

# THE **FAIR VALUE** OF INVESTMENTS IN UNLISTED INFRASTRUCTURE EQUITY

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The robustness of better data  
& advanced methods

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# Summary

- As more investors consider allocations to unlisted infrastructure, the need to bring the asset class into the mainstream of risk management, asset allocation and prudential regulation is increasing rapidly. New prudential rules, the Covid-19 pandemic and the increasing visibility of infrastructure in individual retirement products have made the frequent reporting of fair infrastructure valuations all the more urgent.
- Measuring the fair market value and therefore the risks of unlisted infrastructure is made more difficult by the paucity of data, Appraisal values are typically stale and do not reflect the market conditions including the latest price of risk applicable to private infrastructure. In the absence of comparable transactions, most unlisted infrastructure investments have effectively been booked at or near their historical cost.
- Thanks to recent advances in data collection and asset pricing techniques, it is now possible to estimate the evolution of fair market prices for unlisted infrastructure equity investments. In this note, we report that:

- 1** Common risk factors explain observable market valuations of unlisted infrastructure companies.
- 2** The risk premia of these factors can be measured on an ongoing basis, as new transactions take place. Thanks to these risk premia, individual assets that do not trade but are exposed to the same factors can also be priced.
- 3** This approach predicts transactions prices accurately within 5% of observed transaction prices and produces robust series of returns with no smoothing.

This technology allows measuring the true yield of infrastructure investments, their optimal contribution to multi-asset portfolios, duration and much more.

# Fair value matters for investors in infrastructure.

Market prices are essential for investors to make sensible investment decisions.

Many investors are aware that the market price of unlisted infrastructure equity has evolved considerably over the past decade and a half, with a long period of increases in market valuations and compression of yields, which started abating in 2017 and was partly reversed in 2020 due to the impact of the Covid-19 pandemic.

These evolutions remind us that estimating fair market value is an essential aspects of investing in illiquid, unlisted infrastructure equity.

When entering the secondary market or taking part in a 'continuation' fund, a robust assessment of fair value is necessary since the price paid by investors determines their cash yield, which often attracted them to infrastructure in the first place.

Beyond the current yield, assessing the performance of infrastructure assets also requires measuring capital appreciation, including to decide when is the right time to exit investments and benefit from capital gains. This is true whether assets are otherwise booked at cost or at fair value.

Measuring fair market value is also necessary to measure and manage the risks of infrastructure investments.

Total return volatility is strongly related by the variance of market prices. The market prices of unlisted infrastructure change with dividend expectations but also with the evolution of market discount rates. In fact, with long-term cash flows, these valuations can be quite sensitive to changes in interest rates and risk premia.

Measuring these risks plays a key role in risk management and reporting, asset-liability management and deciding on an optimal strategic asset allocation to the infrastructure asset class.

In this note, we show that while investors in illiquid assets like infrastructure have long been plagued by "stale" NAVs and opaque valuation assumptions, recent innovations in asset pricing and data collection allow the robust estimation of the fair market price of unlisted infrastructure equity investments. The ability to measure market prices on an ongoing basis for the infrastructure asset class opens a new era of transparency for infrastructure.

# Appraisal NAVs are stale.

**Investors cannot rely on appraisals to capture the fair value and the risks of infrastructure investments.**

A look at the appraisal NAVs reported by infrastructure funds reveals that they cannot possibly reflect the evolution of the fair value of unlisted infrastructure equity. This point is made abundantly clear by looking at the volatility of appraisal valuations in unlisted infrastructure portfolios: given the returns, the reported NAV volatility implies a wildly unrealistic risk-return profile as shown in table 1, which describes the appraisal NAVs of 13 unlisted infrastructure equity portfolios representing USD23.4bn of investments in 2020.

If the risk level implied by the volatility of infrastructure appraisals in these portfolios was true, infrastructure would represent a huge risk-free arbitrage opportunity with a Sharpe ratio of 3. Even in private markets, such arbitrage opportunities cannot exist for long, let alone remain the case for ten years.

**Ergo, appraisal NAVs are smooth and do not capture the fair market value of infrastructure investments.**

**Table 1: The Unbelievably Smooth Risk and Return Profile of Infrastructure Appraisals**

	3-year	5-year	10-year
Appraisal NAV Total Returns	8.72%	9.65%	9.24%
Appraisal NAV Total Returns Volatility	2.73%	2.68%	2.85%
Implied Sharpe Ratio	2.79	3.19	2.86
Volatility of Appraisal NAVs only	2.34%	2.48%	2.38%

Source: Annual and quarterly reports, NAV of assets for 13 funds investing solely in unlisted infrastructure equity and representing USD23.4bn of investment at the end of 2020.

In fact, the discount rates used to appraise these investments change very little over time and are not market discount rates. They fail to capture both the evolution of the term structure of interest rates or the latest price of risk required by market participants to invest in illiquid infrastructure companies.

The naive view on private asset valuation often include the claim that the risks of these assets are somehow 100% idiosyncratic, and that such investments can be benchmarked using an absolute rate of return since their discount rates are not related to financial market fundamentals. This is, of course, not the case. In fact, under IFRS 13, valuations should be market-based, not entity-specific. Fair value estimates should reflect the impact of market factors, including the price of risk and the value of time.

IFRS 13 defines fair value in terms of exit price: "the price that would be received to sell an asset or paid to transfer a liability in an orderly transaction between market participants at the measurement date." Thus, unlisted infrastructure equity investments cannot not be assumed to be worth their unadjusted NAV if market-based valuations are available. Next, we describe a novel approach to measure the market prices of illiquid infrastructure assets.

# Our approach

Despite the paucity of data available on transaction prices, it is possible to assess the fair market value of illiquid assets accurately.

Investors have typically had to rely on stale NAVs because too few transactions were available in the unlisted infrastructure equity market to make meaningful comparisons. Infrastructure companies are quite different from one another and trade rarely. EDHECinfra research shows that unlisted infrastructure companies trade in the secondary market about once in their life\* on average i.e., many never do.

Building robust comparables would require thousands of secondary market transactions for each type of infrastructure company. In a market as illiquid as unlisted infrastructure equity, this is not possible.

However, despite the low number of observations available, it is possible to reduce the number of dimensions of the problem by using a factor model.

Instead of having to observe thousands of individual transactions, the equity risk premia, EV/Ebitda ratio or any other market valuation metric can be estimated by breaking down available observations into a limited number of risk factors (e.g. leverage, size, etc) and re-estimating these factor premia on a regular basis, using recent transaction values and their factor exposures.

Other infrastructure companies are all exposed to the same factors, only in different quantities. All infrastructure companies have an exposure to the size factor, the profit factor etc. Once the premium or risk premia of individual factors are estimated from actual deal values, the valuation of other infrastructure company, can be derived given its exposure to these factors.

Our research shows that the most relevant, robust and persistent risk factors that explain transaction prices in unlisted infrastructure transactions are:

- Leverage (Liabilities / Total Assets)
- Size (total assets)
- Profitability (Return on Assets)
- Investment (Capex / Total Assets)
- Country risk (Term Spread)
- A range of control variables: business model and industrial activities according to the TICCS® taxonomy\*\*

## A model of expected returns

Step 1: get the risk premia ( $\gamma$ ) from market prices

$$P_j = \sum_{t=1}^T \frac{D_{j,t}}{(1+r_t + \gamma_j)^t}$$

Step 2: estimate the price ( $\lambda$ ) of each risk factor given the factor exposures ( $\beta$ ) of each transaction

$$\gamma_j = \beta_1 \times \lambda_1 + \beta_2 \times \lambda_2 \dots + \omega = \sum_{k=1}^K \beta_{j,k} \times \lambda_k + \omega$$

Step 3: apply factor prices ( $\lambda$ ) to new assets to compute their risk premia given their factor exposures.

$$\hat{\gamma}_i = \sum_{k=1}^K \beta_{i,k} \times \hat{\lambda}_k$$

\* Based on a sample of more than 6,800 private infrastructure companies in 25 countries

\*\* The Infrastructure Company Classification Standard or TICCS® is a taxonomy used to describe infrastructure investment and portfolio

# Input data

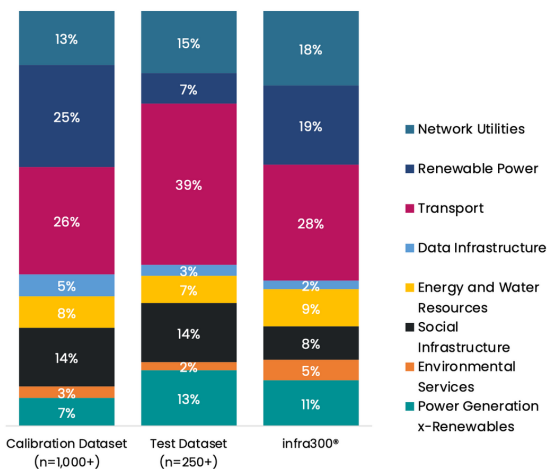
Our valuation model is calibrated using a wide and deep sample of market transactions across the different segments of the universe.

EDHECinfra has identified 6,800+ investible infrastructure companies in the 25 countries where most of the transactions take place (the 'principal' market - IFRS 13). Of these, a sample of 650+ firms are actively monitored at a great level of financial details to make a representative sample of this universe. These are the firms that are priced to make indices like the infra300 index.

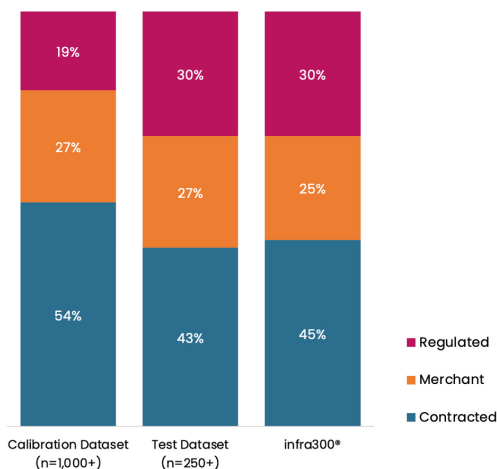
The data used to calibrate the EDHECinfra model of expected returns uses 1,000+ observed secondary market transactions of unlisted infrastructure observed over 20 years, 250+ of which are tracked in EDHECinfra indices. Figure 1 shows the coverage of the model input data, the test dataset and the infra300 index weights, which represent the global investable universe.

**Figure 1: Distribution of the model input price data by segment: model calibration dataset and model test dataset vs. the infra300® index weights (global market)**

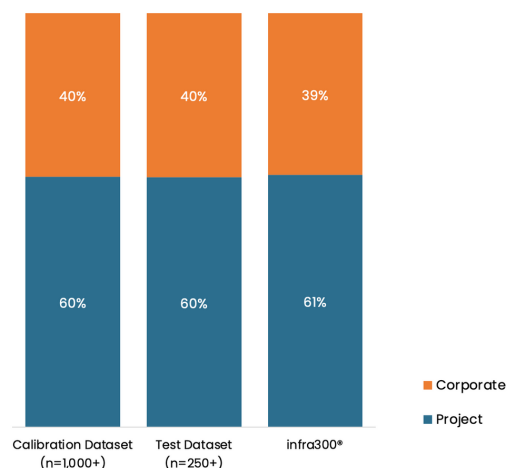
## Sector Breakdown



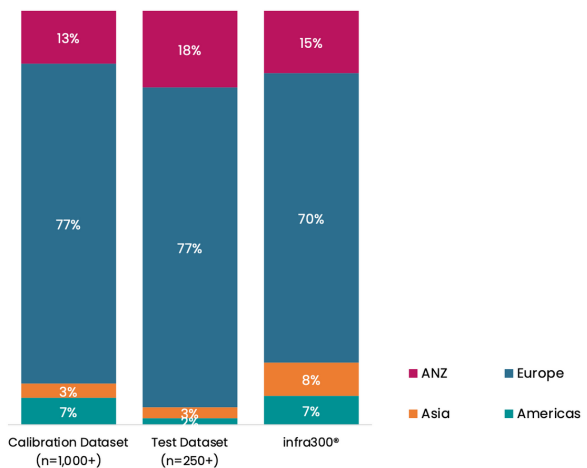
## Business Model Breakdown



## Corporate Structure Breakdown



## Geographic Breakdown



Source: EDHECinfra, data from 2000 to 2020

# A robust model of expected returns and prices

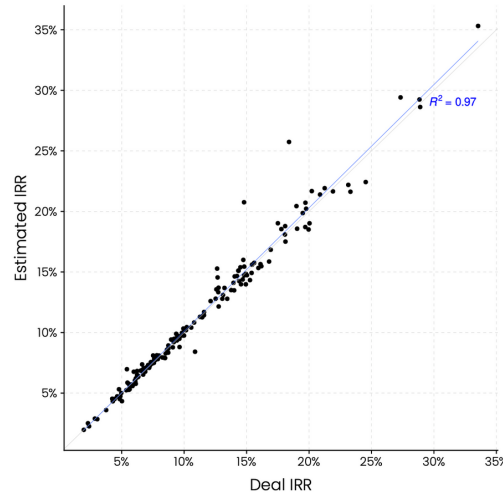
Figure 1 shows that the structure of the input data used to calibrate the risk factor model described earlier is in line with the global investible universe as measured by the infra300 index.

For the 250+ transactions that correspond to companies tracked in the EDHECinfra universe and for which observed secondary market prices are also available (the test dataset) we can compare observed and model-predicted valuations directly.

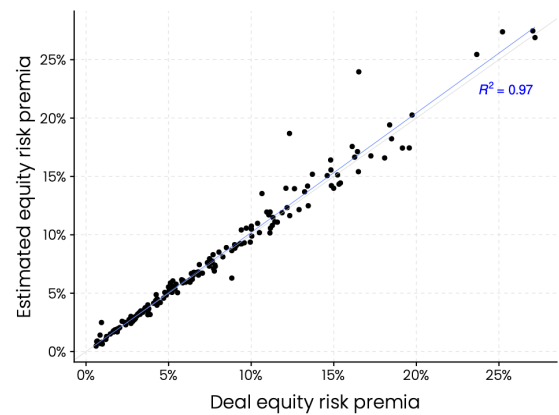
Figures 2, 3 and 4 show a comparison between model-predicted IRRs, risk premia and EV/EBITDA ratios with actual values for the test dataset of 250+ observed transactions between 2000 and 2020.

Model-predicted prices are accurate. The prediction error is typically within 5% of observed prices (see Tab. 2 & Fig. 5).

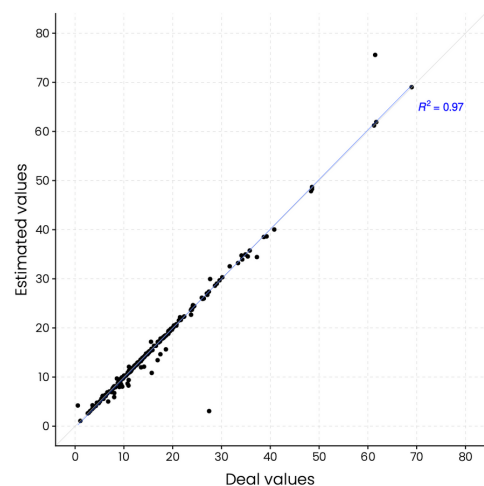
**Figure 2: Estimated vs. Reported Deal IRRs**



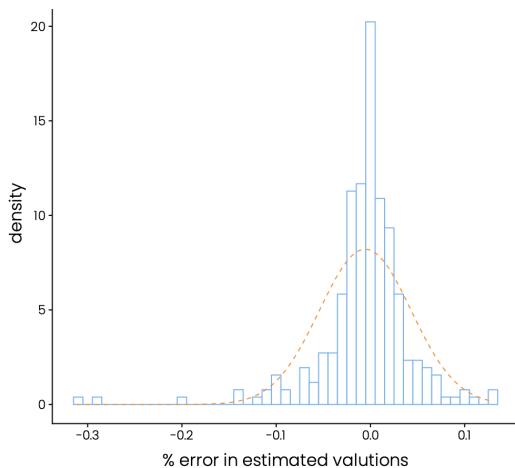
**Figure 3: Estimated vs. Reported Risk Premia**



**Figure 4: Estimated vs. Reported EV/EBITDA**



**Figure 5: Distribution of In Sample Pricing Model Errors: Predicted vs Observed**





**Table 2: Quantiles of Model Errors**

10% Quantile	25% Quantile	Median	Mean	75% Quantile	90% Quantile
-5.00%	-1.95%	-0.22%	-0.55%	1.64%	3.85%

**Table 3: Estimated vs. Reported Valuation Ratios and model goodness of fit**

Ratio	Reported Mean	Estimated Mean	Reported Median	Estimated Median	R <sup>2</sup>	RMSE*
EV/EBITDA	15.54	15.34	12.98	12.61	0.97	2.27
P/Book	2.37	2.28	1.65	1.59	0.87	0.90
P/Sales	3.35	3.21	2.52	2.32	0.85	1.43

\* root mean squared error

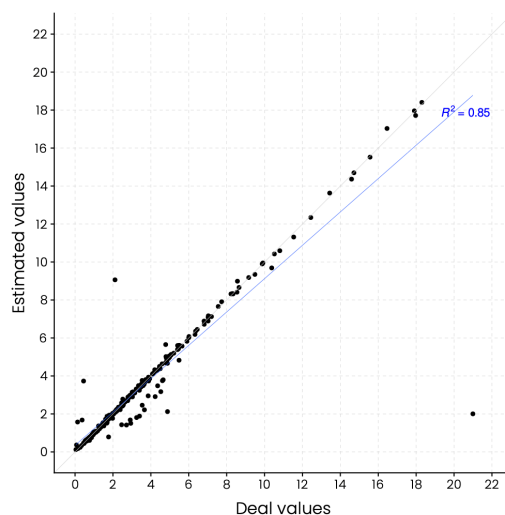
Figures 6 and 7 show the price to sales and price to book ratios of reported transactions against model predicted values.

A perfect match between model and predicted prices would line up all dots on these plots on the 45 degree line. The match is imperfect for two reasons:

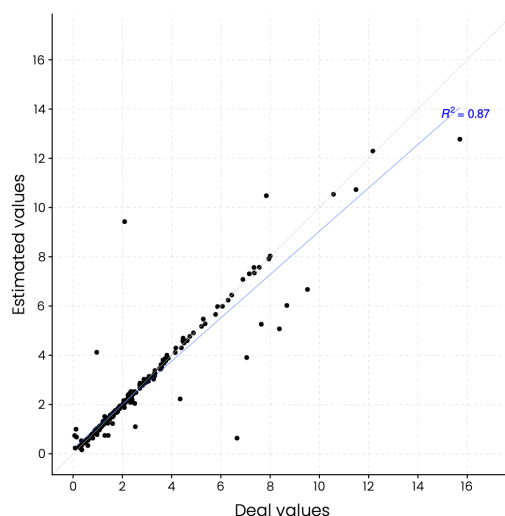
- The model predicts the average price an typical investor would pay for a given asset. In reality, buyers may pay more or less than the model predicted average due to their own price preferences.
- The model itself is imperfect and while it captures the systematic part of the pricing in markets well (see appendix on robustness), it may not embed all the assumptions or hypotheses made by buyers at the time of the transaction.

In general however, the match is very good as shown in table 3: predicted valuation ratios are very close on average to observable ones. Estimated prices for all assets in the universe are thus likely to be the best estimate of fair the value of these investments.

**Figure 6: Estimated vs. Reported Price to Sales Ratios**



**Figure 7: Estimated vs. Reported Price to Book Ratios**



Next, we review a series of case studies of individual equity transactions and what the EDHECinfra asset pricing model predicts.

We show that the value of individual cases is well-captured by a systematic, risk-based approach to asset valuation.

# Case study: 2017 Autovia del Camino (A-12) equity sale

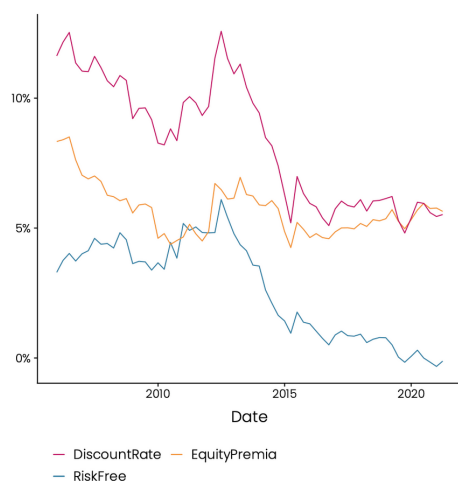
## A toll road company in Spain

This company is a 72-km shadow toll road project between Pamplona and Logroño and became operational in 2006. In July 2017, RREEF sold a 100% of its equity in the project company to Archmore International Infrastructure Fund II for USD210m.

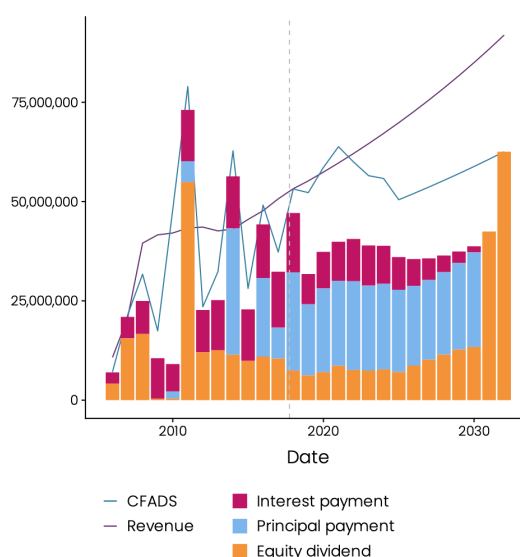
Remaining life at the time of valuation was 15 years, until 2032. Revenue growth forecast in 2017 was at 3-4% per year.

Table 4 shows the loadings for this company equity premia at the time of the transaction and the resulting valuation inputs. Table 5 shows the model-predicted valuation vs. the observed market price.

**Figure 9: Cost of capital for Autovia del Camino 2005-2020**



**Figure 8: Cash flows waterfall in Q3 2017**



**Table 4: Risk factor loadings, risk premia and discount rates in Q3 2017**

	Company	Sector*	Global*
<b>Factor Loadings</b>			
Leverage	89.6%	83.7%	78.4%
Size (USDm)	533.3	999.0	1,310.2
Profitability	7.6%	10.4%	11.1%
Investment	2.0%	4.4%	4.5%
Term spread	2.9%	2.4%	2.1%
<b>Valuation inputs</b>			
Risk premia	5.0%	5.5%	5.3%
Discount rate	5.8%	7.6%	7.2%

\* average on valuation date

**Table 5: Estimated vs. Reported Valuations**

	Reported	Estimated	% diff
Equity price (USDm)	209.79	208.93	-0.41%
EV/EBITDA	17.35	17.33	-0.13%
P/Sales	4.50	4.48	-0.41%
P/Book	2.55	2.54	-0.41%

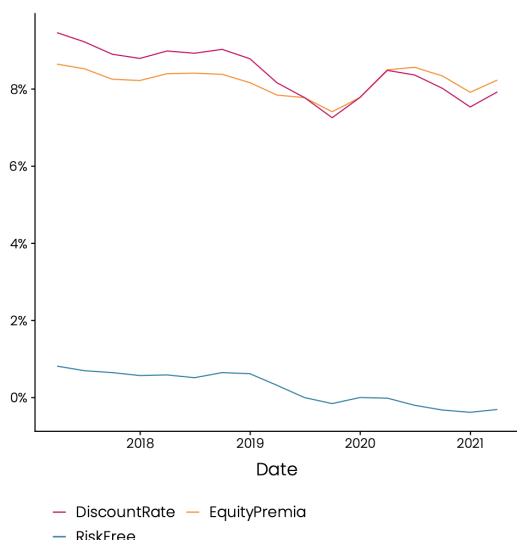
# Case study: 2018 Cloosh valley wind farm equity sale

## A partially contracted on-shore wind energy project in Ireland

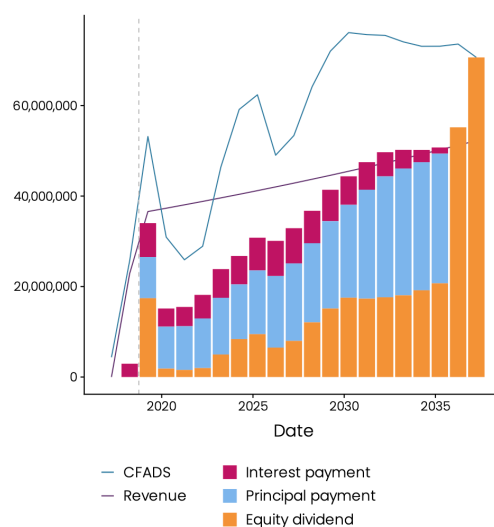
Cloosh Valley Wind Farm has a capacity of 108MW. The project is contracted under Ireland’s REFIT 2 support regime until 2032, was financed in 2015 and became partly operational in 2018. In September 2018, developer Coillte sold 25% of the company to GR Wind Farms for EUR34.5M. Remaining project life at the time was 19 years, until 2037. Revenue growth forecast was 2% per year at the time.

Table 6 shows the factor loadings for this company’s equity premia model at the time of the transaction and the resulting valuation inputs. The investment factor (capex) is still high compared to the sector average because the project is still partly at the development stage, which has the effect of increasing the risk premia, as does the lower than average profit factor loading.

**Figure 11: Cost of capital for the Cloosh Valley wind farm 2005-2020**



**Figure 10: Cash flows waterfall in Q3 2018**



**Table 6: Risk factor loadings, risk premia and discount rates in Q3 2018**

	Company	Sector*	Global*
<b>Factor Loadings</b>			
Leverage	99.7%	79.3%	78.1%
Size (USDm)	220.9	350.8	1,326.9
Profitability	10.2%	15.1%	11.2%
Investment	38.6%	8.3%	4.3%
Term spread	1.8%	2.1%	2.0%
<b>Valuation inputs</b>			
Risk premia	8.4%	5.2%	5.8%
Discount rate	9.0%	6.9%	7.8%

\* average on valuation date

**Table 7: Estimated vs. Reported Valuations**

	Reported	Estimated	% diff
Equity price (USDm)	160.15	155.32	-3.01%
EV/EBITDA	19.65	19.37	-1.40%
P/Sales	7.74	7.50	-3.01%
P/Book	7.15	6.94	-3.01%

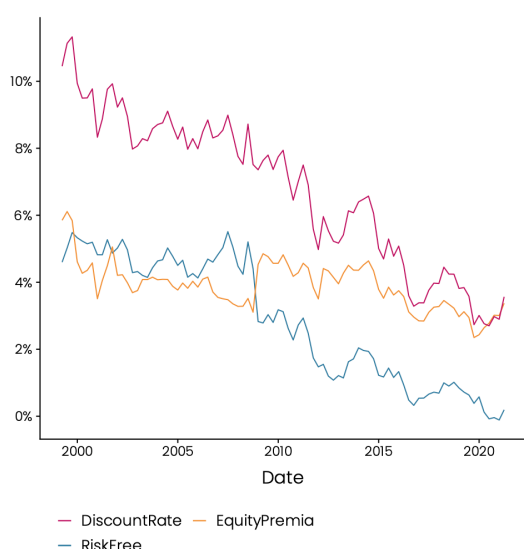
For these reasons, discount rates are higher than the sector average but later decrease reflecting the evolution of the risk profile. Table 7 shows the model-predicted valuation vs. the observed market price at the valuation time.

# Case study: 2010 M40 motorway equity sale

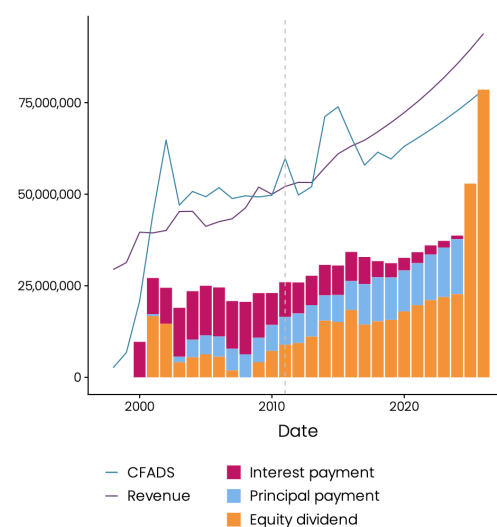
## A DFBO road concession in the UK

The M40 motorway is 143km-long linking London, Oxford and Birmingham. It is constructed under the government's design-build-finance-operate (DBFO) scheme with a 30 years concession and payment is by traffic-related shadow tolls from the government over the life of the contract. In September 2010, John Laing Infrastructure Fund acquired a 50% controlling interest in UK Highways M40 Motorway for GBP 37.1m (at a valuation of USD115m). Remaining project life at the time was 16 years, until 2026. Average revenue growth forecast was 2.7% per year. Table 8 shows the factor loadings for this company's equity premia model at the time of the transaction and the resulting valuation inputs. While leverage and profitability were in line with the sector's

**Figure 13: Cost of capital for the M40 2000-2020**



**Figure 12: Cash flows waterfall in Q3 2010**



**Table 8: Risk factor loadings, risk premia and discount rates in Q3 2010**

	Company	Sector*	Global*
<b>Factor Loadings</b>			
Leverage	91.4%	83.7%	78.7%
Size (USDm)	218.6	915.4	1,103.1
Profitability	6.1%	6.6%	10.3%
Investment	0.0%	8.7%	8.9%
Term spread	3.4%	3.7%	3.5%
<b>Valuation inputs</b>			
Risk premia	4.3%	6.3%	8.8%
Discount rate	7.0%	11.0%	12.4%

\* average on valuation date

**Table 9: Estimated vs. Reported Valuations**

	Reported	Estimated	% diff
Equity price (USDm)	115.49	116.31	0.71%
EV/EBITDA	20.14	20.20	0.31%
P/Sales	2.64	2.66	0.71%
P/Book	3.13	3.15	0.71%

average, the company reported no capex (investment factor) at the time, leading to lower risk premia compared to the sector average.

Table 9 shows the model-predicted valuation compared the observed market price at the valuation time.

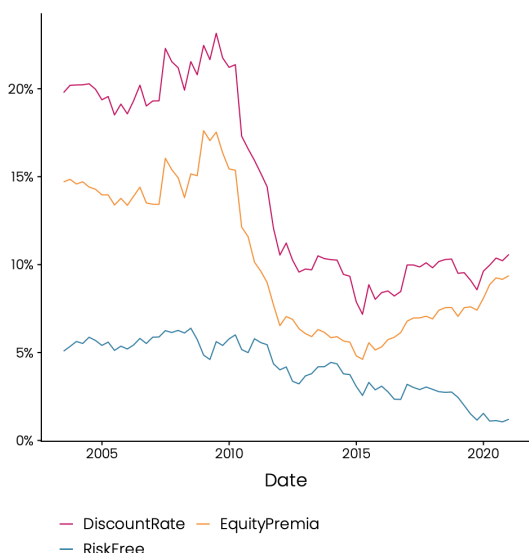
# Case study: 2020 Dalrymple Bay coal terminal equity sale

## A Coal Terminal in Australia

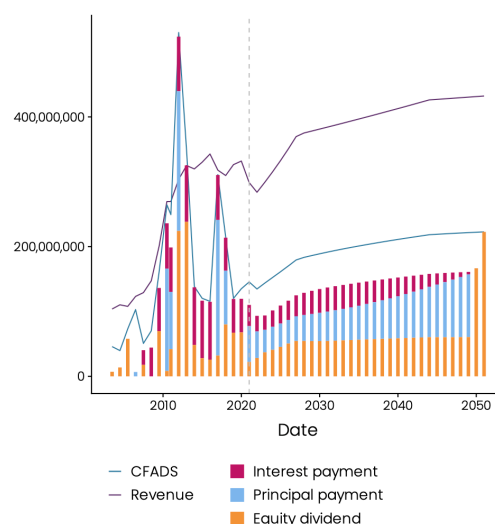
Located at the Port of Hay Point, Dalrymple Bay Coal Terminal (DBCT) is part of one of the largest coal exporting ports in the world, exporting thermal and metallurgical coal from Central Queensland to ports around the world. The terminal is owned by the Queensland State Government and leased for 50 years with a 49 year option to operate, maintain and develop the terminal. In December 2020, Brookfield Asset Management sold 51% stake of Dalrymple Bay Coal Terminal at a value of approximately AUD1.3bn (USD1bn).

Remaining project life at the time (without the renewal option) was 31 years, until 2051. Average revenue growth forecast stands at 0.8% per year. Table 10 shows the factor loadings for this company's equity premia model at the time of the transaction. The lower profitability and investment factors, as compared to the

**Figure 15: Cost of capital for Dalrymple Bay**



**Figure 14: Cash flows waterfall in Q4 2020**



**Table 10: Risk factor loadings, risk premia and discount rates in Q4 2020**

	Company	Sector*	Global*
<b>Factor Loadings</b>			
Leverage	84.5%	68.1%	76.9%
Size (USDm)	2,510.7	1,057.3	1,376.7
Profitability	6.5%	8.8%	10.8%
Investment	0.8%	5.1%	3.6%
Term spread	1.5%	1.1%	1.2%
<b>Valuation inputs</b>			
Risk premia	9.4%	10.6%	7.7%
Discount rate	10.6%	11.4%	8.1%

\* average on valuation date

**Table 11: Estimated vs. Reported**

	Reported	Estimated	% diff
Equity price (USDm)	999.33	979.38	-2.00%
EV/EBITDA	19.14	19.02	-0.64%
P/Sales	2.79	2.74	-2.00%
P/Book	2.70	2.65	-2.00%

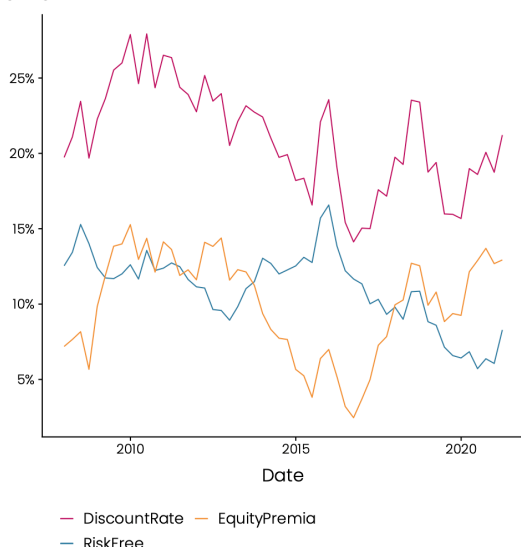
sector averages, have an offsetting effect resulting in a discount rate roughly in line with the sector. Table 11 shows the model-predicted valuation vs. the observed market price at the valuation time.

# Case study: 2017 Sao Paulo Metro Line 4 equity sale

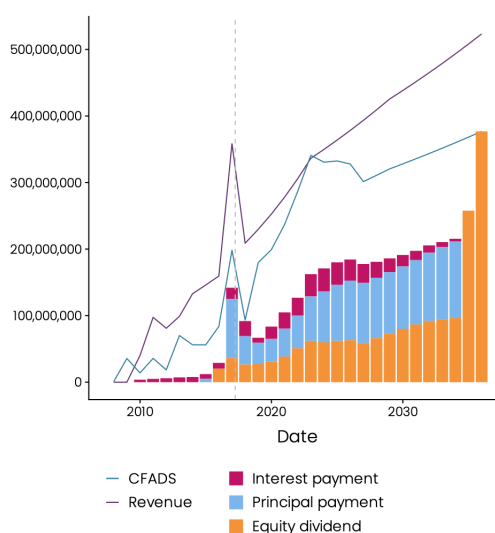
## A PPP light rail project in Brazil

This PPP project is 12.8km metro line crossing the southwest to the northeast of Sao Paulo in Brazil, under a 30-year DBFO concession. It became operational in 2011. In March 2017, Brazilian infrastructure operator CCR acquired a 15% stake for USD53m (at a valuation of USD350mn). Remaining project life at the time was 19 years, until 2036. Average revenue growth forecast was about 1.5% per year at the time. Table 12 shows the factor loadings for this company's equity premia model at the time of the transaction and the resulting valuation inputs. The higher profitability of this project compared to the sector average accounts for a much lower risk premia. However, with higher long-term interest rates in Brazil than elsewhere, the discount rates are still higher than in the rest of the sector.

**Figure 17: Cost of capital for Sao Paulo Line Metro PPP 4**



**Figure 16: Cash flows waterfall in Q1 2017**



**Table 12: Risk factor loadings, risk premia and discount rates in Q1 2017**

	Company	Sector*	Global*
<b>Factor Loadings</b>			
Leverage	77.1%	84.3%	78.4%
Size (USDm)	434.5	459.0	1,300.6
Profitability	17.6%	11.9%	10.8%
Investment	12.1%	6.5%	4.6%
Term spread	-0.8%	2.1%	2.0%
<b>Valuation inputs</b>			
Risk premia	5.0%	8.6%	5.5%
Discount rate	15.0%	10.7%	7.5%

\* average on valuation date

**Table 13: Estimated vs. Reported**

	Reported	Estimated	% diff
Equity price (USDm)	352.63	349.36	-0.93%
EV/EBITDA	8.57	8.53	-0.52%
P/Sales	1.10	1.09	-0.93%
P/Book	4.35	4.31	-0.93%

Table 13 shows the model-predicted valuation vs. the observed market price at the valuation time.

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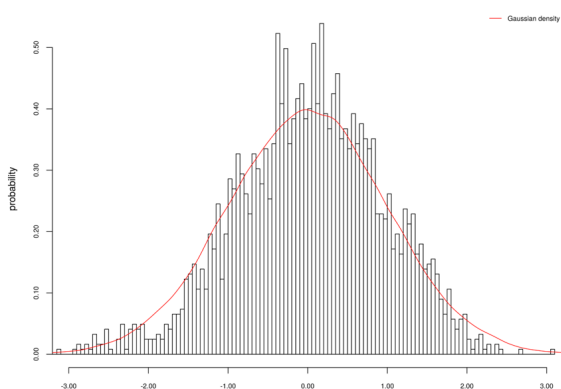
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# Appendix

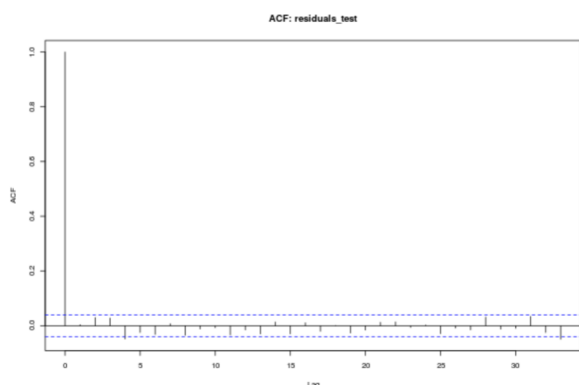
## Model robustness: Residuals

Residuals show that systematic part of transaction prices is explained by the model of expected returns.

**Figure 18: Histogram of model residuals**



**Figure 19: Residuals serial correlation plot**



The differences between the predicted risk premia and the observed data are the residuals of the model. Figures 18 and 19 show that model residuals are like 'white noise' i.e. they represent the idiosyncratic, gaussian, uncorrelated 'noise' around true market prices. The model explains the systematic drivers of the price of risk in infrastructure markets well since it only leaves this 'noise' unexplained: the idiosyncratic part of each transaction price.

## Model robustness: Returns

Returns computed with model valuations exhibit no smoothness and reflect fair market returns.

**Table 8: Return serial correlation tests**

	Total returns	Price returns
Autocorrelation	0.04170	-0.00310
Ljung-Box test (p-value)	0.69885	0.97728

The valuations results in asset-level price and total returns that exhibit no serial correlation or smoothness and capture the variance of fair market prices.

## List of Countries

List of 25 countries included in the assessment of the global principal market of infrastructure investors

Australia, Austria, Brazil, Canada, Chile, Germany, Spain, Finland, France, United Kingdom, Hungary, Ireland, Italy, Malaysia, Netherlands, Norway, New Zealand, Philippines, Poland, Portugal, Russia, Singapore, Slovakia, Sweden, USA







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