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RESEARCH INSIGHTS

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An asset class is born

The next generation of EDHEC*infra* indices is ready. They are computed quarterly, use meticulously curated private data for hundreds of companies in the 25 most active markets in the world and cutting-edge fair value asset pricing methods.

A key element in this project was the definition of the universe. Infrastructure may not be easily defined but infrastructure investment has to be. When we started working on this topic at EDHEC we decided to focus more on what 'infrastructure investment is like' – ie, what drives risk – and less on what 'infrastructure does' (move people or electricity from A to B, etc).

This is because at the heart of any financial investment decision lies the trade-off between risk and future value. Even in highly illiquid, opaque private markets, as we show in a series of new papers, the systematic factors driving prices in unlisted infrastructure debt and equity, investors make choices that reflect perceived risks and price these risks accordingly.

Hence, a classification of broad risk families found in infrastructure was a key starting point for the creation of The Infrastructure Company Classification Standard (TICCS). Immediately adopted by the industry, from the largest asset owners and managers to multilateral institutions and standard-setters, TICCS is a four-pillar taxonomy that captures the different types of business risks, industrial activity, geo-economic exposure and corporate governance that characterise infrastructure companies.

TICCS thus provides the building blocks for the definition of key market segment indices but also to build custom benchmarks for investors with different infrastructure strategies and exposures. Indeed, because of its size and illiquidity, the broad market infrastructure sector remains uninvestable. Instead, asset owners and managers are exposed to various combinations of assets aggregated over time, following a more or less well-defined strategy.

TICCS allows the building of custom benchmarks to understand the risks of existing strategies and define new ones.

Adding adequate benchmarks to the infrastructure investment process will be an important innovation. As our annual survey demonstrates, most investors use highly inadequate benchmarks and know it.

We conducted one of the largest surveys ever made of infrastructure asset owners and managers in 2019. We found that most investors use absolute benchmarks or listed infrastructure indices to determine their investment strategy, monitor performance and manage risk.

The vast majority of respondents also acknowledge major issues with their infrastructure benchmarking practices: current benchmarks are not representative, do not measure risk, do not allow investors to target or define a strategy and do not offer much information about correlations with other asset classes.

Without adequate benchmarks, the development of a global infrastructure asset class, which is one of the objectives of the G20, is necessarily limited, if not compromised.

This situation will evolve and, in all likelihood, improve with the development of the asset class. One could make comparisons with the development and gradual improvements made in other alternative asset classes that began to attract institutional investors a couple of decades ago, such as real estate or hedge funds.

Long-term investment in illiquid assets creates a demand for monitoring (as the alternative to trading in and out of the asset class) and as better databases and benchmark offerings are created, growing and successful alternative asset classes like infrastructure begin the long road towards maturity, transparency and better benchmarks.

Frédéric Blanc-Brude, Director, EDHEC Infrastructure Institute

An uncomfortable truth

Noël Amenc, Frédéric Blanc-Brude, Abhishek Gupta and **Jing-Li Yim**

Investors do not understand the risks they are taking when investing in infrastructure

The 2019 EDHEC*infra*/G20 survey of infrastructure investors is a detailed study of benchmarking practices among asset owners and managers. It brought to light a significant issue with regard to the investment process in infrastructure: investors do not know how much risk they are taking and they are not happy about it. Key findings include:

- ***Investors mostly use absolute-return benchmarks (based on the risk-free or inflation rate), but less than 10% think they are good enough.*** The major concerns include: they are not representative, do not measure risk and do not allow asset liability management.
- ***Current absolute-return infrastructure equity benchmarks are not ambitious and are not hard to beat.*** Most investors use a spread over real or nominal rate of 400–500bps. In a low rate environment, this is less than annualised stock market returns.
- ***When investors use relative benchmarks, they use 'fake benchmarks'.*** Preferred relative benchmarks are often listed infrastructure indices, which have been shown by academic research to have 100% correlation with broad equity indices. Otherwise, investors use 'industry peers' as a relative benchmark, despite the well-known issues encountered with valuation and return smoothing in private markets, as well as the difficulty in making direct comparisons.
- ***With current benchmarking practices, investors in unlisted infrastructure equity cannot understand their risk and define their infrastructure investment strategy.*** The practices described by investors correspond more to the definition of a hurdle rate than a benchmark. Current benchmarks cannot be used to identify systematic rewarded risks, monitor risk-adjusted performance or set risk budgets.

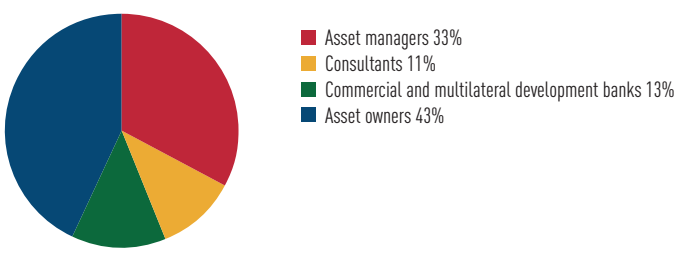
A representative survey of infrastructure investors worldwide

More than 300 respondents took part in the survey, including representatives of 130 asset owners accounting for $10trn in AUM – ie, more than 10% of global AUM.

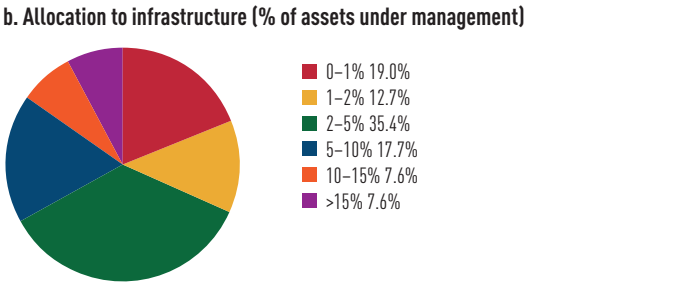
This is the largest survey ever undertaken of asset owners and managers active in the infrastructure space and is representative of the views of large sophisticated investors, with 50% of respondents reporting more than $25bn AUM and 30% reporting more than $50bn AUM.

1. Distribution of survey respondents and their allocation to infrastructure

a. Distribution of respondents



b. Allocation to infrastructure (% of assets under management)



Source: 2019 EDHEC*infra*/G20 survey

Infrastructure asset allocation requires a benchmark

Asset-allocation or policy benchmarks are meant to capture the broad characteristics of individual asset classes in order to determine the size of each allocation in the total portfolio.

Policy benchmarks reflect a long-term risk allocation choice with regard to the relevant asset class and may be a combination of sub-indices representing an investor's preferred opportunity set. For instance, in the case of infrastructure, one might want to gain exposure to a combination of contracted infrastructure investments in project vehicles in the transport and renewable energy sectors, or focus exclusively on regulated infrastructure companies.

Thus, strategic allocation to unlisted infrastructure equity or debt can involve multiple tilts defined in terms of business risk, industrial activity, geo-economic exposure and corporate governance (see The Infrastructure Company Classification Standard [TICCS], on the EDHEC*infra* website for more details).

This policy benchmark is the basis for strategic asset allocation exercises because it provides investors with measures not only of performance but also of risk and correlation with other asset classes.

In the most advanced cases, policy benchmarks can be designed to reflect a choice of risk allocation defined in terms of individual risk factors, which may also be common risk factor exposures across asset classes – eg, infrastructure investments are exposed to interest rate risk (duration) due to their long-term nature, and they share this risk factor with other asset classes, such as bonds.

An intuitive manner to highlight the role of the asset allocation benchmark is the so-called core-satellite approach to portfolio management (see Amenc et al [2008], for a full discussion), by which any investment in a given asset class can be divided into two parts:

- The 'core'[1] represents the risk-return profile of the average investment in a representative portfolio of the targeted asset class (eg, an investor might favour a combination of contracted infrastructure projects and merchant power projects in the OECD) and sets the absolute level of risk (and expected returns) chosen by the investor. In the listed equity space, it would be an index fund. In the unlisted infrastructure space, it is likely to be a non-investible benchmark capturing the characteristics of an investor's infrastructure investment strategy;
- The 'satellite' portfolio(s) are invested by active managers or internal investment teams and defined in terms of their tracking error relative to the core. In the listed space, this can be defined as a 'portable alpha' fund, excluding the effect of exposure to the index from the assessment of the active strategy. In the unlisted infrastructure space, if the core portfolio is not investible directly, managers must deliver both core and satellite exposures together, but the contribution of each part is made explicit.

A core-satellite approach to active asset management has multiple benefits:

- Allowing active managers to deviate significantly from the benchmark leads to a better use of the manager's skills;
- In the case of infrastructure, because building portfolios and achieving a degree of diversification takes time, the manager's tracking error can be set dynamically to reflect the implementation of the infrastructure investment strategy: a younger portfolio can have a larger tracking error relative to the long-term asset allocation benchmark, but the gradual implementation of the strategy should lead to closer tracking of the policy benchmark;
- Allowing a clear distinction between the value added by the design of the strategic asset allocation represented by the benchmark (core portfolio) and the outperformance generated by active portfolio management.

1 This use of the term 'core' should not be confused with the 'core infrastructure' terminology employed by asset managers in the private equity and real estate sectors.

This last point highlights the importance of selecting the correct benchmark, both to deliver the desired risk exposure and to determine the contribution of the manager or investment team.

With unlisted infrastructure investment, because of illiquidity and the difficulty in accessing the next transaction, the manager's contribution consists of both creating the core portfolio (transaction by transaction) and improving on the expected core portfolio performance.

Investors acknowledge major issues with the allocation benchmarks they use

Figure 2 shows that absolute benchmarks are the most popular among unlisted infrastructure equity investors, be they asset owners, managers or consultants, with 70% of respondents reporting using such benchmarks to make strategic asset allocation decisions.

This high reliance on absolute return benchmarks suggests that investors are restricted to making investment and allocation decisions based solely on target returns, rather than taking the risks involved in infrastructure investments into account.

Figure 3 shows that respondents that picked absolute return benchmarks use mostly risk-free rate and inflation-based benchmarks. In almost 55% of cases, the required excess return is below 500bps. We note that a small proportion of investors, especially asset managers, require even lower excess returns. Thus, excess returns required by infrastructure investors at the allocation stage are often lower than the equity risk premium found in public markets, which can be a surprise given the illiquid nature of the assets.

Meanwhile, about 30% of investors surveyed reported relying on relative asset allocation benchmarks.

Unfortunately, current choices of relative benchmarks are also inadequate according to survey respondents. Of those respondents that preferred using relative benchmarks for strategic asset allocation to unlisted infrastructure equity, the majority said they rely on a listed infrastructure index or industry peers.

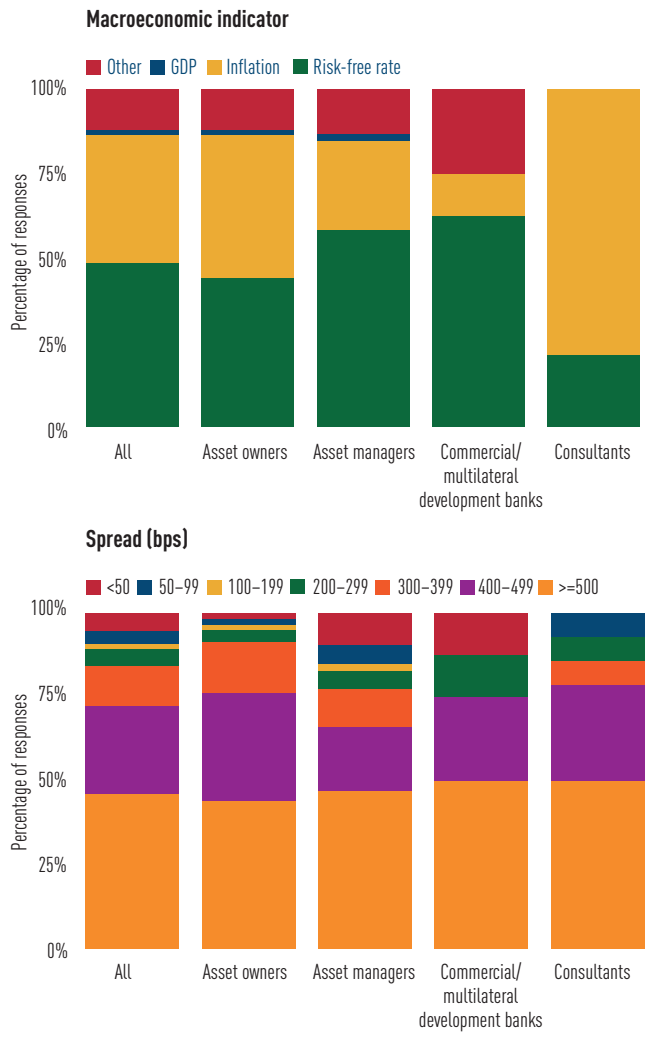
Figure 4 shows that almost 50% of asset owners use a listed infrastructure index as their infrastructure allocation benchmark, despite the majority of them not investing in listed infrastructure, as also reported in the survey.

Moreover, previous research has shown that listed infrastructure indices make for a poor proxy of the unlisted infrastructure asset class. Blanc-Brude and Whittaker (2017) apply mean-variance spanning tests to all major listed indices and show that they do not add diversification benefits to an investor's portfolio. Bianchi et al (2018) show that the returns of listed infrastructure indices are also easily explained away for a standard Fama-French factor model. In Amenc et al (2017) listed infrastructure strategies are found to have a market beta of one and zero alpha.

Hence, using listed infrastructure indices as benchmarks for unlisted infrastructure is not very different from using the broad equity market as an infrastructure benchmark, perhaps with a couple of factor tilts. As a result, it is unclear how investors make asset allocation decisions on this basis, since most optimisers would then recommend either no infrastructure allocation or entirely replacing public equity with infrastructure in the portfolio.

The other main type of relative benchmark used for asset allocation is 'industry peers', in the case of approximately 25% of investors.

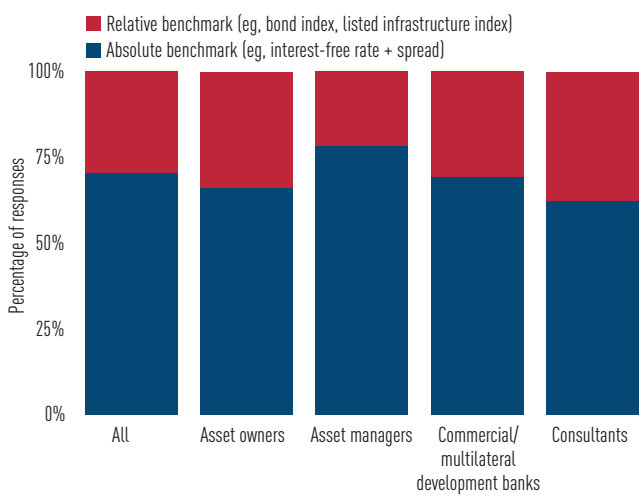
3. Absolute benchmark used for infrastructure equity investments



Source: 2019 EDHEC*infra*/G20 survey

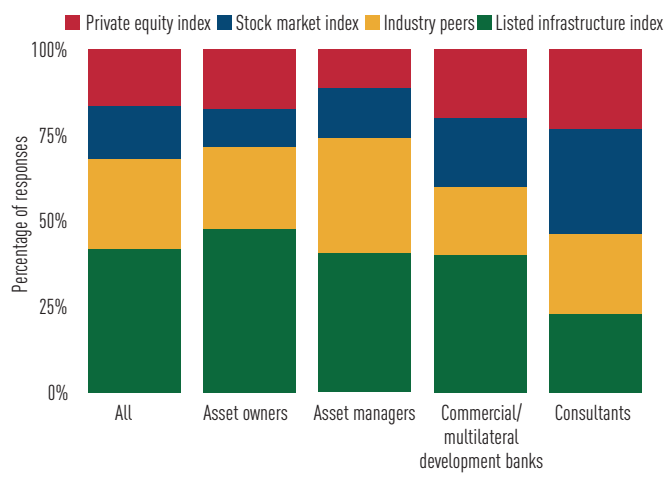
Such peer benchmarks are created by aggregating reported infrastructure funds' IRRs, and they face their own series of methodological issues. First, the classic issues of stale valuations and return smoothing found in private markets precludes any measure of risk using such indices (see Amenc [2008], for a detailed discussion of similar issues with real estate indices). Second, in such contributed indices, constituents are neither representative of the market nor of the strategy of any given investor, making direct comparisons difficult.

2. Benchmark used for infrastructure equity investments



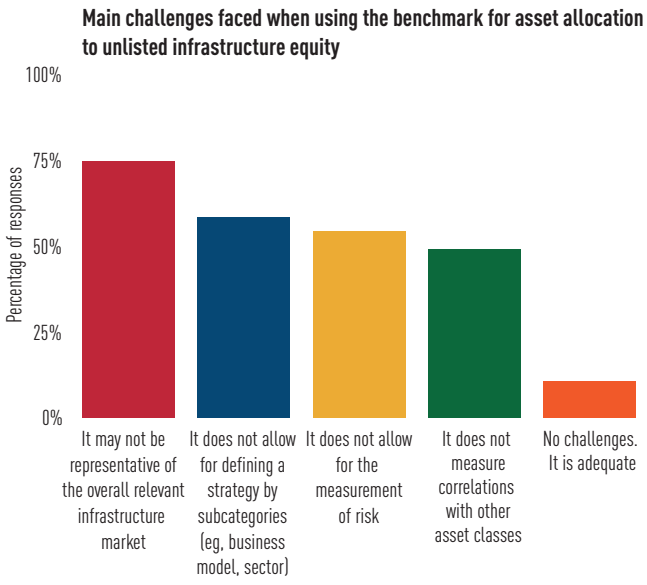
Source: 2019 EDHEC*infra*/G20 survey

4. Relative benchmark used for infrastructure equity investments



Source: 2019 EDHEC*infra*/G20 survey

5. Reported issues with asset allocation benchmarks for infrastructure equity investments



Source: 2019 EDHEC*infra*/G20 survey

As figure 5 shows, only a handful of respondents think that using such benchmarks does not raise issues.

Absolute-return benchmarks do not measure or take into account the underlying risk (unless the investment is to be considered risk-free and with an alpha of 5%) and thus partly defeat the point of using an asset allocation benchmark, which is fundamentally an exercise about return covariance between asset classes or risk factors.

Almost 75% of respondents said that the aforementioned benchmarks are not representative of the overall relevant infrastructure market.

Over 50% said that these benchmarks do not allow definition of a strategy by subcategory, such as business model and sector.

Around 50% of respondents acknowledged that these benchmarks do not allow for the measurement of risk or correlations with other asset classes.

In order to make the best strategic allocations to infrastructure, investors need a customised benchmark of unlisted infrastructure investments – be they equity or debt investments – that is representative of their investment strategy and preferences, provides a measure of risk-adjusted returns, and allows the measurement of correlations with other asset classes.

Such indices and benchmarks are being developed by EDHEC*infra* using a methodology that ensures the representativeness of index constituents in both time and space and the calibration of expected returns to available transaction data in all principal markets in which this information can be observed, ensuring that such indices reflect the fair value and the risks.

From allocation to monitoring: the need for custom benchmarks

Performance monitoring benchmarks differ from the asset allocation benchmarks discussed in the previous section insofar as they should represent actual investment choices made when implementing a fund's investment policy.

Monitoring benchmarks aim to represent as well as possible the investments that were actually made.

In the case of infrastructure, the difference between policy and performance monitoring benchmarks is all the more significant in that the ability to implement any given style or tilt is itself uncertain: infrastructure markets are notoriously illiquid and in part driven by public procurement and other policy decisions that are not easily predicted.

The implementation of a broad policy allocation to infrastructure may take multiple incarnations: different levels of geo-economic, industrial or business-risk exposures are likely to require dedicated sub-allocations and will be fully known only after the fact. For instance, the high degree of specialist industrial knowledge required to make investments in any infrastructure sector usually militates for individual sub-strategies or mandates.

Perhaps even more importantly, building large, well-diversified positions in any segment of the unlisted infrastructure space remains very difficult today, given the average time and size of individual transactions.

As a direct result, while policy benchmarks focus on long-term rewarded risks, performance-monitoring benchmarks may need to be tailored to an investor's or their manager's actual portfolio, and achieving sufficient granularity is very important to benchmark the investments fairly and accurately.

As discussed above, in a core-satellite context, investors can monitor and manage the performance of asset managers and investment teams by defining a core portfolio which is representative of the expected behaviour of a given infrastructure investment style or strategy and a satellite portfolio defined in terms of its tracking error relative to the core.

In the case of highly illiquid asset classes like unlisted infrastructure in which a well-defined 'core' is not directly investible, this distinction gives investors a way to monitor the dual objective given to asset managers: to deliver the core strategy (deal by deal) and to outperform the average as captured by the core benchmark.

An implementation of this approach to monitoring unlisted infrastructure managers can make use of the tracking error given to a manager as a representation of the construction of the infrastructure portfolio: the younger the portfolio, the larger the tracking error. As a portfolio of infrastructure debt or equity increases in size and representativeness, the tracking error should be reduced to only represent the space within which the manager can deliver alpha.

Investors acknowledge more issues with performance monitoring benchmarks

In the 2019 EDHEC*infra*/G20 survey, 50% of respondents declared using the same benchmarks for performance monitoring as they do for strategic asset allocation and around 75% of infrastructure equity investors reported using absolute benchmarks for performance monitoring.

In light of the comments above, this is highly problematic. While absolute benchmarks are a good indicator of the target return achieved, in order to monitor performance adequately investors should use a benchmark that represents their choice(s) of investment policy explicitly defined in terms of risk profile.

In effect, the practices described by investors in this survey correspond more to the definition of a hurdle rate rather than a benchmark.

Figure 6 shows that 70% of respondents acknowledged that the benchmarks they use for performance monitoring do not allow investors to measure risk-adjusted performance. When the same question was asked of asset owners only, more than 75% of respondents reported similar concerns.

Almost 40% of respondents also agreed that the use of another asset class as a proxy for unlisted infrastructure equity is a challenge.

Close to 30% of respondents acknowledged that current private benchmarks tend to report smoothed returns.

Figure 6 shows that around 30% of asset owners said that current industry-peer, money-weighted benchmarks do not allow for a fair comparison of asset managers.

Indeed, such indices are sensitive to the timing of cash flows, which can vary across fund managers and can even be manipulated to achieve higher returns.

Managing infrastructure investment risk with a benchmark

In a portfolio context, risk management aims to control and optimise the amount of risk taken by investors per unit of expected reward (excess return or spread). As such, it revolves around the sources of remunerated risk found in various securities – ie, the factors that explain and predict the price and therefore the returns of these securities.

Priced risk factors are the result of fundamental economic and financial mechanisms but are usually proxied by observing these characteristics of the investments made, be they firms or credit instruments, that systematically explain or drive asset values. This implies that a robust statistical model of expected returns can be calibrated using observable and predictable inputs.

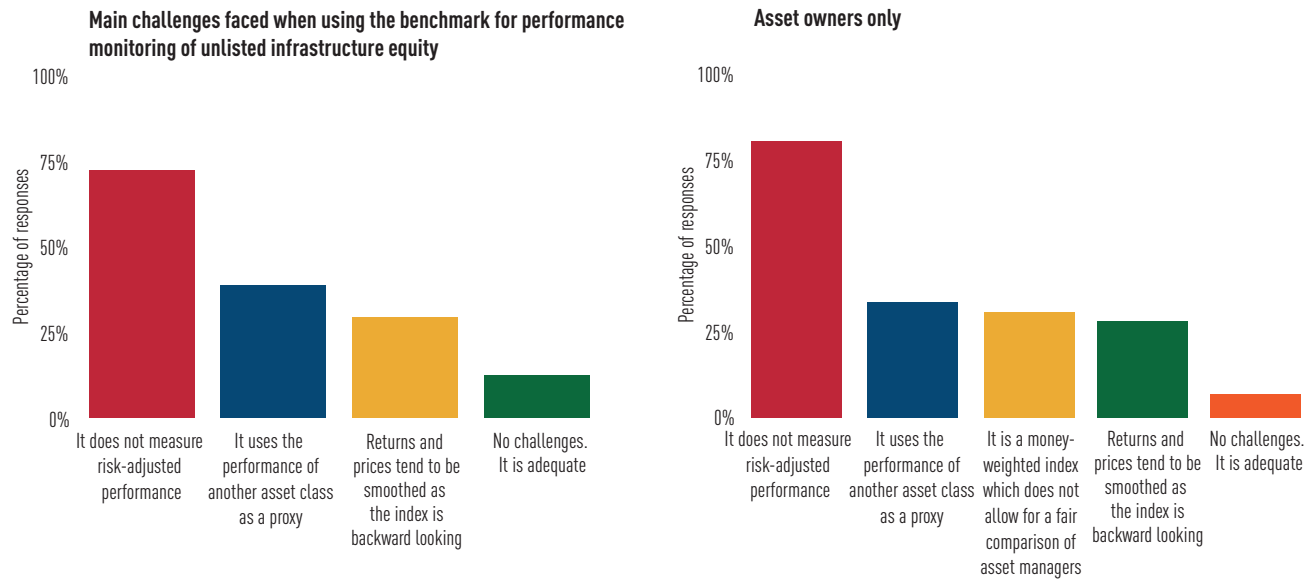
For instance, most asset values are impacted by movements in interest rates, hence these assets are all exposed to interest rate risk (often referred to as 'duration'). Not all assets are equally exposed to interest rate risk, however: depending on their maturity and expected payouts, asset values are more or less influenced by movement in the rates of interest – ie, various assets 'load' more or less on the duration risk factor.

An important issue with using benchmarks for managing risks in infrastructure investment is the necessity to accurately and persistently capture the underlying risk exposure of a given infrastructure investment strategy or mandate.

As discussed earlier, the construction of an infrastructure portfolio can be a lengthy process and the uncertainty that characterises trading time as well as the type of available investment over time mean risk exposures can be expected to evolve significantly over time.

Infrastructure investors also face changing risk exposure at the universe level: the underlying investible universe keeps changing as new countries embrace infrastructure privatisation, or others turn their back on certain types of concession contracts, etc. Likewise, the energy transition towards low-carbon power production is happening on a global scale, creating new industrial and geographic exposures within the 'power generation' investment style.

6. Reported issues with with performance-monitoring benchmarks for infrastructure equity investments



Source: 2019 EDHEC*infra*/G20 survey

This is reminiscent of the sub-optimality issues found in cap-weighted market indices: standard stock indices exhibit both sector and style biases (concentrations) that make them either relatively inefficient or relative unstable in terms of risk exposures (Amenc [2006]). Moreover, these biases tend to change over time, making standard cap-weighted indices unsuitable as benchmarks since their implicit risk exposures drift in the long run in a manner that investors cannot control.

The solution to this issue is to build benchmarks that have constant sector and geographic weights or, even better, target a constant exposure to certain risk factors.

We identified earlier that, for infrastructure investors, a choice of strategic benchmark effectively embodies two challenges: 1) creating the core portfolio to which the benchmark refers and 2) providing outperformance relative to this benchmark.

A decomposition of risk exposures by factors creates more flexibility to build the infrastructure portfolio (since factor exposures are present in all investments) and allows consideration of the optimisation of the reference benchmark/portfolio in order to achieve the desired risk exposure determined at the strategic level.

Moreover, to the extent that risk factors are found within multiple asset classes, investors' total portfolio risk is also partly determined by the dependencies between assets classes created by common risk factor exposures.

For instance, interest rate or credit risk can be expected to be present in multiple asset classes like fixed income and also infrastructure, including infrastructure equity, since leverage is typically high in infrastructure companies and the repayment period very long. As a result the current value of any stream of future dividends to equity investors is partly driven by the movement of interest rates (discount rates) and the possibility of being 'wiped out' by a default.

Understanding how each asset class component of the portfolio loads on various cross-asset class risk factors is essential in the risk measurement and management process.

The absence of infrastructure investment risk management

In the survey, more than 50% of investors declared that they use the same benchmarks for risk management as for strategic asset allocation and performance monitoring. Nearly 70% of investors in unlisted infrastructure continue to use absolute return benchmarks for the purpose of risk management. This suggests that the infrastructure portfolio risk management function is very limited among most investors.

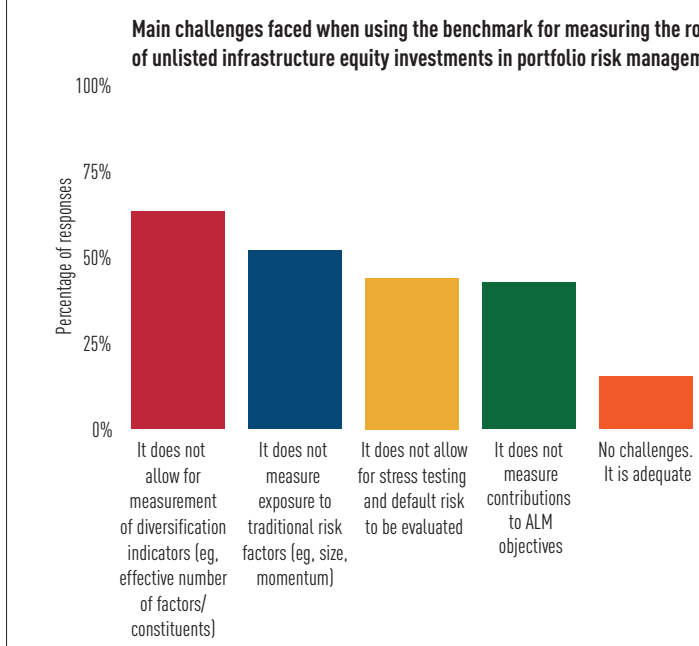
Some 10% of respondents said that their choice of benchmark is adequate for risk management purposes. Among the vast majority of respondents there is a consensus that current practices present a number of challenges.

Figure 7 shows that over 50% of respondents are concerned that the aforementioned benchmarks do not allow for measurement of diversification indicators such as effective number of factors/constituents.

Fifty per cent worry that the benchmarks do not measure exposure to traditional risk factors such as size and momentum, which are likely to be found in multiple asset classes involving equity investment.

Likewise, around 40% of equity investors said that current benchmarks do not allow for stress testing or default risk mapping, nor do they measure contributions to asset liability management objectives.

7. Reported issues with risk management benchmarks for infrastructure equity investments



Source: 2019 EDHEC*infra*/G20 survey

Conclusion: the long road ahead

A benchmark is defined as a portfolio of reference and, consequently, it is supposed to be representative of the risks of the managed portfolio. It is widely accepted that the choice of benchmark plays an important role in portfolio performance.

Benchmark construction allows objectives to be fixed in terms of the portfolio's systematic risk exposure, which is reflected in the choice of strategic asset allocation. Benchmarks also serve to evaluate portfolio performance.

However, this new and very large survey shows that most investors rely on absolute benchmarks to determine their allocations to infrastructure equity or debt.

This implies that most such allocation decisions are completely ad hoc and, in all likelihood, highly sub-optimal, because portfolio optimisation tools cannot be applied without risk measures.

Indeed, infrastructure investors acknowledged this situation in their responses to this survey, highlighting the many flaws of their own current practices.

Without adequate benchmarks, the development of a global infrastructure asset class, which is one of the objectives of the G20, is necessarily limited, if not compromised.

The results of this survey highlight the need to use better-defined benchmarks that measure risk and can help investors make better-informed asset allocation, monitoring and risk management decisions.

This situation will evolve and, in all likelihood, improve with the development of the asset class. One could make comparisons with the development and gradual improvements made in other alternative asset classes that began to attract institutional investors a couple of decades ago, such as real estate or hedge funds.

Long-term investment in illiquid assets creates a demand for monitoring (as the alternative to trading in and out of the asset class) and as better databases and benchmark offerings are created, growing and successful alternative asset classes like infrastructure begin the long road towards maturity, transparency and better benchmarks.

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Measuring the fair value of unlisted infrastructure assets: doing it right

Frédéric Blanc-Brude

*In a series of new papers, EDHEC*infra *puts forward a methodology that can address some of the most difficult issues with regard to the fair valuation of highly illiquid assets such as infrastructure equity and debt instruments*

Infrastructure investments are notoriously illiquid. According to recent EDHEC*infra* research, on average, a privately-held infrastructure company trades some or all of its shares once in its lifetime in the secondary market. Given how many times shares of Heathrow airport and Thames Water have changed hands, it is clear that most infrastructure companies never trade.

Asset managers and investment teams also like to highlight how heterogenous infrastructure companies are. Indeed, it is not easy to find directly comparable deals, let alone ones that happened in the last quarter.

Fair value matters

How then might asset owners and managers know the fair market value of their investments? Does it matter?

The regulator thinks so. The fair value accounting of alternative investments, of which unlisted infrastructure is one category, is now a clear point of focus. The US Securities and Exchange Commission (SEC) in particular has increasingly been taking action against alternative asset managers with respect to:

- Valuation methodologies that are not in line with basic fair value accounting principles and rules;
- Conflicts of interest between managers and valuers;
- Inadequate choice of discount rates in discounted cash flow (DCF) models;
- Not using potential credit and corporate events in the valuation of debt securities; and
- The misrepresentation of valuation methodologies in marketing material.

Likewise, the European Union's Alternative Investment Fund Managers Directive (AIFMD), which has been transposed into EU member state law since 2013, requires alternative asset managers to put in place an independent valuation process (article 19) ensuring a "sufficient degree of objectivity" and, in the case of illiquid securities, detailed and documented procedures including the data sources used to compute fair values.

Other regulatory trends increasingly require the measurement of fair value in private infrastructure investments. For instance, held-to-maturity loans held by banks regulated by the Financial Accounting Standards Board (FASB), of which infrastructure project finance loans are a subset, and that are "other than temporarily impaired" have to be written down to their fair value – that is, losses must be booked at their fair value.

Crucially, measuring fair value matters for the integrity of the investment process:

- The asset allocation decision to invest in unlisted infrastructure calls for a market benchmark that can be compared with other asset classes on a like-for-like basis;
- Investors' fiduciary duty requires that they monitor infrastructure asset managers and investment teams' performance on an ongoing and meaningful basis;
- The compensation of investment managers and investment teams requires a clear and ongoing understanding of the value they create and the performance they achieve;
- Likewise, asset manager selection requires a clear understanding of their investment track record relative to a meaningful benchmark, comparable to other managers and asset classes; and
- Finally, and most importantly, investors need to measure the risks inherent in infrastructure investments, since it is only by taking these risks that they can expect to earn a corresponding return. In this respect, measuring the variance of infrastructure investments' fair value is of the essence.

The problem with the raw data

Probably the most fundamental principle in the IFRS framework is the requirement, in the absence of continuously traded securities, to calibrate asset valuation to contemporaneous market prices for equivalent trades.

While infrastructure companies seldom trade individually, there are numerous deals each year in the most active markets around the world. EDHEC*infra* has identified 25 national markets for which the share of the global deal flow and the ratio of secondary to primary transactions are both high enough to justify considering these markets as IFRS 13 'principal' markets: markets in which enough willing buyers and sellers reveal their price preferences by trading.

However, using reported prices presents an important challenge for valuation purposes: because of the low frequency of individual company trading and the heterogeneity of the asset class the raw data is fundamentally biased.

On the equity side different types of infrastructure projects and companies trade in certain places at certain points in time, and observable transaction

prices are not likely to form a representative set of prices of the investable universe. Transactions that took place 10 or 15 years ago are likely to be concentrated on different types of projects, countries and sectors (say, real toll roads and gas-fired power) than more recent transactions (say, renewables and data storage).

Unlike unlisted infrastructure equity, for which a limited but significant number of secondary market transactions can be observed, private infrastructure debt is seldom the object of secondary transactions at all. It is, however, possible to observe a large number of primary transactions – that is, spreads at the time of origination.

Again, even on a large scale, debt spread data can be expected to exhibit significant biases: different types of infrastructure projects and companies raise financing in certain places at different points in time, and observable primary spreads are also unlikely to be representative of the universe. Instead, origination follows procurement and industrial trends, for example, it tends to cluster in time and space when and where governments procure new infrastructure using a privately financed model.

Reported price data is also biased at the source: the reporting of unlisted infrastructure secondary market transactions can be expected to be limited and biased due to the private and often confidential nature of this information. On the debt side, it is primarily obtained from the loan-syndication market and therefore does not cover transactions executed in 'clubs' or markets where large syndications by international banks are less common. It is also likely to disproportionately cover larger transactions.

Hence, for an investor needing to value a buy-and-hold portfolio of infrastructure assets, available price data is unlikely to provide an unbiased set of comparators. Is it fair to try and mark to market a merchant power plant senior term loan originated 12 years ago using current spreads corresponding to new wind farm financings?

Tests also show that raw price data in both the unlisted equity and private debt space is not only biased but also serially correlated: part of what explains any deal value is the value of the previous deals, irrespective of anything else (sector, country, etc). Hence, when looking at comps, valuers are never looking at the characteristics of one asset, but a whole cohort of them, whatever their individual characteristics.

CAPM to the rescue?

Note that this problem is not circumvented by using a DCF methodology: the choice of discount rate still requires finding a good contemporaneous proxy of expected returns for the relevant type of security at the time of valuation.

For unlisted infrastructure, a number of investors/valuers use a single-factor capital asset pricing model (CAPM) and a listed infrastructure index to proxy the beta of the asset.

This creates two other issues that are not easily resolved:

- Single-factor models like the CAPM are not robust and have been shown time and time again in academic research to be unable to explain asset prices satisfactorily;
- Listed infrastructure proxies have been extensively studied in the academic literature and repeatedly shown to be highly correlated with broad market stock indices and to have little to no unique characteristics. In other words, they cannot be considered a satisfactory proxy of unlisted infrastructure (except if investors believe that unlisted infrastructure has a market beta of 1 in the CAPM sense).

The use of listed infrastructure proxies in combination with a naïve single-factor model of expected returns for valuation purposes may in fact have led many investors in infrastructure to book losses in 2009 that they might not have had to consider under a more robust, better calibrated framework. For one thing, at that time, raw infrastructure prices were rising steadily.

A solution: use a multi-factor approach

We propose an intuitive and powerful solution to this problem: by mapping actual transaction prices to a number of well-defined, economically motivated risk factors, we can decompose individual transaction prices by factor and estimate time-varying, unbiased and independent factor effects (risk premia) as and when transactions take place.

These risk factors are like the DNA of each transaction price. Once we understand what makes each new price, we can use its genetic makeup to estimate the price of any asset, since all infrastructure companies' DNA is made of the same elements, only in different quantities.

The statistics of this process is a version of what physicists and engineers use in signal processing applications (a Kalman filter). This set-up treats the usual multi-factor model of expected returns as series of risk premia to be repeatedly estimated over time (each time there is a new transaction) and it treats new transaction prices as a combination of signal (about the factor prices) and (white gaussian) idiosyncratic noise.

With enough transaction price data and detailed information about each investment (debt or equity) to build factor exposures such as 'size', 'leverage', 'profitability' etc, as well as a company classification that reflects systematic risk buckets[1], robust factor prices can be extracted and re-used for all assets to be priced on each transaction date.

The results we report in two new papers on the factors driving equity and debt prices in private infrastructure markets (see the next two papers in this supplement) are very robust (we report regression residuals that are indeed white noise and not serially correlated).

This can be applied to individual assets. Say we want to price an existing real toll road in 2019. How many comparable deals can we look at? Practically none. However, this toll road has a size, leverage, exposure to interest rates (country), profits, business model (merchant) etc.

Because we can observe plenty of other transactions in 2019 that also have a size, leverage, etc, and we can extract a factor price for each one of these at each point in time, we can now easily price the toll road that had no comps.

Once we can document the robust risk premia characterising individual factors and sector control variables over time, we can also apply them to a more representative population of investable companies or instruments, one that is designed to track the major segments of the infrastructure market irrespective of whether firms trade or not – ie, without any bias created by the deal flow or the availability of transaction price data for a specific type of asset.

Pricing this representative population of underlying assets gets us closer to an average measure of market prices at each point in time.

Measuring fair value makes sense

One of the main findings in this new research is that unlisted infrastructure valuations make sense: they are driven by systematic risk factors albeit not only.

We also witness an evolution of the average price, in the equity space, it is a shift upward from 2009 to 2017, followed by a plateau. This reflects the gradual re-pricing of unlisted infrastructure from a new and rather unknown asset class to an investment that is more valuable (because it is low risk). We note that this trend is also partly correlated with equivalent stock market metrics.

In the debt space, spreads shifted upwards in 2008 but once systematic risk factors are taken into account, the remaining 'trend' has barely increased by 30bps.

Hence, price discovery takes place in private markets which process information and reflect systematic effects as well as long-term valuation trends. Illiquid markets work, but in slow motion.

Measuring fair value is possible and can be done so that price ratios or discount rates are calibrated to contemporaneous market observed prices in principal markets.

*The EDHEC*infra *asset pricing methodology is described in the paper, Unlisted Infrastructure Asset Pricing Methodology (A modern approach to measuring fair value in illiquid infrastructure investments), which can be found on our website.*

1 The Infrastructure Company Classification Standard (TICCS) provides a four-pillar taxonomy.

Do systematic risk factors explain unlisted asset prices?

Frédéric Blanc-Brude and **Christy Tran**

*A paper drawn from the EDHEC*infra*/LTIIA Research Chair explores systematic drivers of prices in unlisted infrastructure equity and finds robust factor effects as well as a historic shift upwards in the pricing regime*

Unlisted infrastructure prices have increased considerably over the past decade. Was it a bubble or a normal phenomenon? How much do fundamental economic mechanisms explain the evolution of prices? As figure 1 shows, revenues and profits can be volatile in infrastructure companies and the case of merchant infrastructure correlates significantly with the business cycle.

In a new paper – Which factors explain unlisted infrastructure asset prices? Evidence from 15 years of secondary market data – we show that systematic risk factors can largely explain the evolution of average prices but also that valuations have shifted to a higher level. We show that unlisted infrastructure equity prices do not exist in a vacuum but are driven by factors that can be found across asset classes.

Six factors are found to explain the market prices of unlisted infrastructure investments over the past 15 years: size, leverage, profits, term spread, value and growth. To these usual suspects, one can add sector and geographic effects. The result is an unbiased view of the evolution of prices (price-to-sales and price-to-earnings ratios).

We also find that on top of standard risk factors associated with most firms, sector-specific factors explain the level of prices and their recent evolution. For instance, renewable energy projects are found to have much higher price-to-sales ratios than average infrastructure companies, while social infrastructure has lower than average price-to-sales and roads valuations trend up and down with the economic cycle.

Our analysis documents the contribution of these factors to the evolution of average prices over the past 15 years. Their effect is found to have been mostly persistent over this period – ie, individual risk premia have been stable albeit, in some cases, time-varying. These effects are thus likely to continue driving prices in the future.

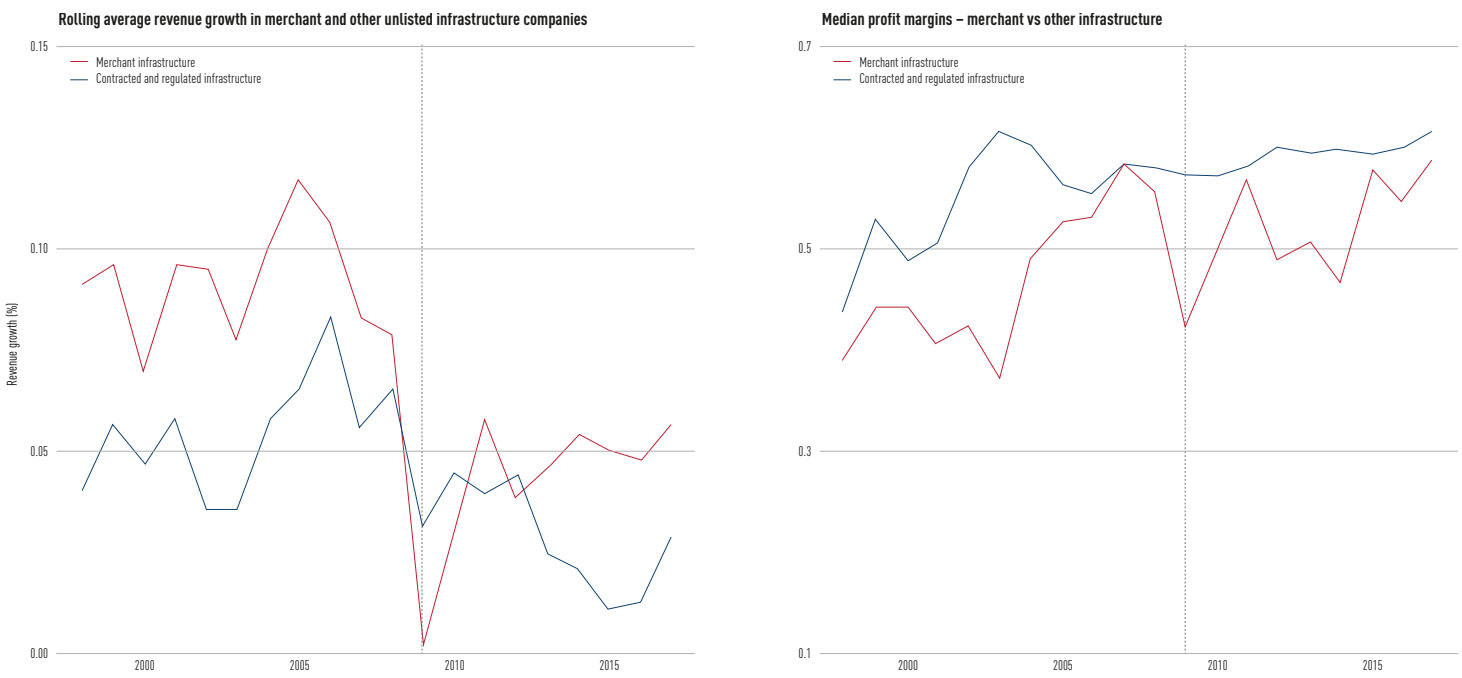
At the aggregate level, we document a degree of covariance between unlisted infrastructure prices and equivalent measures in public equity markets. At the sector level, patterns emerge with higher correlation with public markets in certain sectors more exposed to the economic cycle (eg, roads) and others experiencing peaks followed by a decrease in prices, like in the power sector.

A second phenomenon documented in this paper is a shift to a generally higher price regime for the unlisted asset class during the 2008–15 period. During those years, the effect of certain risk factors on prices become less powerful, notably leverage, as average prices increase seemingly independently of their risk profile. During that period, the nature of investors active in the unlisted infrastructure market has also shifted: a period of price discovery (which has sometimes been called a bubble) led to lower required returns as the risk preferences of the average buyer of private infrastructure companies evolved. This period appears to end after 2015, when prices stabilise.

Infrastructure businesses are expected to deliver steady and predictable cash flows and to the extent that this is the case they should be expensive. Hence, after 10 years of price increases a price consensus may have been reached.

Unlisted infrastructure prices will, in all likelihood, continue to be driven by common factors in the future, while the evolution of investor preferences

1. Rolling average revenue and profit growth in the merchant and contracted/regulated infrastructure sectors 1998–2018



Source: Blanc-Brude and Tran, 2019

will also determine the general level of prices and of the fair value of the unlisted infrastructure asset class. Our results show that despite the evolution of investor preferences, systematic risk factors mostly continued to explain prices over that period, indicating that valuations remained, on average, rational and fair.

Approach: from biased transaction prices to unbiased factor prices

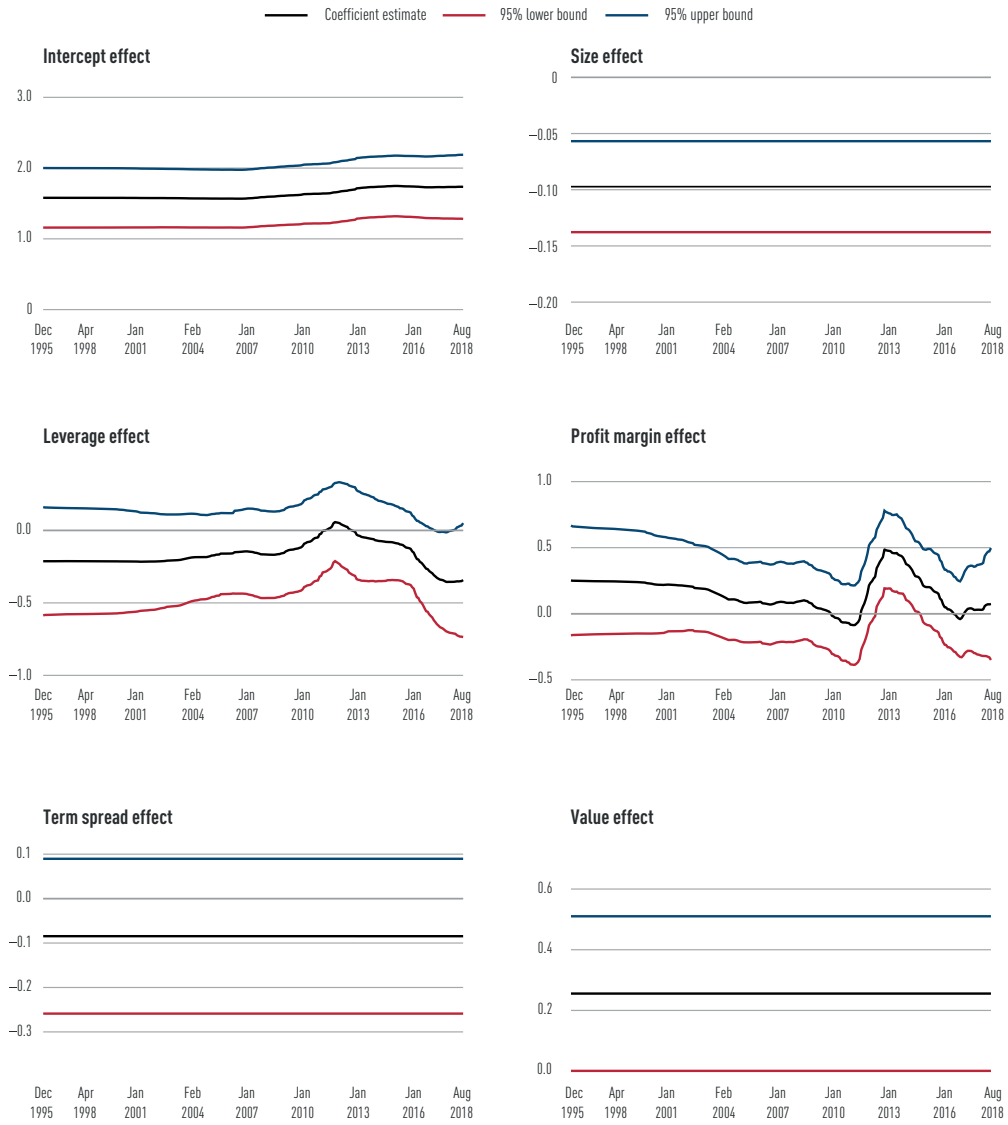
One of the most important requirements of the IFRS 13 framework is to calibrate valuations to observable market prices. Private infrastructure is an illiquid market and assets do not trade often. As a result, observable transaction prices are limited and are not representative of the investible market. But the prices and returns of unlisted infrastructure equity can be expected to be driven by certain common factors, including some that exist in other asset classes and are well known.

To overcome this issue, we estimate the effect of six factors that impact observable transaction prices and apply these to the more representative EDHEC*infra* universe of unlisted infrastructure companies. We use statistical filtering techniques (Kalman filter) to capture the changing impact of these factors on prices over time as investor preferences and market conditions change. These factor effects are unbiased and statistically robust.

This allows us to compute thousands of 'shadow prices' for those unlisted infrastructure companies that did not trade over the past 15 years. With this approach we can document the price dynamics of the unlisted infrastructure market for the underlying population and not just for a biased sample of available transaction data.

We use a price-to-sales ratio (PSR) as a valuation measure, which reflects the willingness of an investor to pay for future risky revenue growth and dividends, adjusted for risk. We find that PSRs are well behaved statistically and present multiple advantages over price-to-book and price-to-earnings ratios, not least in that they always have a positive sign. A higher PSR indicates buyers are willing to pay more per dollar of average historical revenues, suggesting that these revenues are either expected to grow or are considered more predictable. PSRs are also the standard metric used in international capital markets and may be compared directly with the equivalent ratio for public equity indices.

2. Factor-implied price-to-sales ratio of the EDHEC*infra* universe of unlisted infrastructure companies, December 1995–August 2018



Source: Blanc-Brude and Tran, 2019

3. Summary statistics of the time-varying factor effects found in unlisted infrastructure equity prices

	Min	Max	Median	Mean	Standard deviation
Size	–0.10	–0.10	–0.10	–0.10	0.00
Leverage	–0.35	0.03	–0.17	–0.16	0.09
Profit margin	–0.07	0.45	0.10	0.15	0.14
Term spread	–0.08	–0.08	–0.08	–0.08	0.00
Value	0.26	0.26	0.26	0.26	0.00
Revenue growth	–0.00	0.12	0.03	0.04	0.04
Growth asset	0.22	0.22	0.22	0.22	0.00
Airports	–0.18	0.49	0.05	0.09	0.25
Network utility	0.28	0.28	0.28	0.28	0.00
Oil and gas	0.42	0.42	0.42	0.42	0.00
Ports	0.30	0.30	0.30	0.30	0.00
Power	–0.14	–0.14	–0.14	–0.14	0.00
Renewables	0.68	0.83	0.80	0.79	0.04
Roads	–0.02	0.42	0.29	0.25	0.12
Social infrastructure	–0.42	–0.42	–0.42	–0.42	0.00

Source: Blanc-Brude and Tran, 2019

The six risk factors that explain unlisted infrastructure prices

- ***Size:*** Previous research shows that small-cap stocks tend to outperform large-cap stocks because they have a higher exposure to systematic risk factors, undergo longer periods of distress in bad times, pose higher credit risk or are less liquid. In the case of infrastructure, larger assets are found to have lower prices – ie, higher returns. Effectively, size is a proxy of liquidity: larger infrastructure projects are more illiquid, complex to develop and the object of information asymmetries between buyers and sellers.
- ***Leverage (credit risk):*** As with other firms, credit risk has an impact on equity investors in infrastructure, who take the risk of being 'wiped out' in the event of default. Infrastructure companies that have higher leverage – proxied by the ratio of total liabilities to total assets – thus have, on average, lower prices.
- ***Profits:*** Also in line with theory, profitability impacts prices directly and positively. We find that the effect – proxied by the profit margin – is time-varying and more important during bad times (the years following the financial crisis).
- ***Term spread:*** The value of infrastructure investments, with their high upfront capital costs, is determined by their long-term cash flows. They are therefore sensitive to interest (discount) rate changes. The term spread – the difference between long-term and short-term interest rates – is found to have a negative impact on prices, also as theory predicts. In an international context, differences in term spread can also signal differences in country risk, especially when short-term rates are at the zero-lower bound, which is the case during most of the relevant period of observation.
- ***Value:*** A value effect exists if companies are 'cheap' from one perspective or another. We look at infrastructure companies that report negative book values during their first 10 years as a proxy of the 'value' period in their life-cycle. We find that the greenfield stage corresponds to a different level of prices than during the rest of the firm's life-cycle.
- ***Growth:*** Infrastructure companies have limited growth opportunities as by nature they are designed to deliver individual investment projects with fixed revenues. Still, merchant infrastructure projects and corporates have

opportunities to grow. For these companies, higher expected growth relatively increases prices. We also find that, in line with theory, realised revenue growth tends to have a positive effect on valuations.

Stylised facts: the dynamics of unlisted infrastructure prices

Price-to-sales ratios of infrastructure companies are significantly higher than in public markets, irrespective of market conditions. This reflects the ability of infrastructure companies to transform income into dividends, as highlighted in previous studies, pay-out ratios (dividend pay-outs over revenues) tend to be four to five times higher in mature unlisted infrastructure companies than in listed companies of equivalent size, leverage and profitability.

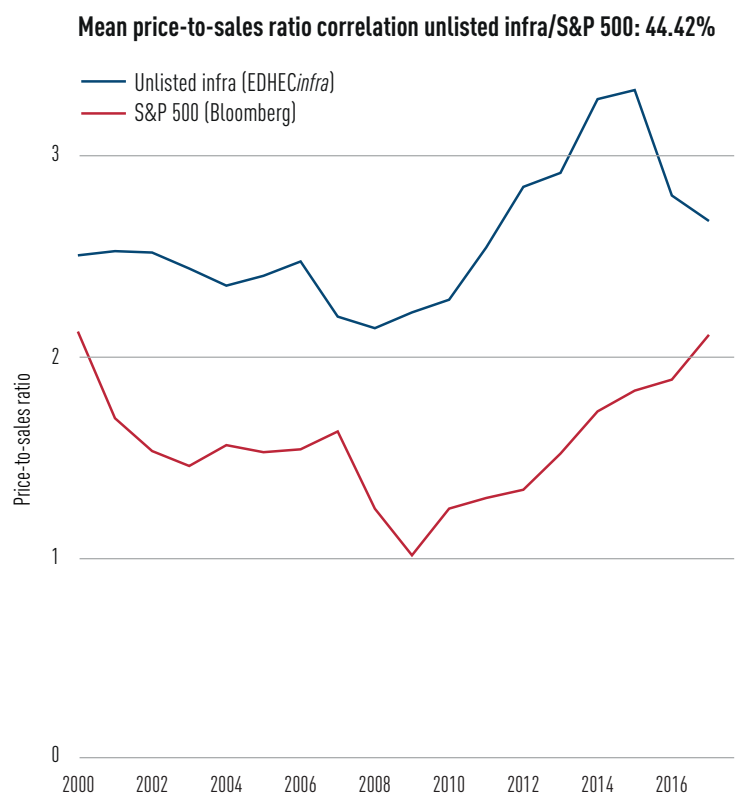
Price-to-earnings ratios tend to be much more volatile than in public markets. Indeed, pay-outs may be higher as share of revenues but they are also more variable as a result of the significant financial and operational leverage that characterises infrastructure companies. Their large but mostly fixed production costs make any excess revenue a source of pure profit, but since any decline in revenues is not easily matched with a decline in production costs, profits can decline very fast as well.

For the most part, the factors driving unlisted infrastructure secondary market prices make sense: size, leverage, value or profitability have the signs predicted by theory and their effects are persistent, albeit variable, across time. This is significant to define an ex ante factor model of returns for the purpose of asset valuation.

Price formation and discovery is slow: the factor effects documented above can take several years to change from one level to another, as transactions and investor preferences are processed by market mechanisms. This is partly the reflection of unlisted infrastructure's status as a 'new' asset class, so that numerous transactions were necessary over many years for 'fair' prices – representing the willingness to pay of numerous buyers and sellers at one point in time – to emerge. Prices do not react immediately to short-term variations in financial conditions: the swings in price-to-earnings are due to the fact that prices stayed on a steadily increasing path for most of the period, while earnings swung up and down, especially in the merchant sector. This can be both a function of the slow processing of price information in a highly illiquid market, as well as the reflection of the belief by buyers that most of the value of infrastructure companies is embodied in a long-term business model, which can be considered impervious to short-term volatility.

Valuations are not out of line with fair value: because price movements can be explained by systematic factors and the remaining variability of transaction prices appears to be idiosyncratic, prices can be said to have mostly evolved to reflect the preferences of market participants taking major risk factors into account. In other, words, pricing has remained rational and informed. The fact that prices have increased a lot over the past decade cannot simply be attributed to a 'wall of cash' effect in a market where many participants were chasing few available opportunities.

4. Example of time-varying systematic effect driving the price-to-sales ratio of infrastructure companies



Source: Blanc-Brude and Tran, 2019

The pricing of private infrastructure debt

Frédéric Blanc-Brude and **Jing-Li Yim**

Which factors explain private infrastructure credit spreads (and discount rates) and how do they evolve over time? Are infrastructure project finance spreads and infrastructure corporate spreads driven by common factors?

In new research, EDHEC*infra* examines the drivers and evolution of credit spreads in private infrastructure debt.

We show that common risk factors partly explain both infrastructure and corporate debt spreads. However, the pricing of these factors differs, sometimes considerably, between the two types of private debt instruments.

We also find that private infrastructure debt has been 'fairly' priced even after the 2008 credit crisis. That is because spread levels are well explained by the evolution of systematic risk factor premia and, taking these into account, current spreads are only about 20bps above their pre-2008 level. In other words, taking into account the level of risk (factor loadings) in the investible universe and the price of risk (risk factor premia) over the past 20 years, we only find a small increase in the average level of credit spreads, whereas absolute spread levels are twice as high today as they were before 2008.

A better approach to estimating market credit spreads

The main difficulty facing econometric research on the pricing of infrastructure debt is the paucity and biases of observable data. Secondary transactions are very rare and usually not instrument-level sales. Still, large numbers of primary transactions (at the time of origination) can be observed. Nevertheless, this data is biased: origination follows procurement and industrial trends – eg, it tends to cluster in time and space when and where governments procure new infrastructure using a privately-financed model. Simply observing origination credit spreads over time does not take into account the underlying market for private infrastructure debt to which investors are exposed.

Primary spread data is also auto-correlated – ie, what best explains the spread for a given infrastructure borrower is not its characteristics, but the spread of the previous transaction.

To address these issues and estimate the effect of individual risk factors on

spreads we do two things. First, we estimate the evolution over time of the risk factor premia and determine their unbiased effects on spreads over time. Second, we use the EDHEC*infra* universe, a representative sample of existing infrastructure borrowers – as opposed to the biased sample of new borrowers in the primary market – to apply the risk premia estimated in the first step to the 'factor loadings' (the characteristics) of this better sample, thus computing a current market spread for each one, at each point in time.

Using a factor model in combination with a representative sample of investible assets can correct the bias and paucity of available data: as long as such factors can be documented in a robust and unbiased manner (see figures 4 and 5), they can be used to assess the fair value of private debt investments over time, whether they are traded or not.

What factors explain infrastructure credit spreads?

Our results show how the aftermath of the 2008 crisis changed and sometimes removed well-established relationships between certain factors and the cost of corporate and infrastructure debt: the impact of base rates on loan pricing disappeared, structural differences between markets vanished and certain sectors like roads experienced a continued increase in the price of long-term private financing.

Our results are statistically robust and explain the data well. We show that infrastructure and corporate credit spreads are determined by a combination of common factors that can be grouped into four categories:

- ***Market trend:*** the largest effect driving credit spreads in both infrastructure and corporate debt is a time-varying trend factor which captures the state of the credit market over time. This effect is not explained by loan or borrower characteristics. In the case of infrastructure debt, this effect is roughly constant but exhibits 'regime shifts', especially 2008 (up) and 2014 (down). In the case of corporate debt, it is an upward trend also exhibiting jumps in 2008 and 2012. We find a 20bps increase in infrastructure spreads compared to pre-crisis levels, down from 75bps at the height of the credit crisis, indicating a degree of mean-reversion.

Credit risk only explains part of the level of credit spreads.

We find that infrastructure borrowers that are exposed to merchant risk are required to pay a time-varying premium from 20–40% above the market average at the time.

1. Example of time-varying systematic effect driving the credit spreads of infrastructure debt instruments,

* = log-transformation. Source: Blanc-Brude and Yim, 2019

Size has no effect on average corporate spreads but is a driver of lower risk premium in infrastructure debt. In effect, larger loans can be interpreted as a signal of lower credit risk in infrastructure finance.

Industrial groups can be considered a partial proxy for credit risk but are mostly not significant, expect for social infrastructure and, among corporate

2. Summary statistics of the time-varying factor effects found in unlisted infrastructure spreads

	Min	Max	Median	Mean	Standard deviation	SE
Intercept	5.16	5.58	5.28	5.33	0.13	0.10
Benchmark rate	–0.15	–0.00	–0.10	–0.10	0.04	0.04
Euribor	–0.31	0.10	–0.14	–0.12	0.14	0.07
Size	–0.08	–0.00	–0.06	–0.05	0.02	0.02
Maturity	0.03	0.03	0.03	0.03	0.00	0.01
Refi	–0.21	0.32	0.07	0.07	0.12	0.08
Acquistion	–0.07	0.25	0.20	0.15	0.11	0.11
Merchant	–0.31	0.34	0.09	0.08	0.19	0.08
North America	0.05	0.58	0.42	0.34	0.17	0.07
Latin America	–0.24	0.80	0.33	0.35	0.29	0.11
APAC	–0.10	0.24	0.14	0.11	0.09	0.10
Power generation	–0.02	0.08	0.03	0.03	0.03	0.06
Renewable power generation	–0.05	0.07	–0.00	0.00	0.04	0.05
Energy and water resources	–0.44	0.23	–0.13	–0.11	0.14	0.12
Network utilities	0.08	0.08	0.08	0.08	0.00	0.07
Social infrastructure	–0.47	0.27	–0.16	–0.15	0.19	0.13
Data infrastructure	0.01	0.54	0.30	0.29	0.13	0.10
Road companies	–0.23	0.18	–0.06	–0.05	0.12	0.09

Source: Blanc-Brude and Yim, 2019

3. Factor effects found in unlisted infrastructure spreads by time bucket

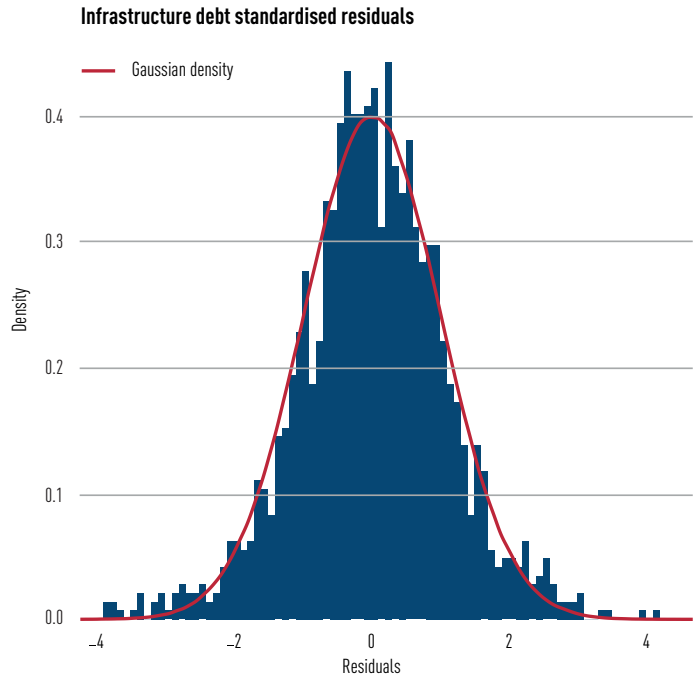
	2000–05	2005–10	2010–15	Since 2015
Intercept	5.25	5.26	5.51	5.39
Benchmark rate	–0.11	–0.14	–0.06	–0.01
Euribor	–0.16	–0.20	0.07	0.04
Size	–0.07	–0.05	–0.03	–0.04
Maturity	0.03	0.03	0.03	0.03
Refi	0.01	0.16	0.09	0.04
Acquistion	0.25	0.23	0.08	–0.06
Merchant	0.06	0.14	0.19	0.33
North America	0.47	0.39	0.10	0.18
Latin America	0.62	0.25	0.22	0.06
APAC	–0.02	0.17	0.14	0.11
Power generation	0.06	0.05	0.01	–0.02
Renewable power generation	–0.05	0.01	0.06	0.06
Energy and water resources	–0.18	–0.12	–0.01	0.14
Network utilities	0.08	0.08	0.08	0.08
Social infrastructure	–0.17	–0.33	0.04	0.18
Data infrastructure	0.46	0.31	0.17	0.15
Road companies	–0.20	–0.14	0.04	0.12

Source: Blanc-Brude and Yim, 2019

4. Observed and predicted spreads using a time-varying factor model and Bayesian/Kalman filtering

Source: Blanc-Brude and Yim, 2019

5. Regression residuals of the factor model match the hypothesis of Gaussian noise in the data



Source: Blanc-Brude and Yim, 2019

borrowers, infrastructure corporates, which have come to benefit from a substantial discount relative to average market spreads in recent years.

- ***Liquidity:*** Other drivers of spreads are proxies of the cost of liquidity for creditors.
- ***Maturity:*** While it is difficult to capture in static models, maturity is found to be a significant and time-varying driver of spreads for corporate debt, with a higher premium charged during a period of lower bank liquidity (2008–16), whereas infrastructure debt has a constant maturity premium.

While the effect of size is primarily a matter of credit risk, we note that in periods of limited creditor liquidity (2008), even infrastructure debt becomes more expensive as a function of size. However, this effect is not strong enough to create a size premium.

Re-financings, which are not a significant driver of spreads in normal times, are shown to be more expensive in times of credit market stress, especially for infrastructure debt.

- ***Cost of funds:*** the benchmark against which floating rate debt is priced has been a factor explaining the level of credit spreads. Base rates are inversely related to spread – ie, higher rates imply lower spreads – but this effect is shown to have all but vanished since 2008. Since then, the level of credit spreads and that of base interest rates has become completely uncorrelated.
- ***Market segments:*** taking base rates into account, some markets are chapter than others as a result of the well-known segmentation of credit markets. This is the case when comparing Libor vs Euribor priced loans but also the different geographic areas in which different lenders operate. Again, since 2008, these differences have tended to disappear.

Towards fair value in private infrastructure debt

Our assessment of the impact of certain risk factors in the formation of aggregate credit spreads is relevant for at least three reasons:

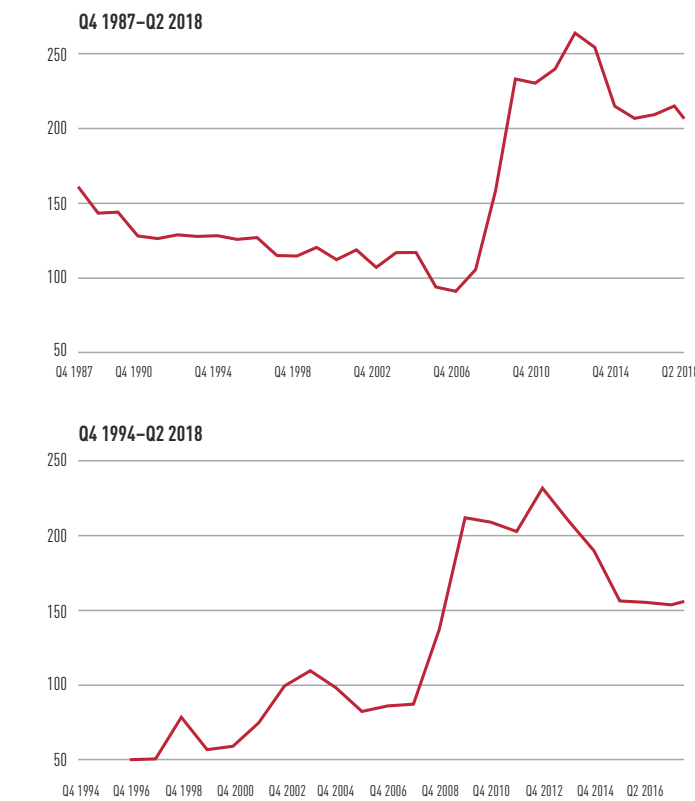
- While observable spreads are biased due to the segmentation and low liquidity of the private credit market, unbiased factor prices (premia) can be estimated from observable spreads, and used to determine the factor-implied spreads for any instrument at any time;
- The time-varying nature of individual risk premia implies that re-pricing individual instruments over time can be material and is required if such investments are to be evaluated on a fair value basis;
- A multi-factor model of spreads – ie, discount rates – allows more robust valuation taking into account the effect of systematic risk factors. One of the most important requirements of the IFRS 13 framework is to calibrate valuations to observable market prices, thus ensuring that estimated spreads represent current investor preferences at the measurement time. While fair value is not always required for debt instruments, which are booked at their face value unless they become impaired, the requirement to evaluate assets on a like-for-like basis will only grow as the private debt asset class becomes a more significant part of investors' portfolios.

The market prices of infrastructure debt

Applying our findings to the EDHEC*infra* universe of private infrastructure debt, we can compute factor-implied spreads for a representative population of credit instruments. We take into account the effect of the various factors on each instrument in the universe and report the average spread of the underlying population – ie, not the origination spreads which are an input to the model but valuation spreads which are the output of the factor model.

Figure 6 shows these results for infrastructure project finance spreads and for infrastructure corporates.

6. Factor-implied spreads for the EDHEC*infra* universe of private debt instruments



Source: Blanc-Brude and Yim, 2019

Does better ESG improve infrastructure returns?

Tim Whittaker and **Silvia Garcia**

The environmental, social, and governance (ESG) aspects of infrastructure investments have been an increasingly important set of considerations for investors

ESG is very relevant to the infrastructure sector. Infrastructure is critical to the health and wealth of economies, and infrastructure spending increases economic output and overall factor productivity. Furthermore, some types of infrastructure, such as renewable energy projects, are expected to contribute to a more sustainable future and can be considered sustainable infrastructure.

Wiener (2014) defines sustainable infrastructure as that which integrates ESG directly into a project's planning, building and operating phases with the aim of mitigating risk, reducing emissions and promoting social cohesion and economic development while ensuring resilience in the face of climate change or other shocks.

The relationship between the impact of certain companies' activities on their social and natural environments on the one hand and their ability to deliver a certain level of financial performance on the other is now a central question in the debate around responsible investment, especially when investors represent large constituencies of members of pension plans, whether they belong to collective or individual schemes.

In effect, favouring investments with desirable ESG characteristics is becoming a matter of principle or investment philosophy for an increasing proportion of investors.

Figure 1 shows that the vast majority of investors who took the 2019 EDHEC*infra*/G20 survey of infrastructure investors are at least somewhat aware (48%), if not very aware (42%), of the ESG characteristics of their infrastructure investments.

Figure 2 shows that in the 2016 edition of this survey, 17% of asset owners identified achieving ESG objectives to be a 'first-order question', possibly at the expense of financial performance. In 2019, this figure has reached close to 36%.

This implies that, rather than using ESG as driver of (higher or lower) returns in the portfolio, investors increasingly see ESG as a set of filters that should lead them to exclude certain assets from their investment set.

Meanwhile, the argument is often made by asset managers that better ESG investing goes hand in hand with higher returns or even that an 'ESG factor' exists and that it drives the performance of companies over and above traditional risk factors.

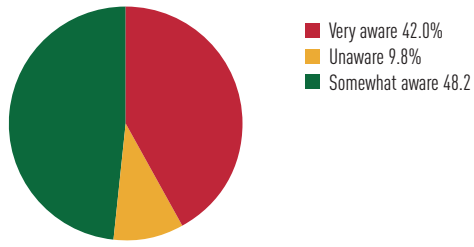
Why more sustainable infrastructure should exhibit systematically higher returns might seem puzzling from the point of view of asset pricing theory. The question of ESG's impact on infrastructure returns relates to the risk exposures created by the corresponding firm characteristics. If different levels of ESG impact affect the riskiness of investment in infrastructure companies, their values should reflect this.

Thus, if more sustainable energy infrastructure is less likely to face costly future carbon emission regulation, it can be considered less risky than otherwise equivalent assets: hence, it should have lower expected returns.

Conversely, if renewable energy investments are understood to create a large exposure to energy sector regulatory risk, then such investments should indeed be expected to exhibit higher returns. For instance, a government could abruptly withdraw subsidies to the solar sector, pushing an entire generation of renewable energy projects to the brink of bankruptcy.

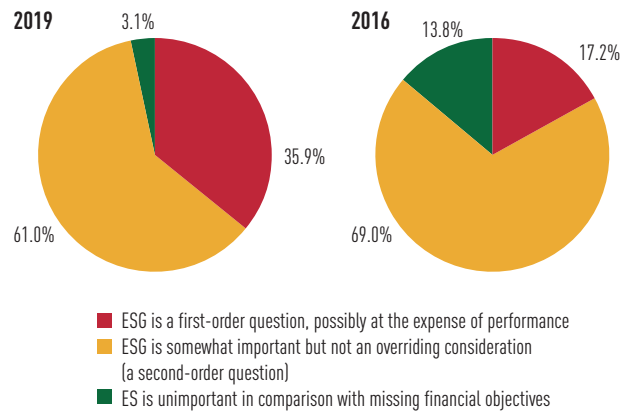
One question is whether the ESG characteristics of infrastructure companies, and the risk exposures they create, can be expected to have a clear-cut, systematic impact on returns. In fact, the effect of the E in ESG is not necessarily the same as that of the S or the G. These effects, which are mostly a matter of current and future regulation, may have different sizes and signs. They may also change size and sign over time. What the net effect of better ESG incorporation on infrastructure returns should be is not self-evident.

1. How aware are investors of the ESG performance of their infrastructure investments?



Source: 2019 EDHEC*infra*/G20 survey

2. How principled is institutional investors' stance about the social and environmental impact of infrastructure investments?

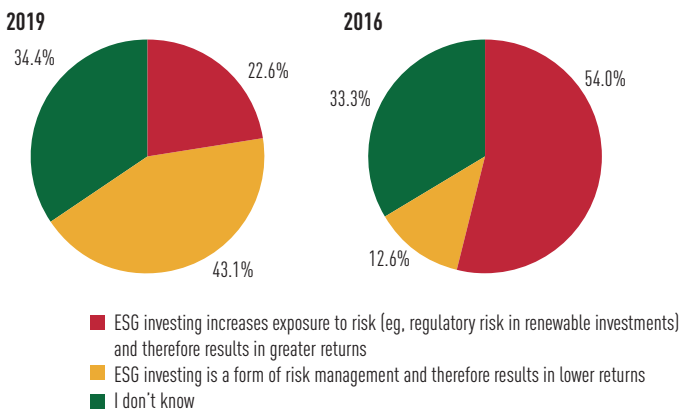


Source: 2019 EDHEC*infra*/G20 survey

A second question is whether the actual impacts of certain infrastructure businesses on the economy, environment and society at large may ever enter the realm of the regulation of these sectors and impact their bottom line. For instance, say that most ports in Europe are part of well-documented drug-trafficking routes, ensuring the distribution of cocaine across Europe (see Europol [2013]) and contributing to an equally well-documented negative social impact. It seems unlikely that the same port companies should, as a result, be expected to face new and costly regulation to address what is essentially a law-enforcement issue. Not all social or environmental impacts of infrastructure companies, of which there are many, are the object of regulation or re-regulation that may have a systematic effect on the financial performance of infrastructure firms. Externalities are, by definition, not priced.

Figure 3 shows the 2016 and 2019 responses to the question 'Does better ESG lead to higher or lower returns?' In three years, the dominant view has shifted from the notion that ESG should lead to higher returns (implying

3. Does better ESG lead to higher or lower returns?



Source: 2019 EDHEC*infra*/G20 survey

higher risk) to the opposite view: better ESG means managing/lowering risks and thus should lead to lower returns (higher prices).

Both views are of course valid in theory, as discussed above. The question of which effects play the largest roles in practice remains a matter of empirical research.

Future research will aim to establish any empirical link between actual impact and financial performance. In the meantime, this topic remains an important aspect of infrastructure investors' 'investment beliefs' and one that is evolving over time, as the survey results demonstrate.

In a first paper on this topic, we compare ESG reporting scores and their relationship with return on assets and find that they are not correlated in any meaningful way.

Does ESG reporting make a difference?

The most recent paper drawn from the EDHEC*infra*/LTIIA Research Chair is the first attempt at studying the relationship between the ESG and financial characteristics of infrastructure companies, which is now a central question for investors in the infrastructure asset class.

In this paper, as a first attempt to address this topic, we investigate the role of ESG reporting in relation to the financial performance of infrastructure companies. Indeed, data on ESG reporting are available and there are grounds in the academic literature for arguing that the tendency to report ESG practices are related to actual sustainable outcomes.

This paper is made possible by cross-referencing two unique databases covering the behaviour of infrastructure firms: the ESG scores computed by GRESB Infrastructure since 2016, which measure the level of reporting and management of ESG, and the financial metrics corresponding to the EDHEC*infra* universe.

We examine three simple questions:

- Which firms choose to report ESG data?
- What explains differences in ESG reporting scores?
- Do higher ESG reporting scores tend to correspond to higher or lower returns?

Using a series of statistical tests and regression analyses, we report the following findings:

- ***The likelihood of ESG reporting is related to corporate structure and size.*** Using the EDHEC*infra* universe as a reference, we find that companies that report ESG data tend to be larger and less leveraged than the firms in a representative universe of investable infrastructure companies. They are also more likely to be 'corporates' rather than 'project' companies (ie, project finance special-purpose vehicles). Interestingly, contrary to our expectation, firms that tend to report ESG data are not the most profitable firms.
- ***The ESG reporting scores are driven by similar factors.*** We find that the level of ESG scores is positively correlated with firms' size and age, while firms that are more leveraged tend to have lower scores. Indeed, larger, less leveraged and more mature firms have more resources available and likely more free cash flow to implement social responsibility initiatives, thus boosting their ESG scores. In this study, there is no support for the hypothesis found in the academic literature that more profitable firms also have higher ESG performance ratings.
- Finally, we find that ***ESG scores do not correlate positively or negatively with financial performance*** for unlisted infrastructure firms. Importantly, we do not find any negative relation between ESG reporting scores and financial performance (return on assets), suggesting that implementing ESG policies and practices does not harm financial performance either.

ESG is not a risk factor

These findings make sense in the context of existing academic research on reporting and the characteristics of firms.

They also make sense from an asset pricing perspective: once traditional risk factors that tend to explain performance are taken into account (eg, size, leverage, corporate structure, etc), any difference in the level of ESG reporting by firms is explained away.

This is congruent with the finding in listed equity research that ESG screens tend to 'load' on multiple risk factors (like 'value' or 'low volatility'), which are well-known drivers of excess returns in equity markets. Hence, ESG screens create implicit risk factor tilts in investment portfolios. Once these effects are taken into account, any ESG effect that might be correlated with higher or lower returns disappears.

In a context where institutional investors are increasingly demonstrating that ESG filters represent principle-based investment philosophies, the notion that ESG should be somehow implicitly linked to performance is in fact not helpful.

There are many reasons that infrastructure investors, managers and operators may choose to report on, and improve, their ESG performance. These include protecting reputation and social licence, the pre-emptive insurance effect for adverse ESG events (tail risks), responding to investor preferences and mandates, changes in environmental legislation, increasingly stringent governance requirements and reflecting the values of stakeholders including pension holders, employees and the community.

Instead, investors can aim to design investment strategies and policies that are optimal, given their investment preferences and objectives, including any ESG filter that they may wish to implement upfront.

Tomorrow: better reporting, better data

This study highlights that much further work is needed to understand the link between ESG and financial performance, especially long-term effects.

Our results are limited by the length of the time series available and would benefit from an update when longer time series become available. This is particularly relevant when it comes to ESG, because one of the key expected mechanisms by which ESG might impact financial performance is by lowering the volatility of a company's cash flows as the impact of negative effects can be avoided or mitigated. These 'tail risks' may only be detected in datasets covering long time periods. It should be noted that if this were the case, higher ESG scores would, of course, mean lower returns, since such firms would be exposed to lower total risk.

More granularity in future datasets will also allow differentiating the effect of the E, the S and the G in ESG, which may have different and contrary relationships with firm characteristics and performance.

Future research can also explore relationships between ESG scores and other measures financial performance such as probability of default, Sharpe ratio, maximum drawdown and value-at-risk.

These results also have implications for ESG reporting and benchmarking – the tendency of mainly larger corporates to report more often and to provide better ESG data can be addressed through the development of more streamlined, standardised ESG reporting that is independently validated. This will improve the granularity of the data available and better discriminate between the characteristics of infrastructure corporates and projects.

This first research paper represents a stepping stone for future empirical research on impact investing in infrastructure. In particular, a sharper focus on ESG issues that are material to each firm, and the development of new metrics that focus on the actual environmental, social and economic impact of infrastructure companies will allow for a much deeper understanding of the relationship between ESG and the performance of infrastructure investments. These are all areas of active development that will enhance any future research.

The authors and EDHEC*infra wish to thank GRESB Infrastructure for making this study possible by sharing the GRESB 2016–18 datasets of ESG reports by infrastructure investors.*

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Is infrastructure always an active strategy?

Frédéric Blanc-Brude

For asset managers and asset owners that choose to invest directly, building a substantial exposure to unlisted infrastructure can take a long time and require significant amounts of capital.

Each transaction takes time (often more than 12 months) and unlisted equity investments in particular can be very lumpy, with ticket sizes often in the hundreds of millions or billions of dollars. This naturally leads to risk concentration in infrastructure portfolios, especially during the first decade of their development.

Not only is trading time uncertain but the possibility to invest can also be partly unknown: most infrastructure is public and such investments are the object of government procurement and privatisation processes that can be uncertain and sometimes reversed.

As a result, rather than picking the best deals, infrastructure investors are often left doing the deals they can, when they can, if they can.

Achieving sufficient diversification within the infrastructure portfolio should thus be a source of concern and monitoring.

Portfolio diversification matters because financial markets remunerate systematic risk. Indeed, even if a degree of idiosyncratic or company-specific risk is remunerated in highly illiquid and segmented markets like unlisted infrastructure (which remains an empirical question) remunerated systematic risk remains at the heart of the risk-return trade-off that should characterise any financial investment decision.

For self-declared long-term investors wishing to take buy-and-hold positions in unlisted infrastructure, only systematic risk factors should matter and be expected to deliver risk premia at a medium- to long-term horizon.

Hence, ensuring that infrastructure investments not only create diversification benefits within the total portfolio but are themselves well-diversified is not a trivial question.

Survey respondents were asked how many assets they think are required to have a well-diversified portfolio of unlisted infrastructure investments.

Since private infrastructure investments are known to be lumpy and highly leveraged, which suggests non-Gaussian returns, the achievement of sufficient diversification is likely to require a large number of assets.

Still, figure 1 shows that the majority of respondents to the 2019 EDHEC*infra*/G20 survey of infrastructure investors believe that fewer than 20 assets are sufficient to have a 'well-diversified' portfolio of unlisted infrastructure investments. This is believed to be the case by more than 60% of asset managers.

Respondents' views are likely to be anchored in the reality of infrastructure investing: respondents tended to report a number of assets in line with the average number of investments made by unlisted infrastructure funds or asset owners that practice direct investment. Larger portfolios cannot be easily achieved by a single fund or direct asset owner.

These results suggest that the diversification of unlisted infrastructure assets is not given much serious thought by asset owners and managers.

Respondents' views on diversification may arise from a common misconception based on studies reporting that a portfolio of 20–30 stocks can achieve adequate diversification (Statman [1987], Evans and Archer [1968]).

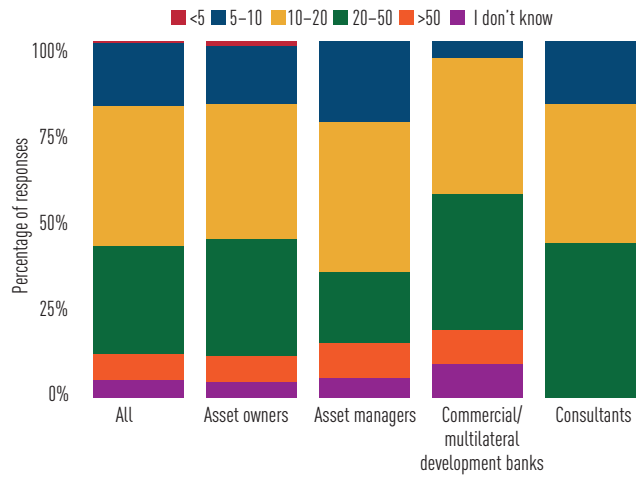
These results may hold on average but not for any random set of 30 stocks. Moreover, these papers mainly cover US stocks. More recent studies covering global stocks find that even 100 stocks may not be enough to achieve full diversification, particularly in periods of stress (Domian et al [2007], Alexeev and Tapon [2012]).

Likewise, research on real estate investment has found that when returns are not Gaussian, portfolios may need up to 250 assets to achieve high levels of diversification (Callender et al [2007]).

It seems likely that several dozens – and perhaps hundreds – of infrastructure investments are required to achieve significant portfolio diversification, even though such high numbers of individual assets are unattainable in today's institutional portfolios.

This first finding thus begs the question: is infrastructure investment always active? To what extent can investors expect managers or their own investment team to deliver outperformance relative to an asset class benchmark if they cannot access the systematic characteristics of the asset class itself?

1. How many assets are required to have a well-diversified portfolio of infrastructure investments?



Source: 2019 EDHEC*infra*/G20 survey

As long as most investors in infrastructure find themselves exposed to a (mostly) ad hoc portfolio of (relatively) small number of lumpy investments, their understanding of their own risks and how to benchmark them should be different than if they could reliably invest in a well-diversified portfolio of unlisted infrastructure equity or debt.

Still, even with a portfolio of one asset, any investor in unlisted infrastructure is both exposed to systematic risk factors that can be proxied with a representative benchmark (eg, a benchmark with the same factor loadings as the one asset) and can in principle assess its own alpha (positive or negative) relative to this benchmark.

The compensation of the manager responsible for building this imaginary single-asset portfolio should then depend mostly on this alpha since any other manager making any other infrastructure investment with the same characteristics would on average have delivered an exposure to the same remunerated risk factors.

The same applies with more than one asset.

Hence, even if limited diversification is possible and infrastructure investment is an active strategy, benchmarking remains not only relevant and also central in the investment process since active strategies are about delivering alpha, which can only be known using a benchmark.

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