Infrastructure investment for long-term investors: The challenge of measuring performance

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1. Matching long-term infrastructure projects with long-term investors: a roadmap
2. What drives the performance of infrastructure equity?
3. Understanding credit risk and value in infrastructure debt
4. Conclusions and next steps
Matching long-term projects and investors: The need for long-term performance monitoring
1. Two key trends in institutional money management: direct investment and liability-driven investment

→ investors want to buy segregated cash flows with a duration, a positive yield spread over treasuries and, if possible, a link with inflation.

2. This is what the 'infrastructure investment narrative' (Blanc-Brude, 2013) is supposed to deliver: low biz cycle correlation, inflation hedge, predictable cash flows, stable valuations, illiquidity premium...

3. But it has not proven to be a straightforward to deliver so far.
   ★ the first generation of investment products in "infrastructure" (equity funds) was not well-suited to long-term investors' needs and has created a certain backlash amongst the largest investors.
Why is it difficult to match long-term money with long-term projects?

1. There is a consensus amongst large investors that the classic PE model applied to infrastructure assets has not delivered what they wanted: too short-term, too risky, too expensive.

   → This has led to the rise of the so-called Canadian model i.e. DIY
   → At the same time, a second generation of investors is currently pouring money into infrastructure funds that are not very different. Why?
   → On the debt side, few solutions have existed so far.

2. A more fundamental economic question: Long-term investment implies better monitoring of performance (long-term investors are active shareholders) but also forming return expectations at long horizons, for illiquid assets (held to maturity) with limited rebalancing opportunities i.e. "passive" investment.

   → How can this be best reconciled?
The value of delegation and the need for performance monitoring

1. Large investors may internalise monitoring along with asset selection, but for most investors, there should be added value in delegation to a specialist.

2. The way forward for effective and efficient investment in long-term illiquid infrastructure assets must combine
   → preserving the benefits of delegation to a specialist manager who can act on behalf of an active asset owner, with
   → sufficient long-term performance benchmarking to allow a more passive investment stance, justified as the strategic asset allocation level.

3. As long as unlisted investments were a subplot of (small) alternative allocations, monitoring and benchmarking were less obvious concerns. With potentially large allocations, they become necessary.
The need for a benchmark

The absence of investment benchmark becomes an impediment to strategic asset allocation decisions and an adequate regulatory framework with regards to infrastructure investment.

1. The lack of clarity about what "investing in infrastructure" actually means has limited the visibility of investors who need to take a view at the strategic asset allocation level, their 1st order problem.

2. This lack of knowledge of what infrastructure investing might means from a strategic asset allocation perspective also tends to support the view amongst regulators that infrastructure investment is high risk.

→ Conclusion: we need to measure performance better, and produce performance measures that are relevant to asset allocation and prudential regulation.
Approach: the roadmap

To arrive at a useful investment benchmark for long-term, illiquid assets like infrastructure equity and debt, a number of steps are required:

1. Start with the underlying...
   - Propose a financial definition of the relevant instruments
   - Determine how underlying asset performance may be measured → this is the topic of two forthcoming papers on infrastructure equity and debt (Blanc-Brude and Ismail, 2014; Blanc-Brude et al., 2014)
   - Standardise data reporting and collection

2. Build portfolios of underlying assets as investment benchmarks
Defining infrastructure

1. Any asset-specific valuation methodology should rest on a clear definition of the underlying
2. The need to use a cash flow model calls for a tractable and preferably uncontroversial cash flow model
3. Such a definition (and easily defined model) is provided by limited recourse project financing (Basel-2 definition): project finance can be considered to be an ideal-type of how infrastructure project cash flows are supposed to behave.
4. "Infrastructure" is not limited to project finance but project finance embodies the expected behaviour of investable infrastructure.
A project finance SPV:
Well-defined, investable infrastructure assets

Contract with a public or private party creating a binding commitment to pay

[rights to a pre-agreed revenue stream*]
*subject to performance

AND/OR

[rights to a merchant revenue stream]

License granting the right to operate a regulated monopoly on a commercial basis

{ProjectCo}

contracts with other firms to commission a number of tasks at a fixed price

rights to the firm's free cash flow

$senior debt$
$ junior debt$
$equity$

#facility manager
#operator
#builder

...established by a consortium of firms to enter into a long-term contract

...raises long-term finance for the construction, operation and maintenance of the relevant infrastructure
Measuring unlisted infrastructure equity performance

Meridiam Infrastructure & Campbell Lutyens Research Chair
What is the challenge?

1. Most methods applied to PE/RE (self-reported NAVs, repeat sales, PMEs, hedonic pricing) are inadequate.

2. All we can observe is an initial investment value, a base case dividend forecast, a truncated series of realised dividends and forecast revisions.

3. So we want to estimate the performance of an asset that is lumpy, held to maturity, for which most cash flows remain to be observed, with no market prices, limited observed cash flows in time series and limited granularity in the cross-section...

4. Finally not all investors will attribute the same value to the same asset.

5. This is not just an empirical problem... it goes at the heart of LTI: assets with delayed payoffs determined by a set of future circumstances that can only vaguely be predicted by past events.

   → the combination of illiquidity with long repayment periods means that we cannot look at value without a cash flow model: we have to mark to model.

   → That is also why a clear definition is essential: no definition, no model...
Modelling approach

1. Make groups of *homogenous* assets by type of financial structure (e.g. initial leverage, amortisation profile, tail length)

   ★ the decision to lend is a partial price signal (the lenders have read all the documentation i.e. high leverage signals *low* asset risk)

2. Model this generic *equity cash flow process*

3. Calibrate the model with cash flow observations and forecast revisions

4. The result is a measure of expected cash flows (dividend growth) and cash flow volatility. It is modelled as a *dynamic Markov chain*, and updated using *Bayesian inference* techniques as new data becomes available.

5. Expected cash flows are expressed as **a function of the base case dividend forecast**: the equity service cover ratio or $ESCR_t$ (see Blanc-Brude and Ismail, 2013b)
The equity cash flow process

1. We use the investment base case as a point of reference to compute the **Equity Service Cover Ratio**. For a stream of cash flow to equity $C^i_t$ in each future state of the world $i$ at time $t$:

   $$ESCR^i_t = \frac{C^i_t}{C^0_t}$$

2. $E_t(ESCR_t)$ provides a direct measure of expected cash flows when multiplied by the base case dividends

3. $\sigma_t ESCR_t$ is a direct measure of cash flow volatility.

4. The output of our cash flow model is the **conditional distribution** of $ESCR_t$.

   → Bayesian inference: initially we simulate (or guess) the value of $ESCR_t$ in state $i$, later we observe it and update its probability distribution.

   ★ Once the distribution of $ESCR_t$ is characterised, it can be combined with the investment base case (always known) to derive performance measures.
Valuing expected cash flows

1. Expected cash flows and discount rates co-vary
2. The true discount rate of individual investors is unobservable but we can observe their initial investment decision (valuation)
3. Assuming a functional (auto-regressive) relationship between discount rates and cash flow volatility, we can derive the **implied term structure of discount rates** that best explains $N$ actual individual investment decisions into the same cash flow process. (least square curve fitting)

$$
\min_{\alpha, \beta, c, \rho} \sum_{i=1}^{N} \left( \sum_{j=0}^{T} \left( \prod_{s=1}^{S} \exp(-r_t) \mathbb{E}(ESCR_t | C_t^0) \right) \right)^2
$$

where $r_t = \alpha + \beta r_{t-1} + c \sigma ESCR_t + \epsilon_t$

→ Since we will observe a range of prices, we also derive a range of discount rates
(conditional) Performance measures

→ The resulting performance measures are conditional (on today's knowledge)

1. Return measures: we can compute period returns, yield to maturity and returns in excess of the base case
2. Risk measures: expected loss, value-at-risk, conditional value-at-risk
3. Performance: yield spread / VaR

→ Risk/performance measures are derived from the expected loss measure

\[
E_t(L_t) = \max\left(\sum_{s=t}^{T} \prod_{j=t}^{s} \exp(-r_j) C_0^s (1 - E_t(ESCR_s))\right), 0
\]

with \( C_0 \) the base case dividends and \( r_t \) the implied discount rate.
A generic economic infrastructure project

Base case equity cash flows (m)

Probability of default and probability of lock-up

Average equity upside and downside

99.5% one-year equity value-at-risk
Measuring unlisted infrastructure equity performance

What have we learned?

★ It can be done!

• The required input data is manageable and exists. Furthermore, it can be standardised and turned into a reporting framework for infrastructure equity managers.

→ to better calibrate the different cash flow models **we need to collect more empirical observations**

→ Our knowledge will remain conditional but expected cash flows for younger projects will benefit from accumulated knowledge about older ones.
Measuring unlisted infrastructure debt performance

NATIXIS Research Chair
Characteristics of infrastructure project debt

1. Senior claimant to the SPV's cash flow
2. Project debt tends to have a shorter duration than equity i.e. in the base case it is repaid before the end of the project's life. There remains a certain amount of cash flows in the 'tail' which acts as a form of collateral.
3. Numerous covenants (non-financial default triggers) give lenders automatic control-rights in certain states of the world (cash sweeps, clawback, escrow reserve accounts). In certain circumstances, lenders can 'step-in' and re-organise (re-structure) the project in order to maximise loan recovery.
4. Like project equity, debt is illiquid, not traded (held to maturity) and without a unique valuation measure...
A different challenge

1. Recovery rates are endogenous in project finance and project loans include explicit **embedded options** (to re-structure, to re-finance). These options are controlled by numerous covenants requiring the continuous monitoring of the firm.

2. We need to **price these options** (the impact on expected value of the loan's tail given the covenants) in order to describe performance accurately.
   → Standard approaches to loan valuation do not incorporate embedded options.

3. Embedded options imply that the default threshold may deviate from its value in the base case if re-organisations occur: **debt re-structuring needs to be integrated in the analysis of value and risk.**

   ★ Since the firm's assets consist only of cash flows, they can be observed (or modelled) and structural credit models are ideally suited (as opposed to reduced form)
Choice of approach

The presence of unhedgeable risks (market incompleteness) and of embedded options suggests a structural credit risk model using the following approach:

1. Model the cash flow available for debt service (CFADS) in different states using existing empirical evidence for generic types of project debt terms and covenants (Markov Chain + Bayesian inference + data collection)

2. Risk neutralise the probability distribution of cash flows (probability transform + separation between hedgeable vs. unhedgeable risks)

3. Determine the different paths of the cash flow to debt holders given covenants and embedded options (Black-Cox decomposition)

4. Value of the expected cash flow under the risk neutral measure (i.e. discounted at the risk free rate)

As before the presence of un-hedgeable risks gives rise to a range of values.
Debt cash flow metrics

Fundamental intuition:

• SPVs report their debt service cover ratio on a regular basis using a reasonably comparable format (DSCR certificates)

• Contrary to the CFADS (the free cash flow of the firm) which is not easily observable and comparable between SPVs, the DSCR provides a direct, comparable measure of the credit dynamics of multiple loans.

• Using the DSCR and the base case debt service (also observable), we can model the dynamics of credit risk and value in project to finance at each point in the project lifecycle

★ Grouping SPVs by ex ante DSCR profile (i.e. by broad credit risk profile), with information about base case debt service and tail length, and well-documented DSCR dynamics, we can calculate the relevant performance metrics.
Defining and predicting default

Default is defined as:

\[ \text{Default}_t \iff \text{CFADS}_t < \text{Debt Service (Principal+Interest)}_t \]

\[ \text{Default}_t \iff DSCR_t \equiv \frac{\text{CFADS}_t}{\text{Debt Service (Principal+Interest)}_t} < 1 \]

In other words, the default point at time \( t \) is unambiguously

\[ DSCR_t = 1 \]

and the the probability of default \( p_t \) at time \( t \) is written:

\[ p_t = \Pr(DSCR_t < 1 | \min_{j < t} DSCR_j \geq 1) \]
Predicting cash flows and value

Expected CFADS can be reconstructed from base case debt service and the expected value of $DSCR_t$ since

$$E(CFADS_t) = E(DSCR_t) \times (P + i)_t^{\text{basecase}}$$

The two first moments of the conditional distribution of $DSCR_t$, $E_t(DSCR_t)$ and $\sigma_t DSCR_t$, can be used to express the usual distance to default (DD) measure used in the valuation formula of the firm's debt (see Blanc-Brude and Ismail, 2013a):

$$DD \approx \frac{V_0 - \bar{B}}{\sigma_{VV_0}} \quad \rightarrow \quad DD_t = \frac{CFADS_t - (P + i)_t^{\text{basecase}}}{\sigma_{CFADS_t} CFADS_t} = \frac{1}{\sigma_{DSCR_t}} \frac{(P + i)_t^{\text{basecase}}}{(P + i)_{t-1}^{\text{basecase}}}(1 - \frac{1}{DSCR_t})$$

Distance to default is the main input of the valuation framework:

$$q(t, T) = F(-DD(T) + \rho_1 p_1(t) + \rho_2 p_2(t) + \ldots),$$

where $F(.)$ is the CDF of the firm's assets, $\rho_1, \rho_2, \ldots$ are the correlations of the return on total assets to the chosen risk factors, and $p_1(t), p_2(t), \ldots$ are the prices per unit of risk for corresponding risk factors.
The value of the tail: Dynamic debt renegotiation

Determination of the new debt service once default has occurred:

1. Once a credit event has occurred (e.g. DSCR falls below a pre-agreed threshold), the path of the debt cash flows is renegotiated: the tail of the loan plays a crucial role.

2. The new debt service is determined by taking into account what each party would lose in the absence of renegotiation.

   • If there is no renegotiation, the project must fail and be taken over by lenders (which may seek a new equity investor).
   • Re-structuring must take place as long as the value of either debt or equity post-restructuring is higher than in the absence of renegotiation i.e. as long as lenders can get more than the liquidation value and the equity holders more than zero, a new debt schedule should be agreed.

(see Blanc-Brude et al., 2014, forthcoming)
Dynamic debt renegotiation
Decomposing the different paths

Figure 1: Black Cox Decomposition
Generic credit risk profile with rising DSCR

Debt service cover ratio

Distance to default

Probability of default

99.5% Value-at-Risk
Measuring unlisted infrastructure debt performance

What have we learned?

⋆ It can be done as well! (but this is a very different asset pricing problem)

1. Performance measures are conditional on available information and valuation is not unique.

2. Infrastructure debt credit risk is endogenous: there are few if any instances of default of payment and high ex post recovery rates (because of the contingent control rights of the lenders to use the tail as collateral)

3. Infrastructure debt credit risk is dynamic

4. As for equity investments we need to collect more data under a standardised reporting format to better calibrate the models which give us the past and expected performance measure we need to invest in infrastructure instruments.
Conclusions
Building conditional knowledge about infrastructure investment performance

- Underlying infrastructure projects are unlisted and seldom traded, moreover most of the cash flows of the projects relevant to investors today are still to occur, often far into the future:

  → Our task is to measure the performance of assets that are held to maturity, for which no immediate traded equivalent exists and without a complete cash flow history...

- We cannot do without models! (so we are marking to model)

- Nevertheless, we can build models based on generic, well documented types of assets (project finance) and that can be updated as information becomes available for comparable cash flow processes. Such models can be kept simple and transparent (and be improved)

  → We still need to collect data to calibrate such models (in Bayesian inference, the more data we observe, the less out prior assumptions matter)
What kind of benchmark will be needed?

1. A market benchmark?
   - What is representative of investable "infrastructure" today?
   - How investable at time $t$ is this representative basket?
   - A representative portfolio may be built over time, in which case the *marginal contribution* of individual assets to a target performance profile becomes important to know.
   - Will the basket still be representative once invested?

2. A managed strategy benchmark?
   - Given the investment characteristics of certain generic types of infrastructure projects (categorised by financial structuring), what investment strategies can we implement?
   - Max Sharpe ratio? Min volatility? Max effective duration? &c
   - Opportunities to design efficient portfolios exist in the cross-section (different types of projects, different types of instruments) and across the lifecycle (e.g. greenfield + brownfield) (see Blanc-Brude and Ismail, 2013c)
The road map: making infrastructure relevant for investors
The road map: progress to date
Contribute!

Developing institutional investment in infrastructure will not happen without a significant involvement from investors, managers, regulators and academics:

1. We need to think clearly about the mechanisms and instruments
2. We need to agree on methods, data reporting and benchmarking strategy
3. We need a lot more data! (to build our posterior view of probabilities)

You can help (create a 5-trillion dollar industry).

★ Read our papers
★ Join the debate and support the development of adequate methodologies and a cash flow reporting standard for project finance
★ Contribute your historic and future data
References


