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Infrastructure: Shifting the Long-Term Investment Paradigm

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Pension funds and insurers discovered infrastructure investing, somewhat counter-intuitively, around the same time that they began adopting the principles of factor investing. Thus, the schizophrenic search for an infrastructure "asset class" started just as other asset classes were being gradually rejected as unreliable portfolio building blocks.

The objective of seeking exposures to investment factors, which can sometimes seem like the post-modern deconstruction of asset management, really amounts to the search for a well-specified model of asset returns, without missing variables or hidden collinearity. It is the recognition that taxonomies that are not built to correspond to an underlying value process can lead risk management astray if assets are given similar labels when their performance is driven by fundamentally different forces, or vice-versa. Thus, notional grouping of assets (stocks, bonds, private equity, etc.) can sometimes create little information or predictive power. Instead, as is well documented in the financial literature, focusing on a series of systematically rewarded risk factors can allow investors to improve risk-adjusted performance considerably by improving the diversification of both unrewarded and rewarded risks.

Such improvements spring from the discovery of persistent effects in the cross-section of asset prices (also known as factors), often based on economic intuitions and better explanations and predictions of returns than asset class labels.

What are the implications of these evolutions for long-term investment in infrastructure? Is there a point in looking for an "infrastructure asset class"?

Intuitively, infrastructure corresponds to large structures of steel and concrete created to perform a series of industrial functions (water and power supply, transportation, etc.) and is typically labeled following such functional classifications.

But a clear distinction must be made between infrastructure as a matter of public policy, in which case the focus is rightly on industrial functions, and the point of view of financial investors, who may be exposed to completely different risks through investments in firms providing exactly the same industrial functions (e.g. a real toll road and an "availability payment" road[1]).

Hence, the sector classification or "reality" of infrastructure investments constitutes a poor model of the determinants of future cash flows, whether they accrue to equity or debt investors, as a series of EDHEC-Risk Institute papers has now documented (see Blanc-Brude 2013; Blanc-Brude and Ismail 2013; Blanc-Brude, Wilde, and Whittaker 2015 for a discussion and quantitative analyses).

Instead, we argue that a number of characteristics associated with **the structuring of capital projects involving highly relationship-specific assets, that can only be repaid over multiple decades of effective use,** constitute a much more powerful framework to understand, benchmark and predict long-term returns in infrastructure debt or equity.

Thus, infrastructure investment can be construed as a way to buy claims on future cash flows created by long-term contractual arrangements between public and private parties (or alternatively between two private parties). Indeed, in numerous cases, infrastructure investors do not actually own any steel or concrete, which must remain part of the eminent domain of the State. When they do (e.g. certain privatized utilities) the value of their investment is conditioned not by the tangible nature of the asset, but in a license to operate a natural but regulated monopoly.

To help investors achieve long-term goals through asset allocations to infrastructure, two important methodological leaps are now needed.

First, we must recognize that the notion of "infrastructure" is only a **heuristic device** used to access something that investors really want i.e. a mental short-cut designed to create exposure to certain factors, but neither a thing nor an end in itself.

If holding infrastructure debt and equity can give investors access to cash flow processes that have useful characteristics from an asset allocation or from a liability-driven investment perspective, our focus should be on identifying and measuring these characteristics and on designing the relevant investment strategies.

In this respect, substantial progress has been made towards identifying the characteristics that can be expected to systematically explain the financial performance of infrastructure investments. In particular, the growing consensus around the limited role of industrial sector categories in explaining and predicting performance, and the much more significant role played by contracts and by different infrastructure "business models" such as "merchant" or "contracted" infrastructure (see Blanc-Brude, Hasan, and Ismail 2014 for examples), or different forms of utility regulation, is encouraging.

We return to this point in the following article on the collection of standardized investment data for infrastructure investments.

The second important evolution with respect to long-term investment in infrastructure is the transition from a heuristic to a **learning process.**

Indeed, it is not sufficient for long-term capital to be "patient" or to show "persistence through periods of short-term under-performance" (FCTL 2015 p: 6).

Investment factors should be persistent, but long-term investors may not know enough about them today to decide whether they themselves ought to be. Moreover, there may never be enough representative historical data about infrastructure investment to build a robust model of expected performance encompassing the next 50 years (see Blanc-Brude 2014 for a detailed discussion).

The possibility of **learning** should thus become an integral part of the approach taken by long-term investors to make and adapt long-term investment decisions, in particular with regards to sequential investments such as infrastructure. The higher monitoring demand that comes with buy-and hold strategies can be combined with inference techniques designed to revise or update prior assessments of value and performance, as and when new data becomes available.

For instance, Blanc-Brude and Hasan (2015) show that while it is difficult to empirically document the cash flow dynamics of infrastructure projects spanning multiple decades, we can optimize the use of available information by integrating what we know today about different types of financial structuring decisions and contractual terms found in infrastructure investments, to build models of expected cash flows and conditional volatility that can be calibrated and improved with the data that does exist.

Furthermore, once the relevant data to update pricing and risk models has been identified, the standardization of its collection becomes possible, as we discuss in a recent EDHEC-Risk paper (Blanc-Brude et al. 2015), which proposes a data collection template for the creation of infrastructure investment benchmarks.

The combination of a reporting framework with a central database of infrastructure project information and monitoring and valuation frameworks that are built to integrate new information as it becomes available, which EDHEC has been developing, will allow investors to improve and adapt their long-term investment decisions with regards to infrastructure. Both aspects are covered in the following two articles.

In conclusion, if infrastructure investing is to come of age and become fully integrated in the asset allocation and asset-liability management of investors, a change of focus is required from the same investors and most of the managers that provide them with access to infrastructure assets.

This new focus should be on collecting the kind of information that can help answer the questions that investors (and their regulators) actually have about performance and risk.

With the new data collection template defined by EDHEC, which has been designed to correspond to the requirements of the relevant asset pricing and risk models, a rationale exists to collect data effectively and efficiently to build infrastructure investment benchmarks.

Collecting this information now requires large-scale co-operation between investors, creditors, academic researchers and the regulators that can help make such reporting part of a new standard approach to long-term investment in infrastructure by institutional players. •

References

Blanc-Brude, F. *2013. Towards Efficient Benchmarks for Infrastructure Equity Investments. EDHEC-Risk Institute Publication, Meridiam, Campbell-Lutyens and EDHEC Research Chair on Infrastructure Equity Investment Management and Benchmarking. Singapore: EDHEC-Risk Institute, 88.*

Blanc-Brude, F. *2014. Benchmarking Long-Term Investment in Infrastructure. EDHEC-Risk Institute Position Paper, June.*

Blanc-Brude, F., M. Hasan and T. Whittaker. *2015. Data Collection for Infrastructure Investment Benchmarking: Objectives, Reality Check and Reporting Framework. Working Paper, mimeo.*

Blanc-Brude, F., and M. Hasan. *2015. The Valuation of Privately-Held Infrastructure Equity Investments. EDHEC-Risk Institute Publication, EDHEC, Meridiam and Campbell-Lutyens Research Chair on Infrastructure Equity Investment Management and Benchmarking January. Singapore: EDHEC-Risk Institute.*

Blanc-Brude, F., and O. R. H. Ismail. *2013. Who Is Afraid of Construction Risk? Portfolio Construction with Infrastructure Debt. EDHEC-Risk Institute Publication, EDHEC and NATIXIS Research Chair on Infrastructure Debt Investment Solutions. Singapore: EDHEC-Risk Institute; EDHEC Risk Institute-Asia, 128.*

Blanc-Brude, F., M. Hasan, and O. R. H. Ismail. *2014. The Valuation and Performance of Unlisted Infrastructure Debt. EDHEC-Risk Institute Publication, EDHEC and NATIXIS Research Chair on Infrastructure Debt Investment Solutions July. Singapore: EDHEC-Risk Institute.*

Blanc-Brude, F., S. Wilde, and T. Whittaker. *2015. The Performance of Listed Infrastructure Equity: a Mean-Variance Spanning Approach. EDHEC Business School Working Paper, Singapore.*

FCTL. *2015. Focusing Capital on the Long Term: Reorienting Portfolio Strategies and Investment Management to Focus Capital on the Long Term.*

[1] Real toll roads charge user fees as a function of effective traffic, whereas "availability payment" projects receive a fixed compensation from the public sector in exchange for the construction, operations and maintenance of a road according to a pre-agreed output specification.

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Setting the Standard for Data Collection and Reporting in Private Infrastructure Investments

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In recent years, frequent calls have been made in policy fora for data collection efforts to be stepped up with respect to infrastructure investment, but it is often unclear which data should be collected, to achieve what end, and how.

In a new paper (Blanc-Brude et al. 2015), we propose a template for collecting and reporting infrastructure investment data for the purpose of building investment benchmarks corresponding to reference portfolios of privately-held infrastructure debt or equity.

To establish what data needs to be collected, we start from the reasons why infrastructure investment benchmarks are in demand and list the key questions that such benchmarks should be expected to answer.

What are the relevant questions?

- Asset allocation: documenting the risk-adjusted performance of infrastructure investments compared to other public or private assets includes deriving measures of **expected and realized returns, return volatility and of the correlation of these returns** with the market. This determines whether there is such a thing as an infrastructure "asset class" that could improve existing asset allocation policies, or what combination of investment factors infrastructure debt and equity might correspond to.
- Prudential regulation: The current treatment of privately-held infrastructure is debatable and certainly contradicts the investment beliefs that draw investors to these assets. Without **adequate measures of extreme risks** and calibrations of existing prudential frameworks, institutional investors are less able to invest in infrastructure.
- Liability-driven investment: infrastructure investments may have the potential to contribute to asset-liability management objectives, even if they do not correspond to a well-identified asset class. Different **duration and inflation hedging measures** of infrastructure investments will play a key role in their integration in the asset-liability structure of investors. Arriving at such measures is fully part of the objective to create infrastructure benchmarks.

Why these questions cannot be answered today

The questions are important to the future of infrastructure investment by long-term investors, in particular investors with a liability profile and subjected to prudential rules, such as insurance firms. However, the current state of investment knowledge does not allow them to be answered.

- **Market proxies are ineffective:** looking for estimates of expected performance and risk of privately-held infrastructure investments in the market for publicly-traded securities has not delivered meaningful results so far. Listed infrastructure equity and debt indexes tend to exhibit higher risk than broad market indexes (higher maximum drawdown, higher VaR) partly because they are highly concentrated in a few large constituents. Crucially, they do not suggest any persistent improvement in investors' existing portfolios (see Blanc-Brude 2013; Blanc-Brude, Wilde, and Whittaker 2015 for a review and quantitative analysis).
- **Existing research using private data is too limited:** existing sources and studies on the performance of infrastructure PE funds suffer from major limitations and cannot be considered representative of the performance of underlying assets. In fact, it is because infrastructure PE funds are not representative that a number of large asset owners have gradually opted to invest directly in infrastructure. Likewise on the debt side, information available from rating agencies about infrastructure debt, while much richer, is insufficient to answer questions about the performance, extreme risk and effective duration of reference portfolios of private infrastructure debt.
- **Reported metrics are inadequate:** the metrics currently reported in infrastructure investment are also not fit for purpose. Appraisal-based net asset values (NAVs) suffer from the usual stale pricing issues which lead to smoothing and underestimating the volatility of returns, and the use of constant internal rates of return (IRRs) precludes building portfolio measures, identifying sources of return (factors) or computing the correct duration measures with risk profiles that are expected to change over time, which is the case with infrastructure projects.

Recent progress: from definitions to data collection

In June 2014, Blanc-Brude (2014) put forward a roadmap for the creation of infrastructure investment benchmarks. This roadmap integrates the question of data collection upfront, including the requirement to collect information known to exist in a reasonably standardized format and limited to what is necessary to implement robust asset pricing and risk models.

A number of the recommended steps have now been taken and the framework required to define and launch the data collection process now exists. Defining infrastructure investments from a financial perspective, the only relevant perspective to build investment benchmarks, was a necessary first step.

A clear distinction had to be made between infrastructure as a matter of public policy, in which case the focus is rightly on industrial functions (water supply, transportation, etc.) and that of financial investors who may be exposed to completely different risks through investments in firms providing exactly the same industrial functions (e.g. a real toll road and an "availability payment" road[2]).

Substantial progress has been made towards identifying those characteristics that can be expected to systematically explain the financial performance of infrastructure investments. In particular, the growing consensus around the limited role of industrial sector categories in explaining and predicting performance, and the much more significant role played by contracts and by different infrastructure "business models" such as "merchant" or "contracted" infrastructure, or different forms of utility regulation, is encouraging.

A first result has been the identification of limited-recourse project finance as a major and well-defined form of investment structuring for infrastructure projects. Benchmarking project finance debt and equity by broad categories of concession contracts, financial structures and life-cycle stage is one approach to creating reference portfolios that can be used as benchmarks, including for prudential regulation as

To establish what data needs to be collected, we start from the reasons why infrastructure investment benchmarks are in demand.

[2] A road project company receiving a fixed compensation from the public sector in exchange for the delivery of the construction, operations and maintenance of a road up to a pre-agreed output specification.

the recent EIOPA consultations suggest.[3]

In due course, other approaches can complement this first step to integrate other types of underlying infrastructure business models (e.g. "RPI-X" vs. "rate of return" utility regulation) in a broader benchmarking exercise of privately-held infrastructure investments.

With the financial instruments corresponding to infrastructure investment usefully defined, the second necessary step was to design a performance and risk measurement framework that can provide robust answers to the questions identified above.

Privately-held infrastructure equity and debt instruments are not traded frequently and cannot be expected to be fully "spanned" by a combination of public securities. Hence, they are unlikely to have unique prices that all investors concur with at one point in time. A two-step approach to measuring performance is therefore necessary:

1. Documenting the statistical distributions (mean and variance) of debt service and dividends in order to address the fundamental problem of unreliable or insufficiently reported NAVs or losses given default (LGDs);
2. Estimating the relevant (term structure of) discount rates, or required rates of returns, and their evolution in time. Here too, progress has been made and recent EDHEC research provides a framework addressing both steps, taking into account the availability of data, while applying best-in-class models of financial performance measurement.

The result is a list of data items required to implement adequate methodologies and answer the right questions. This list includes "base case" and revised cash flow forecasts for equity and debt investors, as well as realized debt service and dividends, and key financial ratios, in particular debt service and equity service cover ratios, and their determinants. Finally, modeling cash flows requires knowledge of loan covenants and expected and realized investment milestones.

Once the expected value and volatility of cash flows to creditors and investors is known, as best as current information allows, the relevant term structure of discount rates can be estimated to derive past and forward-looking measures of performance, risk and liability-hedging.

Starting from a distribution of cash flows, several approaches are available, such as factor extraction from initial investment values, following Ang et al. (2013). Blanc-Brude and Hasan (2015) provide an application to infrastructure project equity, which is detailed in a separate article in this supplement: A New Framework for the Valuation of Privately-Held Infrastructure Equity.

A second option is the risk-neutral valuation approach described in Kealhofer (2003). Blanc-Brude, Hasan, and Ismail (2014) provide an application to private infrastructure debt that integrates the Black and Cox (1976) extension of the Merton (1974) structural model, and allows for debt restructuring post-default, hence valuing the option available to infrastructure lenders to restructure project debt.

Implementing these methods requires collection of a set of data items, including initial investment values and credit spreads, all of which are observable.

The detailed list of the required data items is presented in Blanc-Brude et al. (2015).

The need for cooperation

Having progressed towards clear definitions of underlying assets, and built robust, state-of-the-art pricing and risk models that avoid the pitfalls of existing practices (e.g. averaging IRRs) and are designed to deliver the answers needed by investors, regulator and policy-makers, it is now time to collect the relevant information.

With the data collection template defined by EDHEC, which has been designed to correspond to the requirements of the relevant asset pricing and risk models, a rationale exists to collect data effectively and efficiently to build infrastructure investment benchmarks.

Collecting this information now requires large-scale cooperation between investors, creditors, academic researchers and the regulators that can help make such reporting part of a new standard approach to long-term investment in infrastructure by institutional players.

This work is ongoing at EDHEC and benefits from the support of numerous private sector organizations including long-standing research sponsors such as NATIXIS, Meridiam and Campbell Lutyens, as well as the members of the Long-Term Infrastructure Investor Association. •

References

Ang, A., B. Chen, W. N. Goetzmann, and L. Phalippou. *2013. Estimating Private Equity Returns from Limited Partner Cash Flows. Working Paper.*

Black, F., and J. C. Cox. *1976. Valuing Corporate Securities: Some Effects of Bond Indenture Provisions. Journal of Finance 31 (2): 351–67.*

Blanc-Brude, F. *2013. Towards Efficient Benchmarks for Infrastructure Equity Investments. EDHEC-Risk Institute Publication, Meridiam, Campbell-Lutyens and EDHEC Research Chair on Infrastructure Equity Investment Management and Benchmarking. Singapore: EDHEC-Risk Institute; EDHEC-Risk Institute, 88.*

Blanc-Brude, F. *2014. Benchmarking Long-Term Investment in Infrastructure. EDHEC-Risk Institute Position Paper, June.*

Blanc-Brude, F., and M. Hasan. *2015. The Valuation of Privately-Held Infrastructure Equity Investments. EDHEC-Risk Institute Publication, EDHEC, Meridiam and Campbell-Lutyens Research Chair on Infrastructure Equity Investment Management and Benchmarking January. Singapore: EDHEC-Risk Institute.*

Blanc-Brude, F., M. Hasan and T. Whittaker. *2015. Data Collection for Infrastructure Investment Benchmarking: Objectives, Reality Check and Reporting Framework. Working Paper, mimeo.*

Blanc-Brude, F., M. Hasan, and O. R. H. Ismail. *2014. The Valuation and Performance of Unlisted Infrastructure Debt. EDHEC-Risk Institute Publications, EDHEC and NATIXIS Research Chair on Infrastructure Debt Investment Solutions July. Singapore: EDHEC-Risk Institute; EDHEC-Risk Institute.*

Blanc-Brude, F., S. Wilde, and T. Whittaker. *2015. The Performance of Listed Infrastructure Equity: a Mean-Variance Spanning Approach. EDHEC Business School Working Paper.*

Kealhofer, S. *2003. Quantifying Credit Risk I: Default Prediction. Financial Analysts Journal. JSTOR, 30–44.*

Merton, R. C. *1974. On the Pricing of Corporate Debt: The Risk Structure of Interest Rates. Journal of Finance 29: 449–70.*

Collecting this information now requires large-scale cooperation between investors, creditors, academic researchers and the regulators that can help make such reporting part of a new standard approach to long-term investment in infrastructure by institutional players.

[3] *See https://eiopa.europa.eu/regulation-supervision/insurance/investment-in-infrastructure-projects*

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A New Framework for the Valuation of Privately-Held Infrastructure Equity

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In a new paper drawn from the Meridiam/Campbell Lutyens research chair at EDHEC-Risk Institute, we propose a dedicated valuation framework for privately-held infrastructure equity investments.

Following the roadmap to create long-term infrastructure investment benchmarks described in Blanc-Brude (2014), this framework takes into account the challenges of valuing privately-held and seldom-traded infrastructure equity investments, while aiming to design a methodology that can be readily applied given the current state of empirical knowledge and, going forward, at a minimum cost in terms of data collection.

Three challenges

The valuation of unlisted infrastructure project equity stakes requires three significant challenges to be addressed:

- **Endemic data paucity:** while primary and secondary market prices can be observed, sufficiently large and periodic samples, representative of different types of infrastructure projects at each point in their multi-decade lifecycle are unlikely to be available every year in each regional market.
- **The term structure of expected returns:** the nature of such investments requires estimation of a term structure of discount factors at different points in their lives that reflects the change in their risk profile. Indeed, in expectation, infrastructure investments can exhibit a dynamic risk profile resulting from the sequential resolution of uncertainty, including the frequent de-leveraging of the project company's balance sheet.
- **The absence of a unique price** for a given investment in unlisted infrastructure, which springs from the fact that there is no direct traded equivalent to the payoff of infrastructure project equity. It follows that prices are partly driven by investor preferences and that substantial bid/ask spreads are likely.

The first point is partly a mundane aspect of the difficulties encountered when collecting data on private investments, but also a reflection of the nature of long-term equity investment in infrastructure. The type of infrastructure projects that have been financed in the past are not necessarily representative of investment opportunities today. Thus, even if year-23 dividends for projects that were financed 24 years ago can be observed today, they may not be good predictors of dividends in projects financed 3 years ago, 20 years from now. For example, projects financed in the early 1990s may have been in sectors where fewer projects exist today (e.g. telecoms) or rely on contractual structures or technologies that are not relevant to long-term investors in infrastructure today (e.g. coal-fired merchant power).

Data paucity is an endemic dimension of the valuation of privately-held infrastructure equity investments i.e. we must start from the premise that we cannot observe enough data to simply derive prices empirically. Instead, we acknowledge a position of relative ignorance and aim to build into our approach the possibility to improve our knowledge as new cash flow and transaction data that can be used to update models of dividend distributions and asset pricing become observable.

The second point about the term structure of expected returns has long been made in the finance literature: using constant and deterministic discount rates is defective if projects have multiple phases and project risk changes over time as real-options are exercised by asset owners.

It also amounts to assuming that the risk-free rate, asset beta, and market risk premium are constant and deterministic, when we know that such variables are time-varying and stochastic. Moreover, the internal rate of return (IRR) of individual investments cannot be easily used to estimate performance at the portfolio level, as the IRR of a portfolio is not the same as the weighted-average IRRs of individual investments.

Thus, using methodologies based on discounting at a constant rate, while common in the corporate sector, is inadequate for the purposes of long-term investors, who need performance measures that can help them make hedging, risk management, and portfolio management decisions.

The third point (the absence of unique pricing measures) is a reflection of what is usually labeled 'incomplete markets' i.e. the fact that the same asset can be valued differently by two investors, and yet this does not constitute an arbitrage opportunity (and therefore the bid-ask spread does not narrow) because transaction costs are high and because, in the absence of complete markets, investor preferences partly explain prices.

The existence of a range of (or bounds on) values is also impacted by market dynamics: if a new type of investor (e.g. less risk averse) enters the private infrastructure equity market, the range of observable valuations for similar assets may change. Likewise, if some investors want to increase their allocations to unlisted assets, given the limited available stock of investable infrastructure projects at a given point in time, their valuations may rise, but not those of others (who may sell).

Hence, the important point is that the required rate of return or discount rate of individual investors' infrastructure equity is fundamentally unobservable: it cannot be inferred from observable transaction prices since it is both a function of the characteristics of the asset (e.g. cash flow volatility) and individual investor preferences.

Improving existing valuation methods

Because of these challenges, existing approaches developed to value private equity investments are mostly inadequate for the purpose of valuing unlisted infrastructure project equity.

In our review of the literature we identify three groups of valuation techniques: repeat sales, public market equivalents and factor extraction from cash flows. Importantly, these techniques all imply that enough data can be observed to compute a price.

The repeat sales approach assumes that asset betas can be inferred from discrete and unevenly timed transaction observations after correcting for price staleness and sampling bias, while the public market equivalent approach implies that public asset betas can be combined to proxy the return of unlisted assets. Cash flow-driven approaches are less normative and aim to derive the unobservable rate of return of unlisted assets by decomposing their implied returns into traded and untraded components ex post facto, that is, once all cash flows have been observed and can be related to equally observable market factors.

Thus, these approaches cannot be directly applied to privately-held infrastructure investments, the value of which is determined by streams of expected and risky cash flows that mostly occur in the future, and for which few comparable realized investments exist today.

Existing approaches also typically fail to take into account the subjective dimension of asset pricing in the unlisted space and compute asset betas and alphas as if a unique pricing measure existed i.e. as if all investors had similar preferences, and in some papers, as if private equity exposures could always be replicated with a combination of traded assets.

Deriving discount factors endogenously

To the extent that infrastructure dividend cash flows can only be partially observed today, their expected values cannot be decomposed into exogenous factors (markets, the economy, etc.), the future value of which is not known today and would be very perilous to predict 30 years from now.

Instead, we must derive the relevant discount factors endogenously i.e. using observable information about each private investment in infrastructure equity including, as suggested above, its contractual characteristics, location, financial structure, etc., as well as the value of the initial equity investment made, which is also observable.

Hence, we argue that a robust valuation framework for equity investments that solely create rights to future (and yet largely unobserved) risky cash flows, as is the case of privately-held infrastructure equity, requires two components:

1. A model of expected dividends and conditional dividend volatility, calibrated to the best of our current knowledge;
2. A model of endogenously determined discount factors, that is, the combination of expected returns implied by the distribution of future dividends, given observable investment values.

In other words, as for any other stock, the valuation of privately-held equity in infrastructure projects amounts to deriving the appropriate discount rates for a given estimate of future dividends. But while this process is implicit in the pricing mechanism of public stock markets, in the case of privately-held equity with distant payoffs, we have to derive the relevant parameters explicitly, taking into account the characteristics of infrastructure assets.

Dividend distribution model and required data

The dividend stream or cash flow process can be described as state-dependent and we introduce a new metric for infrastructure project dividends: the equity service cover ratio or ESCR, which is computed as the ratio of realized-to-base case dividends.

The base case equity forecast of infrastructure equity investments, while not necessarily accurate, provides a useful and observable quantity, which by definition spans the entire life of each investment. Thus, we propose to describe the behavior of equity cash flows in infrastructure projects as a function of this initial forecast, in order to create metrics that allow direct comparisons between different equity investments.

In our paper, we show that the value of the ESCR at each point in the lifecycle of infrastructure equity investments can be used as a state variable describing the dynamics of the cash flow process. In combination with a given project's base case dividend forecast (which is known at the time of investment), knowledge of the distribution of the ESCR at each point in time is sufficient to express the expected value and conditional volatility of dividends.

The fact that new observations are not redundant today (we can still learn about the dynamics of dividends in infrastructure investment by collecting new data), justifies the need for an ongoing and standardized reporting of these cash flows to keep learning about their true distribution and value the infrastructure investments made today, tomorrow.

Filtering implied market values (and their bounds)

Since the term structure of expected returns of individual investors/deals is unobservable and lies within a range (or bounds) embodying market dynamics at a given point in time, we adapt the classic state-space model mostly used in physical and natural sciences to capture the implied average valuation (or state) of the privately-held infrastructure equity market at one point in time and its change from period to period. Using such a model also allows us to capture the market bounds on value implied by observable investment decisions for a given stream of expected cash flows.

The objective of state-space models is parameter estimation and inference about unobservable variables in dynamic systems, that is, to capture the dynamics of observable data in terms of an unobserved vector, here the term-structure of discount factors. Hence, we have an observation equation relating observable data to a state vector of discount factors, and a state equation, which describes the dynamics of this state, from one observation (transaction) to the next. Each transaction corresponds to a new state i.e. a given term structure of discount factors matching the price paid in that transaction (the initial investment) with expected cash flows, which may or may not be the same as the previous transaction's.

Given a stream of risky future dividends, if the price paid in the current transaction is different from that paid in the previous one, it must be because the valuation state has shifted. The valuation state can change due to a change in investor preferences between the two deals, or due to a change in the consensus risk profile of those kinds of investments (e.g. projects with commercial revenues after a recession), or because of a change in the overall market sentiment (the average) valuation.

Thus, by iterating through transactions, we may derive an implied average valuation state (a term structure of discount factors) and its range, bounded by the highest and lowest bidders in the relevant period.

Later, when dividend payments are realized, period returns can be computed using the discounted sum of remaining cash flows as the end-of-period value (given the implied term structure of discount factors at that point).

In our research, we define the observation equation using a dynamic version of the standard Gordon growth model (discounted dividends) and the state equation using an autoregressive (with a one-period lag) model of the term structure of expected returns, which can be derived from the kind of factor model of expected excess returns that is commonly found in the financial literature. We take the view that expected returns are a function of conditional dividend volatility.

In a simple, linear setting, we show that we can iterate through observable investments, while estimating model parameters on a rolling basis, to capture both the implied expected returns (and discount factors) during a given reporting period and track these values and their range (arbitrage bounds) from period to period.

Illustration

As an illustration of our approach, we apply the dividend and pricing models to a generic case of privately-held infrastructure investment, assuming an expected ESCR and ESCR volatility profile (including the probability of receiving no dividends in any given period).

Given a base case dividend scenario inspired by an actual infrastructure project financed in Europe in the last decade, we obtain a full distribution of future dividends and apply our valuation framework to this assumed dividend process for a (an equally assumed) range of investment values. Some of the key outputs are shown in the following exhibits.

Exhibit 1 shows the resulting filtered term structure of expected period and multi-period (average) expected returns filtered from a range of 20 consecutive initial transactions in this type of project.

Exhibit 2 shows the resulting values of the dividend discount factor[4] at the time of valuation and the expected average price and its range for this group of transactions.

Finally, Exhibit 3 shows how we can implement this model with rolling parameter estimation to track the implied average expected returns and price of consecutive transactions from period to period.[5]

These results spring from model inputs that are only inspired by existing data and a number of intuitions about privately-held infrastructure equity investments, and can only be considered an illustration. However, they show clearly that with well-calibrated cash flow models and a transparent valuation framework, the kind of performance measures that have so far been unavailable to long-term investors can readily be derived and monitored in time, as new investments are made.

Future steps

Next steps include the implementation of our data collection template to create a reporting standard for long-term investors and the ongoing collection of the said data. Beyond, in future research, we propose to develop models of return correlations for unlisted infrastructure assets in order to work towards building portfolios of privately-held infrastructure equity investments. These developments will take place with the support of, and in collaboration with the financial industry and its regulators.

This work continues with the support of Meridiam and Campbell Lutyens, as well as the other members of the Long-Term Infrastructure Investor Association, who are spearheading the standardization and mass collection of data to calibrate the cash flow and pricing models described above. •

EXHIBIT 1

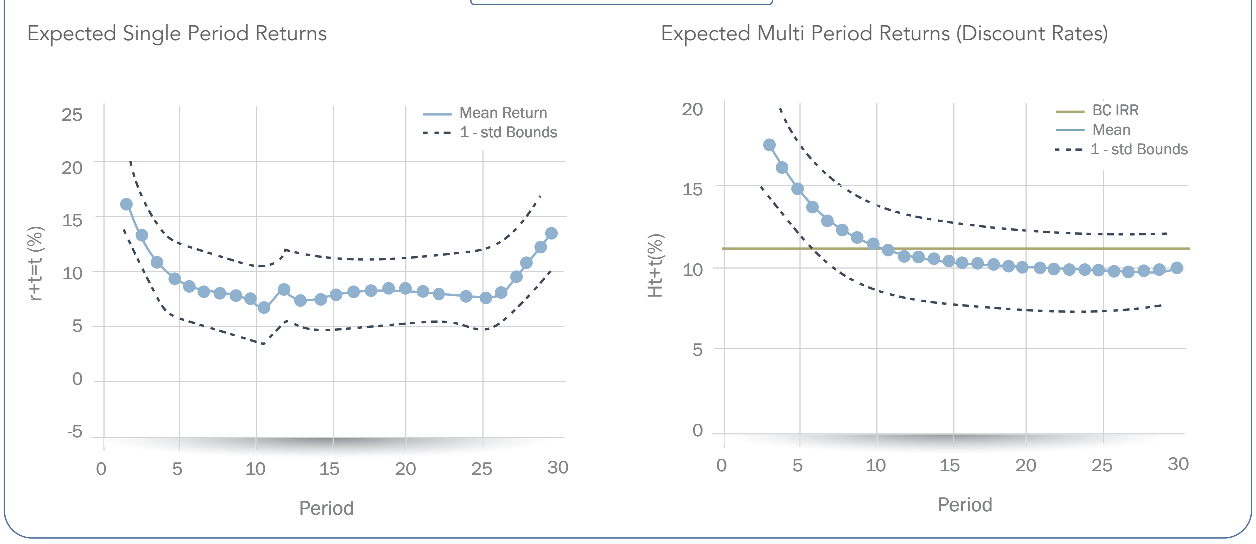


EXHIBIT 2

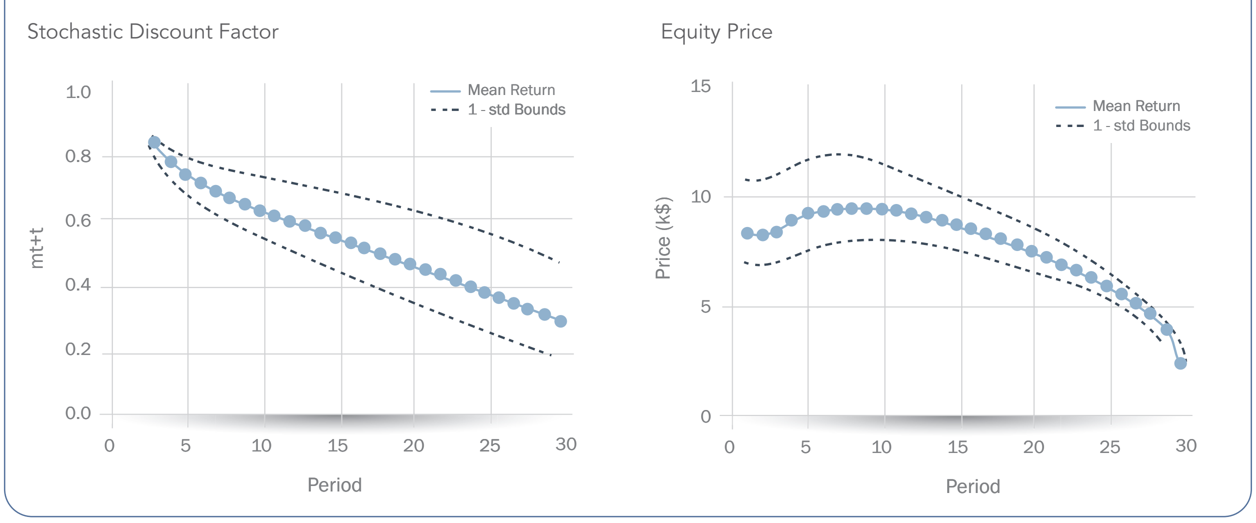
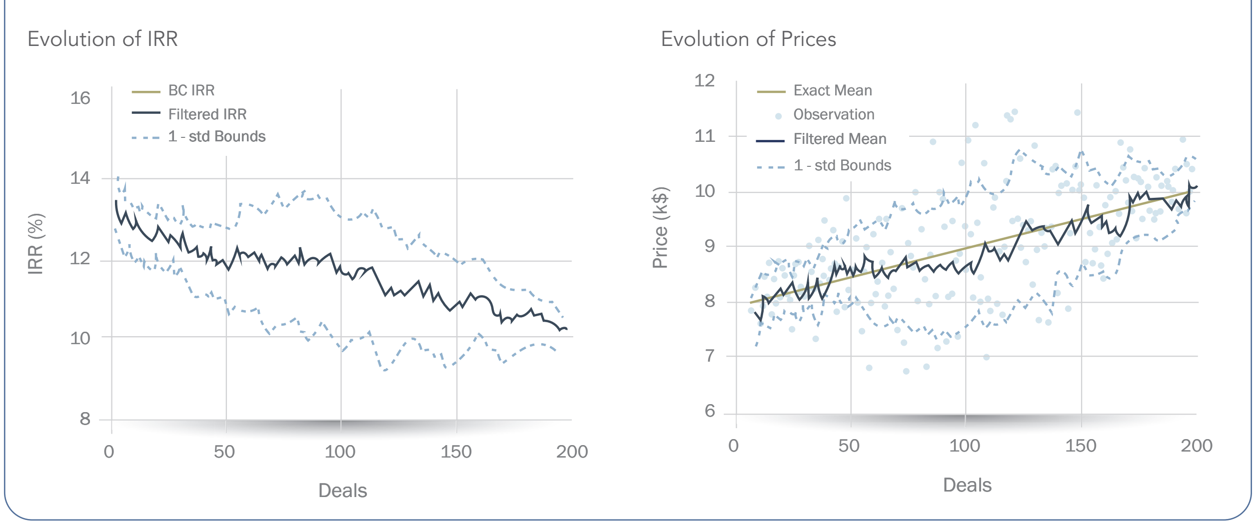


EXHIBIT 3



References

Blanc-Brude, F. 2014. *Benchmarking Long-Term Investment in Infrastructure. EDHEC-Risk Institute Position Paper, July.*

Blanc-Brude, F. and M. Hasan. 2015. *The Valuation of Privately-Held Infrastructure Equity Investment. EDHEC and Meridiam/Campbell Lutyens research chair on Infrastructure Equity Benchmarking. Singapore: EDHEC-Risk Institute, March.*

[4] Using continuously compounded (log) returns, the discount factor is simply the exponent of minus the total return from the valuation date until the relevant period.

[5] In this example, the average price investors are willing to pay for the same infrastructure asset is assumed to increase continuously (perhaps because investors increasingly value assets that pay predictable dividends in bad states of the world) but the range of prices investors are willing to pay to buy a stake in this (unchanged) dividend process is also assumed to change. Initially it is assumed to widen (say that new investors become active in this market and have different preference or views on risk); half way through the 200 observed transactions, the range of valuations is assumed to start shrinking (perhaps there is now a greater consensus amongst investors about risk or more traded assets allowing replication).