

Towards Efficient Benchmarks for Infrastructure Equity Investments

A review of the literature on infrastructure equity
investment and directions for future research

January 2013



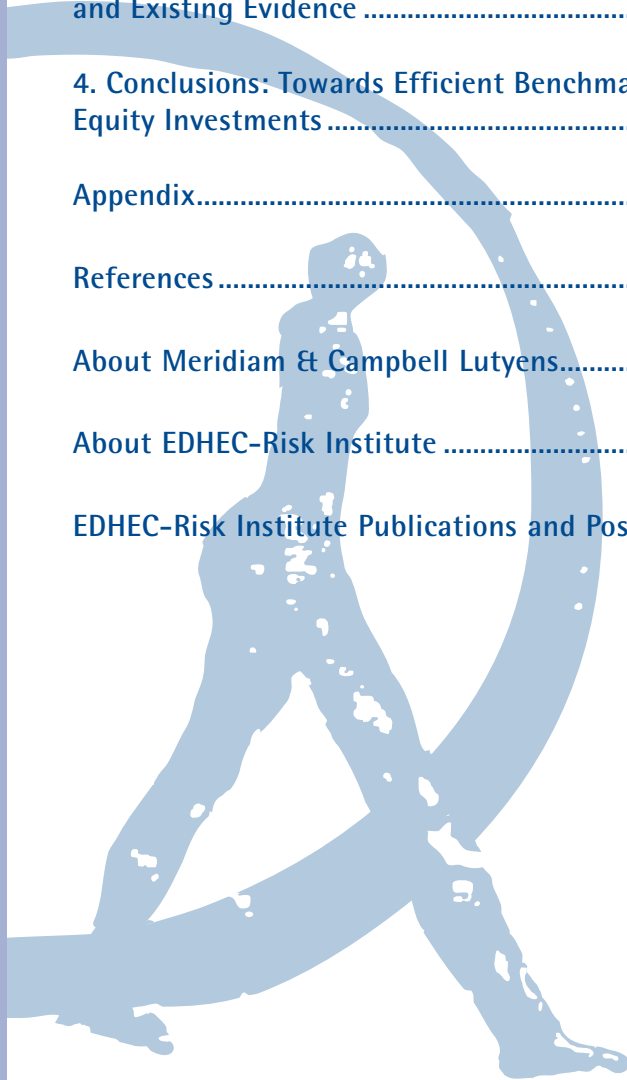
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Foreword

This publication marks the launch of the Meridiam/Campbell Lutyens research chair on infrastructure equity investment management and benchmarking at EDHEC-Risk Institute. Under the responsibility of Frédéric Blanc-Brude, Research Director at EDHEC Risk Institute—Asia, this chair examines the investment characteristics of infrastructure equity investment from the point of view of institutional investors.

This research chair aims to bring clarity to institutional investors and regulators about the nature and investment profile of underlying infrastructure assets and of different types of investment funds using infrastructure as an underlying asset. In the context of the current shift towards alternative investment amongst institutional investors, this work will benefit the entire investment management community and help improve asset allocation and portfolio construction decisions.

This research will follow three directions concurrently. First, by helping the investment management industry to better appreciate the financial economics and investment characteristics of underlying infrastructure investments, be they standalone projects or integrated utilities, we aim to contribute to improved investment vehicle design by intermediaries and to enhanced usage of infrastructure equity in long-term asset allocation decisions.

Second, in the context of the regulatory changes affecting long-term investors, we aim to develop theoretical insights allowing for finer risk assessment and valuation of infrastructure equity. The objective is to assist institutional investors in the design, calibration and update of internal models that adequately account for the specificities of equity infrastructure investment when

determining risk-based solvency and capital requirements.

Finally, we aim to discuss the bases for a cash flow-reporting standard with the industry and engage in a wide-ranging effort to collect new data from investors in infrastructure equity, and work towards the development of meaningful and useful performance and risk benchmarks.

This foundation paper starts from the empirical observation that infrastructure investing has not proven straightforward for institutional investors and that investment performance has so far seemed out of sync with their expectations. It makes two important contributions to the approach of infrastructure equity investment: firstly, using fundamental results and insights from economics and corporate finance, it shows that underlying infrastructure equity investments are not real assets as is sometimes argued, but financial assets representing rights to contractually determined cash flows. Secondly, it reviews the past decade of academic research on investment vehicles using infrastructure equity as an underlying and shows that the infrastructure equity *beta* has so far remained elusive and that passive investment solutions remain to be built. This research chair is dedicated to promoting research supporting such developments.

We would like to express our gratitude to our partners at Meridiam and Campbell Lutyens for their support of this important research effort into improved understanding, standardisation and benchmarking of infrastructure equity investments.



Frédéric Ducoulombier
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About the Author



Frédéric Blanc-Brude is Research Director at EDHEC Risk Institute–Asia and heads the Institute's thematic research programme on infrastructure financing and investment. Prior to joining EDHEC-Risk Institute, he worked for ten years in the infrastructure finance sector advising developers, financiers, governments, and supranationals, and being actively involved in transactions representing a cumulative value of more than USD6bn in Europe, Asia and the Middle East. Between 2008 and 2011, he headed the Chinese operations of a boutique consultancy specialised in energy and water projects in Shanghai and Beijing. He has published his research in academic journals, co-authored reports for supranationals such as the European Investment Bank and the World Bank as well as for the World Economic Forum and other commercial entities. He regularly presents his work at academic and industry conferences. He has also taught international finance at King's College London and designed and delivered executive seminars on infrastructure finance. He holds a PhD in Finance from King's College London, an MSc in Political Theory from the London School of Economics and Political Science, a Master in Economics from Panthéon-Sorbonne University, and is a graduate of the Paris Institute of Political Studies (Sciences Po).

Executive Summary



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The paper highlights a recent research quandary with respect to infrastructure equity investment which has also been a source of interrogation for final investors: while the economics of underlying infrastructure investment suggests a low and potentially attractive risk profile, the experience of investors and available research evidence have been different and rather mixed. This paper attempts to explain why this has been the case and what new research and benchmarking efforts are necessary to create investment solutions that realign expectation and observed investment performance as well as to inform the regulatory debate in relation to institutional investing in long-term assets like infrastructure equity.

Our contribution is threefold: in a first part, we discuss the nature of underlying infrastructure equity and what mechanisms explain its investment characteristics. Next, we review the rationale for infrastructure investing by insurance companies and pension funds and existing empirical research on the performance of existing investment routes and vehicles. Finally, we discuss what approaches to benchmarking and portfolio construction might best capture the characteristics of underlying infrastructure and highlight the need for new data collection and appropriate benchmarking methodologies.

The nature of underlying infrastructure investments

Infrastructure equity investments derive their characteristics from the contractual relationship that creates the opportunity to delegate¹ investment in stand-alone infrastructure facilities. These investments

are relationship-specific i.e. they have little or no value outside of the contractual relationship in question, in particular, they have no value if they are not used. In this respect they are the opposite of real assets since they have no intrinsic value. From the relationship specificity of infrastructure investments also springs their *tenor*, since they can only be recouped over a period of effective use. This tenor is typically long enough (beyond ten years) to qualify as long-term.

Furthermore, a significant proportion of any country's infrastructure is *public* infrastructure insofar as a public entity guarantees the continuity of service. Thus, despite investment delegation, the ownership of most tangible infrastructure remains explicitly in the public domain, and always implicitly under the eminent domain of the State. Hence, when contracts have a well-defined tenor (e.g. project finance), the terminal value of such investments can be considered to be zero.² Likewise, when assets are held in perpetuity (e.g. utilities) the exit value of the firm's equity should solely be a function of risk-adjusted expected cash flows to equity.

In the absence of valuable tangible assets, it follows that firms existing solely to enter into long-term contracts delegating investment in standalone infrastructure projects – usually known as project companies or special purpose vehicles, but also utilities – derive their value solely from the characteristics of those contracts and the cash flows to which they give rights.

These contracts delegating infrastructure investment are characterised by a risk-sharing mechanism embodied by

1 - Here the term 'delegation' refers to any contractual arrangement by which one party assigns the execution of a task to another, as it is used in economics and contract theory. 'Public service delegation' which often designates concession contracts for public services is only one case of task delegation.

2 - Here 'terminal value' refers to holding an equity investment in an infrastructure project until maturity i.e. the end of the contract.

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the revenue model agreed between the delegating party and the party carrying out the investment. While numerous risk-sharing agreements can be envisaged, in principle, few are used in practice (Blanc-Brude 2012c).

Thus, three types of contracts are used to delegate investment in 'public' infrastructure, that is when the party delegating investment in an infrastructure project is the public sector:

- **Availability payment schemes**, by which the public sector promises to pay a **fixed income** over a pre-agreed period, typically in excess of two decades, in exchange of what the investor accepts responsibility for the investment, operating, debt service and residual equity cash flows related to delivery of an infrastructure project, according to an agreed output specification. Terminal value is set to zero and control of the physical assets is returned to the public sector at the end of the contract. This model is typically used to deliver social infrastructure projects like schools, hospitals or government building.

- **Commercial schemes**, by which the public sector enters into the same contract with an investor but in exchange for a **variable income cash flow**. This is typically the case with tolled transportation projects, for which the investor is granted the right to collect tolls/tariffs from users. Terminal value is set to zero in most jurisdictions. This model is typically used for transport projects with real tolls.

- **Capped commercial schemes** consist of the same investment proposition than commercial schemes but with a **larger degree of revenue sharing with the public sector** on the upside (e.g. capped/floored equity returns in utilities, shadow tolls in

transport projects, etc). Terminal value may not always be set to zero e.g. privatised utilities own tangible assets outright and in perpetuity, but as discussed earlier, an implicit contractual relationship with the public sector (eminent domain), to which an explicit regulatory framework may be added, conditions the value of the investment.

The first proposition can be considered as the reference contract while the second and third propositions are variants including a risk premium for commercial risk and varying degrees of risk sharing between the public and private sector. Downside protection for example may take the form of implicit (e.g. continuity of public service for utilities) or explicit government guarantees (e.g. minimum revenue guarantees in some toll road concession contracts).

In the case of private infrastructure, that is when both parties are private firms, contractual arrangements tend to combine the availability payment model using a so-called 'take-or-pay' purchasing agreement, by which the party delegating investment also commits to paying for up to a certain level of output defined as a proportion of capacity, and commercial risk for the remaining capacity (e.g. coal processing terminal).

Having acknowledged the contractual nature of infrastructure equity investments, we review how they are created empirically. The immense majority of them correspond to either privatised utilities or project financing. Together, these two forms account for most privately invested infrastructure in Europe and the world since the 1980s.

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Hence the contractual and regulatory arrangements found in project financing and utility regulation can explain cash flows to equity and what risks should be taken into account when valuing individual projects. The literature argues that project-specific risks like construction and operations are well managed through networks of contracts. The role of the financial structure is also of interest given the high leverage observed in project financing and the increasing leverage of regulated utilities' balance sheets in recent years. Here, the academic literature on corporate finance argues, perhaps counter-intuitively, that high leverage is a sign of low asset risk.

As is well documented in the economic literature, private investment creates incentives for cost control and operational efficiency. Hence, construction or credit risk in a project finance setting can be considered endogenous or managed risks. Exogenous sources of risk affecting cash flows to equity in infrastructure projects and utilities include demand risk, contract renegotiation and political risk. Empirical studies show that the presence of demand risk in the revenue model of an infrastructure investment vehicle creates significantly riskier equity. To the extent that the equity returns of different infrastructure assets are influenced by different demand risks or influenced differently by the same demand risk, there is diversification potential in a portfolio context.

Moreover, the lifecycle of infrastructure projects – from construction to operations to decommissioning – can be expected to impact equity valuations, risk and profitability and be a source of portfolio diversification as well.

Finally, the economic literature argues theoretically and empirically that long-term contracts will almost necessarily lead to renegotiations either because the contract is silent about a particular state of the world, or because the opportunity to continue the delegation process under the conditions initially agreed is questioned by one party. In this context, the economic regulation of utilities is a case of planned renegotiation. However, the outcome of renegotiation is not necessarily to increase equity risk insofar as it allows for the continuous adaptation of the contractual commitment of the parties. It can however be a source of opportunism and redistribute the contract surplus *ex post*.

Thus, economics and financial economics provide a rich framework to understand the nature of underlying infrastructure equity investment. Theoretical and empirical work on contracts and economic regulation in particular highlight the mechanisms that drive the risk and returns of infrastructure equity.

Investing in underlying infrastructure

The decision to invest equity in firms that solely enter into long-term contracts delegating investment in infrastructure projects must rest on an explicit or implicit model. In line with our review of the nature of underlying infrastructure, we call this model the infrastructure investment narrative after Daniel Kahneman definition of a narrative as “the passive acceptance of the formulation given” (Kahneman, 2002). According to this often implicit model, tangible infrastructure assets, immobile and demanding high sunk capital costs and long

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repayment periods, are expected to create **monopolies** thanks to barriers to entry and increasing returns to scale. Thus, assets owners are expected to benefit from the **low elasticity of demand creating pricing power** and an inflation hedge, as well as low return covariance with other investments, allowing attractive risk-adjusted returns.

Investors may decide to invest in infrastructure equity for other reasons than the investment narrative defined above, with different time horizons and different return expectations. **Still, we expect the majority of investors to be considering infrastructure equity investment in order to replicate this investment narrative, either to contribute to objectives of performance seeking (higher Sharpe ratio) or liability hedging (duration, inflation link, etc).**

The empirical question is how this investment narrative may be captured. We review existing research on several vehicles: listed infrastructure indices, listed infrastructure funds, unlisted close-ended 7 to 10-year private equity style funds (PE) and direct investment (without intermediation or external managers) in project company equity and privatised utilities by final investors. **Existing academic research finds that listed infrastructure indices and unlisted infrastructure PE do not deliver the infrastructure investment narrative consistently**, while direct investment can be expected to suffer from important portfolio construction issues leading to over-concentration. The research results reviewed here may help explain the evolution of the perception of infrastructure equity investment amongst final investors over the last decade, and their reported

frustration regarding the delivery of the infrastructure investment narrative.

However, we argue that none of these strategies is designed to access the characteristics of underlying infrastructure effectively and efficiently. Indeed, they are driven by a focus on the physical characteristics of underlying infrastructure assets and, in the case of unlisted PE funds, they are speculative strategies with a focus on exit value as opposed to capturing the full tenor of infrastructure contracts. Direct investments by final investors should be more suitable in principle but lot sizes create significant diversification challenges without intermediation i.e. access to granularity.

In order to capture the investment narrative suggested by the economics of infrastructure investment, better benchmarks and more appropriate strategies are needed.

Benchmarking infrastructure equity investments

Institutional investors should express great interest in using index-based products to increase their exposure to infrastructure.

Indices have the potential to meet the major expectations institutional investors have of infrastructure investment.

In a multi-asset class context, indices can provide infrastructure market beta and therefore a means of diversification.

Also supporting the fact that index instruments make infrastructure diversification possible, infrastructure index portfolios by themselves are likely to provide attractive risk-adjusted returns, suitably designed index portfolio will optimise the risk-reward ratio at the

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portfolio level by combining constituents on the basis of scientific diversification. The production of an infrastructure beta requires that the portfolio be made free of specific risk. If specific risk cannot be easily diversified, then betas will not be available and there will be basis for compensation of total risk rather than market risk only.

Although the potential benefits of index-based infrastructure products seem very attractive, our current knowledge based on past experience of PE funds or listed infrastructure companies is inappropriate to develop such products.

Building infrastructure betas will require concerted efforts between final investors, investment managers and academics.

We argue that infrastructure equity investment should rely on two principles: building blocks that are representative of the contractual nature of the underlying and portfolio/benchmark construction that optimises the risk/return trade-off of these building blocks.

Efficient portfolio construction and benchmarking using infrastructure equity should aim to optimise diversification benefits by exploiting the different phases of the asset lifecycle and the different level of systematic and remunerated risk found between different types of contractual and regulatory frameworks. Creating efficient benchmarks for infrastructure equity investing will go a long way in allowing final investors like insurance companies and pension funds to assess the riskiness of such investments.

It is apparent from our review and discussion that substantial data reclassification as well as new data collection is needed, and a significant amount of theoretical and empirical work remains to be done to arrive at appropriate benchmarks and to test the sensitivity of equity investment to different categories of risk found in project finance, regulated utilities and other legitimate infrastructure investments areas, including the role and diversification potential of the different periods in the lifecycle of infrastructure investments. We also aim to inform the regulatory debate in relation to institutional investing in long-term assets like infrastructure equity under, for example, the Solvency II regime. Data collection, reporting standards and the development of infrastructure equity benchmarking research will be some of the major undertakings of the EDHEC-Risk Institute Research Chair supported by Meridiam & Campbell Lutyens in 2013 and 2014.

1. Introduction



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The paper highlights a recent research quandary with respect to infrastructure equity investment which has also been a source of interrogation for final investors: while the economics of underlying infrastructure investment suggests a low and potentially attractive risk profile, the experience of investors and available research evidence have been different and rather mixed. This paper attempts to explain why this has been the case and what new research and benchmarking efforts are necessary to create investment solutions that realign expectation and observed investment performance as well as to inform the regulatory debate in relation to institutional investing in long-term assets like infrastructure equity.

There is also a regulatory dimension to this issue requiring the calibration and design of capital requirements for investments in infrastructure equity and equity funds in the context of the regulation of the European insurance industry under the Solvency-II regime, as well as the future regulation of occupational pension schemes.

The introduction and extension of risk-based solvency and capital requirements are fundamental trends in global financial regulation that impact financial practices and innovations everywhere, and indeed, the issue of capital requirement design in relation to long-term investment like infrastructure has recently been highlighted in a public letter between the European Commission Internal Market and Services Directorate General (Faull, 2012) and the European Insurance and Occupational Pensions Authority (EIOPA).

For this reason, we focus our discussion on the nature and characteristics of listed and unlisted infrastructure equity investment in Europe because Europe is the region where most of such investments have taken place³ and we expect the continent to continue to be the preferred area for such investments; we also note that fostering institutional investment in infrastructure is a major policy objective of the European Union.

Our contribution is threefold: in a first part, we discuss the nature of underlying infrastructure equity and what mechanisms explain its investment characteristics. Next, we review the rationale for infrastructure investing by insurance companies and pension funds and existing empirical research on the performance of existing investment routes and vehicles. Finally, we discuss what approaches to benchmarking and portfolio construction might best capture the characteristics of underlying infrastructure and highlight the need for new data collection and appropriate benchmarking methodologies.

The infrastructure sector is often described using a series of industrial classifications such as utilities, transport, energy, water, public buildings &c. However, it is also escaping a widely agreed definition. All involved rely on the proverbial wisdom that they shall know it when they see it. In the first part of this paper, we argue that from the perspective of an institutional investor, physical or industrial categories provide very little insight into the nature of the investment made and may lead to inadequate or spurious benchmarking. Instead, infrastructure investment

³ - There is also more observable data for Europe than other regions with the possible exception of energy infrastructure in the US.

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consists of acquiring financial assets (as opposed to real assets) creating claims on future risky cash flows, most often with zero terminal value. This is both a function of the relationship-specific nature of tangible infrastructure and of its frequent public policy dimension, which warrants the eminent domain of the State, leaving investors with explicit or implicit financial commitments through contractual claims or regulation.

In the second part, we discuss the relationship between the investment objectives of institutional investors, the nature of underlying infrastructure equity investment and available investment strategies and vehicles. We argue that the oft-described characteristics of underlying infrastructure equity, captured by what we call the "infrastructure investment narrative," are more or less well replicated by different investment strategies, vehicles, structures and asset selection and weighing schemes. Hence, the characteristics of underlying infrastructure equity can be distorted or lost through certain investment routes, which should not be confused with the underlying discussed in the first part of this paper. This is particularly the case when the physical characteristics of infrastructure projects are used to design investment strategies instead of their contractual characteristics, which better embody the financial economics of infrastructure equity investments. We review existing academic research on listed infrastructure equity indices, unlisted private equity funds often called infrastructure funds, and direct infrastructure equity investment by institutional investors.

Finally, we discuss efficient benchmarking and portfolio construction using underlying infrastructure equity and highlight the need for systematic and standardised data collection but also the need for further theoretical developments. First, we argue that categorising assets according to their contractual features allows investors to better capture the infrastructure investment narrative. Second, we discuss portfolio construction with infrastructure equity exploiting the diversification potential of cross-sectional (e.g. demand risk) or longitudinal (project lifecycle) remunerated risk factors. Efficient investing in infrastructure equity can be expected to deliver considerable risk reduction through the diversification of idiosyncratic risks.

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2. The Nature of Underlying Infrastructure Equity Investments



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2.1 Long-Term Finance and the Nature of Infrastructure Investments

Infrastructure investment is typically included in the 'long-term finance' category (Faull, 2012) i.e. investments with a multi-decade horizon. If there is something special about long-term finance, it implies that the intended outcome cannot always be replicated with a series of short-term trades. Indeed, the economic literature suggests repeatedly that strategies aiming to deliver long-term objectives suffer from endemic cognitive and market failures: if the long-term is only an accumulation of short-terms, consumption and investment behaviour can be such that the long-term never happens. At least two phenomena can explain this: the functional form of the observed time discounting and the level of the discount factor.

The first mechanism is well documented in the theoretical and empirical literature: agents are time-inconsistent and discount future utility using a hyperbolic functional form instead of an exponential one. Time- or dynamic-inconsistency implies that the regular re-appraisal of the cost and benefits of a particular course of action lead to changing course of action and never achieving the initial goal. The second problem is the short-term focus of investors that leads to over-discounting the future as discussed by Haldane (2011) i.e. independently of the functional form, the level of the discount rate is too high.

Infrastructure investment is conditioned by a reality principle that makes it inescapably long-term: large, irreversible investments in immobile structures and buildings require long or multiple repayment periods. Thus,

considering the endemic market failure that characterises long-term investment in general, it can be a source of wonder that tangible infrastructure is ever financed at all.

The solution to time inconsistency in long-term finance is to enforce dynamic consistency by creating commitment mechanisms and building credibility (including credible threats). Consistent planning and commitments, contractual for the most part, can have the effect of restoring dynamic-consistency that is, as long as enforcement is always effective, to turn a multi-period game into a single period case of 'false-dynamics' (Laffont & Martimort, 2002): as long as commitment is binding and credible, the expected outcome is the one defined by the first and last moments in the contract. Time consistency thus creates a *tenor*.

In what follows, we return to the role of contracts to create and enforce dynamic consistency in infrastructure finance and, *in fine*, explain the investment characteristics of infrastructure equity. As we will discuss, infrastructure finance consists primarily in the creation of credible commitment mechanisms allowing large, immobile, relationship specific investments to take place.

2.2 On the Existence of Investable Infrastructure Assets

A first question is to ask why there exists investable, standalone infrastructure at all. This is the classic question of the boundary of the firm and of the choice between integration and delegation faced by economic agents (Coase, 1937). In the

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context of infrastructure investment, we distinguish between a private case and a public case.

In the private case, a privately owned entity, say a coalmine, can decide to invest directly in its own coal terminal infrastructure (integration), or it can decide to delegate the task of financing, building and operating the terminal to another private firm (delegation).

In the public case, the public sector can decide to invest directly in public roads or buildings, or it can decide to delegate the task of financing, building and operating public infrastructure to a private firm. **Of course the public sector almost never builds or operates infrastructure itself and instead procures these services from private contractors.** The crucial difference between traditional procurement (i.e. integration) and delegation, is the requirement that the private firm *invests* in infrastructure delivery instead or on behalf of the public sector.

In both private and public cases, as long as delegation is preferred to integration – as long as the benefits of specialisation are higher than the agency costs of delegation – investable infrastructure assets can be created i.e. one may invest equity in an specific corporate entity to which the task of delivering and operating the infrastructure has been delegated.

This not a trivial question since under certain conditions, integration will be preferred to delegation and the option to invest in specific infrastructure assets then evaporates, leaving only investment in vertically integrated firms in the private

case or **public debt in the public case.** The existence of standalone investable infrastructure assets is thus a matter of preferring delegation to integration when it comes to procuring relationship specific assets like infrastructure.

2.3 The Role of Long-Term Contracts

With relationship specific investments, both parties may hold each other up *ex post* and because they anticipate such opportunistic behaviour, *ex ante* investment tends to be suboptimal, when there is any investment at all (Segal, 1999). Conversely, if either party could easily re-contract with other parties (i.e. if the investment is not relationship specific) or if the investment was short-lived, the **hold-up problem** would not occur.

The threat of *ex post* hold up explains the existence of vertically integrated conglomerates in the private case and the role played by the public sector as the default investor in infrastructure assets in the public case: because integration creates residual control rights for the owner, when the value of the investment is higher for party A than it is for party B, A tends to integrate B in order to achieve the desired level of investment (Hart, 1995).

Investing in physical infrastructure is thus a textbook case of the hold-up problem:

- Infrastructure requires that most capital investment be made at the beginning of the investment period while the return to investors only accrues gradually and often incrementally;
- Physical infrastructure is immobile and has almost no alternative use i.e. it is *relationship specific*.

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Delegation is desirable if it lowers total costs. In a world where firms may be more of less efficient (adverse selection) and make more or less efforts to control costs (moral hazard), delegation is desirable, if the contract can create incentives for the most efficient firm(s) to self-select and bid for the delegation contract. This is why delegation *must* involve risk-transfer: risk transfer creates incentives for the efficient firm to put in a bid and to control costs if it can be made residual claimant to its own cost savings. Hence equity, insofar as it creates right to residual cost savings, plays an important role in the creation of an incentive-compatible contract for the delegation of investment in a relationship specific asset.

4 - With this arrangement, a party (usually a group of producers) undertakes to pass (put through) an agreed minimum amount of material (such crude or refined oil or gas) through a processing plant (called a processing agreement) or a pipeline (called a pipeline agreement) during a fixed period (month, quarter, year). Also called throughput agreement. With a tolling contract, a tolling contract does not require the converter, processor, or transporter to purchase the input material or to sell the output product.

To sum up, the preference for delegation relies on the possibility of long-term contracting, and the difficulty for the delegating authority or firm is to write a risk transfer contract that will create incentives for the efficient firms to self-select and to bid: the party wishing to delegate investment in dedicated infrastructure assets has to make a sufficiently attractive proposition to the party making the investment, which, in turn, has to commit to delivering the most cost efficient investment solution for a given level of output.

2.4 The Role of Commitment

The outcome of investing in underlying infrastructure assets is thus a function of the *credibility* of commitment by two parties: the credible commitment to invest against that the credibility of commitment not to expropriate the return of the investor. As discussed above, commitment enforces dynamic consistency and allows long-term finance to take place.

In the private case, an example of commitment mechanism is for the coal mine to enter into a 'take-or-pay throughput contract'⁴ with the party investing in developing and operating the coal terminal. The coalmine thus commits to using (or paying for) a guaranteed amount of the terminal's capacity according to an agreed tariff formula. The terms of this agreement determine the incentives for the terminal investor to enter into the contract in the first place and to invest in enough capacity (to commit capital) to always meet at least the minimum service requirements of the coalmine according to agreed-upon terms of service.

In the public case, the public sector may, for example, grant a concession contract to a private utility to invest in and operate the water infrastructure of a city and commit to allow water tariff increases according to an agreed formula and schedule. In turn, the utility is expected to invest in network expansion and treatment facilities and to meet, for example, pre-agreed coverage targets and drinking water quality standards.

Importantly, in the two examples above, both parties to the contract can agree on the quality and quantity of output and write a contract specifying these parameters. If the quality of output in particular is not 'contractible' then integration solutions tend to dominate delegation because the agent has strong incentives to minimise its costs by delivering low quality infrastructure (Hart, 2003; Hart, Schleifer, & Vishny, 1997).

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2.5 The Contractual Nature of Underlying Infrastructure Assets

While infrastructure assets are usually understood to be tangible assets – physical structures of steel and concrete – from the point of view of financial economics, infrastructure investment is better defined as a *high sunk cost, long-term investment in immobile, relationship-specific assets*. In this context, **it is contracts, not concrete that matter**. In other words, the physical characteristics of tangible infrastructure only determine the need for long-term contracts, which in turn determine the investment profile of infrastructure investments.

This is made apparent when considering the role of tangible asset ownership in the public case: in the majority of cases in Europe for example, **when the public sector delegates investment in public infrastructure to a private entity, the private firm does not own any tangible asset**.

Roads belong to the Transport Department, schools belong to local authorities and municipalities, hospitals belong to public healthcare units, defence facilities such as training equipment or strategic transports belong to the Ministry of Defence, etc. Nor do firms need to own any tangible assets to raise finance, as long as they have the commitment of the public sector in the form of a long-term contract entitling them to build, operate and receive an income in relation with a specific piece of physical infrastructure.

In other cases, the firm does own the physical assets it invests in e.g. private prisons in the US, certain telecommunication public-private contracts⁵ and, for the most part, privatised utilities (e.g. UK privatised water

companies own the treatment facilities, distribution networks and meters that they operate and invest in). But while ownership gives residual control to the firm when contracts and regulation are silent, the public sector remains the ultimate guarantor of what is considered to be a public service. In other words, the public sector has a right of eminent domain⁶ over utilities' assets when contracts and regulation are silent which supersedes private ownership and is embodied in the utility's licence to operate.

The contracts delegating infrastructure investment are characterised by a risk-sharing mechanism embodied by the revenue model agreed between the delegating party and the party carrying out the investment for the duration of the contract. While numerous risk-sharing agreements can be envisaged, in practice, three types of contracts are used to delegate investment in public European infrastructure:

- *Availability payment schemes*, by which the public sector promises to pay a fixed income over a pre-agreed period, typically in excess of two decades, in exchange of what the investor accepts more or less unlimited responsibility for the investment, operating, debt and equity cash flows incurred to invest in the delivery of an infrastructure service, according to an agreed output specification. Terminal value is set to zero and control of the physical assets is returned to the public sector at the end of the contract. This model is typically used to deliver social infrastructure projects like schools, hospitals or government building.
- *Commercial schemes*, by which the public sector enters into the same contract with an investor but in exchange for a risky income cash flow. This is typically the case with

5 - One example is the Skynet 5 private finance initiative (PFI) in the UK. While Skynet 5 is a satellite-based communication system for military and government uses, the satellites are the property of the developer. 6 - 'Eminent domain' refers to the right of the sovereign to expropriate any private concern with compensation. Here it also refers to the fact that public services do not cease to be a public concern after they have been privately invested.

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tolled transportation projects, for which the investor is granted the right to collect tolls/tariffs from users. Terminal value is set to zero in most jurisdictions. This model is typically used for transport projects with real tolls.

- *Capped commercial schemes* consist of the same investment proposition than commercial schemes but with a larger degree of revenue sharing with the public sector on the upside (capped equity returns in utilities, shadow tolls in transport projects). Terminal value may not always be set to zero e.g. privatised utilities own tangible assets outright and in perpetuity, but as discussed earlier, an implicit contractual relationship with the public sector (eminent domain), to which an explicit regulatory framework may be added, conditions the value of the investment.

The first proposition can be considered as the reference contract while the second and third propositions are variants including a risk premium for commercial risk and varying degrees of risk sharing between the public and private sector. Downside protection may take the form of implicit (continuity of public service) or explicit government guarantees (minimum revenues).

The private case tends to be a combination of availability payments resting on a take-or-pay purchasing agreement up to a certain capacity and commercial risk for the remaining capacity. Thus, in our example, the coalmine would commit to using or paying for the equivalent of a given percentage of the terminal's capacity at a pre-agreed tariff, and to pay pro-rata its use of any supplementary capacity.

Thus, infrastructure assets are not real assets. Project finance equity or the shares of privatised utilities are only financial assets. From an investment point of view, infrastructure assets are better understood as contractual claims on future cash flows.

Having acknowledged the contractual nature of infrastructure equity investments from the point of view of financial economics, we review how such assets may be created empirically.

The immense majority of infrastructure equity investment corresponds to one of two models: privatised utilities and project financing. Together these two corporate forms account for most privately invested infrastructure since the 1980s.

2.6 Creating and Regulating Investable Infrastructure Assets

The literature differentiates between two forms of regulation of infrastructure investment delegation: regulation by contract and regulation by agency. Regulation by contract requires parties to write a long-term contract defining the conditions under which investment delegation takes place. Regulation by agency consists of having a third party, typically an independent administrative unit, in charge of setting the price of outputs or the return to investors, allowing for the regular re-assessment (planned renegotiation) of the contract's terms.

In practice, investors may differentiate between standalone investment vehicles (project finance⁷) on the one hand, and private infrastructure providers (e.g. utilities) on the other. Regulated utilities follow,

7 - We use the definition of project finance given in the Basel-II accord: "Project finance (PF) is a method of funding in which the lender looks primarily to the revenues generated by a single project, both as the source of repayment and as security for the exposure. This type of financing is usually for large, complex and expensive installations that might include, for example, power plants, chemical processing plants, mines, transportation infrastructure, environment, and telecommunications infrastructure. Project finance may take the form of financing of the construction of a new capital installation, or refinancing of an existing installation, with or without improvements. In such transactions, the lender is usually paid solely or almost exclusively out of the money generated by the contracts for the facility's output, such as the electricity sold by a power plant. The borrower is usually an SPE that is not permitted to perform any function other than developing, owning, and operating the installation. The consequence is that repayment depends primarily on the project's cash flow and on the collateral value of the project's assets. In contrast, if repayment of the exposure depends primarily on a well-established, diversified, credit-worthy, contractually obligated end user for repayment, it is considered a secured exposure to that end-user." Basel II: International Convergence of Capital Measurement and Capital Standards: A Revised Framework' (November 2005)

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by definition, the regulation by agency model, while most project finance as well as a number of concession contracts in certain jurisdictions correspond to regulation by contract.

Privatised utilities and project financing account for most of primary infrastructure financing over the past 30 years: US\$1.1Tr of state-owned infrastructure assets have been privatised since the 1980s in OECD (\$700bn) and developing countries (\$400bn) combined (OECD, 2007; World Bank, 2012), mostly through IPOs and M&As, and US\$2.5Tr of infrastructure project financing was closed between 1995 and 2009 (Blanc-Brude, Jensen, & Arnaud, 2010).

2.6.1 Monopoly privatisation and regulation

Historically, the corporatisation and privatisation of businesses that build and operate physical infrastructure has been the first reason why investable infrastructure assets have been created.

Utilities typically produce in specific locations and distribute their output over a widespread communication or distribution network. While this can be envisaged in the private case, most large-scale infrastructure operations tend to have a public policy dimension (and a government department to match) and thus fall in the public category. The network externalities of utilities tend to create **monopolies** because high sunk costs create barriers to entry and increasing returns to scale make a single firm the cheapest supply option i.e. the cost function is said to be sub-additive (Baumol, 1977). One of the most significant dimensions of such investments is the very large difference between average and marginal

costs. It follows that network externalities lead to market failure because the large sunk costs are risky and, even if long-term commitment can be created and credibly enforced, **few long-term investments are immune to technological obsolescence**. This explains why investing in utilities has often been done by the public sector (Joskow & Noll, 1981). However, the cost of public sector integration has also been historically high because public sector ownership creates little incentives towards productive efficiency and the chronic underinvestment or misallocation of investments that tends to ensue have historically led to low service standards and high total costs (Meggison, 2005).

The choice of privatising utilities and giving them access to capital markets implies that investment delegation should lead to higher and cost-efficient investment in what remains services that are ultimately guaranteed by the public sector. As discussed above, for long-term investment to take place the public sector has to commit to a business model that is sufficiently attractive to investors. **However, private monopolists do not tend to behave very differently than public ones:** they also have incentives to under-invest and over-charge. Delegation can thus take several forms, which we outline below.

The first one consists of breaking up monopolies and **introducing competition**, thus creating incentives for private profit maximisers to invest efficiently in stand-alone assets, while networks remain public or regulated (see below).

Indeed, the activities of utilities can roughly be split between production, transmission

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and distribution, which are typically vertically integrated in the state-owned case. **Unbundling** activities and introducing competition at the production stage is, for example, common in the energy sector, where power producers can be independent from the transmission and distribution network, to which they sell their output in a more or less competitive market or via long-term off-take contracts, by which the network operator commits to buying their output according to an agreed tariff formula. Thus, new generation capacity can typically be financed using dedicated project financing, as described in the next section. Likewise, gas pipelines and wellheads can be unbundled and financed on a stand-alone basis, solely backed by forward purchase contracts.

In sectors such as water or power transmission, **introducing competition is less straightforward and regulation is often considered necessary.** However, the normative approach to regulation is subject to debate in the literature because it suggests that **private firms should not be in favour of regulation while active lobbying in favour of introducing regulation is well documented (Viscusi, Harrington, & J. M. Vernon, 2005),** and because regulation should be expected to lower prices which is not necessarily found to be the case (Stigler & Friedland, 1962). These criticisms led to the notion of **regulatory capture** (Jordan, 1972) i.e. different groups are able to lobby the regulator to create investment conditions that are to their advantage. Peltzman (1976) articulated this theory and predicted that regulators would predominantly distribute rents to the best-organised group (producers) but also spread them across all parties, including

consumers to maximise their political support. Thus, depending on the political economy of the sector, the profitability of privatised utilities may be set at a different level and be more or less volatile over time.

In this context, the second approach to utility regulation is to explicitly cap the investor's rate of return to a 'fair' level and to expropriate any excess returns, but rate-of-return regulation has been criticised for leading to 'gold-plating' (i.e. over-investment) and low productive efficiency in utilities (Averch & Johnson, 1962), especially in combination with regulatory capture by the firm. However, it can also be interpreted as a form of long-term commitment by the public sector to let investors earn a return (on equity) that is considered commensurate with their risk, as in the US case throughout the twentieth century (Helm, 2009).

The third option, known as price-cap regulation, consists of simulating competition through 'yardstick competition' i.e. setting the price of the firm's output according to a computed efficiency frontier, leaving private monopolists to achieve the necessary cost savings and making them residual claimants to these cost savings.

Price cap regulation was invented in the UK to address the critique of rate of return regulation and simulate competitive forces by setting 'efficient' price levels, letting firms improve productive efficiency and resetting the efficient price level every five years.⁸ In practice, price cap also amounts to expropriating excess returns but without committing on the level of fair returns that investors are allowed to receive. In effect, crude price cap regulation leads

8 - The original intention behind the privatisation of utilities was to introduce competition and to abolish the monopoly enjoyed by state-owned enterprises (Littlechild, 1983). Indeed, Baumol showed that an industry is a natural monopoly only if its cost function is sub-additive across the whole range of its outputs (Baumol, Panzar, & Willig, 1982). While this has not been successful in some sectors like water utilities, other sectors have undergone rapid technological change and monopolies have often been reduced if not altogether abolished in the telecoms sector for example or in power generation. This suggests that long-term investors considering monopoly to be a desirable feature of the utilities sector should bear in mind that such characteristics cannot be taken for granted and may change and even disappear within a decade thanks to technological change.

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to operational cost efficiency but only to minimal investment by the firm. However, tariff setting in UK utilities led to the question of investors' return, including the valuation of their exit, and to the creation of a regulatory asset base (RAB). By providing explicit guarantees to the RAB, the regulators transfer equity risk from the firm to its customers, thus creating a *de facto* commitment mechanism (Helm 2009).

Thus, while it does not necessarily rely on an explicit contractual arrangement, the privatisation of infrastructure monopolies relies on more or less implicit commitment mechanisms: through a combination of operating licences and regulatory rules and practices, the public sector must credibly commit to letting the firm receive a sufficiently attractive return on equity. In return, the firm must credibly commit to invest. The regulatory framework is thus the main determinant of the investment return profile.

The alternative model, project finance, relies explicitly on contracts and is now used to deliver the majority of new privately invested infrastructure assets in the world.

2.6.2 Project finance and corporate governance

With project finance, the use of long-term contracts as commitment mechanisms is explicit: first a new corporate entity is created that enters into a long-term contract with the delegating entity. The new entity, typically called **special purpose vehicle (SPV), Project Company or infrastructure company (infraCo)**, is funded with equity capital provided by the firm and other investors and raises debt

to finance its capital programme. The SPV then hires contractors to build and operate an infrastructure facility.

In the private case, the SPV is created and initially financed by, say, a consortium of construction firms and a port operator. The SPV then raises debt finance, typically with a gearing ratio of 7.5:1, possibly up to 9:1.⁹ In the private case defined earlier, the SPV enters into a throughput take-or-pay agreement with the coalmine, by which the coalmine commits to using (or paying for) a certain minimum capacity of the terminal according to the certain indexed tariff formula for 25 years. In this example, the coalmine still takes all market risk. The SPV typically owns the tangible assets that constitute the terminal including land and structures, which are also a source of security for the SPV's lenders. However, the main source of lender comfort is the SPV's 25-year off-take contract, which provides them with the necessary visibility of future free cash flow available for debt service.

In the public case, most new privately invested infrastructure is also delivered using project finance under so-called **public-private partnership contracts (PPPs)**. For example, the public sector may award a contract to build and operate a school or a motorway. Likewise, an SPV is created and funded by a consortium of firms and other investors that commission the construction and operation of the asset from other firms, typically their own subsidiaries. Under the contract, the public sector commits to paying a fixed fee to the SPV in exchange for the delivery of a school building and its operations according to a pre-agreed output specification. In the case of a motorway, it may grant the SPV the right to collect tolls

9 - Blanc-Brude *et al.* (2010) document a stable average leverage level in infrastructure project finance at 75% between 1995 and 2009.

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from users according to an indexed tariff formula, it may directly pay *shadow* tolls, calculated as a function of effective traffic, or it may pay a fixed 'availability' fee based on the delivery and maintenance of the road according to pre-agreed performance criteria such as the number of accidents per month, average speed or the absence of congestion.

As discussed above, in the public case, tangible assets are typically not owned by the SPV, which raises capital solely on the back of the public sector's commitment through a long-term contract to let it invest on its behalf in infrastructure construction and operations according to an agreed business model.

In turn, the SPV enters into a network of contracts that define the commitments of the relevant parties, most notably: a debt contract, a construction contract and an operating contract, in order to manage the risks that are transferred in the delegation contract.

2.6.3 Source of equity risk in infrastructure investments

Following the main findings of the empirical literature (reviewed below), we group the factors impacting equity risk in infrastructure in five categories:

- Credit: the uncertainty over the ability of the firm to service its debt;
- Demand: the uncertainty over the revenue stream of the firm;
- Construction and operations: the uncertainty which characterises the cost of building and operating tangible infrastructure;
- Renegotiation: the changes to the contractual and regulatory arrangements

that led to investment delegation, including regulatory reviews (determinations);

- Political risk: the change in the perception of the desirability of delegation by the public sector.

To these risks, one may add interest and foreign exchange risks but these are not specific to infrastructure investments and for our purpose may be considered random or fixed.

Since, as we argued, contractual and regulatory arrangements determine the investment characteristics of equity stakes in utilities and project financing vehicles, *the riskiness of these investments is a direct function of these arrangements.*

In this context, it is useful to differentiate between risks that are exogenous or endogenous to the contract. Endogenous risks refer to those uncertain outcomes over which the equity owner can have an influence by, for example selecting the best builder or improving operational efficiency. Probably the most striking form of endogenous risk in infrastructure investment is credit risk, which, as we shall see, can be structured to maximise the ability of the firm to borrow while minimising its risk of default. We return to these aspects below and how they impact equity risk.

Exogenous risks refer to those uncertain outcomes which the equity owner cannot influence, including certain aspects of construction and operating risks like weather conditions, but also and most importantly, market conditions when the contract delegating the responsibility to invest also stipulates that the firm will

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receive a risky income as a function of demand or traffic (what we have called 'commercial schemes' above). Credit risk is also partly exogenous insofar as the credit cycle influences the opportunity and the cost of raising new debt or of refinancing.

In what follows, we review the economics and finance literature with regards to the five risk categories identified above, with a focus on their endogenous or exogenous character and how they may impact equity risk.

2.6.3.1 The role of the capital structure

Debt plays a significant role in project finance because it tends to be the main source of capital. **Reviewing fifteen years of project finance transactions**, Blanc-Brude *et al.* find that project finance leverage consistently averages 75% of capital raised across sectors and can be as high as 99% (Blanc-Brude *et al.*, 2010). Such high leverage suggests that equity investors have a highly contingent claim in such structures and may lose a great deal in the event of default. This opens two questions: what is the probability of default? And what happens to equity owners in the event of default?

The theoretical literature on project finance and corporate governance (Berkovitch, 1990; Chemmanur & K. John, 1996; T. John & John, 1991; Shah & Thakor, 1987) **highlights the role of leverage as one of the most counter-intuitive dimension of project financing, strongly challenging the Modigliani and Miller's irrelevance theorem, according to which corporate financing decisions do not affect firm value.**

The finance literature shows that **infrastructure project finance can in fact reduce the net financing costs associated with large capital investments (Esty, 2004), and that high leverage plays an important disciplinary role by preventing managers from wasting or misallocating free cash flow, and deterring related parties, including the public sector, from trying to appropriate it (Hart, 1995; M. C. Jensen & Meckling, 1976). Because leverage mitigates these costly incentive conflicts among capital providers, managers, and deal participants, it increases expected cash flows available to capital providers, thereby establishing a link between financing structure and asset values. In this context, loan financing is a signal of creditworthiness (Fama & M. C. Jensen, 1985). Indeed, infrastructure assets have few growth options, hindering over-investing in negative NPV projects, and making investment decisions more easily monitored by external claimholders (Sawant, 2010a).**

The empirical literature on infrastructure projects finance (Blanc-Brude & Strange, 2007; Brealey, Cooper, & Habib, 1996; Esty, 2002; 2004; Kleimeier & Megginson, 1994; 2000; 2001), concludes repeatedly that **historically project finance loans have been different from corporate lending and that the nexus of contracts that enables project financing plays a fundamental role in the determination of the investment characteristics of infrastructure debt and equity: in leveraged finance, debt is used to increase the return on equity, creating incentives to take risks. In project finance, because the financial viability of a single project has to be demonstrable with a high probability, debt is used to minimise the cost of capital and creates incentives to minimise**

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risks. The endogeneity of default risk in project finance is thus in stark contrast with the exogenous nature of default risk in structured products (e.g. CDOs), which treat the default risk of individual securities as a statistical input, not as an output of the exercise.

It follows that, in project finance, high leverage should be interpreted as a signal of *low* asset risk (Esty 2002). This is confirmed by several empirical studies of the probability of default and recovery rates of project finance debt (Moody's Analytics, 2012a; Standard & Poor's, 2007). On average, default rates are higher during the early phase of the contract (partly because of construction risk and project ramp up) but they gradually and continuously decrease signalling lower equity risk as well.

Moreover, the same studies show that in the event of default, most projects experience rapid recovery. Hence, in most cases, the equity is not 'wiped out' by a default, as opposed to the standard case of corporate finance. This is consistent with the notion that the firm has no tangible assets that lenders could use as security, instead both lenders and equity holders have to 'work out' a rapid recovery from default in order to avoid higher losses. While lenders may have step-in right allowing them to replace the firm's management or put covenants in place allowing them to capture all free cash flow (cash sweep) for a period, the long-term value of the firm's equity may not be affected materially, even though the frequency and size of dividend pay-outs are likely to be, especially in the short term.

While high leverage is a defining feature of infrastructure project financing, the

financial structure of regulated utilities in Europe has also been converging towards highly geared balance sheets. The regulated utilities sector has also experienced increasingly high leverage in recent years, as the predictability of income left room for higher indebtedness. For example, UK water utilities, which historically have been leveraged to a maximum of 50% reached debt-to-capital ratios of 85% in recent years (OXERA, 2002).

However, leveraging utilities is not solely a matter of optimising capital costs for a given level of firm risk as in project finance, but is also influenced by regulation. Helm argues that in the UK case, the weighted average cost of capital used by regulators overestimated the cost of debt, and allowed constant re-leveraging, creating a windfall for investors (Helm, 2009) and making new equity investment less attractive with a WACC well below the cost of equity. Helm argues that this has led to the gradual exhaustion of UK utilities' balance sheets and that the increasing use of debt led a number of major privatised monopolies such as the rail network to collapse and to have to be re-integrated on the public sector balance sheet i.e. equity risk now lies with taxpayers. Helm predicts that the same fate of *de facto* nationalisation (mutualisation of the equity risk) awaits overleveraged UK utilities. (Helm 2009).

2.6.3.2 *The role of demand or revenue risk*

As is well documented in the empirical literature, demand or traffic risk is the primary reason why infrastructure projects experience significant problems (Standard & Poor's, 2004), including default and therefore equity losses.

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The well documented 'optimism biases' can lead to the overestimation of future demand or traffic (Mott MacDonald, 2002). Several authors report that demand forecasts are usually over-optimistic in both publicly and privately financed projects with this optimism bias averaging 20% (Flyvbjerg, Bruzelius, & Rotherngatter, 2003a).

Blanc-Brude & Strange (2007) measure the impact of three types of revenue risk corresponding to the three types of schemes discussed earlier (availability payments, commercial and capped commercial schemes) on credit spreads in highway project financing in Europe and find that, *ceteris paribus* revenue risk is a statistically significant driver of credit spreads. Likewise, we expect equity risk to be a function of revenue risk.

2.6.3.3 The role of construction & operations risk

Construction risk is often a serious source of concern for institutional investors considering infrastructure investment. As discussed above, construction risk in greenfield infrastructure projects can spring from two factors. First, there is uncertainty about the conditions under which the numerous tasks associated with building a large structure can be accomplished: ground conditions, the weather, engineering challenges, unexpected archaeological sites, etc. all make the actual cost of building infrastructure uncertain. This uncertainty is highly idiosyncratic: projects are unique and usually built in different locations at different points in time. It is exogenous.

The second category of uncertainty found in infrastructure project construction has to do with who is exposed to uncertain costs

and what they can do about it. This is best understood as an agency problem: if the risk of higher construction costs is not borne by the party in charge of building – as is the case in traditional public infrastructure procurement – there is moral hazard i.e. little incentives to control costs. Moreover, such procurement methods are also likely to suffer from adverse selection: the party selected to build the project may not always be the best one when it comes to controlling costs, and this is difficult to know in advance for the procuring authority.

Risk transfer through enforceable contracts deals very well with this situation: if the party building the project is made partly or fully responsible for the variability of costs, two things happens: the builder now has strong incentives to control costs and, if enough risk is transferred, only those builders who know that they can control costs well will bid.¹⁰ In other words, construction risk transfer leads to projects in which only the best builders manage their own construction risk.¹¹ It follows that a proportion of construction risk found in infrastructure projects is a function of who is exposed to it. This risk is endogenous to the choice of procurement contract.

Thus, while exogenous construction risk is almost completely idiosyncratic, endogenous construction risk may be partly systematic if procurement choices encourage adverse selection and moral hazard. This is exactly what existing studies of construction risk show: the cost of building traditional infrastructure procurement is found to be systematically 20% over budget (Flyvbjerg, Holm, & Buhl, 2002).¹² Subsequent papers (Flyvbjerg, Holm, & Buhl, 2004; Flyvbjerg,

10 - This is a separating equilibrium: we document such a case in the market for construction of PFI schools: some builders almost only bid for PFI construction contracts (fixed-price) and others only bid for traditional contracts. (Blanc-Brude, 2012a)

11 - A third thing that may happen is that only large firms that are in a position to diversify the exogenous risks described above can bid and there may be very few such firms. As a consequence, competition may be limited and prices higher than they otherwise would be, even after adding the builder's cost of carrying his own (fully-diversified) construction risk.

12 - In effect, Flyvbjerg's dataset focuses on very large projects, some of which are private. Large private projects can carry very high and impossible to quantify exogenous risks (e.g. Eurotunnel, an unprecedented venture to dig a rail tunnel underneath the Channel) or be too large for anybody to be in charge of cost control (e.g. Metronet, one of the two entities used to create public-private partnership for investing in the London Underground). But average projects with adequate risk transfer contracts are expected to leave mostly well-known exogenous risk for builders' to manage directly.

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Skamris holm, & Buhl, 2003b) show that cost overruns and delays breed more cost overruns, explaining why things can get so bad in some cases and thus why the observed frequency distribution is so skewed to the right. This double failure at construction risk measurement and management in traditional infrastructure procurement has been widely documented (Mott MacDonald, 2002). The construction risk of the public sector is high because endogenous risk is not managed through risk transfer.

Once construction risk is contractually transferred to the builder, it must change shape insofar as it is endogenous i.e. a function of the builders efforts to control risks. Infrastructure project finance creates such an incentive scheme: construction risk is typically transferred from the project company (InfraCo), which is the borrower of infrastructure debt, to the builder, which commits to a date-certain, fixed price construction contract. Of course, if a project's construction phase goes very wrong the risk may come back to the InfraCo, which is ultimately responsible. But since only the better builders bid for the risk transfer contract, we expect their own risk to be lower than the public sector's and *insurable* through a risk transfer contract.

As long as construction risk is endogenous, the risk of cost overrun experienced in public works is transformed by risk transfer under a privately invested scheme and public sector construction risk is not very revealing of private sector construction risk (Blanc-Brude, 2012b). Looking at *ex ante* and *ex post* construction costs in public and private road projects in Europe, Blanc-

Brude (2008) finds that privately financed projects, all of which have an SPV structure as described above, experience little or no cost overruns whereas publicly financed ones experience the same range of cost overruns than previously documented by Flyvbjerg *et al.*¹³ In a recent study, we confirmed this finding using a new dataset of *ex ante* and *ex post* construction costs in infrastructure project finance in Europe (Blanc-Brude, 2012c).

Further evidence of the endogeneity of construction risk is apparent when examining the default rate of projects by sector: while *on average* project finance debt has a higher default rate during the early years of the contract, social infrastructure PPPs, which require the construction of very standard buildings for which builders can absorb all risks (i.e. construction risk is completely endogenous), have a consistently low marginal default rate from year one to ten, at 0.5% per annum (Moody's Analytics, 2012b).

Hence, if construction risk has no impact on credit risk in European PPPs, we expect its impact on equity risk to be minimal.

Like construction risk, operations risk is passed to sub-contractors who take performance risk up to a certain level. In European PPPs with revenues based on service availability, low performance can lead to penalties being imposed by the public sector to the firm (SPV). However, these penalties serve as tool to incentivise sub-contractors and their level is typically too low to impact the financial performance of the firm materially (Robinson & Scott, 2009).

13 - In effect, project finance forces SPV investors to transfer construction risk to a third party through a fixed price construction contract. As a consequence, construction risk is mostly absorbed, in most cases, by the (efficient and incentivised) subsidiary of the developer that invested equity in the SPV. Extreme construction risk (that cannot be absorbed by a subcontractor) and project delays may still affect financial performance but these remain idiosyncratic risks that investor should aim to diversify as much as possible, as do large developers that have equity invested in numerous projects internationally.

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Still, operating risk, if badly managed, can lead to adverse consequences even to default in some rare cases.

2.6.3.4 The role of contract renegotiation

In a world of incomplete contracts, and limited and asymmetric information about future costs and benefits, contract renegotiation can be a desirable phenomenon: without renegotiation, contracts would simply break down or investment would frequently not occur if parties anticipated the impossibility of renegotiation. However, while renegotiation may well achieve *ex post* equilibrium solutions (i.e. be welfare maximising), the outcome of *ex post* bargaining also introduces uncertainty about the long-term return profile of infrastructure investments. Hence, the payoff from investing in relationship-specific assets is also a function of *ex post* bargaining power (Williamson, 1975).

Renegotiations occur because the trade-off between the cost and benefits of delegation shifts or becomes unsustainable: the return of the firm may have been set to low or too high or have become so. Either way, the real or perceived excess benefits that one party or the other is extracting from the contractual relationship lead the other party to demand renegotiating the terms of the agreement. Several mechanisms can be expected to trigger contract renegotiation including the incompleteness of contracts and opportunistic behaviour by one party or both.

Incompleteness is the primary reason why renegotiation occurs in long-term contracts: even if both parties are in good faith,

things change and contracts necessarily fail to specify all future circumstances. Once renegotiation occurs, each party uses its bargaining power to capture a larger share of the contract's surplus. Because bargaining power may shift over time, especially once the initially investment has been sunk, the return on investment of renegotiated contracts may be different than what was initially agreed.

Guasch reviews more than 1,000 concession contracts between 1985 and 2000 in the water, telecoms, transport and energy sectors, and finds that most concession contracts lead to several major renegotiations, usually within the first three years (Guasch, 2004). He also documents that the majority of renegotiations favour the firm over the public sector. Engel *et al.* (Engel, Fischer, Galetovic, & Hermosilla, 2008) examine 50 concessions and find an average of three renegotiations per contract. Gómez-Ibáñez and Meyer (Gómez-Ibáñez & Meyer, 1993) also report widespread contract renegotiation of road concessions in South Korea, France or Spain. More recently, a survey of PPPs in France found that 97% of contract had been renegotiated, mostly to change the project scope, but also on the question of price indexing and performance. According to the study, which covers 30 contracts at the operating stage, the public sector declared itself satisfied with the outcome of these renegotiations in 90% of cases (EPPP, 2012).

In the private case, the pipeline and energy sectors experience frequent renegotiation and disputes (Creti & Villeneuve, 2004) as well as the oil and gas industry (Walde, 2008) and renewable energy (Looper, 2011).

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A special case of renegotiation is the planned review of the terms of delegation by a regulatory agency, thus addressing the issue of opportunism explicitly. While this creates more credible commitment mechanisms on the downside, it is also at the expense of limiting expectations of upside. In the case of UK water utilities for example, price cap regulation eventually amounts to a form of *ex post* rate of return regulation but without the regulator having to commit to the level of the return beyond the next *determination* (five-year regulatory period).

The regulator's data shows that price cap regulation has considerably reduced the return on investment of regulated utilities from 8% (post tax) in the late 80s to 5% today in real terms. Still, OFWAT considers the cost of equity of UK water companies to be around 7% (OFWAT, 2009). However, we also know that increased leverage (up to 85% in the case of UK water companies) has increased the return on equity to investors. Likewise the US has a long tradition of planned renegotiation of long-term franchises (Troesken 1993).

A second trigger of renegotiation is opportunism, which may lead to renegotiations occurring in bad faith e.g. one party entered the contract anticipating renegotiating and holding up the other party. 'Low ball' bids, offering low prices but anticipating renegotiation as soon as the other party is locked-in, are a common phenomenon in infrastructure procurement from construction companies that are more interested in the building phase than in long-term financial viability (Guasch, 2004), while renegeing on planned tariff increases is a frequently observed behaviour on the part of the public sector (Jensen, 2006). Opportunism occurs because

once contracts are awarded, it is costly to exit the relationship and re-tender a long-term contract. Even the reputation cost of exit can be high, for firms but also for politicians and civil servants (Guasch, Laffont, & Straub, 2005).

While the need to frequently renegotiate long-term contracts is well documented in the literature, its impact on equity risk still needs to be researched. We know that the private party in public-private contracts triggers about half of all renegotiations and research suggests that it often benefits from the outcome. Hence, the average effect on equity risk may be limited.

2.6.3.5 The role of political risk

If long-term investment is made possible by commitment mechanisms that enforce dynamic consistency, then the quality of commitment should be a major determinant of the equity risk of such investments. In the public case, the commitment of the public sector to investment delegation might shift for ideological reasons or it may simply deteriorate because the perception of the fairness or efficiency of the contract becomes questioned. We review the literature on both cases below.

Paradigm shifts

Two recent historical trends suggest that the public sector is committed to the increasing use of private capital in public infrastructure projects:

- The continued retreat of the state from the infrastructure sector since the late 1970s, when most infrastructure was state-owned, with the large scale privatisations of the 1980s in the utilities and telecoms sectors, and the emergence of the PPP model in the

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UK in the mid-1990s, which has gradually been adopted in Europe, North America and beyond;

- The tendency towards fiscal retrenchment in numerous economies with each new economic and financial crisis: from emerging markets since the 1980s to the OECD since 2009, numerous governments may not have the means to finance the investment needed in existing and new infrastructure.

However, a long-term perspective on infrastructure investment and ownership reveals a more cyclical history than recent evolutions might suggest.

In effect, like the famous lighthouse described by Coase (1974), most infrastructure developed since the industrial revolution was initially privately financed and developed (Besançon, 2004). Some infrastructure businesses were almost immediately nationalised because they were deemed of strategic importance (e.g. telecoms in France and Germany) but the notion that certain sectors should be under state control also continued to develop, and by the onset of the First World War (WWI), most utilities were state-controlled in Europe. WWI only increased state control, which remained in place after 1918 including in railways, ports and airlines. Further shocks and economic dislocation (the Great Depression, the second world war) only led to a deepening of state control, which extended to numerous sectors and to most infrastructure assets by the 1950s and until the end of the 1970s (Gómez-Ibáñez, 2003), with the exception of the US where private monopoly regulation remained in place (Megginson 2005). For example, the perceived failure of the private sector to

meet its capital investment commitment in the UK in the 1950s led to the widespread nationalisation of utilities (Helm & Tindall, 2009).

Next, the well-documented paradigm shift led by conservative governments in the US and the UK in the early 1980s signalled a return to the possibility of private infrastructure investment. By then the cost of integration (state-ownership) was perceived to be too great and the potential benefits of delegation significant, including raising revenues for the state and improving the efficiency of entire sectors and of the economy as a whole.

Thus, the privately invested infrastructure of the 19th century had mostly become public by the middle of the 20th century and began to be privatised and made investable again in the mid-1980s to the 90s. During that period, US utilities went from minimal oversight to heavy-handed municipal control before returning to privatisation and 'light-touch' regulation (Troesken, 2006).

Thus, while recent developments tend to suggest that public infrastructure finance has reached the end of (its) history i.e. that the choice of delegation over integration for the provision of public infrastructure is gradually being recognised as superior and that the post-war period of direct state control was an exceptional one, one may prefer to take a view more in line with Olson's theory of institutional ossification (Olson, 1984): shifts between regulatory regimes occur because dominant arrangements have become politically untenable until the policy pendulum swings the other way.

2. The Nature of Underlying Infrastructure Equity Investments

From commitment to resentment

Insofar as the viability of long-term contracts is a function of the quality of commitment, **emerging markets have proven to be especially risky.** The lack of government accountability as well as political instability are more likely to lead to a reversal of commitment than in more advanced economies where governments find it difficult to ignore or renege on the contracts they have entered into. **Focusing on emerging markets, Wells and Gleason give a summary of political reversals in the infrastructure sector in emerging markets and recount how in the late 19th century and early 20th century most infrastructure assets had been privately financed and developed in Latin America, usually by US firms but that a series of nationalisations and expropriations from the late 1920s onward led to most of infrastructure being state-controlled during the post-war period.** External shocks, politically unpalatable tariff increases and the fact that most investors were foreigners led to the complete demise of these investments. **Wells & Gleason also argue that politicians have a tendency to court investors when they need to see new projects developed or new technologies introduced but have little difficulty reneging on their commitments once investments have been made, especially since repeated instances of reneging do not seem to stop the same investors from returning to the same country a few years later (Wells & Gleason, 1995).** In the same vein, Orr reviews the history of several investment booms involving the allocation of significant capital to infrastructure projects in emerging markets and suggests that few long-term contracts supporting new investment in infrastructure projects

remain unchanged after only a few years of operations (Orr, 2006; 2007).

But if, perhaps unsurprisingly, emerging markets embody higher political risk, Vernon's "obsolescing bargain" (Vernon, 1971) seems to characterise long-term contracts everywhere. For example, when the Private Finance Initiative¹⁴ (PFI) was launched in 1992 in the UK, the British infrastructure sector had been starved of capital expenditure for more than a decade and needed to attract capital. When the Labour Party was elected in 1997 on a promise to deliver public services, the PFI provided a very useful vehicle to attract cost-efficient firms and capital. However, ever since their inception or almost, PFI contracts have regularly been criticised in the media and policy arenas, **the main concern being that investors may be receiving returns that are 'too high'.**

An important dimension of the contracts used to deliver new privately financed infrastructure in the UK (and today in France, Germany and beyond), is that they do not set investors' return explicitly, nor do they create formal mechanisms for regularly resetting returns, as opposed to regulated businesses. As a consequence, if competition for the contract was so limited that adverse selection led to granting a large risk-free rent to the firm, or a new technology is introduced that delivers high costs savings, or if the firm is simply very good at generating costs savings or manipulating its financial structure to maximise its return, the temptation for, or the pressure on, the public sector to renegotiate or at least cap profits can become too great to resist.

14 - The private finance initiative is the main UK government program for the procurement of privately invested public infrastructure. Between 1992 and 2012, more than 700 public-private contracts were signed to invest more than GBP100bn of capital (Blanc-Brude 2012b).

2. The Nature of Underlying Infrastructure Equity Investments

As long as the Labour party was in power, its commitment to the PFI remained. Elsewhere in the UK, local government that did not feel bound by the decisions of the Labour party continuously challenged the validity of the rents embedded in PFI contracts. On a number of instances, the governments of Scotland or Wales cancelled planned projects, terminated existing contracts (Roy, 2011) and even sold assets that were still claimed by banks as security (Ashurst, 2007). After a new government was elected in the middle of a financial crisis, which was immediately followed by a crisis of public finances, the commitment of the public sector to the PFI wavered.

Ironically, while the PFI was designed to reduce the cost of traditional public procurement, in its December 2011 *Call for Evidence*, the UK Treasury chose to characterise the past twenty years of PFI procurement as potentially "too costly, inflexible and opaque" (UK Treasury, 2011). Clearly, the commitment of the UK public sector to the long-term contracts delivering its social infrastructure had been eroded.

Following this period of uncertainty, the UK Treasury published a document entitled "A new approach to public private partnerships" (UK Treasury 2012). While the documents states that "equity investors in PFI projects are perceived to have made windfall gains, and this has led to concerns about the value for money of projects", it also signals the continued commitment of the State to use investment delegation to deliver public infrastructure projects. It suggests that several billion pounds of efficiency savings have been realised through the *ad hoc* review of operating costs. The impact of these renegotiations

on equity returns is unclear, but the most significant step taken by the UK Treasury with this reform is the requirement to publish equity returns in PFI contracts.

Transparency may indeed be the best insurance against future political risk in the sector.

2.7 Conclusion: Equity Risk, Commitment and the Project Lifecycle

From our review of the economics and financial economics of infrastructure investment, we conclude that infrastructure equity investments derive their characteristics from the contractual relationship that creates the opportunity to delegate investment in stand-alone infrastructure facilities.

These investments are relationship-specific i.e. they have little or no value outside of the contractual relationship in question, in particular, they have no value if they are not used. In this respect they are the opposite of real assets since they have no intrinsic value: they are claims on project cash flows (residual claims in the case of equity). From the relationship specificity of infrastructure investments also springs their *tenor* since the initial investments they entail can only be recouped over a period of effective use. In other words, with project finance we can create equity investment with a defined maturity.

Next, the contractual relationship in question create different types of equity risk profiles depending on the revenue risk, credit risk, construction and operations risk and the uncertainty introduced by

2. The Nature of Underlying Infrastructure Equity Investments

contract renegotiation and regulation, as well as political risk. In turn, the riskiness of equity invested in firms created to enter into these contracts is a function of the quality and enforceability of the commitment mechanisms that allocate and manage these risks.

Infrastructure equity investment at the underlying level suggests a low risk environment signalled by high leverage and in which most risks are well managed through risk transfer contracts. Exogenous risks, in particular demand/traffic and *ad hoc* regulatory changes as well as policy reversals signal different levels of equity risk in infrastructure investments.

Perhaps one of the most interesting dimensions of equity risk in project finance is that it is non-linear over time: infrastructure projects have a lifecycle from construction to operations and decommissioning that implies different risks and different return profiles for the different components of the capital structure. Moreover, the choice of debt repayment profile may have a significant impact on equity risk and the probability of positive dividend yield.

In effect, contrary to the classic case in corporate finance, equity risk follows a predictable average transition path during the life of an investment. **If the risk profile of infrastructure equity is non-linear but predictable, this has important implication for dynamic portfolio construction.** We return to this point in the last part of this paper.

3. Investing in Infrastructure: The Investment Narrative and Existing Evidence



3. Investing in Infrastructure: The Investment Narrative and Existing Evidence

The decision to invest equity in firms that solely enter into long-term contracts delegating investment in physical infrastructure projects must rest on an explicit or implicit model. From our review of the investment characteristics of underlying infrastructure, we call this model *the infrastructure investment narrative* after Daniel Kahneman (2002) definition of an investment narrative as "the passive acceptance of the formulation given."

This investment narrative has led to the development of a number of investment products in both listed and unlisted equity that are labelled as 'infrastructure', perhaps most notably the classic close-ended seven to ten-year private equity structure, to try and access the investment characteristics of underlying infrastructure equity described above.

In what follows, we review the implicit model or investment narrative found in most industry publications and argue that **it fails to focus on the most relevant dimension of infrastructure finance – contracts – but instead commits the fallacy of equating the physical characteristics of tangible infrastructure with its expected investment characteristics.** This fallacy of composition ("a toll road is a toll road") leads to investment products that partly fail to deliver the proposed narrative, as the academic research that we review below tends to confirm.

In short, no clear picture emerges in academic research from the main existing strategies and vehicles that rely on infrastructure projects and utilities as underlying equity investments. However, we argue that these approaches are not well

designed to capture the characteristics of underlying infrastructure described in the previous section. From a financial regulatory perspective (e.g. Solvency 2), this may lead to a misconception of the risk and returns implied by infrastructure investment.

3.1 The infrastructure investment narrative

In recent years, the gradual emergence and formulation of a narrative about the characteristics of infrastructure investment as a previously unrecognised asset class has caught the attention of investors and academics.

The proposed investment narrative highlights the opportunity to invest in well-defined tangible assets: physical structures of steel and concrete providing essential services. According to numerous industry publications, tangible infrastructure assets, immobile and demanding high sunk capital costs and long repayment periods, are expected to create monopolies thanks to barriers to entry and increasing returns to scale. Thus, assets owners are expected to benefit from the low elasticity of demand creating pricing power and an inflation hedge, as well as low return covariance with other investments, allowing attractive risk-adjusted returns. (AMP & Shane, 2007; Chambers, 2007; Morgan Stanley, Andrews, & Wahba, 2007; RREEF & D. Martin, 2005; Vanguard, Wallick, & Cleborne, 2009) (JPMAM & Weisdorf, 2007) (RREEF, Mansour, & Patel, 2008)

The focus on tangible assets leads to a categorisation by industrial sectors, which typically include transportation (airports, roads, rail), utilities (water treatment

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and distribution, power generation, transmission and distribution), telecoms and social infrastructure (school, hospital, prison and other public buildings, certain non-combatant defence assets etc). Each sector is expected to have a specific risk and return profile determined by its physical characteristics: mature toll roads are expected to yield 8-12% IRR while schools or prisons yield 9-14% and new toll roads 12-16% (Weber, 2009).

This narrative is usually expressed against a background of high investment demand: estimates show that very significant new infrastructure investment is needed worldwide and that, both cost efficiency requirements and fiscal considerations make governments unlikely to be able to finance future investment demand. Public policy is thus increasingly supportive of private investment in infrastructure assets.

This is very attractive indeed for institutional investors, most of whom are required to meet a combination of performance-seeking and liability-hedging objectives (Amenc *et al.* 2010). Illiquid assets such as infrastructure play a growing role in pension funds' alternative investment decisions (Sender 2010) as part of a performance-seeking portfolio (PSP) and infrastructure may also contribute to a liability-hedging portfolio (LHP) if it can offer exposure to predictable, a-cyclical and inflation-linked cash flows.

In what follows, we review existing empirical research on listed, unlisted and direct infrastructure equity investments and discuss their relevance and relative ability to deliver the infrastructure investment narrative: *the notion that underlying*

infrastructure should deliver stable long-term, inflation-linked cash flows and superior risk adjusted performance.

3.2 Listed infrastructure

A number of infrastructure indices have been created to proxy the performance of listed infrastructure assets.

However, what qualifies as listed 'infrastructure' is subject to debate and a number of indices are more akin to an infrastructure equity *theme*: they include firms that are likely to benefit from the expected growth of the infrastructure sector worldwide because they provide essential technology or know how e.g. energy recovery devices for water desalination, wind power turbines, facility management services etc.¹⁵ Whether or not infrastructure is a valid equity theme, such indices are only indirectly related to the infrastructure asset class narrative and to the long-term risk transfer contracts that we discussed in the previous section.

Still, several indices are exclusively focused on listed utilities, transportation, telecoms and energy firms as well as listed infrastructure funds, and aim to provide a market-cap weighted proxy of the sector's performance. In what follows, unless otherwise stated, the term 'listed infrastructure' includes utilities.

As shown in table 4 and 5 (see appendix), utilities, telecoms and transport in the US, Europe and Australia dominate the listed infrastructure space. Indeed, since the 1970s, IPOs have been the default method to fully or partly privatise existing state-owned utilities and transportation infrastructure and the most important privatisation programmes have occurred in these jurisdictions. Thus,

15 - The recently launched STOXX infrastructure suppliers 50 index is in this category.

3. Investing in Infrastructure: The Investment Narrative and Existing Evidence

listed infrastructure market capitalisation has grown considerably. Rothballer and Kaserer estimate that the number of listed infrastructure companies that own or have a concession for physical infrastructure assets and generate more than 50% of their revenues from these assets increased from 216 to 1,458 between 1980 and 2010, excluding American depository receipts, funds and trusts¹⁶ (Rothballer & Kaserer, 2011).

Figure 6 (see appendix) confirms that the listed infrastructure space is significant with major indices reporting market capitalisations in excess of US\$1Tr in June 2012, mostly consisting of utilities as the difference in size between the **UBS World Infrastructure Index** (which, at USD200bn market capitalisation, excludes utilities) and the **UBS World Infrastructure and Utilities Index** (USD1.4Tr) confirms. In comparison, listed infrastructure funds represented a global market capitalisation of \$55.7bn in 1H2011 but one that has also grown considerably, from eight funds globally in 2000 to 43 funds in 2011 (Preqin, 2011).

3.2.1 Risk-adjusted performance

Several papers examine the performance of listed infrastructure. Looking at a sample of 32 hand-picked¹⁷ infrastructure entities listed in Australia, **Peng and Newell (2007) find that for the period between 1995 and 2006, listed infrastructure exhibits higher returns, but also higher volatility than equity markets.**⁸ Still, they show that listed Australian infrastructure has a better Sharpe ratio than the market and that the correlation between Australian listed infrastructure and utilities returns and the market is not significant over their full sample period (1995-2006). However,

they also document that the correlation of returns is not constant and tends to increase over time (after 2001). In a follow up study, Newell and Peng (2008) find that in the US, infrastructure (ex-utilities) underperforms stocks and bonds over the period from 2000 to 2006 while utilities outperform the market.

Using a multifactor model of excess returns adjusting for Fama-French style factors (Fama & French, 1997), Bird *et al.* (2011) find that listed infrastructure and utilities proxied by the UBS indices for Australia and the US generates excess returns from 1995 to 2009. They find that listed infrastructure exhibits much higher volatility than listed utilities and has a higher market beta. **They find a high and significant equity beta of 1.35 for US infrastructure and of 1.00 for Australian infrastructure, while listed utilities in their sample have more defensive equity betas between 0.47 and 0.57.** This is consistent with the Fama & French (1997) study of the cost of equity across industries from 1963 to 1994, which finds that telecommunication and utilities have the lowest market risk among all industries in both the CAPM sense and the Fama-French three-factor model with beta values of 0.66 for both sectors.¹⁹

Using a sample 1,458 listed firms in the transport, telecoms and utilities sectors, Rothballer and Kaserer (2011) find that infrastructure stocks have lower market risk than equities in general but not lower total risk i.e. they find high idiosyncratic volatility. They also report significant heterogeneity in the risk profiles of different infrastructure sectors. The authors argue that construction risk, operating leverage, the exposure to regulatory changes and

16 - They acknowledge that their sample focuses on privatised economic infrastructure (utilities and transport) and thus excludes other assets such as social infrastructure.

17 - The authors use content analysis to select listed entities that best fit the infrastructure narrative. Out of 1,800 firms listed on the ASX they select 32 with a cumulative market capitalisation of A\$55bn. 18 - Finkenzeller & Fleischmann (2012) report similar findings using the same dataset.

19 - Alexander (2000) finds similarly low beta values for his sample of 71 transportation infrastructure firms. The results from most regulatory reviews regarding the determination of adequate capital costs also support these findings (OXERA, 2002; Quach & Wheatley, 2011).

3. Investing in Infrastructure: The Investment Narrative and Existing Evidence

the lack of product diversification explains this volatility. Looking at the 35 Hong Kong-listed infrastructure entities, Newell *et al.* report similar findings of relatively low market correlation but significant volatility (Newell, Chau, Wong, & K, 2009). Rothballer and Kaserer's robust findings about the volatility of infrastructure stocks also confirm the results of several industry studies which suggest that the volatility of the UBS infrastructure and utilities index is on par with equities and real estate, but that market correlation is relatively low (Colonial First State Asset Management, 2009; RREEF, Mansour, & Hope, 2007).

Examining three major listed infrastructure indices between 2002 and 2009, Sawant also finds that return distributions show negative skew and high kurtosis and high volatility and concludes that infrastructure equity indices do not provide a good proxy to be exposed to underlying infrastructure (Sawant, 2010b). Rothballer and Kaserer's (2011) also find that listed infrastructure entities exhibit leptokurtic returns.²⁰

The finding that listed infrastructure entities exhibit high levels of idiosyncratic risk combined with leptokurtic returns has implications for portfolio construction since building well diversified positions may demand a larger number of investments that with other stocks, as underlined by Ducoulombier (2007).

3.2.2 Sources of excess returns

Some industry publications mention interest rate risk as a major characteristic of listed infrastructure (Russell Investments, 2009). Likewise, the academic literature identifies leverage as one of the main sources of excess returns in listed infrastructure.

Bird *et al.* suggest that the negative skew and positive kurtosis of listed infrastructure returns indicates the use of significant leverage and that the deterioration of performance for US utilities and Australian listed infrastructure during market downturns is also driven by high debt levels. The same authors report that infrastructure funds create additional gearing of up to 65 per cent in terms of net debt to enterprise value.²¹ The leverage used by infrastructure funds creates a second layer of debt because underlying investments are already highly leveraged either through project financing.

In the case of utilities, another source of excess return identified in the literature is regulatory risk (Ho & Liu, 2002), which limits upside tariff changes as discussed earlier. Thus, investors can own assets with monopolistic characteristics, but have to forego the possibility of supernormal profits that would cause welfare losses (Bird, Liem, & Thorp, 2011). Guasch and Spiller estimate that regulatory risk introduces a risk premium to the cost of capital of between 2 and 6 percentage points (Guasch, 2004; Guasch & Spiller, 2002).

Recent papers also cast doubt on the durability of excess returns in listed infrastructure. Dimovski studies thirty Australian IPOs in the infrastructure sector between 1996 and 2007 and finds that underpricing is not statistically different from zero (Dimovski, 2011). Thus, the substantial discounts observed in Australia in the 1990s have not persisted, as new buyers understand the nature of infrastructure businesses better and demand for a finite number of assets increases. Likewise, Bird *et al.* also find a reduction in excess returns

20 - Leptokurtic: positive excess kurtosis

21 - Based on leverage estimates by Frankish (2010) and Timotijevic (2007, 2008)

3. Investing in Infrastructure: The Investment Narrative and Existing Evidence

generated by listed Australian infrastructure and utilities in the more recent periods in their sample and suggest that excess returns may disappear in the long run. The same authors report that the Dow Jones Utilities index and Transportation Index in the US from 1931 to 2009 do not create excess returns against the S&P 500, after adjusting for Fama-French factors.²²

Ibboston attempts to create a 'unique' infrastructure index by combining existing indices. Using three version of their composite index (low, medium and high utilities), they find that over the 1990-2007 period, infrastructure returns were similar to that of US equities but with slightly less risk (Idzorek & Armstrong, 2009). Using traditional mean-variance optimisation techniques they arrive at significant infrastructure allocations replacing non-US bonds and global high-yield while delivering a small (18bps) improvement of the optimal portfolio performance. Using the CAPM to create a forward-looking model of expected returns including an infrastructure allocation, they find that adding infrastructure does not lead to a meaningful improvement in the efficient frontier (Idzorek & Armstrong, 2009).

In summary, listed infrastructure is heterogeneous and not easily defined. Utilities dominate the space by number of stocks and market capitalisation and they tend to have average variance but low covariance. However, other entities that usually qualify as 'infrastructure' such as listed infrastructure funds, may have higher market risk in part driven by high vehicle-level leverage.

The literature also suggests that observed excess returns may be temporary and determined by exogenous factors such as policy (the fire sale of state-owned assets in Australia), regulatory lag (the regulator tends to re-set tariffs to cap returns *ex post facto*) and above all the availability of cheap credit leading to over-leveraging. Indeed, it is well-documented that after 2008 over-indebted listed infrastructure funds in Australia had to sell assets in a falling market to meet debt repayment obligations before having to be restructured in the case of Macquarie or liquidated in the case of Babcock & Brown (Tucker, 2008; Ubhi, 2008), which puts the pre-crisis performance reported in Peng *et al.* (2007) in perspective. In this case, the potentially low correlation of many infrastructure fund models with the business cycle is eroded by a strong correlation with the credit cycle.

Table 1 and 2, which show key performance metrics for several major infrastructure indices as well as the S&P Composite and the FTSE All Share indices between 2002 and 2012, echo these conclusions.

The potential for outperformance of listed infrastructure is not constant, with only a clear improvement on market indices in the case of 10-year returns. Table 2 splits the same return data into two 5-year periods corresponding to before and after the 2008 credit dislocation event. It suggests that while listed infrastructure was outperforming before dislocation, something may be broken in its performance model after that. Between 2007 and 2012, all infrastructure indices underperform major market indices and exhibit lower Sharpe ratios.

22 - The authors caution against generalising these results as the composition of the Dow Jones Utilities and Transportation indices are not perfect representation of the 'infrastructure' universe.

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Thus, listed infrastructure fits the infrastructure asset class narrative insofar as it can improve portfolio diversification (Sharpe ratio) but this is mainly a feature of utilities and one has to question whether investing in listed utilities represent anything new for long-term investors.

These studies suffer from a number of limitations: authors use *ad hoc* datasets suffering from historical and country biases in the case of Australia (Peng *et al.* 2007) or industry-provided infrastructure indices which suffer from a fundamental drawback: market-cap weighting leads to poor diversification and even concentration in a few very large stocks. Indeed, existing research has shown that **market-cap weighted indices are so inefficient that they are dominated by equal-weight indices, which are themselves suboptimal (Amenc, Martellini, Goltz, & Milhau, 2010).**²³ In the case of infrastructure and utilities, this concentration can be extreme. Ibboston reports that, in Australia, the top three stocks (Origin, AGL and Transurban) account for at least 60% of the UBS index (Idzorek & Armstrong, 2009). Likewise, listed infrastructure and utility markets outside of Australia consist mainly of large utility companies, while Australian listed data also includes listed infrastructure funds (near 40% of the UBS index). With such high concentration levels it is questionable whether such indices can claim to capture any general infrastructure qualities.

Each index also introduces some heterogeneity in the type of underlying investments that are made and varying degrees of geographic concentration as shown in table 4 and 5 (see annex). With the UBS indices, the weight of privatised utilities

leads, for historical and political reasons, to a geographic concentration in the US, UK and Australia. The 'anglo-saxon' tilt found in most listed infrastructure indices echoes the idea expressed earlier that if most infrastructure is public infrastructure, then infrastructure investment is a function of public policy. By extension, public policy is a matter of institutions and the performance of privatised, listed utilities in Common Law countries may not be very informative of the risk and return characteristics of infrastructure investments in countries that have adopted the Napoleonic code.

The Macquarie infrastructure indices include more European utilities (French, Italian &c) which signals a wider understanding of 'infrastructure' since these vertically integrated firms tends to benefit from construction and technology revenues as well as the collection of tariffs or tolls through the operation of infrastructure assets. It is unclear whether such indices can capture the infrastructure asset class narrative and are not *in fine*, just thematic equity benchmarks.²⁴ Equally problematic is the fact that infrastructure funds (listed or not), while they are typically expected to invest in infrastructure projects or utilities, also include in their mandates investing in infrastructure-related businesses.²⁵

The combination of market volatility, risk concentration and additional leverage makes the investment proposal implied by listed infrastructure funds even more likely to diverge from any of the expected investment performance discussed in the previous section on underlying assets.

23 - Equal-weight portfolios are optimal only if all constituents are identical returns and volatilities, and all pair-wise correlations are equal.

24 - An investment company that chooses investments according to a particular issue or theme. For example, a fund built on an agricultural theme might invest in the equities of farm equipment manufacturers, chemical companies, and other firms that sell agricultural products. Likewise, an investment company might choose to invest in equities that would reflect an ecological or baby-boomer theme.

25 - Macquarie Infrastructure Funds clearly state in their commercial brochures that they aim to invest in infrastructure-related businesses as well as infrastructure projects (Macquarie Infrastructure and Real Assets, 2011).

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Table 1: Risk return characteristics of major infrastructure indices in December 2012

	MSCI World Infra (sector capped)	MSCI World Infra	SE&P Global Infra	FTSE Macquarie Global Infra	UBS World Infra	UBS World Infra & Utilities	UBS Global 50-50 Infra & Utilities	SE&P 500 Comp	FTSE All Share
Performance†									
3 year	14%	13%	16%	13%	15%	13%	14%	16%	15%
5 year	-4%	-7%	-6%	-6%	-4%	-6%	-5%	-2%	-1%
7 year	2%	1%	2%	2%	5%	2%	2%	2%	2%
10 year	5%	4%	8%	7%	11%	7%	8%	4%	4%
Risk*									
3 year	14%	13%	16%	13%	15%	13%	14%	16%	15%
5 year	18%	17%	23%	18%	22%	18%	20%	22%	19%
7 year	16%	15%	20%	16%	20%	16%	18%	19%	17%
10 year	14%	14%	18%	15%	18%	15%	16%	17%	15%
Sharpe ratio#									
3 year	0.2	-0.1	0.1	-0.1	0.4	-0.04	0.2	0.5	0.3
5 year	-0.3	-0.4	-0.3	-0.4	-0.2	-0.4	-0.3	-0.1	-0.1
7 year	0.0	-0.1	0.0	0.0	0.2	0.05	0.01	0.0	0.0
10 year	0.2	0.2	0.4	0.4	0.5	0.4	0.4	0.2	0.2

† annualised monthly returns

* annualised standard deviation of monthly returns

ratio of annualised excess monthly returns over 3-months risk-free rate to annualised standard deviation of monthly returns

Table 2: Characteristics of major infrastructure indices before and after 2008

	MSCI World Infra (sector capped)	MSCI World Infra	SE&P Global Infra	FTSE Macquarie Global Infra	UBS World Infra	UBS World Infra & Utilities	UBS Global 50-50 Infra & Utilities	SE&P 500 Composite	FTSE All Share
Performance (annualised)									
Pre-dislocation*	16%	16%	25%	24%	28%	24%	25%	9%	10%
Post-dislocation†	-5%	-7%	-6%	-7%	-4%	-7%	-6%	-1%	-1%
Risk (annualised)									
Pre-dislocation	8%	10%	10%	10%	12%	10%	10%	9%	10%
Post-dislocation	18%	17%	23%	18%	22%	18%	20%	22%	19%
Sharpe ratio									
Pre-dislocation	1.55	1.33	2.22	2.12	2.09	2.08	2.10	0.71	0.75
Post-dislocation	-0.30	-0.44	-0.30	-0.42	-0.20	-0.41	-0.32	-0.05	-0.07

* January 2003 to January 2008

† January 2008 to January 2013

3.2.2.1 Stable cash yield

In the case of listed infrastructure, industry studies argue that dividend yields are systematically higher with infrastructure stocks (Colonial First State Asset Management, 2010a). We are not

aware of any academic research on this topic but it should not come as a surprise that low growth stocks should offer higher income on average than stocks associated with expectations of higher capital gains. Figure 1 suggests that the average

24 - An investment company that chooses investments according to a particular issue or theme. For example, a fund built on an agricultural theme might invest in the equities of farm equipment manufacturers, chemical companies, and other firms that sell agricultural products. Likewise, an investment company might choose to invest in equities that would reflect an ecological or baby-boomer theme.

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dividend yield of the FTSE Macquarie Global Infrastructure Index (FMGII) is consistently higher than that of the S&P Composite. We run Student's T-test of the independence of FMGII dividend yields with S&P Composite dividend yield and find that we can reject the null hypothesis that they are identically distributed at the 1% confidence level. We also measure the volatility of dividend yields for infrastructure the FMGII and find that it is more than twice as high as the volatility of the S&P Composite dividend yield. Thus, one cannot conclude that infrastructure dividend yields (as they are proxied by the FMGII index) are more stable than the market. They are, however, consistently higher.

3.2.2.2 Inflation protection

The ability to hedge away inflation through infrastructure investment is a core claim of the infrastructure investment narrative and is made repeatedly in numerous industry publications (AMP, 2010; Colonial First State Asset Management, 2010b; 2010a; Lazard, 2011; RREEF *et al.*, 2007; 2008). The typical arguments supporting the claim that infrastructure can hedge inflation are summarised by Rödel *et al.* (2011).

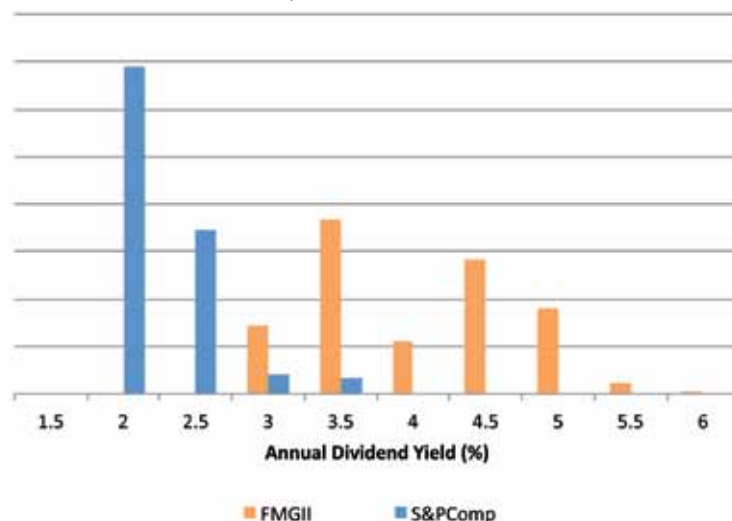
- Infrastructure involves large tangible assets, the replacement costs of which increases in an inflationary environment, thus preserving investment value (RREEF *et al.*, 2007);
- Infrastructure assets create monopolies with pricing power and low elasticity of demand (RREEF *et al.*, 2007);

25 - Macquarie Infrastructure Funds clearly state in their commercial brochures that they aim to invest in infrastructure-related businesses as well as infrastructure projects (Macquarie Infrastructure and Real Assets, 2011).

Table 3: FMGII and S&PComp Dividend Yields (computed daily)

	FMGII	S&PComp
Std Deviation	0.68	0.31
Average	3.78	2.02
Minimum	2.70	1.60
Maximum	5.53	3.37
t-test	1.96	
p value	0.00000	
observations	2,214	

Figure 1: Frequency distribution of FMGII and S&PComp Dividend Yields



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- The economic regulation of natural monopolies grants them an explicit inflation pass-through with tariff setting formulas following the RPI-X model (Euromoney & Rickards, 2008), as is also the case for toll setting formulas in most toll roads (Colonial First State Asset Management, 2009);
- The high share of capital costs in infrastructure businesses minimises their exposure to input price inflation (G. A. Martin, 2010).

However, the literature testing the inflation protection characteristics of infrastructure fails to arrive at such unconditional conclusions. Two industry studies by J.P. Morgan show that the EBITDA of regulated utilities in the US is positively correlated with inflation and that the income cash flows of EU and US regulated utilities grow above the inflation rate (JPMAM, Armann, & Weisdorf, 2008; JPMAM *et al.*, 2009). A similar study examines the ability of a listed infrastructure index to outpace inflation over a given period and concludes that it is highly likely for a 10-year investment period (Russell Investments & Ross, 2009). However, these studies do not test the statistical significance of their conclusions.

Academic papers are more circumspect. While Martin (2010) argues that infrastructure investment can be an inflation hedge, he also concludes that sensitivity of listed utility returns to expected and unexpected inflation is statistically insignificant. Bird *et al.* (2011) measure sensitivity to inflation expectations by comparing listed infrastructure returns with returns to US and Australian inflation linked bonds, using the Barclays US TIPS index and the UBS Australia Inflation Linked bond index. They also test infrastructure inflation hedging

abilities directly by using the CPI and obtain similar results: the US and Australian utility sectors exhibit inflation hedging potential, however, pure infrastructure (non-utility) stocks show no evidence of inflation hedging.

Rödel and Rothballer (2011) conduct the most robust study so far of the potential for additional inflation protection through listed infrastructure. Acknowledging the measurement issues created by existing indices, including the relatively low inflation environment of the period covered by these indices (since the mid-1990s) and the lumping together of domestic and international assets, which tends to blur their inflation hedging characteristics because of exchange rate fluctuations, they build their own index using the Rothballer and Kaserer (2011) dataset of 1,458 infrastructure stocks described above and in line with the approach taken by Amenc *et al.* (Amenc, Martellini, & Ziemann, 2008).

The authors build international return series spanning 37 years of data (1973-2009) as well as a number of shorter domestic series, and match these with international and domestic inflation data. They estimate the impact of expected and realised inflation on 1-, 2- and 5-year rolling nominal returns for domestic and international series but find no evidence of statistically significant improved inflation protection from infrastructure stocks compared with the stock market. Using sub-sector samples defined in terms of 'pricing power' (utilities with natural monopolies) they do not find statistically significant inflation hedging properties over and above that of the equity market in general. These results hold for

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domestic and international series. Likewise, Sawant (2010a) and Peng *et al.* (2007) fails to find any significant correlation between inflation and the returns of listed infrastructure indices.²⁶

Also looking at the effect of expected and unexpected inflation, Boudoukh & Richardson (1993) show that US utilities nominal returns between 1953 and 1990 tend to covary positively with expected inflation, but quite the reverse for unexpected inflation. A follow-up sector study using data from 1928 to 2008 arrives at similar conclusions (Antwerpen, 2010).

3.2.2.3 Drawdown protection

The risk insurance characteristics of infrastructure are another important part of the infrastructure investment narrative: infrastructure returns are expected to suffer less in bad times. Again, the role of the credit cycle is apparent in the results of the different existing studies. Those that rely on pre-Global Financial Crisis (GFC) data conclude that infrastructure offers

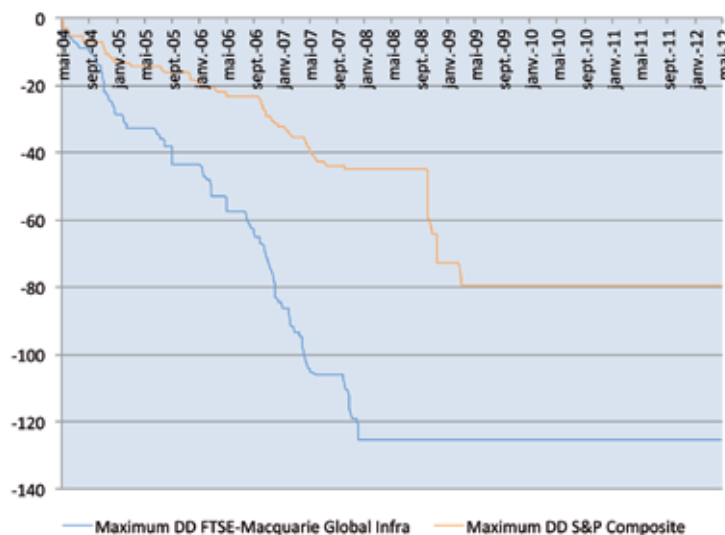
downside protection against other asset classes (Peng & Newell, 2007).

However, papers using post-GFC data conclude that infrastructure offered little defensive characteristics because vehicle level risk (leverage) became significant after 2008. Indeed, as figure 2 illustrates, the risk and maximum drawdown profile of listed infrastructure changes pre- and post-2008. We estimate that the market beta of the FMGII increased from 0.43 before 2008 to 0.57 afterwards. The impact of the credit cycle on the drawdown protection of infrastructure certainly requires more research.

Clearly, the indices that are used in existing research fail to replicate some of the expected characteristics of listed infrastructure equity investment: the hypothesis of less volatile investments creating a better inflation hedge and delivering more predictable dividend income than the market average is not confirmed in academic papers.

26 - Sawant (2010) analyses the correlation of the nominal returns of three infrastructure indices with the U.S. CPI and finds coefficients ranging between 0.09 and 0.11, slightly higher than the correlation of the S&P500 standing at 0.05, yet not statistically significant.

Figure 2: Maximum drawdown (peak to trough) and total return of FMGII and S&PComp



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The market indices labelled 'infrastructure' typically show extreme levels of concentration. Because they are dominated by a few stocks, they cannot be expected to capture any distinctive infrastructure *beta*.

Infrastructure indices also seem to have particularly suffered from the reversal of the credit cycle in 2008. Higher perceived illiquidity of underlying assets may also have played a role in the disposal of listed utilities in the context of generalised liquidity crisis, hence high drawdown risk as shown on Figure 2.

Listed infrastructure indices and the *ad hoc* samples collected for the purpose of the studies reported above rely on a form of fundamental analysis: they extrapolate investment characteristics from the physical/industrial characteristics of tangible infrastructure assets and expect to replicate the characteristics of the average underlying infrastructure investment as described in the first section. Index providers rarely provide unambiguous definitions of the objectives of their indices in their

high-level documentation, let alone metrics that allow for assessing the achievement of objectives (for an illustration in the equity index market see Amenc *et al.*, 2013; Goltz & Tang, 2011). As the above research shows, bundling together a number of firms because they operate privatised utilities or invest in toll roads, without taking the impact of regulatory (rate of return or price cap) and contractual (real tolls, shadow tolls or availability payments) frameworks into account leads to a very unclear picture.

Next, we review existing empirical studies and available data for unlisted infrastructure funds.

3.3 Unlisted Private Equity Infrastructure Funds

Unlisted infrastructure equity funds are a relatively recent invention of the 1990s. PPP funds started in the UK in the 1990s and wider infrastructure funds in Australia in the same decade. They grew ten-fold in recent years, with US\$3.6bn of capital raised in 2004 turning into US\$37.1bn in 2008. As of July 2011, there were 195

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unlisted infrastructure equity funds seeking to invest, or having invested, cumulative capital commitments of \$160 billion (Preqin, 2011).

Unlisted funds can pursue several strategies. Most funds are either primary funds aiming to win deals, manage them through construction and to make a capital gain upon exit with a target net IRR of 20%, or secondary funds aiming to acquire and enhance the long-term income streams generated by operational projects (Innisfree, Kashem, & Green, 2006). Funds horizon is partly a function of their preferred investment strategy: the 7-10 year classic private equity (PE) structures are by far the most common but hybrid funds (investing in projects with short and longer maturities) and evergreen funds are possible.

While discussing listed infrastructure equities revolves around issues of classification and what might constitute 'infrastructure', unlisted funds make it easier the focus on entities investing almost exclusively in underlying assets that are relevant to the infrastructure investment narrative. However, data paucity becomes a significant challenge to develop an unbiased view of investment performance. All existing papers on unlisted infrastructure investment focus on private equity funds and use **data from private equity databases (VentureOne²⁷, Venture Expert²⁸, CEPRES²⁹, etc)** while standalone infrastructure investment return databases also exist **(Probitas Partners, 2007)**. In what follows the term 'infrastructure PE funds' refers to closed-ended seven to ten-year private equity structures using the now classic partnership model (GP/LPs).

Using underlying deal data, a recent paper looks at the investment characteristics of individual investments made by unlisted infrastructure PE funds. A global sample of cash flows from the **CEPRES database** for 363 individual investments made by unlisted funds within a universe of eleven thousand private equity investments between 1971 and 2009, allows Bitsch *et al.* (2010) to test a number of hypotheses congruent with the infrastructure investment narrative. Using non-parametric and regression analysis, they test whether:

- Infrastructure deals are characterised by long-term capital intensive investments
- Infrastructure investments are low risk and have stable cash flows
- Pre- and post-construction projects have a different investment profile

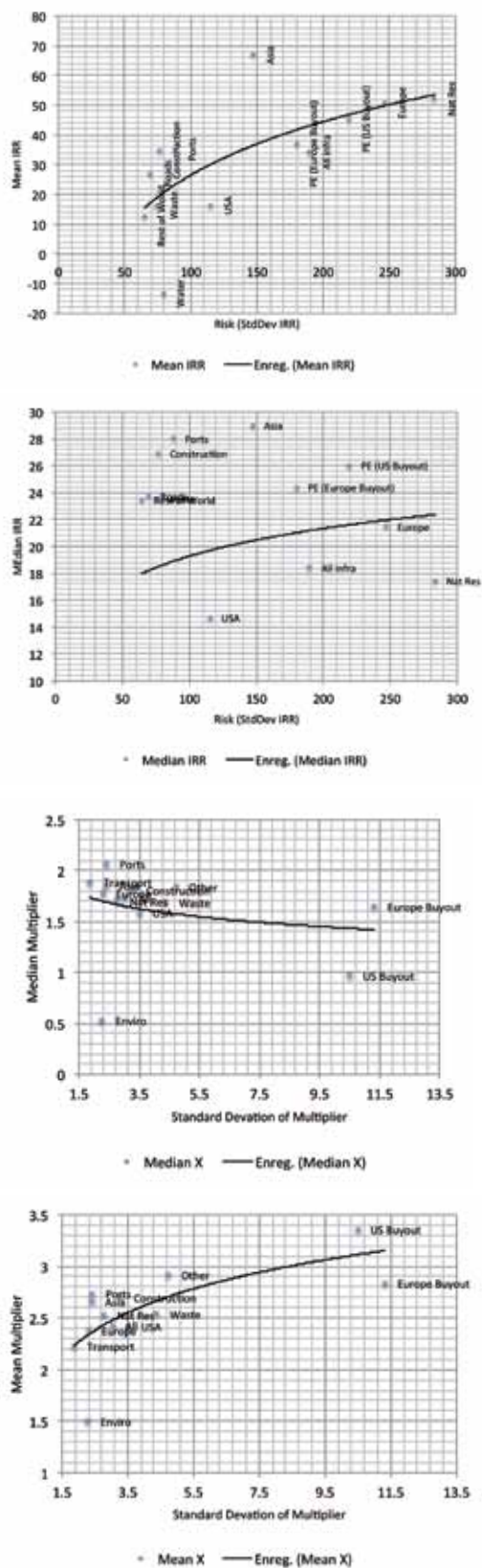
They find that infrastructure investments made by closed-ended, unlisted infrastructure PE funds are five times larger than other PE deals but do not have longer tenors. However, contrary to previous findings about the relationship between individual deals entry/exit times and returns in PE (Lopez-de-Silanes, Phalippou, & Gottschalg, 2011), which suggest that shorter deals are the most profitable, the authors report a statistically significant and large positive relationship between asset holding periods and returns in the case of infrastructure PE. In other words, in infrastructure PE there seems to be a premium for size but this may be a function of a number of biases in the sample.

They also test the variability of cash flows around the average s-shaped cash flow structure of individual investments³⁰ in their database and find that individual investment cash flows in infrastructure

27 - www.dowjones.com/privateequityventurecapital/
 28 - www.venturexpert.com/
 29 - www.cepres.com/
 30 - The relationship between cash inflows and outflows over time is non-constant, hence an s-shape cash flow profile

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Figure 3: Average and median IRR and multiples for individual investments in infrastructure and buyout PE funds (median holding period 45 months, min=2, max=194)



31 - 478 obs. Of underlying investment returns, 1986-2007, 48% us, 37.5% Europe (45% UK, 14% Scandinavia, 10% FR and 9% GE), 11.3% Asia 37% energy, 8% waste, 12% roads, airport and rail, 12% environment, 13.5% ports and terminals, 17% construction

CEPRES data³¹

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PE fund are not less volatile than in other types of PE fund.

Interestingly, they also observe fewer zero (bankruptcy) or below unity (loss) multiples in infrastructure funds compared with other PE funds, while average and median IRRs are higher for infrastructure funds.

The authors conclude that while infrastructure private equity deals have higher average and median returns than their private equity control group, they offer no evidence of more stable cash flows. They argue that unlisted infrastructure deals are highly levered, and that returns are largely driven by higher market and political risk. In line with the argument about leverage, their results also show evidence of the interest rate sensitivity of returns in infrastructure PE.

Thus, the Bitsch *et al.* study tends to show that infrastructure PE deals have a better risk/return profile (a higher Sharpe ratio) than PE deals in general. An industry study by Preqin examining 72 unlisted infrastructure funds with vintage years between 1993 and 2007, concludes that infrastructure funds are less risky and more resilient than buyout, venture, and real estate funds because the standard deviation of net IRRs is lower for infrastructure PE funds and because these funds managed to maintain positive IRRs during the 2008-9 period of financial crisis, which other types of private investment funds failed to achieve (Preqin, 2010). Figure 3, which shows the average risk/return characteristics of infrastructure PE compared with European and US Buyout PE, also from the CEPRES database, as reported in Weber *et al.* (Weber & Alfen, 2010), also tends to confirm that infrastructure PE funds have a different, more conservative profile than other PE funds.

The main difficulty with interpreting the Bitsch *et al.* (2011) results in the context of the infrastructure asset class narrative is to do with sample bias: the data used is drawn from a private equity database (CEPRES) and thus includes only those infrastructure funds that follow the private equity model. While these are the majority of existing infrastructure funds to date, other fund models can be used to invest in infrastructure, such as open-ended funds. Crucially, the definition used to select 'infrastructure' deals in the CEPRES database leads to a significant share (25%) of the data corresponding to telecoms deals in the US, while most deals in the dataset were conducted before 2001, a watershed year for global markets.

While the Bitsch *et al.* study is very rich, it remains difficult to come to clear conclusions about what a pension fund might expect from indirect unlisted infrastructure investments today. Moreover, the investment characteristics of several hundred individual infrastructure PE deals may not be indicative of the expected performance of individual infrastructure PE funds from the point of view of LPs: the characteristics of the average deal, computed from a sample of several hundred deals only marginally inform an investor about what can be expected from investment into an individual PE fund. This is not only because there may be leverage and fees at the fund level, but more importantly because an average computed from drawings of a dozen or less deals will exhibit much more variability than an average computed from drawings of hundreds of deals.

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As discussed earlier, beyond the risk premia that may characterise underlying investments, unlisted infrastructure funds are not neutral pass-through structures: individual funds make between eight and twelve investments during their life and may add another layer of leverage to the one found at the underlying level, thus creating a more concentrated and riskier structure than suggested by the findings of Bitsch *et al.* (2011).

Another frequent concern with infrastructure PE funds as reported by Beeferman (Beeferman, 2008), Inderst (Inderst, 2010) and Bird *et al.* (2011) is the cost of managers, which is similar to other private equity funds and include a management fee of 1 to 2 per cent and performance fees of 10 to 20 per cent, typically with around an 8 per cent hurdle rate (Preqin, 2011). In addition, costs are incurred in the course of transactions, including acquisition fees, financial advisor, arranger, funding and project development fees (Inderst, 2009).

Beyond the question of cost, the PE-like terms of infrastructure funds are widely understood to create conflicting incentives for managers (Inderst, 2010). Instead, some practitioners argue that negotiating terms should only be done once an investment strategy has been set, whether it is long-, short-term or yield-driven (Weber, 2009).

Several papers examine the returns that investors might expect at the infrastructure fund level, net of fees. Using Mercer net-of-fees return data series on five major funds for 1995-2006, Peng *et al.* (2007) find that Australian unlisted infrastructure delivers excess returns and has a Sharpe ratio of 1.47, second only to direct property and that

unlisted returns are more stable than that of listed infrastructure during the period.

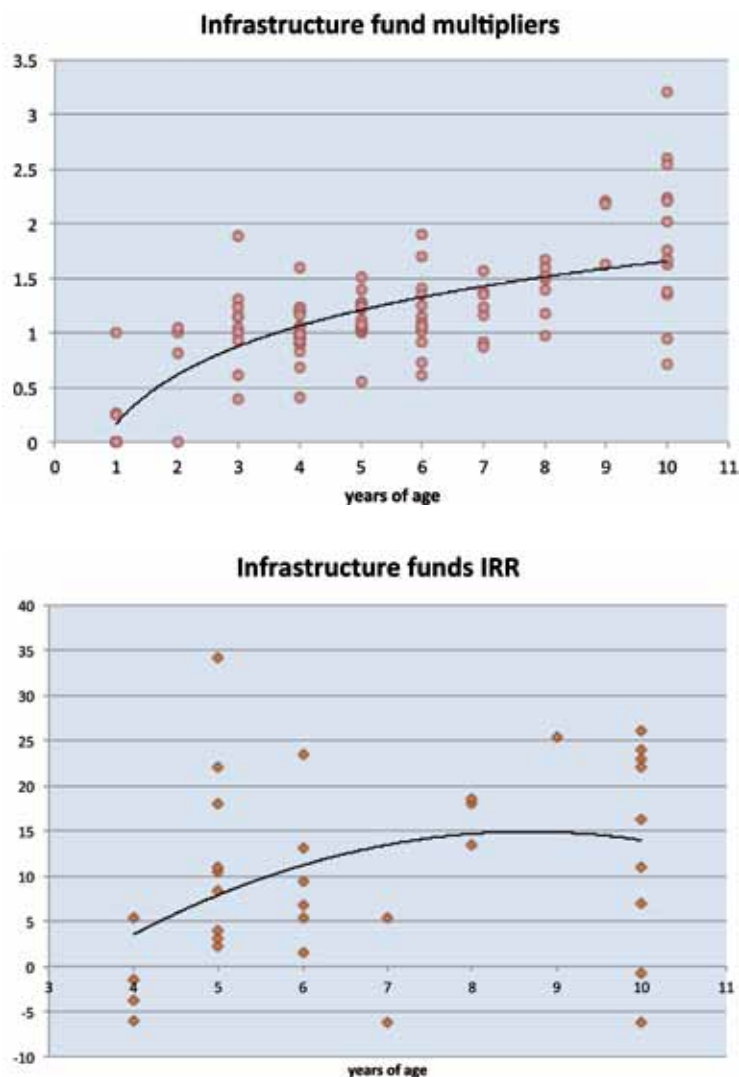
Bird *et al.* (2011) also use Mercer data for ten Australian unlisted infrastructure managers, representing 105 underlying assets worth A\$11.1bn, 59% of which is utilities and a similar proportion is invested in domestic Australian assets, with the balance evenly split between the UK, the US and the rest of the world. They find that, like listed infrastructure, unlisted Australian infrastructure funds exhibit excess returns with the best Sharpe ratio and lowest beta, positive skew and very high kurtosis. DeFrancesco *et al.* also find some evidence of excess returns in unlisted Australian infrastructure but with a small sample (De Francesco, Newell, & Peng, 2011).

However, the use of Australian equity funds to illustrate the characteristics of infrastructure funds is problematic. Bird *et al.* and others report that Peng *et al.*'s results (2007) about Australian infrastructure are biased because they include a period during which assets were acquired at significant discounts from local governments in distress (e.g. the Victorian government in the early 90s) and a benign regulatory environment allowed tariff increases consistently above real GDP growth. Australian unlisted infrastructure funds can also be open-ended (Bird *et al.*, 2011) which is exceptional in other jurisdictions and may thus have a different return profile than the global population of close-ended infrastructure PE funds.

Figure 4 shows the reported returns by vintage year of an international but limited sample of unlisted funds from the Preqin Infrastructure Review (Preqin, 2011). Apart

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Figure 4: Reported IRRs and multipliers for unlisted infrastructure PE funds



(Prequin, 2011)

from the traditional j-curve, by which younger funds have lower returns since they are still in the process of making and exiting investments, the dispersion of returns for mature funds (10 years old or more) is significant and suggests only top quartile funds perform to their investors' expectations with IRRs in the 18–22% range. The high dispersion of returns can also be inferred from figure 4 and the casual observation of the differences between mean and median IRRs and multiples. Moreover, this sample, which is part of an

industry survey, almost certainly suffers from severe reporting biases.

3.3.1 Sources of excess returns

As was the case for listed infrastructure, most authors suggest that leverage is the main source of return in unlisted infrastructure PE. Unlike traditional buyout, there is only a limited scope for managers to 'turn around' infrastructure projects and regulated utilities all of which operate within the tight constraints of, respectively, their financial plan as agreed with lenders

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at financial close, and the requirements of regulators. As suggested above, utilities can show potential for extra leverage at the enterprise level, which PE managers have exploited (Helm & Tindall, 2009), and PE funds themselves tend to add another layer of leverage to increase returns.

Bird *et al.* (2011) also test for an illiquidity premium and report an absence of serial correlation in unlisted Australian infrastructure funds returns (i.e. the absence of evidence of such illiquidity premium). They suggest that monthly unit pricing, changes in foreign currency values, partial allocations to listed infrastructure and the use of discounted cash flow (DCF) methodologies to value assets instead of quarterly appraisals, all create noise which explains the absence of serial correlation in the returns of unlisted infrastructure funds in Australia.

Deal sourcing and exit timing are thus the main sources of added value of infrastructure PE funds.

In general, beyond the casual observation of industry practices, the sources of equity returns in infrastructure funds are badly documented, especially those of hybrid and evergreen funds that may have longer-term investment strategies. Existing studies do not, to our knowledge, attempt multifactor estimations of the different drivers of returns in unlisted infrastructure funds: illiquidity, political risk, leverage &c.

3.3.2 Diversification benefits

The diversification benefits of unlisted infrastructure PE funds are harder to document than for listed infrastructure. Bitsch *et al.* (2010) document a significant

correlation between unlisted infrastructure funds and private equity, as well as a stronger correlation between infrastructure and public equities than between the rest of private equity investments and public equities. Peng *et al.* (2007) find that the correlation of unlisted funds with the stock market is very low but that correlation with property has tended to increase during their sample period (1995-2006). However, Bird *et al.* (2011) fail to find any correlation with public equities in their sample of unlisted funds.

Overall, while a number of unlisted infrastructure PE funds do deliver significant performance, their contribution to improving the Sharpe ratio of the PSP is not well documented and anecdotal evidence suggests that high returns are the result of high risks especially through the use of leverage, which echoes the conclusions sometimes made about real estate funds (ULL, 2011). While the impact of credit dislocation on the investment performance of listed funds is already visible in the data, it will take a few more years to see whether unlisted funds have experienced significant performance deceleration after 2008.³²

Unlisted infrastructure PE funds, the Bitsch *et al.* (2010) paper shows that infrastructure PE cash flows as not less volatile than other PE cashflows, which suggests that dividends are not less volatile either. Whilst these results may be considered counterintuitive in the context of the underlying infrastructure assets themselves, there is no other evidence on this subject.

3.3.3 Inflation protection

Unlisted infrastructure does not fare much better as an inflation hedge in recent

32 - The practice by some managers to have their follow-up funds purchase the assets of previous funds may also delay the evaluation of performance.

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studies. Peng *et al.* (2007) does not find evidence of inflation protection in Australian unlisted infrastructure. Likewise, looking at underlying investments in infrastructure PE funds, Bitsch *et al.* (2010) test whether returns are inflation-linked but cannot find any statistically significant evidence of inflation protection.

In summary, existing research on unlisted infrastructure is limited to one type of investment model, standard private equity fund structure with a relatively short investment horizon. Unsurprisingly, this type of investment vehicle in underlying infrastructure equity fails to replicate the infrastructure investment narrative: it can be very speculative especially if it adds a second layer of leverage to already existing project or utility debt, and it targets market exits after five to seven years.

3.4 Direct equity investments

Direct investment in utilities and projects has gained momentum in recent years amongst pension and sovereign wealth funds that have reportedly grown increasingly dissatisfied with the infrastructure PE fund model. In what follows we review existing research and recent evidence on the profitability of direct equity investment in infrastructure projects.

A natural experiment of pure direct institutional investing in infrastructure projects has been underway for the past few years. For example, large Canadian pension funds decided to move out of infrastructure funds and into direct infrastructure, approximately at the same time, around 2005. As figure 6 illustrates, these portfolios are very young and not completely formed

yet and the legacy of their prior investments in unlisted infrastructure funds still weighs on their reported infrastructure results. Nevertheless, several salient facts can be gleaned from their annual reports:

- Portfolios are sizeable at CND10bn;
- Portfolios are nevertheless concentrated: for example, five assets make up 77% of OMERS infrastructure portfolio in 2010;
- Despite their size, and as consequence of their concentration, each infrastructure portfolio is unique and performs differently, with Sharpe ratio varying from 0.3 to 1.8;
- Building significant investment positions takes years.

Of course, each one of these pension funds has different investment needs and objectives and their infrastructure investment strategies may not be compared directly. In their annual reports, they also report being exposed to foreign exchange risk since significant proportions of their infrastructure portfolio is invested internationally, and being exposed to a varying degree of demand risk: for example the Canadian Pension Plan Investment Board (CPPIB) invests in airports that have returns correlated with economic growth. One fund also reports experiencing low nominal returns because tariffs are indexed to inflation and inflation was very low.

Overall, the move into direct infrastructure investing by Canadian pension funds provides anecdotal evidence supporting the infrastructure investment narrative but also that it remains a very active, alpha-focused strategy demanding costly knowledge. Much idiosyncratic risk is thus concentrated in quite large allocations. The long-term performance of these investment remains untested, in particular the impact

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of foreign exchange and political risk. The history of infrastructure investments suggests that the profitability of foreign invested infrastructure can become a political issue. Between its own taxpayers and infrastructure users and foreign pensioners, it is easy to imagine whose interests numerous governments would choose to protect.

3.4.1 The limits of portfolio construction

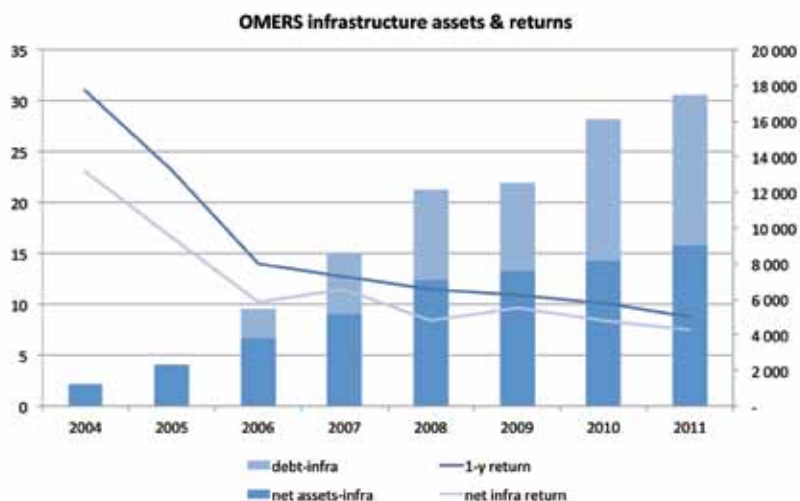
Direct investment in underlying infrastructure assets creates a number of portfolio construction issues, including the difficulty to create a well-diversified portfolio of a reasonable size. The issues found in infrastructure portfolio construction echo those expressed in the literature about real estate assets (King & Young, 1994). Thus, while the infrastructure investment pipeline may be small (but long), individual infrastructure assets tend to be large. This makes building portfolio of infrastructure assets a lengthy process for direct investors.

Hence, with very large assets, satisfactory diversification is unlikely to be possible. For example, with normally distributed returns and equal weights, listed equities

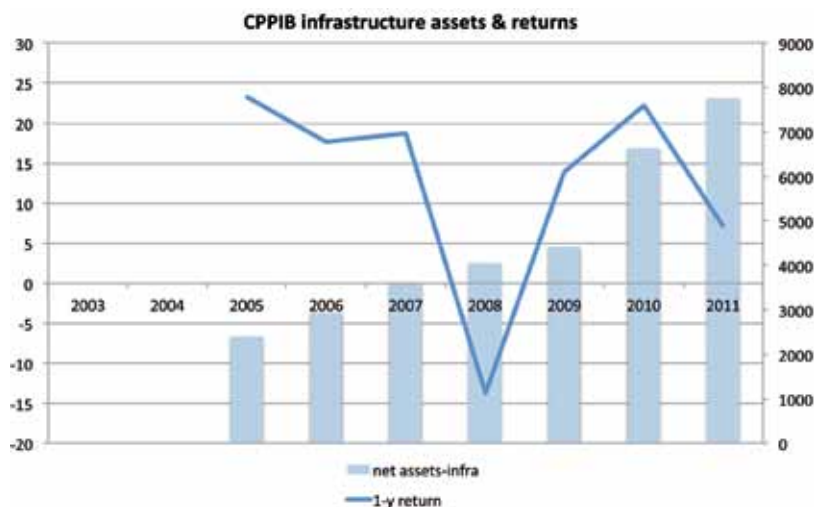
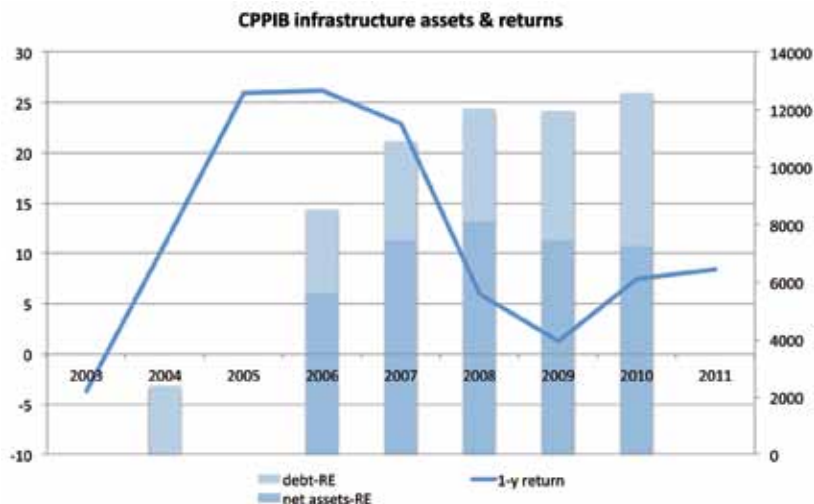
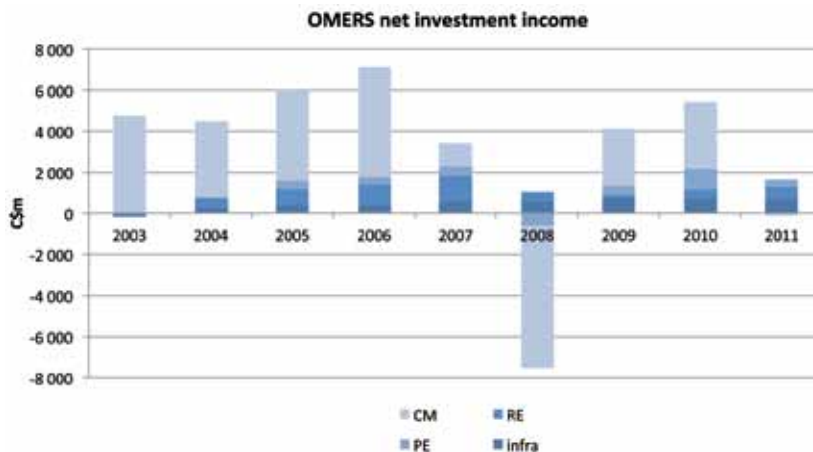
can achieve 95 per cent diversification of specific risk with 44 stocks (Brown & Matysiak, 2000). While infrastructure return distributions are not well-documented, real estate assets can give us some perspective: if returns are skewed and leptokurtic, we know that with assets as bulky as real estate assets, a portfolio of at least 1,700 properties is needed to reduce risk ten-fold (Young, Lee, & Devaney, 2006). The problem of non-normal returns is compounded by the indivisibility of assets, which prevents equal weighting. If equal weighting is not an option, larger portfolios of value-weighted assets are required to obtain the same level of diversification (Ducoulombier, 2007).

Thus, the need to diversify risk as much as possible remains and can be seen in the decision by OMERS to promote a US\$20bn infrastructure vehicle (Williams, 2012), in an attempt to scale up its already large portfolio. But if very large institutional investors can afford to engage in active infrastructure project selection and direct investment, most pension funds cannot, and need to be in a position to invest in benchmarked infrastructure products, which remain to be created.

Figure 5: Infrastructure assets and returns of selected Canadian pension funds



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Source: annual reports 2001-2012

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3.5 Conclusion

Our review of the nature of infrastructure equity investment at the underlying level suggests a low risk environment signalled by high leverage and in which most risks are well managed through risk transfer contracts. However, research on existing listed infrastructure indices and studies, as well as unlisted PE funds using infrastructure equity as an underlying investment, appear to demonstrate potentially high risk and unclear liability hedging properties.

Existing academic research concludes the following:

1. On listed infrastructure

- Listed infrastructure has historically been dominated by utilities and has exhibited low market covariance but not low variance compared with other stocks.
- Listed utilities may have better inflation hedging properties compared to other infrastructure sectors, but there is no *statistically significant* evidence of improved inflation hedging of listed infrastructure or even listed utilities over the stock market in general.
- Listed infrastructure cash yields, while they tend to be higher, are also more volatile than the market.
- A-cyclicalities is also hard to demonstrate in existing studies and looking at listed data. In particular infrastructure indices have changed profile since 2008 and the reversal of the credit cycle.

2. On unlisted infrastructure PE

- Unlisted infrastructure funds are found, in research conducted to date, to have typically emulated the private equity buy-out format, to have used leverage on top of the already significant leverage of most underlying assets and to have charged

significant fees. As such, they often fail to be a transparent risk pooling mechanism by which final investors could address the portfolio construction issues (the lot size problem) that characterise direct infrastructure investment.

- Unlisted infrastructure PE funds as currently researched do not show evidence of offering returns that are inflation linked.
- These results are constrained by the limited access to investment data, in particular, all papers rely on data from PE funds, which are invested according to an ill-defined specialisation, and thus find, unsurprisingly, PE-like results.

3. On direct infrastructure investment

- Direct infrastructure investment remains a very active approach limited to very large investors. The young age of their portfolios and the diversity of their investment objectives limit the evaluation and comparison of direct investing by pension funds.
- Even if infrastructure equity returns were normally distributed and a portfolio of equally sized assets could be built, a *single* well-diversified infrastructure portfolio would have to be extremely large.
- This highlights the need for continued need for intermediation: in all likelihood, infrastructure portfolios are *not* fully diversified,³³ active investment approach is necessary, and project and *manager selection* matters. Indeed, existing infrastructure PE has not provided a systematic answer to generating infrastructure beta. When beta (normal/systematic performance) investing is not reliable, it becomes crucial to pick projects and managers, both internal and external, that deliver top quartile total performance.

33 - Smaller and more numerous social infrastructure investment, like the PFI in the UK, are an interesting exception since they are small enough to allow for a larger number of investments in individual portfolios. The pool of such assets remains limited in size however.

3. Investing in Infrastructure: The Investment Narrative and Existing Evidence

Thus, it is difficult to find a confirmation of the infrastructure investment narrative in existing academic research on infrastructure investment. While this may seem surprising, we argue that these papers suffer from a fundamental problem of study design: they aggregate financial instruments that are labelled as 'infrastructure' based on industrial categories and without attempting to isolate methodically the contractual and regulatory characteristics that explain risks and returns or taking into account what might distort the investment characteristics of the underlying, like PE fund structures.

The expectation is to capture a kind of average 'infrastructure effect' but without explicating the mechanisms at play. It clearly fails. An index should clearly state an investment objective. Second, index design should articulate the rules for asset selection and asset weighting. Understanding the mechanisms or risk factors (e.g. availability payment vs. commercial risk) explaining the behaviour of various sub-universes of infrastructure assets can help in defining rules for asset selection. Knowledge of the conditions of optimality for traditional and alternative forms of weighting and of their risks will be handy when selecting or designing a weighting scheme. Asset selection and weighing rules should be guided by the objective, e.g. to capture the typical risk premia associated with infrastructure equity investment, and suitable metrics should be identified that would guide design or at least allow for a quantitative assessment of the index's ability to deliver on its objective.

3. Investing in Infrastructure: The Investment Narrative and Existing Evidence

4. Conclusions: Towards Efficient Benchmarks for Infrastructure Equity Investments



4. Conclusions: Towards Efficient Benchmarks for Infrastructure Equity Investments

In this paper, we have argued that infrastructure equity investments should be understood to derive their value primarily from contractual and regulatory arrangements, not from the physical characteristics of tangible infrastructure and that, based on existing theoretical research and empirical evidence, infrastructure equity should be expected to be relatively low risk and to have highly idiosyncratic features which should be diversifiable.

However, a review of existing work and empirical evidence of listed, unlisted and direct equity investments in infrastructure does not yield a clear picture and may even suggest that equity risk can be high in a number of investment products that are labelled 'infrastructure'. We have argued that the characteristics of underlying infrastructure equity are not always well captured by these investment routes, be they listed indices defined by industrial code, relatively short-term private equity funds or direct but concentrated equity (and debt) investments by a handful of large pension funds. In short, these investments are inappropriate to capture the characteristics of underlying infrastructure equity as described in the first part of this paper and suggested by what we have called the 'infrastructure investment narrative.'

4.1 The Need for Appropriate Benchmarks

In modern finance theory, separation theorems state that the management of risk and of performance is best done via separate portfolios: for a pension fund or insurance company, performance should

be obtained through optimal exposure to risk factors in order to minimise the burden of contributions or premia, while hedging liabilities is the role of a separate, dedicated portfolio (Amenc *et al.* 2010).

In this context, the choice of benchmark is central to the portfolio construction exercise. In the general case, once reliable estimates of risk and expected returns have been obtained, one may design efficient proxies for asset class benchmarks. But an assessment of expected returns and risk measures for infrastructure equity investment cannot be derived from the existing research results reviewed above, and instead requires the design of appropriate benchmarks.

As it is the case for real estate (Ducoulombier, 2007) institutional investors should express great interest in using index-based products to increase their exposure to infrastructure.

Indices have the potential to meet the major expectations institutional investors have of infrastructure investment.

Indices could provide infrastructure market *beta*. Suitably diversified infrastructure index portfolios would provide attractive risk-adjusted returns for efficient investment in infrastructure and multi-asset class diversification.

Although the potential benefits of index-based infrastructure products seem very attractive, our current knowledge based on past experience of PE funds or listed infrastructure companies is inappropriate to develop such products.

4. Conclusions: Towards Efficient Benchmarks for Infrastructure Equity Investments

Building infrastructure betas will require concerted efforts between final investors, investment managers and academics in order to meet certain minimum requirements. These requirements depend on whether the index is used as a benchmark for investment in specific styles, instruments or locations or as an investment vehicle. Each of these uses has its own set of construction requirements, some of which overlap. For instance, representativity may be more important for indices that are meant to be used as benchmarks for performance measurement, while investability may be of greater importance for indices that are meant to be invested in. What both uses have in common is a requirement for transparency: both the construction methodology and the information to calculate the index, such as its exact constituents and the corresponding returns, should be publicly available.

Based in EDHEC-Risk Institute's previous work on unlisted real estate indices (Schoeffler, 2012), we highlight the four main issues with building a suitable index for unlisted infrastructure:

1. *Valuation*: In the absence of frequent market transactions valuation are contentious but most importantly they may lead to smoothing and a mis-representation of volatility. New research on infrastructure equity valuation and reporting is necessary to arrive at a clear, academically validated and industry-recognised framework.
2. *Representativity*: Given the mostly private and decentralised nature of infrastructure projects, transaction prices or appraisals should be collected directly from market participants, especially from institutional investors. Although institutional investors account for a major share of the overall

infrastructure markets, any index based on information acquired solely from them misses information on the rest of the sector. Such issues need to be addressed explicitly, which could lead, for example, to an index for *institutional* infrastructure investment, with a clear liquidity threshold.

3. *Transparency*: As most providers of indices based on individual deals use proprietary information, the actual components underlying indices are generally not published. Like appraisal-based indices, transaction-based indices also have this problem, to which must be added the extra layer of opaqueness caused by the complex and counter-intuitive econometrics involved in calculating them.

4. *Investability*: Indices based on direct investment would also lack investability. Even if the exact projects an index is based on were known, it would be very difficult if not impossible to invest in these indices. First, the corresponding projects or utilities are most likely not on the market at the corresponding time. Second, index replication with other projects would, given the high unit values involved, certainly require great availability of funds. With these investment restrictions and the general heterogeneity of the sector, index replication would involve considerable tracking error.

These issues need to be addressed in the case of unlisted infrastructure indexing and benchmarking. By using data collected according to clear reporting standards, an index could address the problems of representativity, transparency and investability that can beset current benchmarks. In short, it could be designed to have greater transparency and to be more representative. Using unlisted infrastructure

4. Conclusions: Towards Efficient Benchmarks for Infrastructure Equity Investments

funds with an active secondary market, problems of investability could be addressed.

In terms of representativity, sub-universes can be designed to incorporate the financial economics of infrastructure contracts as discussed in the first part of this paper and including such variables as revenue schemes (e.g. availability payments, real tolls, shadow tolls), financial structure, regulatory regimes &c. In line with the recent initiative by the UK Treasury to have PFI returns published regularly, the index can also be transparent.

Such narrowly defined indices could serve as building blocks for infrastructure equity and could be combined to build efficient portfolios addressing explicit investment objectives.

4.2 Portfolio Construction with infrastructure equity

Investment strategies which focus on the contractual and regulatory characteristics of underlying infrastructure would – inter alia – allow for the creation of more coherent building blocks in order to design an efficient infrastructure portfolio. Each block would be focused on an unambiguous and systematic source of risk impacting underlying infrastructure equity. Individual blocks could then be used to build a diversified infrastructure equity portfolio.

In particular, different levels of revenue risk may be combined with different stages in the lifecycle to obtain a more efficient portfolio risk profile.

The estimation of the effective riskiness of each building block of infrastructure investment may have important regulatory

as well as economic implications. For instance, the possibility of diversification suggests that the riskier types of infrastructure investments (e.g. greenfield toll roads) may well be a component of the well-diversified and efficient infrastructure portfolio for investors for any chosen level of risk preference since even the minimum variance infrastructure equity portfolio would include some of the more risky types of investment projects. The frequent concern that current regularly initiatives may be limiting the financing of risk assets in the economy may be partly addressed through efficient infrastructure benchmarking and portfolio construction.

4.3 Conclusion

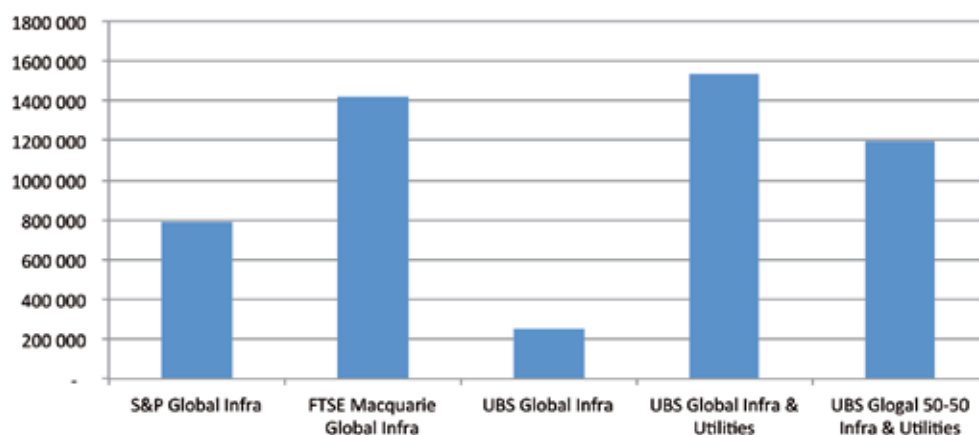
It is apparent from our review and discussion that substantial data reclassification as well as new data collection is needed, and a significant amount of theoretical and empirical work remains to be done to arrive at appropriate benchmarks and to test the sensitivity of equity investment to different categories of risk found in project finance, regulated utilities and other legitimate infrastructure investments areas, including the role and diversification potential of the different periods in the lifecycle of infrastructure investments. Data collection, reporting standards and the development of infrastructure equity benchmarking research will be some of the major undertakings of the EDHEC-Risk Institute Research Chair supported by Meridiam & Campbell-Lutyens in 2013 and 2014.

Appendix



Appendix

Figure 6: Market value of major infrastructure indices, \$m, December 2012



Source: Datastream

Table 4: Major sector components of listed infrastructure indices

Industry Composition	Dow Jones Brookfield	Macquarie	MSCI ACWI Sector Capped	S&P	UBS Global 50/50 Infrastructure & Utilities	UBS Global Infrastructure & Utilities
Pipelines	27	6	15	26	3	6*
Utilities	36	89	33	38	48	85*
Communication	11	2	33	0	19	3
Transportation	22	3	15	36	29	5
Social	0	0	4	0	0	0
Diversified	4	0	0	0	1	0

Source: Dow Jones, FTSE, MSCI, S&P, UBS

* Estimate

Table 5: Major regional components of listed infrastructure indices

Geographical Breakdown	Dow Jones Brookfield	Macquarie	MSCI ACWI Sector Capped	S&P	UBS Global 50/50 Infrastructure & Utilities	UBS Global Infrastructure & Utilities
North America	45	40	NA	36	31	41
United Kingdom	19	9	NA	5	6	8
Continental Europe	21	36	NA	36	49	37
Japan	1	9	NA	6	4	8
Asia ex-Japan	11	5	NA	14	10	6
Latin America	2	1	NA	2	0	0
Middle East/ Africa	1	0	NA	1	0	0

Source: Dow Jones, FTSE, MSCI, S&P, UBS, Idzorek & Armstrong, (2009)

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About Meridiam & Campbell Lutyens

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It specialises in providing to its clients creative and rigorously executed services both in the fields of raising private equity and private infrastructure funds from institutional investors worldwide and in advising on the secondary sale or restructuring of portfolios of funds or direct investments in both these asset classes.

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About EDHEC-Risk Institute



About EDHEC-Risk Institute

Founded in 1906, EDHEC is one of the foremost international business schools. Accredited by the three main international academic organisations, EQUIS, AACSB, and Association of MBAs, EDHEC has for a number of years been pursuing a strategy of international excellence that led it to set up EDHEC-Risk Institute in 2001. This institute now boasts a team of 90 permanent professors, engineers and support staff, as well as 48 research associates from the financial industry and affiliate professors.

The Choice of Asset Allocation and Risk Management

EDHEC-Risk structures all of its research work around asset allocation and risk management. This strategic choice is applied to all of the Institute's research programmes, whether they involve proposing new methods of strategic allocation, which integrate the alternative class; taking extreme risks into account in portfolio construction; studying the usefulness of derivatives in implementing asset-liability management approaches; or orienting the concept of dynamic "core-satellite" investment management in the framework of absolute return or target-date funds.

Academic Excellence and Industry Relevance

In an attempt to ensure that the research it carries out is truly applicable, EDHEC has implemented a dual validation system for the work of EDHEC-Risk. All research work must be part of a research programme, the relevance and goals of which have been validated from both an academic and a business viewpoint by the Institute's advisory board. This board is made up of internationally recognised researchers, the Institute's business partners, and representatives of major international institutional investors. Management of the research programmes respects a rigorous validation process, which guarantees the scientific quality and the operational usefulness of the programmes.

Six research programmes have been conducted by the centre to date:

- Asset allocation and alternative diversification
- Style and performance analysis
- Indices and benchmarking
- Operational risks and performance
- Asset allocation and derivative instruments
- ALM and asset management

These programmes receive the support of a large number of financial companies. The results of the research programmes are disseminated through the EDHEC-Risk locations in Singapore, which was established at the invitation of the Monetary Authority of Singapore (MAS); the City of London in the United Kingdom; Nice and Paris in France; and New York in the United States.

EDHEC-Risk has developed a close partnership with a small number of sponsors within the framework of research chairs or major research projects:

- *Core-Satellite and ETF Investment, in partnership with Amundi ETF*
- *Regulation and Institutional Investment, in partnership with AXA Investment Managers*
- *Asset-Liability Management and Institutional Investment Management, in partnership with BNP Paribas Investment Partners*
- *Risk and Regulation in the European Fund Management Industry, in partnership with CACEIS*
- *Exploring the Commodity Futures Risk Premium: Implications for Asset Allocation and Regulation, in partnership with CME Group*

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- Asset-Liability Management in Private Wealth Management, *in partnership with Coutts & Co.*
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- The Benefits of Volatility Derivatives in Equity Portfolio Management, *in partnership with Eurex*
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- Optimising Bond Portfolios, in partnership *with the French Central Bank (BDF Gestion)*
- Asset Allocation Solutions, in partnership *with Lyxor Asset Management*
- Infrastructure Equity Investment Management and Benchmarking, *in partnership with Meridiam and Campbell Lutyens*
- Investment and Governance Characteristics of Infrastructure Debt Investments, *in partnership with Natixis*
- Advanced Modelling for Alternative Investments, *in partnership with Newedge Prime Brokerage*
- Advanced Investment Solutions for Liability Hedging for Inflation Risk, *in partnership with Ontario Teachers' Pension Plan*
- The Case for Inflation-Linked Corporate Bonds: Issuers' and Investors' Perspectives, *in partnership with Rothschild & Cie*
- Solvency II, *in partnership with Russell Investments*
- Structured Equity Investment Strategies for Long-Term Asian Investors, *in partnership with Société Générale Corporate & Investment Banking*

The philosophy of the Institute is to validate its work by publication in international academic journals, as well as to make it available to the sector through its position papers, published studies, and conferences.

Each year, EDHEC-Risk organises three conferences for professionals in order to present the results of its research, one in London (EDHEC-Risk Days Europe), one in Singapore (EDHEC-Risk Days Asia), and one in New York (EDHEC-Risk Days North America) attracting more than 2,500 professional delegates.

EDHEC also provides professionals with access to its website, www.edhec-risk.com, which is entirely devoted to international asset management research. The website, which has more than 58,000 regular visitors, is aimed at professionals who wish to benefit from EDHEC's analysis and expertise in the area of applied portfolio management research. Its monthly newsletter is distributed to more than 1.5 million readers.

EDHEC-Risk Institute: Key Figures, 2011-2012

Nbr of permanent staff	90
Nbr of research associates	20
Nbr of affiliate professors	28
Overall budget	€13,000,000
External financing	€5,250,000
Nbr of conference delegates	1,860
Nbr of participants at research seminars	640
Nbr of participants at EDHEC-Risk Institute Executive Education seminars	182

About EDHEC-Risk Institute

The EDHEC-Risk Institute PhD in Finance

The EDHEC-Risk Institute PhD in Finance is designed for professionals who aspire to higher intellectual levels and aim to redefine the investment banking and asset management industries. It is offered in two tracks: a residential track for high-potential graduate students, who hold part-time positions at EDHEC, and an executive track for practitioners who keep their full-time jobs. Drawing its faculty from the world's best universities, such as Princeton, Wharton, Oxford, Chicago and CalTech, and enjoying the support of the research centre with the greatest impact on the financial industry, the EDHEC-Risk Institute PhD in Finance creates an extraordinary platform for professional development and industry innovation.

Research for Business

The Institute's activities have also given rise to executive education and research service offshoots. EDHEC-Risk's executive education programmes help investment professionals to upgrade their skills with advanced risk and asset management training across traditional and alternative classes. In partnership with CFA Institute, it has developed advanced seminars based on its research which are available to CFA charterholders and have been taking place since 2008 in New York, Singapore and London.

In 2012, EDHEC-Risk Institute signed two strategic partnership agreements with the Operations Research and Financial Engineering department of Princeton University to set up a joint research programme in the area of risk and investment management, and with Yale

School of Management to set up joint certified executive training courses in North America and Europe in the area of investment management.

As part of its policy of transferring know-how to the industry, EDHEC-Risk Institute has also set up ERI Scientific Beta. ERI Scientific Beta is an original initiative which aims to favour the adoption of the latest advances in smart beta design and implementation by the whole investment industry. Its academic origin provides the foundation for its strategy: offer, in the best economic conditions possible, the smart beta solutions that are most proven scientifically with full transparency in both the methods and the associated risks.

EDHEC-Risk Institute Publications and Position Papers (2010-2013)



EDHEC-Risk Institute Publications (2010-2013)

2012

- Cocquemas, F. Improving Risk Management in DC and Hybrid Pension Plans (November).
- Amenc, N., F. Cocquemas, L. Martellini, and S. Sender. Response to the European Commission white paper "An agenda for adequate, safe and sustainable pensions" (October).
- La gestion indiciaire dans l'immobilier et l'indice EDHEC IEIF Immobilier d'Entreprise France (September).
- Real estate indexing and the EDHEC IEIF commercial property (France) index (September).
- Goltz, F., S. Stoyanov. The risks of volatility ETNs: A recent incident and underlying issues (September).
- Almeida, C., and R. Garcia. Robust assessment of hedge fund performance through nonparametric discounting (June).
- Amenc, N., F. Goltz, V. Milhau, and M. Mukai. Reactions to the EDHEC study "Optimal design of corporate market debt programmes in the presence of interest-rate and inflation risks" (May).
- Goltz, F., L. Martellini, and S. Stoyanov. EDHEC-Risk equity volatility index: Methodology (May).
- Amenc, N., F. Goltz, M. Masayoshi, P. Narasimhan and L. Tang. EDHEC-Risk Asian index survey 2011 (May).
- Guobuzaitė, R., and L. Martellini. The benefits of volatility derivatives in equity portfolio management (April).
- Amenc, N., F. Goltz, L. Tang, and V. Vaidyanathan. EDHEC-Risk North American index survey 2011 (March).
- Amenc, N., F. Cocquemas, R. Deguest, P. Foulquier, L. Martellini, and S. Sender. Introducing the EDHEC-Risk Solvency II Benchmarks – maximising the benefits of equity investments for insurance companies facing Solvency II constraints - Summary - (March).
- Schoeffler, P. Optimal market estimates of French office property performance (March).
- Le Sourd, V. Performance of socially responsible investment funds against an efficient SRI Index: The impact of benchmark choice when evaluating active managers – an update (March).
- Martellini, L., V. Milhau, and A. Tarelli. Dynamic investment strategies for corporate pension funds in the presence of sponsor risk (March).
- Goltz, F., and L. Tang. The EDHEC European ETF survey 2011 (March).
- Sender, S. Shifting towards hybrid pension systems: A European perspective (March).
- Blanc-Brude, F. Pension fund investment in social infrastructure (February).
- Ducoulombier, F., Lixia, L., and S. Stoyanov. What asset-liability management strategy for sovereign wealth funds? (February).
- Amenc, N., Cocquemas, F., and S. Sender. Shedding light on non-financial risks – a European survey (January).

EDHEC-Risk Institute Publications (2010-2013)

- Amenc, N., F. Cocquemas, R. Deguest, P. Foulquier, Martellini, L., and S. Sender. Ground Rules for the EDHEC-Risk Solvency II Benchmarks. (January).
- Amenc, N., F. Cocquemas, R. Deguest, P. Foulquier, Martellini, L., and S. Sender. Introducing the EDHEC-Risk Solvency Benchmarks – Maximising the Benefits of Equity Investments for Insurance Companies facing Solvency II Constraints – Synthesis -. (January).
- Amenc, N., F. Cocquemas, R. Deguest, P. Foulquier, Martellini, L., and S. Sender. Introducing the EDHEC-Risk Solvency Benchmarks – Maximising the Benefits of Equity Investments for Insurance Companies facing Solvency II Constraints (January).
- Schoeffler.P. Les estimateurs de marché optimaux de la performance de l'immobilier de bureaux en France (January).

2011

- Amenc, N., F. Goltz, Martellini, L., and D. Sahoo. A long horizon perspective on the cross-sectional risk-return relationship in equity markets (December 2011).
- Amenc, N., F. Goltz, and L. Tang. EDHEC-Risk European index survey 2011 (October).
- Deguest,R., Martellini, L., and V. Milhau. Life-cycle investing in private wealth management (October).
- Amenc, N., F. Goltz, Martellini, L., and L. Tang. Improved beta? A comparison of index-weighting schemes (September).
- Le Sourd, V. Performance of socially responsible investment funds against an Efficient SRI Index: The Impact of Benchmark Choice when Evaluating Active Managers (September).
- Charbit, E., Giraud J. R., F. Goltz, and L. Tang Capturing the market, value, or momentum premium with downside Risk Control: Dynamic Allocation strategies with exchange-traded funds (July).
- Scherer, B. An integrated approach to sovereign wealth risk management (June).
- Campani, C. H., and F. Goltz. A review of corporate bond indices: Construction principles, return heterogeneity, and fluctuations in risk exposures (June).
- Martellini, L., and V. Milhau. Capital structure choices, pension fund allocation decisions, and the rational pricing of liability streams (June).
- Amenc, N., F. Goltz, and S. Stoyanov. A post-crisis perspective on diversification for risk management (May).
- Amenc, N., F. Goltz, Martellini, L., and L. Tang. Improved beta? A comparison of index-weighting schemes (April).
- Amenc, N., F. Goltz, Martellini, L., and D. Sahoo. Is there a risk/return tradeoff across stocks? An answer from a long-horizon perspective (April).
- Sender, S. The elephant in the room: Accounting and sponsor risks in corporate pension plans (March).

EDHEC-Risk Institute Publications (2010-2013)

- Martellini, L., and V. Milhau. Optimal design of corporate market debt programmes in the presence of interest-rate and inflation risks (February).

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- Amenc, N., and S. Sender. The European fund management industry needs a better grasp of non-financial risks (December).
- Amenc, N., S. Focardi, F. Goltz, D. Schröder, and L. Tang. EDHEC-Risk European private wealth management survey (November).
- Amenc, N., F. Goltz, and L. Tang. Adoption of green investing by institutional investors: A European survey (November).
- Martellini, L., and V. Milhau. An integrated approach to asset-liability management: Capital structure choices, pension fund allocation decisions and the rational pricing of liability streams (November).
- Hitaj, A., L. Martellini, and G. Zambruno. Optimal hedge fund allocation with improved estimates for coskewness and cokurtosis parameters (October).
- Amenc, N., F. Goltz, L. Martellini, and V. Milhau. New frontiers in benchmarking and liability-driven investing (September).
- Martellini, L., and V. Milhau. From deterministic to stochastic life-cycle investing: Implications for the design of improved forms of target date funds (September).
- Martellini, L., and V. Milhau. Capital structure choices, pension fund allocation decisions and the rational pricing of liability streams (July).
- Sender, S. EDHEC survey of the asset and liability management practices of European pension funds (June).
- Goltz, F., A. Grigoriu, and L. Tang. The EDHEC European ETF survey 2010 (May).
- Martellini, L., and V. Milhau. Asset-liability management decisions for sovereign wealth funds (May).
- Amenc, N., and S. Sender. Are hedge-fund UCITS the cure-all? (March).
- Amenc, N., F. Goltz, and A. Grigoriu. Risk control through dynamic core-satellite portfolios of ETFs: Applications to absolute return funds and tactical asset allocation (January).
- Amenc, N., F. Goltz, and P. Retkowsky. Efficient indexation: An alternative to cap-weighted indices (January).
- Goltz, F., and V. Le Sourd. Does finance theory make the case for capitalisation-weighted indexing? (January).

EDHEC-Risk Institute Position Papers (2010-2013)

2012

- Till, H. Who sank the boat? (June).
- Uppal, R. Financial Regulation (April).
- Amenc, N., F. Ducoulombier, F. Goltz, and L. Tang. What are the risks of European ETFs? (January).

2011

- Amenc, N., and S. Sender. Response to ESMA consultation paper to implementing measures for the AIFMD (September).
- Uppal, R. A Short note on the Tobin Tax: The costs and benefits of a tax on financial transactions (July).
- Till, H. A review of the G20 meeting on agriculture: Addressing price volatility in the food markets (July).

2010

- Amenc, N., and V. Le Sourd. The performance of socially responsible investment and sustainable development in France: An update after the financial crisis (September).
- Amenc, N., A. Chéron, S. Gregoir, and L. Martellini. Il faut préserver le Fonds de Réserve pour les Retraites (July).
- Amenc, N., P. Schoefler, and P. Lasserre. Organisation optimale de la liquidité des fonds d'investissement (March).
- Lioui, A. Spillover effects of counter-cyclical market regulation: Evidence from the 2008 ban on short sales (March).

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