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The Fair Value of Investments in Unlisted Infrastructure Equity – Summary of Report

Prepared for GPIF
September 2024

Quantifying Private Markets
London | Singapore

AGENDA

- A modern approach for unlisted infrastructure asset valuation
- Data collection and individual company valuations
- Portfolio-level analysis
- Conclusions

A MODERN APPROACH FOR UNLISTED INFRASTRUCTURE ASSET VALUATION

A. WHY FAIR VALUE?

B. ISSUES WITH CURRENT PRACTICES AND DATA

C. A MODERN APPROACH TO ASSET VALUATION

D. IMPLEMENTATION

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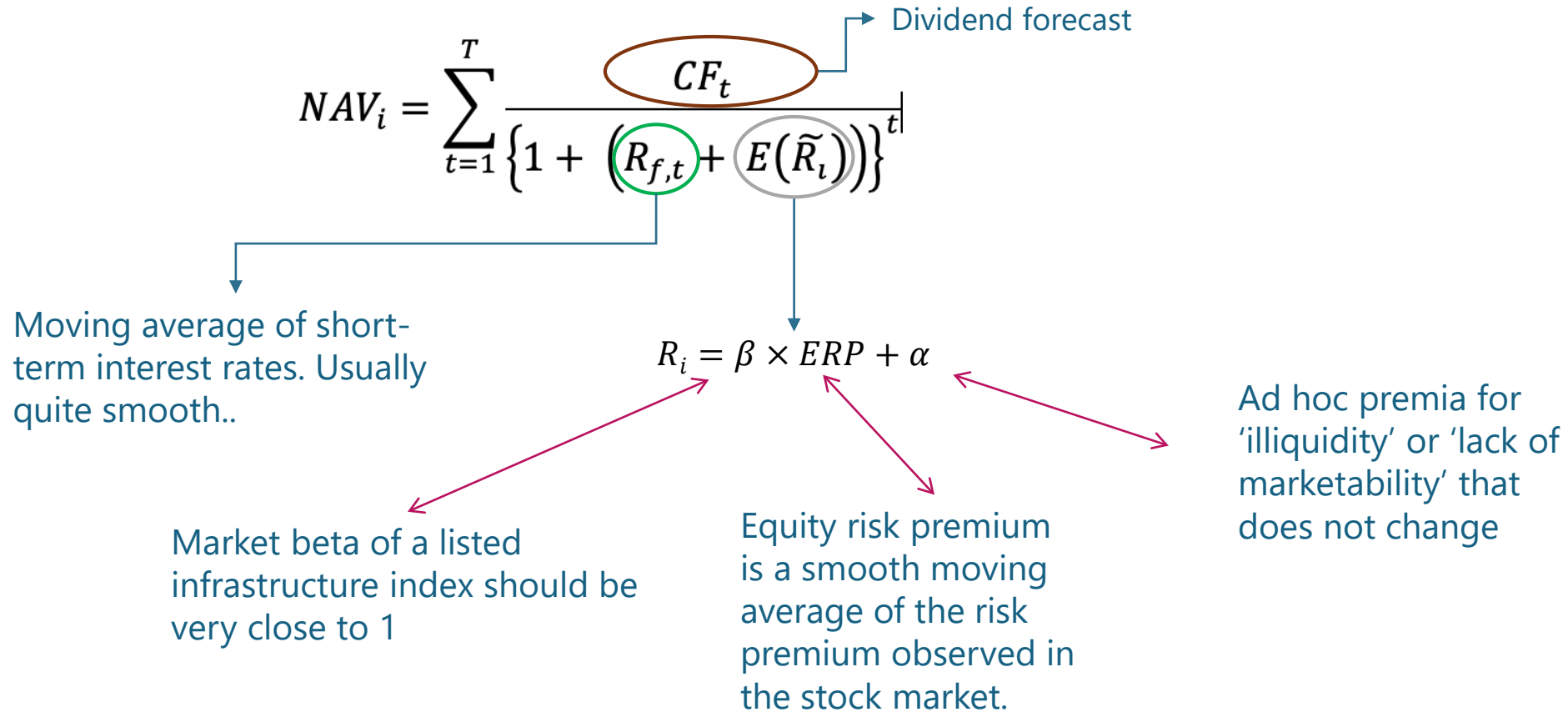An EDHEC Venture

A. WHY FAIR VALUE?

- What is Fair Value? the "exit price" on the date of valuation.
- **Reporting fair value and reporting risk (variance of fair value) are two sides of the same question.**
- Importance of Fair Value for investors like GPIF:
  - Accurate Pricing / Position Keeping
  - Risk Management
  - Transparency and Compliance
  - A reliable basis for making informed investment decisions

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B. ISSUES WITH CURRENT PRACTICES AND DATA:
REPORTED DATA DOES NOT REPRESENT TRUE RISK

- Actual transaction prices are too rare to capture volatility and market prices accurately

- Data contributed by asset managers lacks representativeness, and exhibits survivorship bias, and smooth returns. These practices lead to underestimation of volatility and misrepresentation of risk.

- Private appraisals are "smooth" because:
  - They rely on CAPM which uses the wrong data for risk premia due to a lack of appropriate market proxies.
  - They reply on smoothed discount rates based on outdated data, leading to "stale" NAVs

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B. ISSUES WITH CURRENT PRACTICES AND DATA:
WHY REPORTED NAVS ARE STALE

$$NAV_i = \sum_{t=1}^{T} \frac{CF_t}{\left\{1 + \left(R_{f,t} + E(\tilde{R}_i)\right)\right\}^t}$$

Dividend forecast

Moving average of short-term interest rates. Usually quite smooth..

$$R_i = \beta \times ERP + \alpha$$

Market beta of a listed infrastructure index should be very close to 1

Equity risk premium is a smooth moving average of the risk premium observed in the stock market.

Ad hoc premia for 'illiquidity' or 'lack of marketability' that does not change

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BOTTOM-UP DISCOUNT RATE ASSUMPTIONS ARE HARD TO JUSTIFY OR CHANGE ONCE MADE

I.R.L. Example of Fair Value Reporting by an Infrastructure Manager using CAPM+

Same Transport Asset in France

Investments Name	Fair Value as at 31 December 2019 In 000 euros	Methodology	Discount Rate
		Discounted Cash Flows	Risk Free rate : 1.75% Risk premium : 4.50% Illiquidity premium : 0.75%
		Discounted Cash Flows	Risk Free rate : 1.0% Risk premium : 6.25% Illiquidity premium : 1.0%
		Discounted Cash Flows	Risk Free rate : 1.5% Risk premium : 5.70% Illiquidity premium : 1.0%

Investments Name	Fair Value as at 31 December 2020 In 000 euros	Methodology	Discount Rate
		Discounted Cash Flows	Risk Free rate : 1.25% Risk premium : 5.0% Illiquidity premium : 0.75%
		Discounted Cash Flows	Risk Free rate : 0.75% Risk premium : 6.25% Illiquidity premium : 1.0%
		Discounted Cash Flows	Risk Free rate : 0.0% Risk premium : 4.5% Illiquidity premium : 1.0%

Risk Premia and "illiquidity Premium" are *ad hoc* and hard to justify, even harder to update…

What is the "illiquidity premium" the following quarter? the following year? On what basis?

Clearly, the risk level of transport investments in France changed between 2019 and 2020 (Covid-19 Lockdowns), but **on what basis** *can investors update the risk premia?*

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B. ISSUES WITH CURRENT PRACTICES AND DATA:
REPORTED RETURNS/RISK ARE "SMOOTHED"

Ponzi scheme-style Sharpe ratio?

Reported NAV returns in infrastructure funds (source fund annual reports)

	3-year	5-year	10-year
Appraisal NAV total returns	8.7%	9.7%	9.2%
Appraisal NAV total returns volatility	2.7%	2.7%	2.9%
Implied Sharpe Ratio	2.79	3.19	2.86

Source: Annual reports, NAV of assets for 13 funds of unlisted infrastructure equity representing c.USD23.4bn of investment in 2020

Unlisted infrastructure equity NAV return indices using contributed fund data (Source Preqin/MSCI)

	Preqin Unlisted Infrastructure	MSCI Global Unlisted Infrastructure
10-y Annualized Return	10.41%	13.42%
10-y Annualized Std Dev	3.11%	3.26%
Risk-Adjusted Return	2.99	3.78
Max Drawdown	1.37%	0.00%

Source: Preqin, MSCI,, All computations use quarterly USD Returns.

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C. A MODERN APPROACH TO ASSET VALUATION: SELECTING SYSTEMATIC FACTORS IN PRIVATE MARKETS

Factor selection rests on three criteria by order of importance:

1. **Economic rationale** implying a systematic link with transaction prices, e.g., larger size implies high illiquidity and a lower price, *ceteris paribus.*

2. **Statistical evidence** of covariance between factor loadings (betas) and reported transaction prices

3. **Availability of data** for predictors to the model can be used to shadow price all the assets in the universe.

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C. A MODERN APPROACH TO ASSET VALUATION: PRIVATE INFRASTRUCTURE EQUITY PRICE DRIVERS

A different set of **risk factors and control variables** systematically explain the variance of transaction prices observed in private infra acquisitions and exits.

Factor	Definition (proxy)	Effect on price	Economic Rationale	References
Size	Total Assets	Negative	Larger assets are more illiquid and complex transactions.	Fama & French (1993)
Leverage	Total debt / Total Assets	Positive	Higher leverage increases the risk of future cash flows to shareholders.	Blanc-Brude & Tan (2019)
Profits	Return on Assets Before tax	Positive	Higher profits make future dividend payouts less uncertain.	Blanc-Brude & Tan (2019)
Capex	Capex / Total Assets	Negative	Higher Capex increases the risk of construction cost overruns and delays, making future dividends more uncertain.	Blanc-Brude & Tan (2019)
Country risk	Term Spread	Positive	More uncertain long-term macro prospects (yield curve slope) correlate with greater risks for investors in infrastructure.	Chen & Tsang (2013)
TICCS Control factors	Dummy Variables for TICCS Activity and Business Risk Segments	Positive or Negative	Different segments of private markets exhibit different average level of price because of systematic difference in risk .	See TICCS documentation

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C. A MODERN APPROACH TO ASSET VALUATION
USING ONLY TRANSACTION PRICES

- In practice, we observe **actual transactions** (market prices) and derive from these the implicit premia of risk factors that are common to all infrastructure companies using a Kalman filter (Bayesian inference)

- For each factor, a premia is updated after each deal, separating the market signal from the deal idiosyncratic noise. **Every investment carries pricing information relating to common risk factors**.

- Once we can estimate the price of common risk factors, we can value any asset, given its exposure to each risk.

Estimated based on recent deals

$$\gamma_{t,i} = \sum_{k=1}^{K} \beta_{i,k,t} . \lambda_{k,t}$$

Available for all assets to shadow price (financials)

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D. IMPLEMENTATION

Dividend Forecasts

- Revenue Forecasting: Tailored models for predicting cash flows.
- Cash Flow Waterfall & Dividend Forecast: debt payments before equity payouts.

Market Discount Rate

- Term Structure & Risk Premia: Uses interest rates and systematic risk factors for accurate valuation.
- Dynamic Premia Modelling : monthly data ensures precise risk estimation and alignment with market prices.

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B. ISSUES WITH CURRENT PRACTICES: THE IMPORTANCE OF GETTING THE DISCOUNT RATE RIGHT.

Years	Subordinated Debt Interest Paid	Subordinated Debt Repayments	Dividends	Subordinated Interest Accrued	All Shareholder Cash flows
1	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0.00
3	0.00	0.00	0.00	0.00	0.00
4	673.98	273.15	0.00	673.98	1621.10
5	1301.84	430.57	0.00	1301.84	3034.25
6	1249.26	441.98	0.00	1249.26	2940.50
7	1205.24	124.70	0.00	1205.24	2535.17
8	1189.73	144.34	0.00	1189.73	2523.80
9	1170.83	186.21	0.00	1170.83	2527.86
10	1147.47	214.84	0.00	1147.47	2509.77
11	1121.45	213.07	0.00	1121.45	2455.98
12	1093.83	270.09	0.00	1093.83	2457.75
13	1060.19	233.88	0.00	1060.19	2354.26
14	1035.02	192.04	298.39	1035.02	2560.47
15	1011.01	216.05	514.82	1011.01	2752.89
16	984.00	243.06	442.24	984.00	2653.30
17	953.62	273.44	468.51	953.62	2649.19
18	919.44	307.62	378.95	919.44	2525.45
19	880.99	346.07	514.22	880.99	2622.27
20	837.73	389.33	596.76	837.73	2661.55
21	789.06	438.00	507.96	789.06	2524.09
22	734.32	492.74	556.62	734.32	2518.00
23	672.72	554.34	541.27	672.72	2441.05
24	603.43	623.63	637.87	603.43	2468.36
25	525.48	701.58	757.49	525.48	2510.02
26	437.78	789.28	800.94	437.78	2465.78
27	339.12	887.94	742.22	339.12	2308.39
28	228.13	998.93	696.75	228.13	2151.94
29	103.26	1123.80	1544.59	103.26	2874.91
30	0.00	0.00	3430.90	0.00	3430.90
31	0.00	0.00	9882.19	0.00	9882.19

ORIGINAL VALUATION

Disc Rate	7%
NAV	$3,880.01

DIVIDEND FORECAST ERROR

ERROR	20%
NAV	$3,104.01
NAV ERROR	-20.00%

DISC. RATE ERROR

ERROR	100 basis points
Disc Rate	8.0%
NAV	$3,066.31
NAV ERROR	-20.97%

Getting the **discount rate wrong is much more problematic** than wrongly forecasting the dividends..

A 100-basis point error in the discount rate is worse that a 20% error in the dividend cash flow forecast!

Real Project Shareholder cashflow profile in a 30-year infrastructure project ($M)

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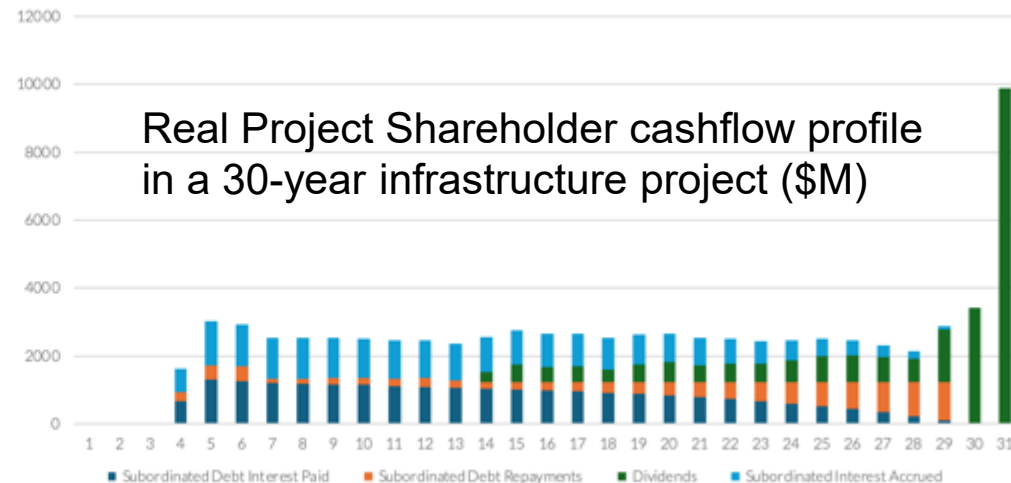
D. IMPLEMENTATION: MARKET RISK PREMIA

Tracking Market Dynamics

- A shift in market prices since 2008: increased demand has lowered the price of risk
- 2016-2019, risk premia returns fluctuated between 650 and 700bps
- Since 2021, premia returned above 8%
- Infrastructure Equity Risk premia spikes during crises (2008, 2012, 2020)

Global Infrastructure Equity Risk Premia

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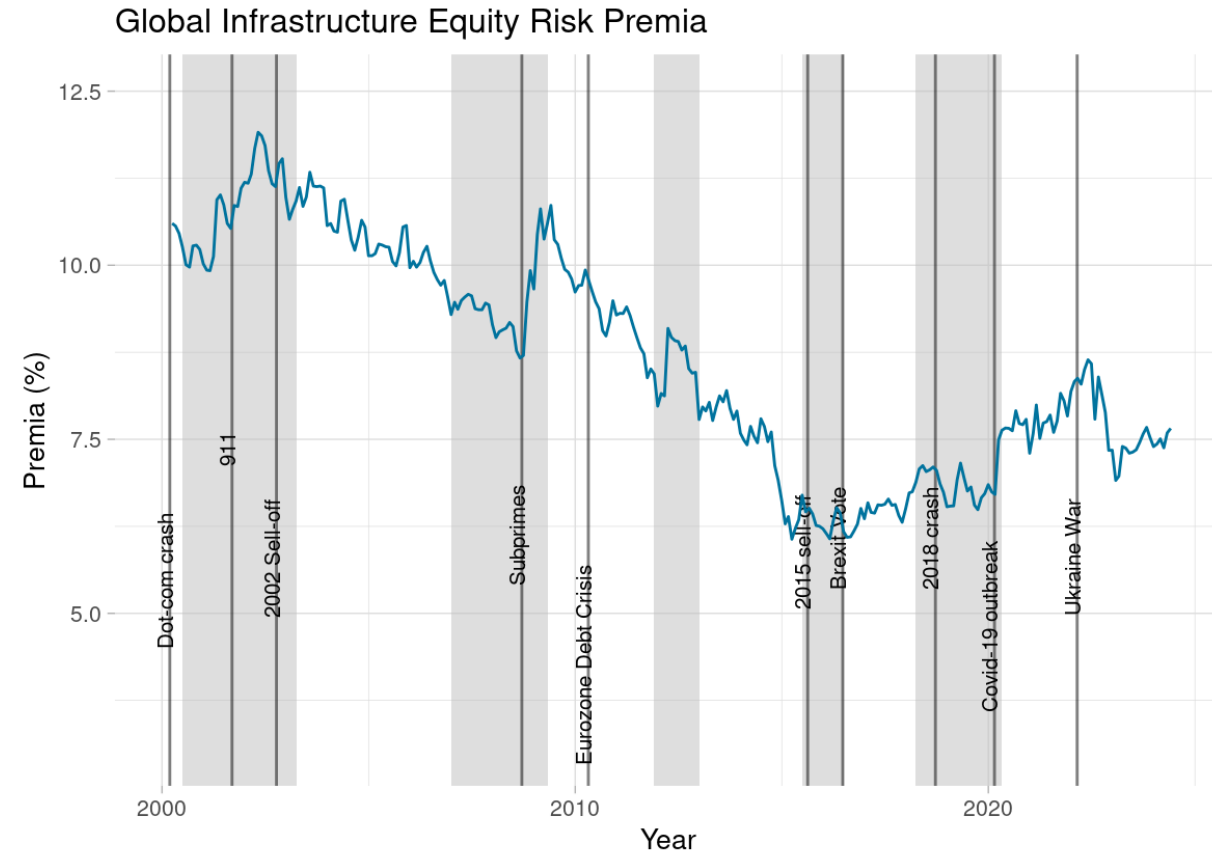
D. IMPLEMENTATION: ROBUSTNESS

At the TICCS segment level the average difference between modelled prices and observed transaction prices is very small.

SECTOR-LEVEL ROBUSTNESS TEST
Average difference between estimate valuation and observed prices (sample of 1k+ transaction)
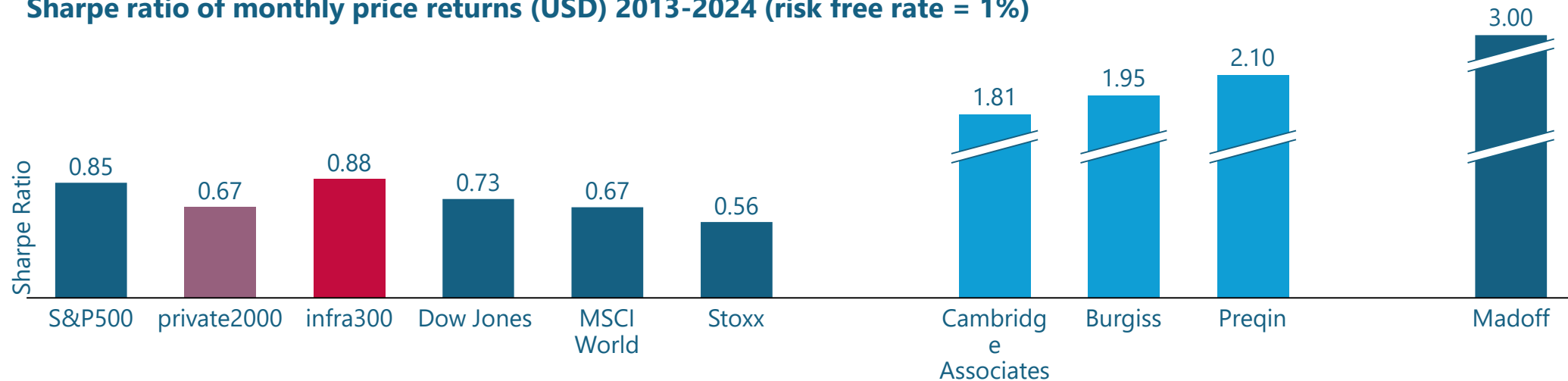
TICCS Code	TICCS Name	Average Difference	Confidence Bounds	
			Lower	Higher
IC10	Power	-1.1%	-6%	1%
IC20	Env. Services	0.0%	-1%	1%
IC30	Social	-2.1%	-7%	4%
IC40	Nat. resources	-0.5%	-4%	1%
IC50	Data	0.6%	0%	2%
IC60	Transport	-0.2%	-3%	2%
IC70	Renewables	-0.1%	-2%	2%
IC80	Net. Utilities	-0.6%	-3%	1%

A good model of infrastructure asset prices calibrated with the right data produces **robust estimates of the average price of assets**, that can be customised to create pricing anchors.

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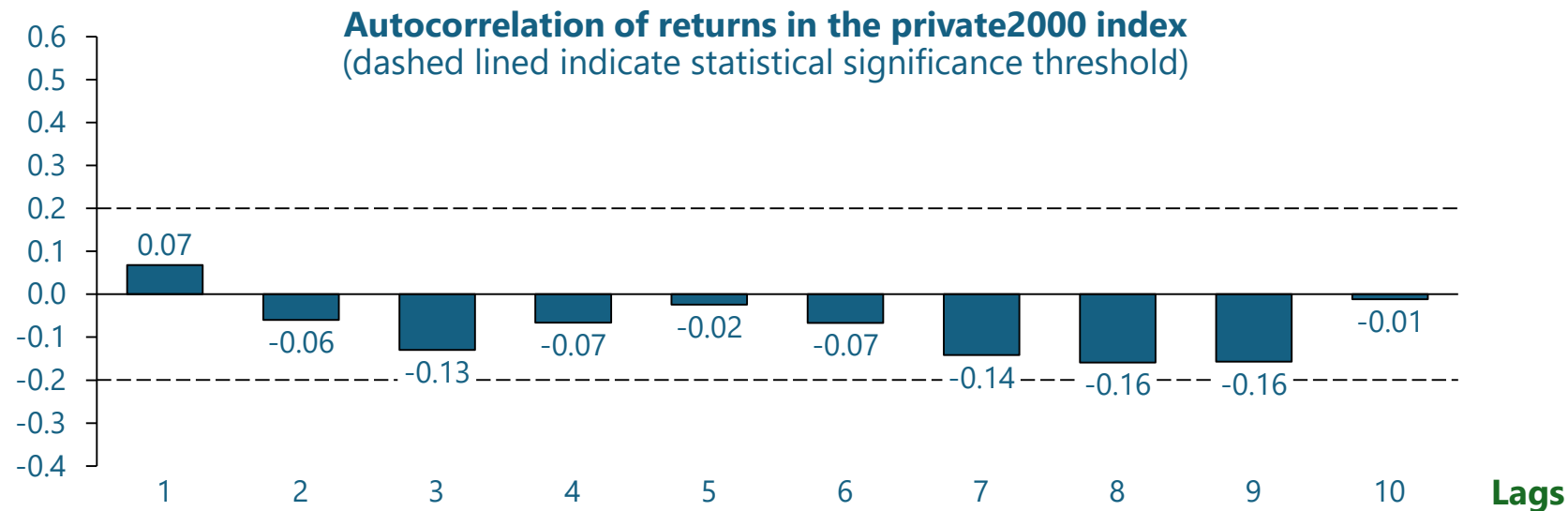An EDHEC Venture

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D. IMPLEMENTATION: ROBUSTNESS

The Sharpe ratio expresses capital returns (in percentage) per unit of risk (volatility) and is a **key test of the robustness of infraMetrics data when compared to other asset classes**, confirming the reasonableness of the results. The same metric disqualifies contributed (smooth) data as a source of risk data.

Sharpe ratio of monthly price returns (USD) 2013-2024 (risk free rate = 1%)

Asset	Sharpe Ratio
S&P500	0.85
private2000	0.67
infra300	0.88
Dow Jones	0.73
MSCI World	0.67
Stoxx	0.56
Cambridge Associates	1.81
Burgiss	1.95
Preqin	2.10
Madoff	3.00

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D. IMPLEMENTATION: ROBUSTNESS

One of the typical signs of 'smooth' private market data that underestimate volatility is the presence of autocorrelation of an index of private asset returns. infraMetrics indices exhibit **no serial correlation in index returns**, confirming that they genuinely capture the risk of private markets.

Autocorrelation of returns in the private2000 index
(dashed lined indicate statistical significance threshold)

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D. IMPLEMENTATION: ROBUSTNESS

The objective of a pricing model is to capture market pricing signals through systematic factors and to leave out the idiosyncratic "noise" of individual transaction prices.

infraMetrics Price-to-Revenue Residuals (log scale)
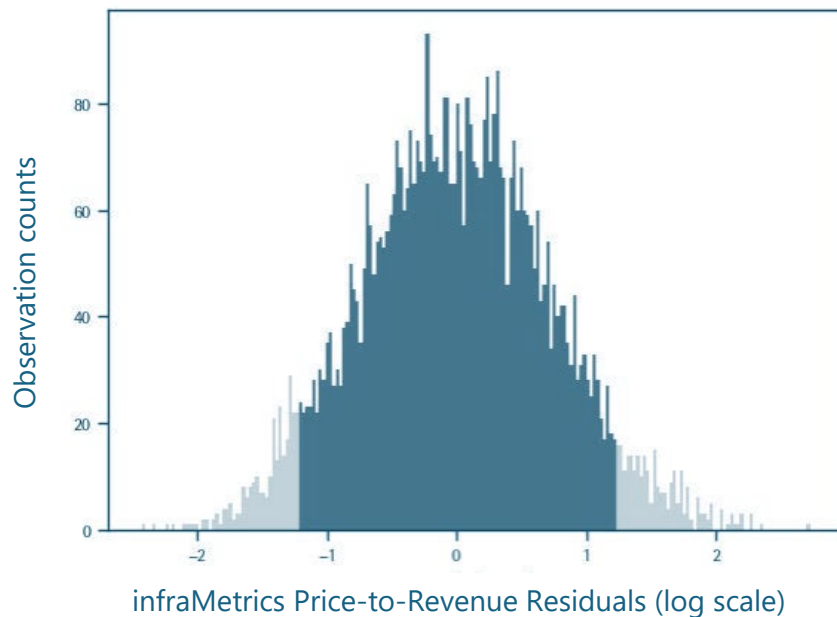
A key measure of robustness is the distribution of the model residuals: the difference between observed transactions and predicted prices.

The infraMetrics model is robust because its residuals are like "white noise": a mean of zero and a symmetrical, bell-curve distribution.

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DATA REPORTING REQUIREMENTS

A. VALUATION REPORTING MATTER

B. RISK REPORTING MATTERS MORE

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A. VALUATION REPORTING
ASSET MANAGERS

- AMs who follow the Global Investment Performance Standards (GIPS) are required to present a full and fair disclosure of their performance, as maximum drawdown.

- However, we know that infrequent valuations by AMs result in less timely information being available to investors, impacting investment evaluations, decisions, and risk assessments.

- An infrastructure asset invested through a fund can sometimes maintain the same NAV for five consecutive years, (Amenc et al., 2023).

- In a higher interest environment, AM face pressure on private asset valuations, as sometimes they are reluctant to update their valuations and impacting their liquidity risk management (Financial Conduct Authority, 2023).

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A. VALUATION REPORTING
ASSET OWNERS

- Asset Owners have regulatory obligations, and fiduciary requirement to maintain **transparency** and **accountability** to their stakeholders through periodic reporting.

- The growth of private (unlisted) investments in pension plans and products creates issues of fairness and fiduciary duty.

- In some jurisdictions (Australia, UK) regulators are pushing for greater control and validations of reported NAVs by pensions funds to avoid valuations from becoming too stale.

- In some countries (Scandinavia), DC plan sponsors are required to have daily valuation of private assets, frequent benchmarking is needed to ensure the valuations are accurate and reflective of current market conditions.

B. RISK REPORTING
RISK PREDICTS PERFORMANCE

- Monitoring risk is essential because it is the best (the only) forward-looking metric to predict performance for investors.

- The failure to anticipate the impact of Thames Water's financial issues is the result of stale valuations that failed to document the increasing risk of the asset. In 2023, Thames Water was riskier than the global utilities sector, e.g., its price-to-sales ratio and EV/EBITDA is significantly below the entire sector and the VaR is 5 times more than that of the sector (Amenc et al, 2023)

Segment	Return Volatility	97.5% VaR	Price to Sales Ratio	EV/EBITDA
Thames Water	37.9%	-64.5%	1.5x	7.6x
infraMetrics Global Regulated Utilities	12.9%	-12.7%	2.0x	12.8x

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DATA REPORTING: WHAT GPIF SHOULD REQUIRE OF FUND MANAGERS

- Fund managers who are entrusted with the savings of the Japanese public and government should report clear information on the value and risks of the investments made in private assets.

- The current practice to report backward looking NAVs is creating a **'veil of ignorance'** between the investor (GPIF) and the asset managers.

- Without adequate position keeping (the current value of the portfolio) or ongoing risk measures, **it is not possible to benchmark or manage the risk of this portfolio.**

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COMPANY DATA COLLATION AND COLLECTION

A. DATA PROVIDED

B. KEY ISSUES

A. DATA PROVIDED BY MANAGERS TO GPIF

We received data for 20 investments for case studies :

1. **The data was partial and limited:** Several of the AM did not provide operating company financial statements, but the accounts of the holding companies: not informative (no 'look through') to determine revenue drivers, analyse the capital structure or the dividend payments. Evaluating the risk of such an investment was difficult with the data provided.

2. **The data was about the investment not the company:** The holding company accounts provide details of the investment manager's valuation and any distributions that may have occurred. Understanding an asset from just such accounts is not possible.

B. KEY ISSUES IDENTIFIED IN THE DATA

- Almost none of the asset values are provided on a fair value basis but instead presented "at cost" – on the basis on this information, GPIF has no visibility on the evolution of the value of the investments.

- The data is often limited in time (not provided for the full like of the asset and sometimes not for the duration of the investment).

- The team managed to collect more information than what AM had provided
  - Longer time series
  - 'look through' data below the HoldCo level

- In the end, the team was able to process financial data for 28 individual assets

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CONCLUSIONS: RISK & PERFORMANCE

- We computed portfolio metrics and created a custom benchmark to compare against in terms of risk and performance, factor attribution and TICCS segments contributions.

- The performance and risk metrics of the toy portfolio highlight the value of the monitoring these quantities for an investor.

- The metrics computed allow a complete understanding of how the portfolio was built and why it is performing the way it is relative to its benchmarks in terms of sector and geography contributions, factor attributions and risk exposures.

CONCLUSIONS: REPORTING & GOVERNANCE

- We established that data reporting by AM/GPs is not sufficient for institutional investors like GPIF to "know their risk" and track the value of their portfolio invested in private infrastructure.

- Better practices and adherence to international standards including fair value standards are possible and can be promoted amongst large LPs to lead GPs to become more transparent.

- Better methods and databases of infrastructure investment data allow much more precise measurements of the risk and fair value of private assets and show the way forward to sophisticated investors.

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