of each index is below:

- **The infra300 index** is a representative set of 300 unlisted infrastructure companies. The companies are selected to form a representative sample by TICCS® categories from an underlying universe of close to 9100+ firms in 27 countries. The index is represented globally in both corporate and project finance companies.
- **The private2000 index** includes the top 2000 private companies by value across 30 countries and diversified by sector. The companies are selected to form a representative sample by PECCS® categories from an underlying universe of close to 1 million firms.

Reference Portfolios

In this section, we look at how reference portfolios are defined by several leading adopters of TPA, while following with an example of using privateMetrics and infraMetrics data to assess fund risk and active returns when allocating to private assets from the reference portfolio.

The reliance on a simple reference portfolio, typically composed of global equities and bonds, to set a risk budget underscores the difficulty of communicating risk exposures in multi-asset portfolios, particularly those with large allocations to private assets. In practice, most institutional portfolios differ substantially from this portfolio.

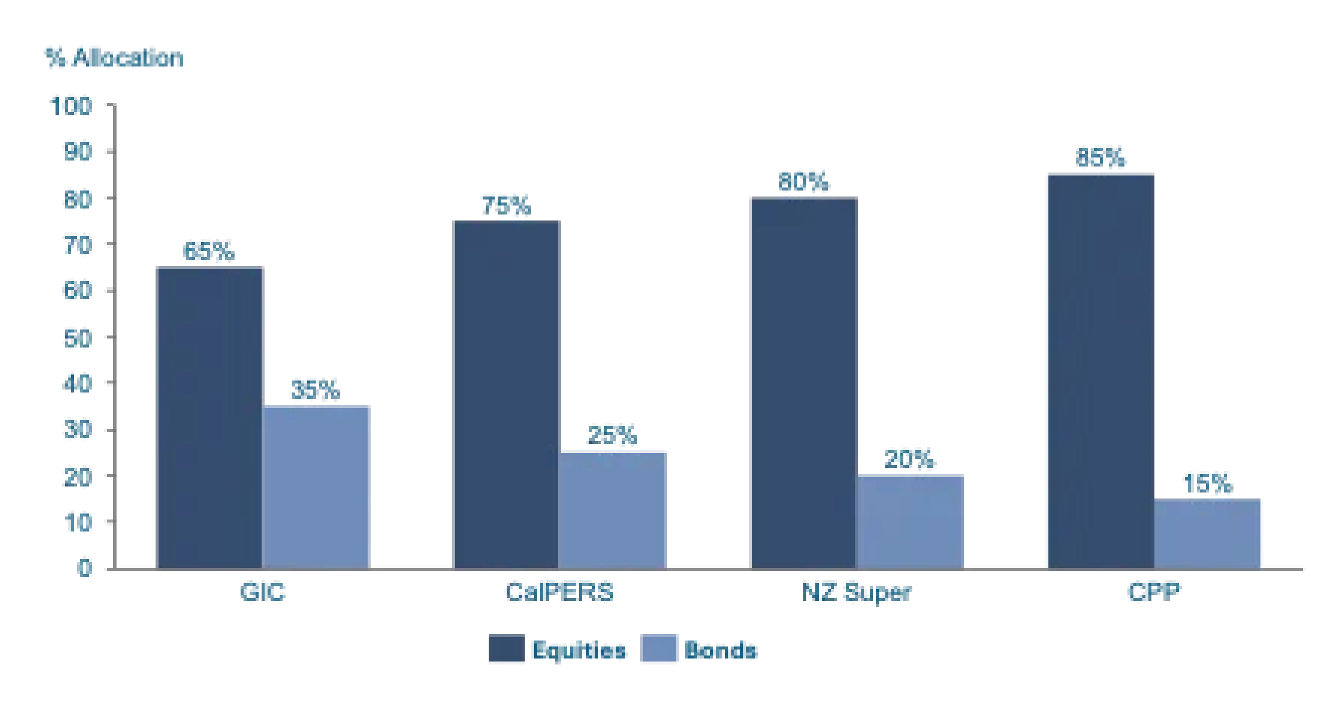
We can look at examples of the reference portfolio composition at several institutions employing TPA, including New Zealand Superannuation, CPP Investments, GIC, and CalPERS. The equities component dominates and is usually proxied by a global equities index. The bond portfolio is comprised of government bonds, often proxied by home country sovereign bonds. The level of equity market risk varies by institutions and considers differing objectives and constraints unique to each institution. In figure 1, from left to right, we can see the risk appetite of each institution. This asset mix will determine a risk budget (annual volatility), potentially an active risk budget (tracking error), and CVAR limits or other extreme risk measures.

According to their 2025 annual report, CPP Investments' (CPP) starting point is a 60/40 portfolio of global equities and Canadian government bonds, an asset mix that would allow the fund to achieve the minimum returns required to sustain the fund at current legislated contribution rates. From this, CPP establishes Market Target Risks, which is the equivalent of a reference portfolio, and is 85/15 global equities/Canadian bonds for the Base CPP and 55/45 for the Additional CPP. This Market Target Risks portfolio sets the risk budget. CPP's actual portfolio, which is much more diversified, would then be managed to maintain a risk profile consistent with that of the 85/15 portfolio.

For NZ Super, approximately 50% of the assets are invested in the reference portfolio, with the remainder allocated to active risk, with the objective to maintain a similar risk exposure as the reference portfolio. That is, listed proxies with similar risk exposure would be sold to fund the active risk.

In terms of private asset exposure, there is a continuum. NZ Super is mostly allocated to listed assets, with just 15-20% in illiquid asset classes whereas CPP, like many Canadian plans, has upwards of 50% allocated private assets.

FIGURE 1 — REFERENCE PORTFOLIO COMPOSITION FOR GIC, CALPERS, NZ SUPER, AND CPP INVESTMENTS



Source: Annual Reports. CPP's Allocation represents Base CPP, and refers to reference portfolio as "Market Risk Target."

Figure 2 shows an example of how the reference portfolio is used to form a risk budget and allocations to active risk. For New Zealand Superannuation, the reference portfolio serves as both a benchmark and an acceptable level of risk that the fund is willing to take on to achieve its objectives. For other funds (GIC, CPPIB), the reference portfolio serves primarily to set a risk budget and not act as benchmark.

Notably, the reference portfolio is not a diversified portfolio and thus not optimal. Diversifying across asset classes would bring higher risk adjusted returns (higher Sharpe ratio) as adding commodities, real estate, infrastructure equity and debt, private equities, and risk mitigating strategies would bring diversification with similar expected returns.

FIGURE 2 — NEW ZEALAND SUPERANNUATION REFERENCE PORTFOLIO TO ACTUAL PORTFOLIO EVOLUTION

Source: New Zealand Superannuation 2025 Annual Report.

Using an 80/20 portfolio of global equities and bonds over the trailing 10 years, we obtain a portfolio standard deviation of ~12%. For some institutions, this would act as the risk level that the board is comfortable with. By diversifying the portfolio into other asset classes, the institution could likely achieve the same expected returns, with less risk, or higher returns for similar volatility. In the former case, they could operate with less risk than the reference portfolio or use leverage to bring risk back in line with the reference portfolio.

For New Zealand Superannuation, they disclose an active risk budget of 4%. They invest approximately 50% of assets in the reference portfolio, with the remaining allocated to other asset classes or strategies, as long as the tracking error does not exceed 4%.

In the example below, we explore how adding a 15% allocation to each of private equities, infrastructure equities, and 10% to infrastructure debt consumes a portion of the active risk budget. To proxy this, we use the private2000 index, the infra300 index, and the infra300 debt index and their trailing monthly returns for the past 10 years. From the initial 80/20 portfolio, we have assumed that the private equities and infrastructure equities were funded by the listed equities portion of the portfolio, while infrastructure debt was funded by the bonds portion. In practice, this could be adjusted to reflect different views on betas to the reference portfolio. For example, more or less of the listed proxies could be sold down to fund the active risk.

First, for definitions, we define tracking error (TE) and information ratio (IR) as the following:

$$TE = \sigma(R_p - R_b) \quad \text{and} \quad IR = (\bar{R}_p - \bar{R}_b) \;/\; TE$$

where R_p is the portfolio return and R_b is the benchmark (reference portfolio) return, otherwise known as active returns. The tracking error captures the volatility of active returns. The information ratio standardises the active returns by the tracking error (active risk). In this case, we have 120 months (10 years) of active returns for each asset class.

Figure 3 shows how we take active risk by shifting from the reference portfolio to include private assets:

■ **FIGURE 3 — REFERENCE PORTFOLIO VS ACTIVE PORTFOLIO**

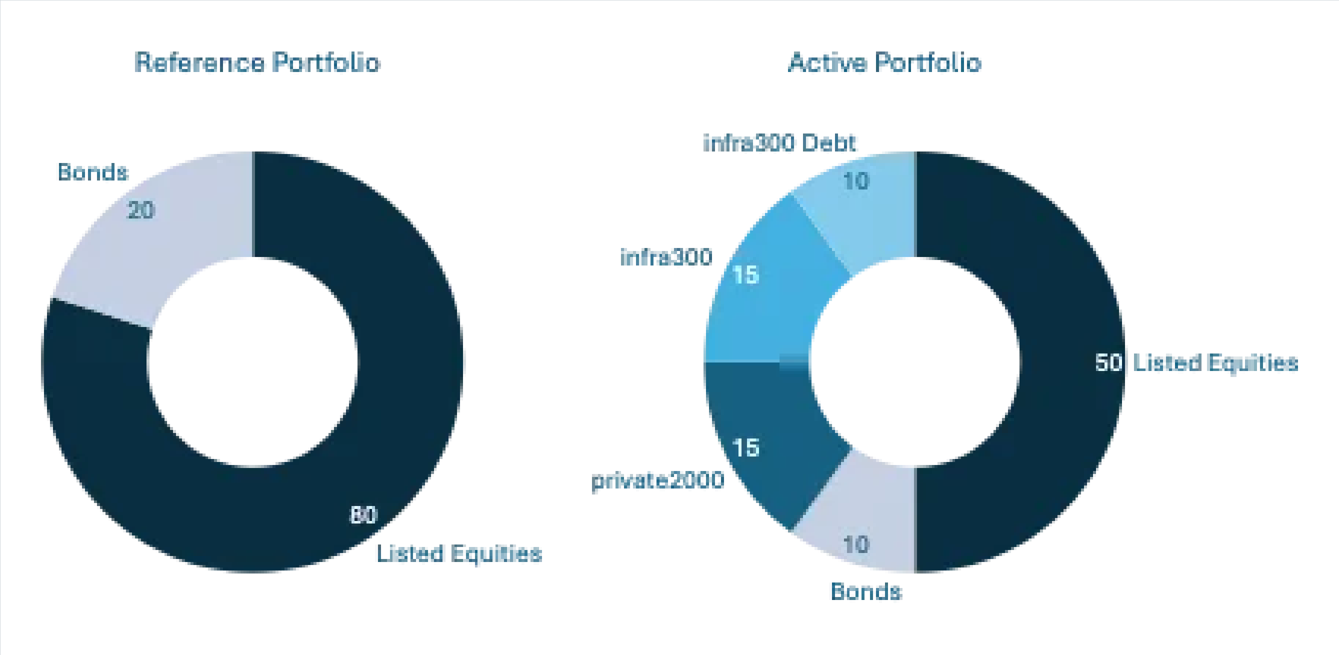


Table 1 evaluates the decision to pivot from the reference portfolio to one that includes private assets, proxied by privateMetrics and infraMetrics indices. Given the higher frequency data (monthly) and market based valuations, we get more sensible return and risk metrics.

■ **TABLE 1 — ACTIVE RETURNS VS ACTIVE RISK**

ASSET CLASS	WEIGHT	ACTIVE RETURN	STANDALONE TE	INFORMATION RATIO	PORTFOLIO TE	% OF TE
private2000	15%	0.46%	3.29%	0.14	2.38%	82.2%
infra300 E	15%	0.10%	0.99%	0.044	0.51%	17.6%
infra300 D	10%	-0.10%	0.29%	-0.35	0.01%	0.2%
Active Port	**40%**	**0.46%**	**—**	**0.16**	**2.89%**	**100%**

Source: privateMetrics, infraMetrics. Calculations by SIPA. Based on trailing 10 years monthly returns.

Adding a 15% weight to private equity via the private2000 index provided an annualised 0.46% active return against a standalone tracking error of 3.29%, or an information ratio of 0.14. Infrastructure equities also contributed positive active returns, though lower than private equities and with significantly less tracking error. Finally, infrastructure debt showed modestly negative active returns, with minimal contribution to portfolio tracking error, showing its risk mitigating potential.

To calculate active returns of the private asset classes, we have assumed each was funded by its closest proxy in the reference portfolio. For private and infrastructure equities, the listed equity sleeve, and for infrastructure debt, the bond sleeve.

At the portfolio level, with 40% in private assets, 50% in listed equities, and 10% in listed bonds, the active return is 0.46% annualised with an information ratio of 0.16. The portfolio tracking error is lower than the sum of the standalone tracking errors, reflecting the diversification benefits in the active returns across the three private asset classes (correlations of active returns <1). In this case, the tracking error is 2.89%. Depending on the tracking error risk budget of the institution, the weights and asset classes can be adjusted. This compares to the 4% tracking error budget noted by NZ Super.

TABLE 2 — RETURN AND RISK METRICS

METRIC	REFERENCE PORTFOLIO	ACTUAL PORTFOLIO
Annualised Return	8.36%	**8.82%**
Annualised Volatility	12.04%	**12.25%**
Sharpe Ratio	0.47	**0.50**

Source: privateMetrics, infraMetrics. Calculations by SIPA. Based on trailing 10 years monthly returns.

In table 2, we observe that the active portfolio generated higher returns with similar volatility, showing an improved Sharpe Ratio. Importantly, because we used privateMetrics and infraMetrics asset level indices, returns and volatilities reflect market conditions. For institutions that rely on stale and smoothed valuations from underlying private asset managers, the volatilities and correlations may be understated, leading to “hidden” risk in the portfolio. This represents a potential disclosure risk with the Total Portfolio Approach. Obtaining a risk budget based on observable listed assets prices (and volatilities) and then allocating to private assets, will almost certainly reduce reported portfolio volatility figures when using appraisal NAVs. If a fund were then to lever the portfolio back to the approved budget, there may be greater risk than that of the reference portfolio.

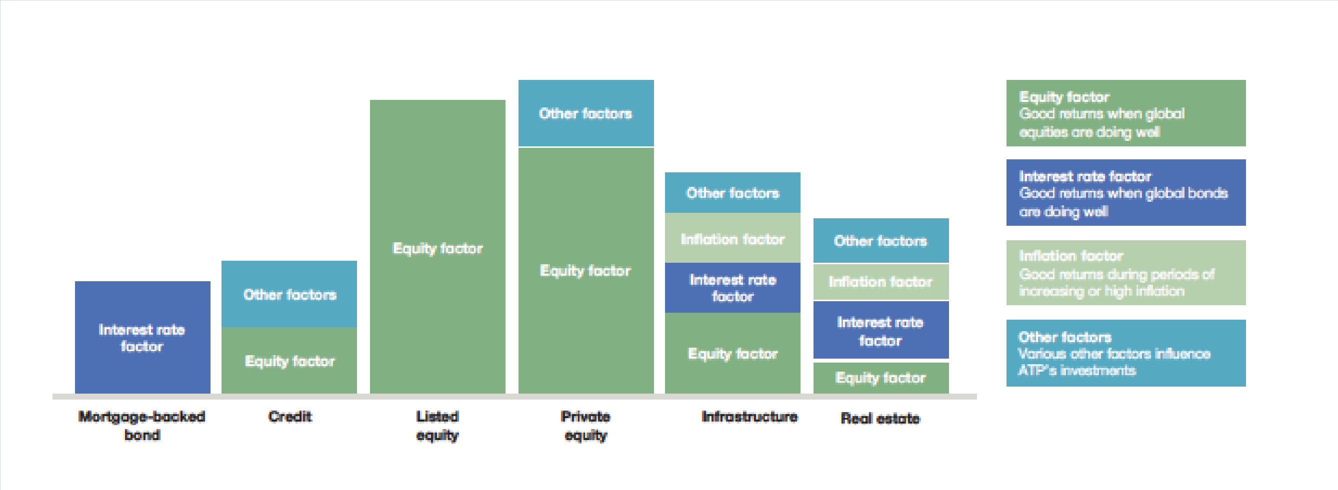
Reference Portfolios & Risk Factors

Closely related to the reference portfolio and risk budget, is the attempt to bucket actual portfolio exposures into compensated economic risk exposures such as equity, interest rates, credit, or other factors. This helps in part to tie back the multi-asset class portfolio to the reference portfolio so that one can understand how much of the portfolio is loading on the equity factor or duration.

CPP highlights in their 2025 annual report that they map investments to risk return factors, including growth risk, real interest rate risk, and inflation risk. Similarly, GIC mentions in their 2025 annual report that asset groupings are based on exposure to growth, income, and inflation. TCorp views their exposures in terms of equity, interest rates, credit, and currency factors, respectively. We can look at an example of this by examining disclosures by the Danish pension manager, ATP Denmark.

Figure 3 illustrates how ATP Denmark assigns various asset classes to underlying risk factor exposures. We observe that asset classes such as real estate and infrastructure are assumed to have exposure to equity risk, duration, and inflation. For infrastructure, this is broadly consistent with the findings from Part I of our TPA paper series (here).

FIGURE 4 — ATP DENMARK INDICATIVE FACTOR EXPOSURES FOR ASSET CLASSES



Source: ATP Denmark Investment Guidelines.

The treatment of private equity, however, is more surprising. Private equity buyouts, despite their highly leveraged capital structures, are assumed to load entirely on the equity factor, with no direct exposure to real interest rates or inflation beyond what is implicitly captured through equity risk. While growth equity and venture capital may reasonably behave like higher-beta equities, the same cannot be said for buyouts, which are structurally more sensitive to interest rates.

Indeed, private equity returns over the past three years suggest that performance has been more strongly influenced by interest rate exposure than by movements in global equity markets.

Categorising investments or asset classes into economic risk factors (eg Equity, interest rates, inflation, credit) presents challenges. For example, the assumption is that private equity loads intensively on the growth factor, proxied by global listed equities. But the behaviour of private equities over the last several years suggests it may be much more sensitive to real interest rates, inflation, credit spreads, and liquidity than listed equities. Being a residual claim on assets behind a significant floating rate debt stack suggests that rates and spreads are much more important to understand private equities, than for listed equities. In the next paper, we will explore this topic in more detail.

Conclusion

The reference portfolio serves primarily as a governance mechanism, providing a clear distinction in mandates for the Board of Directors and Management. While simple and intuitive, there are clear governance risks with this approach given the latitude afforded management and the investment teams.

Large private asset allocations, proxied by listed proxies, may materially misstate total fund risk exposures unless higher frequency, market-based pricing is used. Using privateMetrics and infraMetrics, we observe how private assets can consume the active risk budget, and its impact on total fund risk and Sharpe Ratio. Importantly, the results are realistic. No artificially low volatility figures, or abnormally large Sharpe ratios.

In this context, privateMetrics and infraMetrics provide a practical solution to the challenge institutions face when adopting TPA with significant private asset holdings or seeking to add private assets.

From a governance standpoint, real risk remains. Risk budgets are set with high frequency and transparent listed assets while reported returns and risk are unduly influenced by the private asset portfolio, which may have smoothed valuations and understated risk contributions. In the next paper, we will address this risk in greater depth.

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Access all privateMetrics data programmatically and build your own applications for private market investing and reporting.

Index Catalogue

Browse our catalogue of hundreds of private equity, infrastructure and infra debt indices, inc. market indices like the infra300 and private2000, and thematic indices representing specific market segments.

Taxonomies

Query the PECCS® and TICCS® taxonomies used to create the privateMetrics universe. Access class codes, names and definitions to build your own index and comps customisations applications.

Index Data

Access a comprehensive set of performance and risk metrics for hundreds of private equity, infrastructure and infra debt indices tracking numerous geographies and segments.

Custom Benchmarks

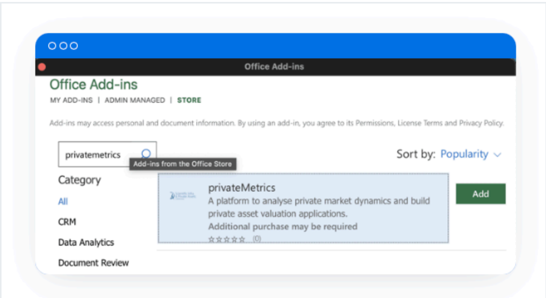
Build custom benchmarks setting target weights by PECCS, TICCS, style and geography that align with your strategy. All index metrics are recalculated for you.

Custom Comps

Create customised comp sets using PECCS® and TICCS® segments, geography and systematic risk profiles. Get metrics like discounts rates and EBITDA multiples.

Yield Curves

Query risk-free rates for a given pricing and maturity date to support discounted cash flow (DCF) calculations, valuation models, and other financial analyses.



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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 signaling 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

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.

Following standard asset pricing notation, the factor exposure or factor loading is called a beta (β), and the factor premium is called a lambda (λ) for the k factors in the model. α is the intercept and ε 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.

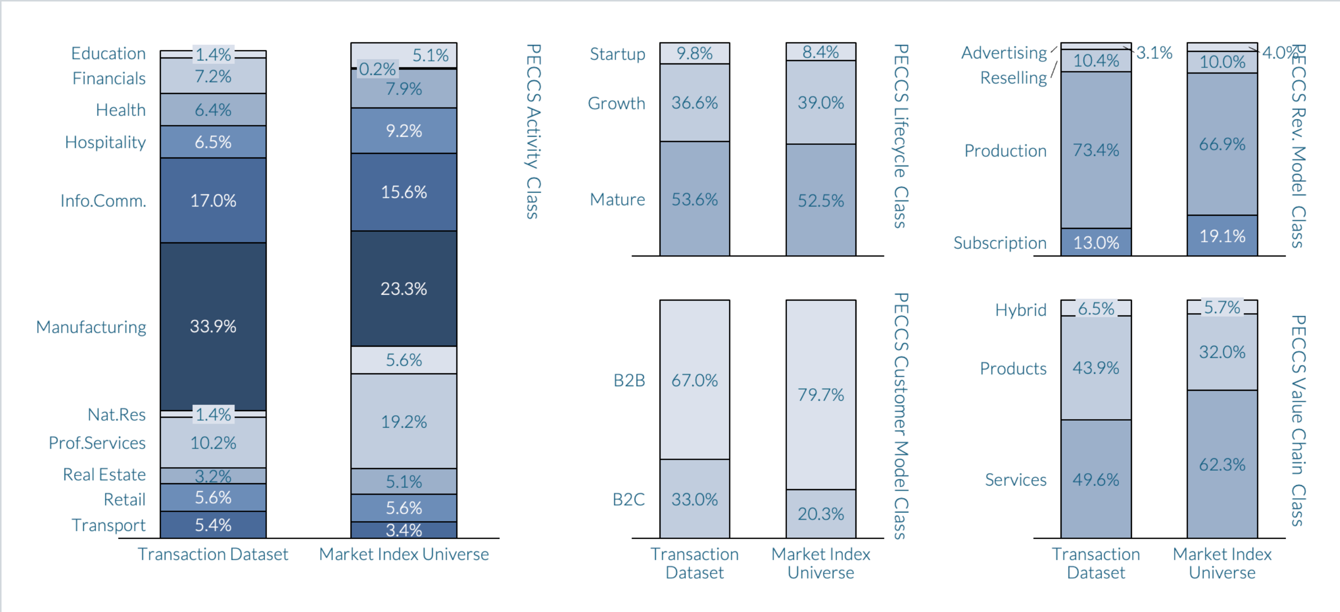
We calibrate this model using new observations monthly to update its estimation of the price of risk of each factor. In other words, each transaction observed is then used to 'update' this model (i.e., obtain new λs) through a dynamic estimation (using a Kalman filter), which retains the memory of past λs while also allowing the new transaction to influence the relationship while keeping the average ε 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 Figure 1.

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 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.

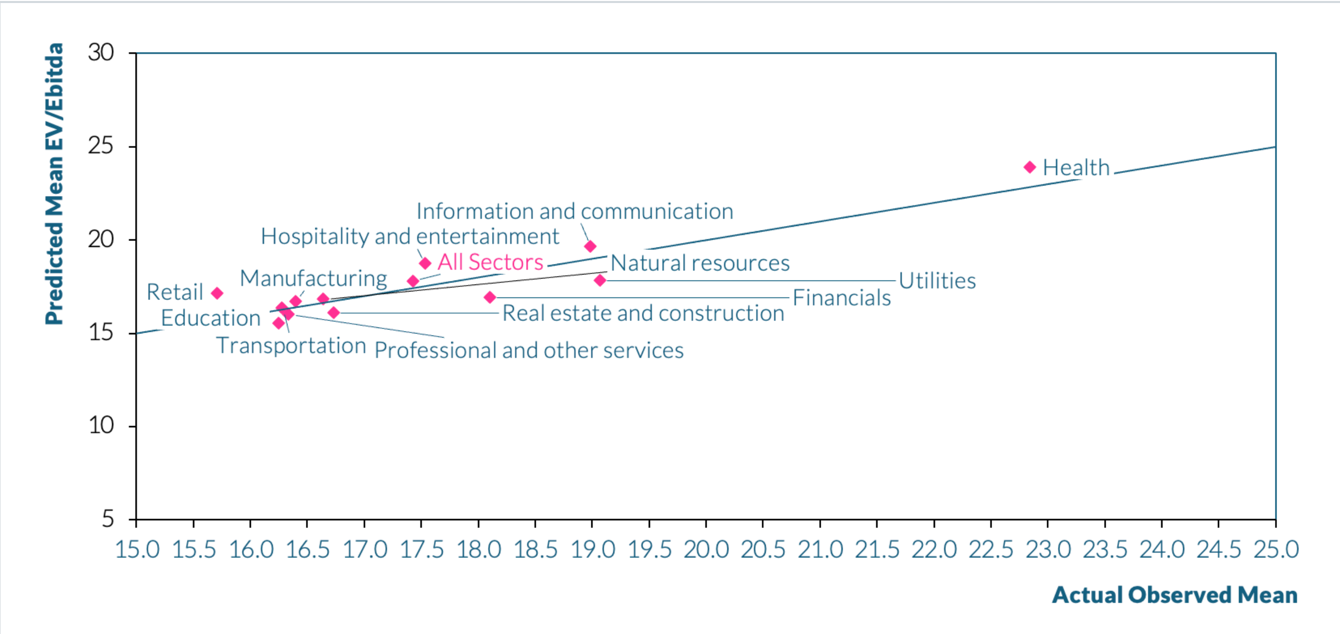
TABLE A2 — AVERAGE ESTIMATION ERRORS ACROSS PECCS® CLASSES

PECCS ACTIVITY	MEAN EST. ERROR
Education and public	0.9%
Financials	1.8%
Health	2.6%
Hospitality and entertainment	-1.1%
Information and communication	-4.4%
Manufacturing	2.5%
Natural resources	9.4%
Professional and other services	3.3%
Real estate and construction	1.9%
Retail	0.5%
Transportation	7.2%
Full Sample	**1.1%**

PECCS CLASS	MEAN EST. ERROR
LIFECYCLE PHASE	
Startup	0.1%
Growth	-1.7%
Mature	2.8%
REVENUE MODEL	
Advertising	1.2%
Reselling	4.6%
Production	2.9%
Subscription	-6.9%
CUSTOMER MODEL	
B2B	1.5%
B2C	0.9%
VALUE CHAIN	
Hybrid	0.6%
Products	1.1%
Services	3.4%

Source: Calculated using over 10k deals from Pitchbook, CapitalQ, 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, CapitalQ, Factset, and other sources between 1999-2022.

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