Infrastructure Indices: Comparative Analysis of Performance, Risk and Representation of Global Listed Proxies

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Abstract

Faced with historically low interest rates, investors are looking further into illiquid assets such as infrastructure in search of alternative sources of income, better diversification and a long-term investment perspective. This paper analyzes the key performance and risk characteristics of the EDHEC*infra* global unlisted infrastructure equity index when compared to the main global listed infrastructure indices during the 2001-2018 period. The descriptive statistics method is applied to determine the representation of the benchmarks commonly used by investors considering infrastructure investments. For the purpose of the market beta analysis, the MSCI World index is also used as a global equities proxy in a linear regression model.

Listed infrastructure is often considered as an income-yielding and defensive equity strategy that provides a liquid proxy for alternative assets (e.g., infrastructure). However, the paper results indicate that the net effect of investing in listed infrastructure remains questionable, even unknown. Recent empirical findings demonstrate divergent stands on benchmarking infrastructure. The high correlation of the main listed infrastructure indices with the broad equity index MSCI World and the inconsistency of research results thus far suggest that infrastructure is an ill-defined investment category within the listed infrastructure space with lacking reliable and useful benchmarking. The commonly used and far-reaching classification of companies with broad industrial nature and business activities that are less relevant to infrastructure may affect the overall representation of the legitimate characteristics of the infrastructure asset class amid the growing enthusiasm among investors.

Keywords: infrastructure, index, benchmarking, listed equity, performance analysis

Introduction

Institutional investments in infrastructure have grown in popularity across the financing sector and have been a highly discussed topic in recent years. In terms of public policy, budget deficits have triggered governments to more frequently engage in cooperation with the private sector for the development and financing of infrastructure projects. The political willingness of many Western European countries has routinely created the demand for pension funds and insurers to invest in infrastructure in an effort to support the larger economy. Such investments are intended to help meet

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long-term investment needs and generate an attractive risk-return profile. This paper aims at capturing the key investment characteristics of infrastructure and answering the research question of whether the performance of global listed indices gives an adequate representation when compared with an unlisted infrastructure proxy.

Many investors have become interested in infrastructure as an 'asset class' due to its appealing characteristics (Inderst, 2010). Infrastructure investments potentially offer some useful characteristics for pension funds and insurance companies that have to match (often inflation-linked) annuity-type liabilities. Infrastructure assets are often expected to have long-term, predictable cash flows; low sensitivity to business cycles; low risk; and low correlations to other asset classes. Furthermore, project finance debt has exhibited relatively favorable default and recovery rates compared to corporate debt between 1983 and 2017 (Moody's, 2018). However, a recent review (Amenc et al., 2019) including documentation and performance data of 144 investment products indicates that listed infrastructure companies often can be risky and expensive while failing to deliver better value.

Infrastructure investments appear as an attractive investment opportunity not only from a risk-return point of view but also from a prudential perspective. Benefiting from lower capital requirements according to the Solvency II regulatory framework for investing in higher quality infrastructure opportunities (European Commission 2016, 2017) has also triggered a growing enthusiasm across investors. Asset owners are also re-discovering 'long-term investing', trying to capture an 'illiquidity risk premium' from infrastructure.

Following this introduction of the infrastructure asset class and motivation of investors when considering investment in infrastructure (section I), this paper outlines the methodological approach (sector II), namely a quantitative analysis used to determine and validate the representation and relevance of the broad listed infrastructure equity indices. The findings from previous studies (sector III) provide some empirical evidence of the importance and benefits of including infrastructure in the investment portfolio mix, as well as expressing some concerns around the foundation and validity of the asset class. However, recent academic research is based mostly on listed asset performance due to a lack of direct performance data. The research gap can be attributed to the data limitations concerning the direct infrastructure performance, which this paper aims to cover to a certain extent by using a private unlisted index. As a next step, a comparative analysis (section IV) of the methodology standards used in building the global indices is undertaken to outline the main characteristics and differences. In section V, the author measures the performance and risk of various global listed infrastructure indices relative to an unlisted infrastructure equity index recently published by the Ecole des Hautes Etudes Commerciales du Nord Infrastructure Institute (EDHEC). The comparison of the various industry-provided thematic indices aims at determining the degree of representation of the main listed infrastructure indices. For that purpose, the author uses quarterly return data for all indices for the period from 1st January 2007 to 31st December 2018 (excluding the Macquarie global index, which was discontinued at the end of 2016). The data used in this paper are based on availability as of 30th June 2019. The paper reports the findings from the underlying analysis and draws conclusion in section VI.

Methodological Approach

This paper is intended to provide a comprehensive review of the performance and key risk parameters of the main global listed infrastructure indices by using a descriptive statistics method. A quantitative analysis (including covariance, correlation, and linear regression analysis) of sample market index data has been performed to determine the representation, validity and relevance of the main listed infrastructure indices. The underlying risk and return analysis consists of measuring the risk-adjusted performance, downside protection, and diversification effect as well as equity market beta tests of listed infrastructure indices compared to the EDHEC*infra* unlisted global infrastructure index and the MSCI World as a global stock market proxy. Further, the paper seeks to provide a detailed description of the key elements in the methodology of those infrastructure indices and thus to enable an adequate comparison of the index building approaches.

Amid the growing popularity of the asset class among institutional investors, the results of this study are targeted to address the need for implementing better-defined benchmarks in the infrastructure space that can help investors in their investment, risk management and asset allocation decisions.

Literature Review

A recent Vanguard study of the listed infrastructure equity market (Geysen, 2018) demonstrated the reduced volatility and diversification effect of an overweight to infrastructure asset class by utilizing a mean-variance approach during the historical period of analysis. However, the paper concluded that the benefits of the enhanced portfolio's risk-adjusted returns need to be weighed against the concentration risk and arguably superior inflation hedge when considering an overweight allocation to infrastructure asset class.

Empirical findings challenge the relationship between listed and unlisted infrastructure investments. Based on an asset

pricing approach (Bianchi & Drew, 2014) on a sub-set of listed stocks in the utility sector derived from publicly listed global and regional infrastructure indices, infrastructure returns did not exhibit any additional premium compared to global stocks or global utilities industry indices, and thus infrastructure could not be defined as a separate asset class. A potential additional return from unlisted infrastructure was considered a function of idiosyncratic risk, infrastructure asset selection, liquidity risk, equity valuation risk or a combination of these. In contrast, Moss (2014) showed the benefit of including an unlisted portfolio consisting of a representative sample of listed infrastructure funds with a neutral to positive impact on the portfolio performance as well as liquidity and diversification effects when using the various databases.

The strong risk-adjusted performance and portfolio diversification benefits of unlisted infrastructure versus listed infrastructure and other listed assets (Newell et al., 2011) underline the increased importance of investing in infrastructure by pension's funds, sovereign wealth funds and insurance companies. The unlisted portfolio performed strongly during the global financial crisis (GFC), thereby activating some considerations regarding the development of an effective asset class.

In replicating an approach consisting of selecting stocks by sectors and levels of income generated from infrastructure activities (set at 90%) paired with testing the performance of various global industry-provided thematic stock indices (e.g. MSCI Infrastructure World), Blanc-Brude and Whittaker (2015) suggested that the infrastructure indices outperform the market benchmark MSCI, likely due to the implicit value factor represented by infrastructure firms; however, they exhibited drawdown risk and tail risk as well as high correlation with the broader stock market during the entire length of the business/credit cycles. Conversely, a pre-defined portfolio of five stocks (representing approximately 280 individual equity stakes) listed on the London Stock Exchange illustrated very little correlation with the market from a price-return perspective, and no correlation at all (i.e., market beta of zero) on a total return basis as a result of the high payout ratio and frequency of those payouts.

In a follow-up publication, EDHEC (Blanc-Brude et al., 2017) indicated the significant outperformance of a broad market index of private infrastructure when compared to the public equity market reference index over the 2000-2016 period, as it also did not suffer from any drawdowns during the market collapses in the 2007-2011 period. By using a bottom-up approach to compare the risk-adjusted performance, the authors showed that most segments of the private index universe, such as infrastructure projects and contracted infrastructure, exhibited an attractive risk-reward profile due to the greater return and lower value-at-risk (VaR); however, they noted the obstacle of having bulky and illiquid investments at the asset allocation level in the absence of well-diversified infrastructure products.

At the end of a series of scientific research papers on the listed infrastructure topic, EDHEC reported false claims and a misleading narrative on listed infrastructure, as most investments could not be considered infrastructure under any definition (Amenc et al., 2017). The reputation of the infrastructure asset class might be compromised due to the lack of transparency around the so-called asset class and the growing appetite of institutional investors (reported at USD 57bn in 2017). EDHEC labels the so-called asset class 'fake infra', as it arguably poses a threat to the infrastructure investment sector by not fulfilling the characteristics of infrastructure. The research on actual constituents of both passive and active listed infrastructure (often campaigned by managers under the broad infrastructure definition) indicates that listed infrastructure has failed to deliver the same performance as unlisted infrastructure investments, namely on key elements such as premium returns, reduced volatility, diversification, downside protection and inflation-linked predictable cash flows.

Controversially, previous academic studies (e.g., Oyedele et al., 2012) supported the inclusion of infrastructure in a broader multi-asset portfolio mix. The study compared global listed infrastructure performance with other asset classes such as stocks, bonds, real estate, hedge funds and private equity during the 2001-2010 period and found that a systematic allocation between 10% and 18% to infrastructure contributes more to risk reductions (i.e., improved diversification), instead of enhancing the return of the overall portfolio mix. Obviously, recent empirical findings show the imminent need to address the issue of treating listed infrastructure and finding an appropriate benchmarking tool as a venue for further research work and studies.

Overview of Global Infrastructure Indices

Infrastructure companies can be described as businesses with long-term, steady and predicable cash flows coming from providing essential services (Inderst, 2010). Investments in real assets like infrastructure companies benefit from very minimal price-elasticity of demand (due to the monopolistic nature of the business), often inflation hedge and little exposure to the business cycle. Institutional investors are continuing to look into infrastructure investments as part of their portfolio. As a result of the growing interest in the asset class, the need to determine the role of infrastructure in the multi-asset portfolio has become imminent.

Within the investment community, infrastructure has various definitions and views with respect to the relation to global indices. Even the listed infrastructure space offers no

universally agreed definition of infrastructure. Generally, infrastructure has a unique definition due to its characteristics and high degree of heterogeneity among sectors. Infrastructure can be defined as the basic facilities, service installations and physical assets needed for providing an essential service to a community or society, such as transportation and communication systems, water and power lines, schools, hospitals, renewable energy, and so on (Inderst, 2010).

In fact, the meaning of 'infrastructure' depends on the definition used for it. The definition of infrastructure by the World Bank (online) dictates the infrastructure services provided by a project, namely electricity generation, transmission and distribution, natural gas transmission and distribution, information and communication technologies (ICT) and transportation.

OECD (2002) defines infrastructure as the system of public works in a country, state or region, including roads, utility lines and public buildings. In the investment context, this usually translates into economic infrastructure (i.e. transport, utilities, communication, and renewable energy) as well as social infrastructure. Infrastructure assets are characterized by capital intensity, longevity, economies of scale, complexity and heterogeneity (Della Croce et al., (2015). The prudential framework of Solvency II (EC, 2016) specifies the definition of infrastructure as physical structures, facilities, systems and/or networks that are essential to the public and/or society, whereas infrastructure project entity or a special purpose vehicle (SPV) refers to a legal entity which does not perform any other functions than to own, finance, develop or operate infrastructure assets.

Defining the infrastructure asset class has been at the center of recent debates with respect to asset allocation strategies or prudential purposes. The EDHEC institute (Blanc-Brude et al., 2017) is believed to have addressed the multiple biases created by data collection from the infrastructure market and the potentially skewed representation of infrastructure as a result of larger investments in the investable market by using a sample universe of infrastructure investments.

Previous empirical works (Geysen, 2018) suggest that infrastructure investments create diversification benefits, improve the risk-return profile of the portfolio and certainly can be helpful in the asset management context. In this paper, the author searches for a meaningful evidence of those benefits, mainly by comparing the performance of the EDHEC private infrastructure equity index to the broader infrastructure benchmarks in the listed infrastructure space. For the purpose of this scientific analysis, the author initially examines the composition, structure, and methodology of eight global infrastructure indices, including one unlisted global private infrastructure equity index, six global listed infrastructure indices and one global listed equity index.

A. *Index Methodology Comparison*

1) EDHEC Global Unlisted Infrastructure Equity Index ('EDHEC*infra*')

The EDHEC global unlisted infrastructure equity index is a market value-weighted representation of the global private infrastructure equity market. The EDHEC*infra* private infrastructure equity investments index is a sample-based universe of investable private infrastructure companies spanning more than 25 countries (mostly OECD and some emerging markets) over 18 years, going back to the year 2000. The index may be argued to offer market-adequate representation of the preferences of buyers and sellers of unlisted infrastructure investments. Index constituents contain all business models including both infrastructure projects (SPVs) and infrastructure corporates.

The EDHEC*infra* index provides an alternative framework of reference relevant to the infrastructure asset class as opposed to the investment categories inherited from private equity and real estate universes. The index selects companies from the specific sub-industries of The Infrastructure Company Classification Standard (TICCS) designed to capture the characteristics of infrastructure investments. The TICCS (see Appendix A) is a four pillar multi-company classification system consisting of three business risk models, various industrial super-classes (corresponding to 30 industry classes and 68 individual asset-level subclasses), four geo-economic exposures and two corporate-governance forms. These filters correspond to the Global Industry Classification Standard (GICS) classification of infrastructure companies as described in Appendix B. In order to be included in the EDHEC*infra* broad market indices, an investable infrastructure company needs to qualify under TICCS classification as meeting one of the eligibility criteria (EDHEC, 2018).

2) Dow Jones Brookfield Global Infrastructure Index ('DJ Brookfield')

Dow Jones Brookfield Global Infrastructure index measures the performance of approximately 100 companies worldwide that are owners and operators of pure-play infrastructure assets with at least 70% of cash flows derived from infrastructure lines of business. The index is produced jointly by S&P Dow Jones Indices and Brookfield Asset Management and, based on GICS classification system (see Appendix B), covers primarily communication, energy, industrials, real estate, and utilities sectors. The index has a modified market capitalization weighting with a total market cap of USD 1.13 trillion, representing 101 firms as of 30th June 2019 (Standard and Poor's Dow Jones Indices, 2019).

3) MSCI Europe Infrastructure Index ('MSCI')

The MSCI Europe Infrastructure Index captures the global opportunity set of listed companies that are owners or operators of infrastructure assets. Constituents are selected from the equity universe of MSCI Europe, the parent index, which covers mid and large cap securities across the 15 developed market countries in Europe. All index constituents are categorized into 13 subindustries according to GICS standard, which MSCI then aggregates and groups into 5 infrastructure sectors: telecommunications, utilities, energy, transportation and social (MSCI defined infrastructure sectors not as official GICS sectors but as aggregated subsets of GICS sub-industries based on the MSCI Infrastructure Indexes Methodology). As of 30th June 2019, the total market capitalization was reported at EUR 637bn, consisting of 51 constituents (MSCI, 2017).

4) RARE Global Infrastructure Index ('RARE')

The RARE Global Infrastructure index tracks the performance of a portfolio of global infrastructure-related equities domiciled in domestic, developed and emerging international markets. This smart beta index seeks to provide focused exposure to infrastructure companies in the transportation, energy, utilities, communication and social services sectors according to GICS. Infrastructure assets include physical structures, networks, developments and projects that communities and economies require to function and grow. Weighting of the index is determined by free float market capitalization, infrastructure exposure and region. The market cap was reported at EUR 2.02tn across 120 constituents as of 28th June 2019 (Legg Mason, 2017).

5) S&P Global Infrastructure Total Return Index ('S&P')

The S&P Global Infrastructure Index, as part of the S&P thematic indices, is designed to track 75 listed infrastructure companies across three distinct infrastructure clusters: energy, transportation, and utilities (telecommunication infrastructure is excluded). The sectorial weighting is determined by the fixed number of constituents. First, 15 emerging market stocks are selected; then, the developed market is sorted out with 30 stocks in transportation (i.e., 40% weight), 30 stocks in utilities (i.e., 40% weight) and 15 energy infrastructure companies (i.e., 20% weight) based on a float-adjusted market capitalization. Stocks with lower market capitalization are allowed if the index provides less than 75 companies in total. Total market capitalization was USD 1.48tn as of 28th June 2019 (Standard & Poor's, 2019).

6) STOXX Global Broad Infrastructure Index Gross Return ('STOXX')

The STOXX Global Broad Infrastructure Index is derived from a portfolio of stocks that have at least 50% of the total most recent annual revenues coming from infrastructure business and/or supplying goods or services to companies from the infrastructure industry. The index includes all developed and emerging markets of the STOXX Global Total Market Index. Its universe is derived from all stocks across the communications, energy, government outsourcing/social, transportation and utilities sectors according to the GICS standard. The index is weighted according to free-float market capitalization with additional weighting cap factors (e.g. sector cap of 40%). Market capitalization was EUR 1.77bn as of 28th June 2019 STOXX, 2019).

7) Macquarie Global Infrastructure Total Return Index ('Macquarie')

The Macquarie Global Infrastructure index reflects the stock performance of companies engaged principally in the management, ownership and/or operation of infrastructure and utility assets. The inde x covers assets classified by GICS such as transportation, telecommunications, social infrastructure and utilities. The weighting is done using a free-float methodology. The index history goes back to July 2000; however, this index was discontinued in 2016 (Macquarie, 2005). The alternative index series to be used is FTSE Global Core Infrastructure Index (see below).

8) FTSE Global Core Infrastructure Index ('FTSE')

The FTSE Global Core Infrastructure Index reflects the performance of infrastructure and infrastructure-related listed securities worldwide, which are categorized in accordance with the Industry Classification Benchmark (ICB), the global standard for industry sector analysis. Constituents are screened according to ICB subsectors that meet FTSE's definition of core infrastructure, which is typically characterized as structures and networks with conveyance of goods, services, information/data, people, energy and necessities. Weights are capped as follows: transportation, 30%; utilities, 50%; and others (e.g., telecommunication, pipelines, REITs, etc.), 20%. The index has a free float-adjusted market capitalization, which was reported at EUR 2.75bn as of 30th June 2019 (FTSE Russell, 2019).

9) MSCI World Index ('MSCI World')

The MSCI World Index in EUR is a free-float weighted equity index that identifies eligible equity securities worldwide. This global benchmark measures and captures large-cap and mid-cap representatives across 23 developed markets. The index covers approximately 85% of the free float-adjusted market capitalization in each country (MSCI, 2019). The MSCI World index is used for comparison purposes only as a global stock market proxy.

Table 1. Global Infrastructure Indices Comparison (page 1 of 3)

Index	1) EDHEC Global Unlisted Infrastructure Equity Index	2) Dow Jones Brookfield Global Infrastructure Index	3) MSCI Europe Infrastructure Index
Description	market value-weighted representation of the global private infrastructure equity market, which represents the preferences of buyers and sellers of unlisted infrastructure investments.	measures the performance of companies worldwide that are owners and operators of pure-play infrastructure assets	captures the global opportunity set of listed companies that are owners or operators of infrastructure assets
Index Family	defined by using filters from the most relevant investors: broad market, market subindices, custom benchmarks	constructed based on Brookfield Asset Management's definition of infrastructure with direct subsets of regional and global infrastructure sectors; another main index is Dow Jones Brookfield Global Infrastructure Composite Index (including Master Limited Partnerships (MLPs))	headline index; part of broad subindices in power (e.g. generation, transmission and renewable), transport (incl. airports)
Usage	private benchmark	benchmarking	headline index/benchmarking
Index Universe	combination of four infrastructure clusters of TICCS classification classes (business risk, industrial, geoeconomic and corporate-governance)	The index is produced jointly by S&P Dow Jones Indices and Brookfield Asset Management and excludes Master Limited Partnerships (MLPs). The index is available in USD, AUD, CAD, and EUR.	Constituents are selected from the equity universe of MSCI Europe, the parent index, which covers mid and large cap securities across the 15 developed markets countries in Europe. MSCI defines infrastructure sectors as not official GICS sectors but aggregated subsets of GICS sub-industries.
Sectors	*business risk (3)* contracted, merchant, regulated *industrials (8)* power generation, environmental services, social infra, energy & water resources, data infra, transport, renewables, utilities *geoeconomic (4)* global, regional, national, subnational *governance (2)* infra project companies (SPV), corporates	*communication* communication (e.g. towers, broadband) *industrials* airports, toll roads, ports *energy* electricity transmission and distribution, *utilities* oil & gas storage, water and diversified sectors	*communication* alternative carriers; wireless tele services *transportation* airport services, roads, rail tracks, ports *energy* oil & gas storage and transportation *utilities* electricity, gas, water *social infra* education services, health care facilities
Number of Constituents	contain 581 companies incl. SPV and corporates	variable; 101 stocks as of 30 June 2018	variable; 51 stocks as of 30 June 2019
Size	USD 349bn representing 474 firms reported as of 31 March 2019	minimum float-adjusted market cap: USD 500mn; USD 1.13tn representing 101 firms reported as of 30 June 2018	free float-adjusted market capitalization EUR 637bn representing 51 firms reported as of 30 June 2019
Liquidity	n/a	threshold of 3-month Average Daily Value Traded: USD 1mn	n/a
Listing	n/a	developed market listing	developed market listing
Weighting	three alternative index-weighting schemes: value, capped value and equal weighting	modified market capitalization weighted	constituent weights within the respective sector are based on free float-adjusted market capitalization
Eligibility	cumulative primary and secondary deal flow since 2000 represents at least 0.5% of the total value of all identified markets; market turnover ratio min. 20% by number of transactions, min. 20% by transaction volume or country is part of the EU; basic procurement data and financial information incl. incorporation and financial close dates, book values	constituents have a developed market listing; and at least 70% of cash flows are derived from infrastructure lines of business	40% infrastructure 60% utilities 15% subindustry weight limits
Diversification	a sampled universe is used for defining the constituents of the global broad market index, which are further filtered according to minimum-size and time-to-maturity filters.	individual stock weights are capped at 10% country weights are capped at 50% industry weights are capped at 50%	telecommunication and utilities sectors are each fixed at 1/3* of the index, while the energy, transportation and social infrastructure sectors have a combined weight of the remaining 1/3
Rebalancing	Time series are adjusted on a quarterly basis	quarterly	quarterly
Launch Date	2019; historical data is backdated and available from 31 March 2001	2008; historical data available from December 2002; pricing adjusted in real time	1998; historical data available since 31 December 1998
Access/Source	Bloomberg ID: BBG00H6Y70L0 (EIPEE Index) EDHECinfra online platform: https://indices.edhecinfra.com/App	Bloomberg ID: BBG000R9S4K9 (DJBGIET Index) S&P Dow Jones Indices website: https://us.spindices.com/indices/equity/dow-jones-brookfield-global-infrastructure-local-currency-index-usd	Bloomberg ID: BBG001XVT251 (MXEU0INF Index) MSCI homepage: https://www.msci.com/documents/10199/bcdb0528-dc83-4be2-a166-27d859766914

*Note that the sector weights of the MSCI Europe Infrastructure Index in between two quarterly reviews may deviate from one-third due to price movement or on-going corporate events on existing constituents.

Table 1. Global Infrastructure Indices Comparison (page 2 of 3)

Index	4) RARE Global Infrastructure Index	5) S&P Global Infrastructure Index	6) STOXX Global Broad Infrastructure Index
Description	tracks a portfolio of global infrastructure-related equities including stocks domiciled in domestic, developed and emerging international markets	measures the performance of 75 of the largest publicly-listed global infrastructure companies from both developed and emerging markets	derived from all stocks that have at least 50% of the total most recent annual revenues from infrastructure business and/or supplying goods or services to companies from the
Index Family	defined by infrastructure assets including physical structures, networks, developments and projects that communities and economies require to function and grow	part of the S&P Thematic Indices; represents the listed infrastructure industry; an equal-weighted version (S&P Global Infrastructure Equal Weight Index) is also available.	derived from the STOXX Developed and Emerging Markets Total Market (all developed and emerging markets of the STOXX Global Total Market Index)
Usage	benchmarking	benchmarking/thematic index	blue chip/theme index
Index Universe	smart beta index seeks to provide focused exposure to infrastructure companies by analyzing the actual sources of corporate cash flows	Three infrastructure clusters (combination of GICS industries) from the S&P Global BMI. Calculation currencies are USD, AUD, EUR, GBP, JPY, KRW, LCL.	defined as all companies listed in developed or emerging markets which are part of the STOXX Global Total Market Index. Price-based, gross and net return in EUR and UDS available
Sectors	*communication* *transportation* *energy* *utilities* *real estate*	cable and satellite airport services, toll roads, rails, ports transmission and distribution, electric generation, oil & gas storage, renewable electricity, gas, water, multi-utilities REITs	*transportation* *energy* *utilities* *(*communication infrastructure excluded)*	airport services, highways, rail tracks, ports oil and gas storage, renewables electricity, gas, water, power producers and energy traders	*communication* *transportation* *energy* *utilities* *social infra*	cable, satellite, data center, tower, wireline airports, rail, roads, water transportation energy utilities, midstream energy waste management, water hospitals, correctional facilities, postal services
Number of Constituents	variable; 120 stocks as of 28 June 2019	75 companies	variable; max. 40 per sector
Size	minimum float-adjusted market cap: USD 500mn; EUR 2.02tn across 120 constituents reported as of 28 June 2019	minimum total market capitalization: USD 250mn; minimum float-adjusted market cap: USD 100mn; market capitalization of USD 1.48tn as of 28 June 2019	EUR 1.77bn market capitalization as of 28 June 2019
Liquidity	threshold of 3-month Average Daily Value Traded: USD 2mn	Thresholds of 3-month Average Daily Value Traded: USD 1mn for developed markets and USD 500,000 for emerging	threshold of 3-month Average Daily Value Traded: USD 1mn
Listing	developed market listing	developed market listing	developed market listing
Weighting	determined by market capitalization, free float, infrastructure exposure, price volatility and region	modified market capitalization weighted	free-float market capitalization with additional weighting cap factors
Eligibility	investments in companies of any size and in any country, including up to 80% foreign and up to 25% in developing or emerging markets; exposure to at least three foreign countries	Target number of stocks from the energy cluster is 15, with total weight capped at 20%; 30 stocks each from the transportation and utilities clusters, with total weight capped at 40% each	at least 50% of the company's revenue is generated in selected infrastructure sectors variable number of total constituents; a cap factor of 40% per sector; the maximum number of companies per sector is given by 40/n, with n = number of subsectors within each of the five
Diversification	leading economic indicators are used to establish weight between economically sensitive sectors and more regulated / defensive sectors on a quarterly basis	individual stock weights are capped at 5% 15 stocks from emerging markets and 60 from developed markets	individual stock weights are capped at 5% sector weights are capped at 30% country weights are capped at 40%
Rebalancing	quarterly	semi-annually	annually
Launch Date	2006; data is available since inception, i.e. 30 June 2006	2007; historical data available since 22 February 2007	2013; historical data available since 16 March 2007; pricing adjusted in real-time
Access/Source	Bloomberg ID: BBG00FF4F3L5 (INFRNR Index) RARE homepage: https://www.rareinfrastructure.com/strategies/rare-global-infrastructure-index/	Bloomberg ID: BBG0016VCZ65 (SPGTINTR Index) S&P indices homepage: https://us.spindices.com/indices/equity/sp-global-infrastructure-index	Bloomberg ID: BBG005815KJ7 (STXGBIGV Index) STOXX website: https://www.stoxx.com/index-details?symbol=STXGBIGV&stoxxindex=stxgbigv&searchTerm=STOXX%C2%AE+Global+Broad+Infrastructure

Table 1. Global Infrastructure Indices Comparison (page 3 of 3)

Index	7) Macquarie Global Infrastructure Index	8) FTSE Global Core Infrastructure Index	9) MSCI World Index
Description	reflects the stock performance of companies engaged principally in the management, ownership and/or operation of infrastructure and utility assets	reflects the performance of infrastructure and infrastructure-related listed securities worldwide	MSCI World Index in EUR is a free-float weighted equity index that identifies eligible equity securities
Index Family	based on FTSE Global Equity Index series. Index covers 48 markets broken down into five regional indices and eight industry/sector indices. For each of the indices a Price index and Total Return index are calculated in local currency, USD, GBP, EUR, JPY and AUD	FTSE Infrastructure Index Series is a comprehensive set of nine cap-weighted indexes, diversified across six FTSE-defined infrastructure subsectors; part of FTSE Global All Cap Index. Index also available in USD, EUR, GBP, JPY and AUD.	MXWO includes developed world markets, and does not include emerging markets. MXWD includes both emerging and developed markets.
Usage	represents trends in all eligible infrastructure stocks	benchmarking	global benchmarking (stocks)
Index Universe	constituent companies in the series are selected from oil & gas pipelines, transportation services, utilities and telecommunications equipment industries	further expands the definition of infrastructure from the structures and networks to include the conveyance of goods, services, information/data, people, energy and necessities; categorized in accordance with ICB	measures and captures equity markets worldwide; small, mid and large caps
Sectors	*communication* satellites, cable and transmission tower *transportation* toll roads, airport, rail tracks, shipping ports *utilities* electricity, water, oil and gas pipelines *social infra* schools, hospitals	*transportation* heavy construction, transportation services, railroads, travel & tourism *utilities* conventional electricity, gas distribution, water, multi-utilities *others* pipelines, fixed and mobile telecommunication, broadcasting, REITs	covers all segments, including GICS sectors
Number of Constituents	n/a; index discontinued in 2016	variable	variable; 1,655 constituents as of 28 June 2019
Size	minimum float-adjusted market cap: USD 250mn	free float-adjusted market capitalization EUR 2.75tn reported as of 30 June 2019	free float-adjusted market capitalizaion
Liquidity	threshold of 3-month Average Daily Value Traded: USD 1mn	individual stocks are screened to ensure that the index is tradable	annual traded value ratio (ATVR); 3 month of frequency trading
Listing	developed market listing	developed market listing	global listing
Weighting	free-float market capitalization, liquidity screens and GIIC	constituent weights within the respective sector are based on free float-adjusted market capitalization	free-float market capitalization
Eligibility	company's primary business is derived from infrastructure activities	constituents derive 65% or more of their revenue from core infrastructure activities	all listed equity securities (including REITs); a security must have a free float-adjusted market capitalization equal to or higher than 50% of the equity universe minimum size requirement
Diversification	n/a; index discontinued in 2016 The alternative index series is FTSE Global Core Infrastructure Index	individual stock weights are capped at 5% sector weights are capped at 50% utilities, 30% transportation, 20% others	Large Cap Index: 70% ± 5%. Standard Index: 85% ± 5%. Investable Market Index: 99%+1% or -0.5%.
Rebalancing	semi-annually	semi-annually	globally synchronized
Launch Date	data available from 1 July 2000; index was later discontinued on 21 November 2016	2011; historical data available from December 2005 with pricing calculated on an end-of-day basis	developed with a base value of 100 as of December 31, 1998
Access/Source	Bloomberg ID: BBG002SWRZ61 (MCGIIILT Index) Macquarie fact sheet: https://www.macquarie.com.au/dafiles/Internet/mgl/au/about-macquarie-group/news/newsitem/2005/docs/19_June_infrastructure_fact	Bloomberg ID: BBG001Y6XYN0 (TFGCIIU Index) FTSE Russell indices homepage: https://www.ftserussell.com/products/indices/infra	Bloomberg ID: BBG002SQLTX4 (MSDEWIN Index) MSCI homepage: https://www.msci.com/world

B. *Summary of index compositional breakdown – definition, scope, methodology, weighting, eligibility and classification*

A common consensus among the global infrastructure indices is that infrastructure is usually defined by assets representing physical structures, networks, developments and projects that communities and economies require to properly function and develop. FTSE further expands the definition in accordance with the ICB classification standard.

In terms of scope, all indices (except MSCI World, which is a pure global equity index used for comparison purposes) measure the performance of global infrastructure companies that are owners or operators of infrastructure assets. EDHEC*infra* further defines its investment universe to represent the preferences of buyers and sellers of the unlisted infrastructure investments. Each index is based on its own methodology in an effort to capture the stock performance of infrastructure companies. In this respect, constituents need to provide a meaningful portion of their cash flows to derive from infrastructure lines of business ranging from 50% (e.g., STOXX) to at least 70% of the company's cash flows (e.g., DJ Brookfield). On the other hand, EDHEC*infra* utilizes a sampled universe for defining the constituents of its global index, which include a large range of categories to ensure that any private infrastructure company worldwide can be included provided it fulfils the eligibility criteria.

The weight of developed markets (consisting predominantly of North America and Europe) appears consistent across the indices, with the exception of the S&P index carrying a minimum weight of 20% for constituents from emerging markets. A broad comparison of the main global listed indices indicates that a free-float market capitalization is the most common weighting method for the vast majority, and some indices provide scaled weightings to allow for a specific contribution from particular sectors (e.g. MSCI, S&P, STOXX, FTSE).

However, the subject indices methodology analysis also shows a fundamental difference in the classification of the infrastructure exposures within an index. A review of the classification standard maintained by the global listed indices, namely the GICS, has determined inconsistent categorization of some index constituents. For instance, many road operating companies are often categorized as construction firms, while airport operators and airline-catering firms are often not distinguished. Further, project finance vehicles (e.g. SPVs) are categorized as "financials" rather than as infrastructure companies with a specific sectorial exposure in developing or operating an infrastructure business. Such differences between the main global listed indices and the EDHEC*infra* index have a meaningful impact on performance, as discussed further in this paper. Nevertheless, the benefits that infrastructure investment delivers to investors can only be achieved by creating exposure to a broad base of assets or at least replicating the characteristics of the infrastructure market.

Return and Risk Analysis

In the subsequent analysis, the author used unhedged USD and EUR denominated data to facilitate an equitable comparison amongst index providers. (Please note that not all indices provide hedged versions of their indices or performance data on a local basis.) For the purpose of this study, the author uses quarterly data from the Bloomberg terminal to examine all indices based on availability as of 30th June 2019. The 3-month Euribor is used a risk-free interest rate benchmark, reported at -0.346% as of 1st July 2019 (Euribor, online).

A. *Performance*

Generally, listed infrastructure has indicated a steady outperformance relative to global equities over the last decade. The companies in those indices have delivered better returns despite major financial events such as GFC (with the exception of MSCI infrastructure index), whereas the global stocks (i.e., MSCI World) suffered higher drawdowns and lower returns during the same period, respectively. However, the EDHEC*infra* index has consistently delivered superior returns (between 11.9% and 16.4%) compared to the listed infrastructure indices (between -1.5% and 12.9% during the entire study period of 2001-2018).

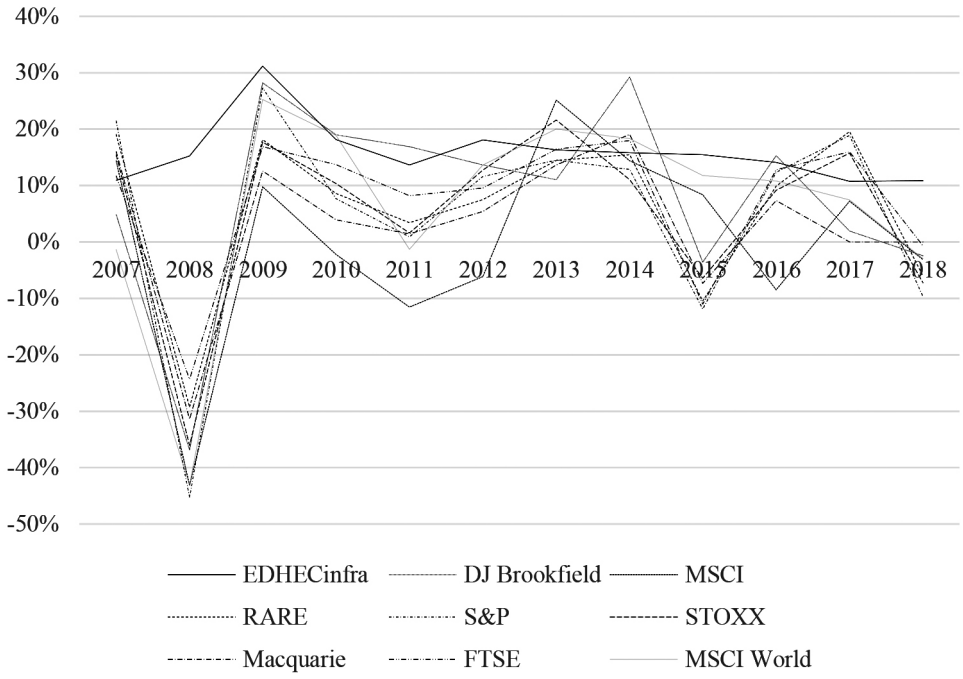
Table 2. Annualized Returns

	3 years	5 years	10 years	12 years	18 years
EDHEC*infra*	11.9%	13.4%	16.4%	15.9%	16.1%
DJ Brookfield	4.9%	8.1%	12.9%	8.1%	10.8%
MSCI	-1.5%	3.7%	3.3%	0.4%	1.2%
RARE	7.8%	5.7%	8.1%	5.9%	6.2%
S&P	7.2%	4.5%	8.5%	5.1%	10.2%
STOXX	5.9%	4.5%	8.6%	5.5%	5.5%
Macquarie	7.4%	6.4%	7.0%	4.1%	6.8%
FTSE	9.4%	7.0%	10.0%	7.3%	8.5%
MSCI World	5.1%	9.1%	12.2%	6.5%	5.0%

Source: Author's calculation baased on Bloomberg (2019).

A recent survey (Amenc et al., 2019) including more than 300 respondents, representing USD 10 trillion in assets

Figure 1. Cumulative Returns since 2007



Source: Author's calculation based on Bloomberg (2019).

under management (AuM), reveals that the initial allocation accounts for at least 90% of the variability in portfolio returns. Therefore, the outperformance of a portfolio as a result of using a certain benchmark may be subjective, as the use of inadequate or irrelevant benchmarks can lead to a false representation of the investor's performance.

Private infrastructure (i.e., EDHEC*infra*) delivers consistently higher returns compared to listed infrastructure (i.e., DJ Brookfield, MSCI, RARE, S&P, STOXX, Macquarie, FTSE) and global equities (i.e., MSCI World). A cumulative return analysis (see Figure 1) shows that private infrastructure was the only index that reported positive returns during the 2007-2008 period, while the EDHEC*infra* index's performance further improved in the aftermath of the GFC period. Even though the overall pattern of returns was relatively analogous in the period 2007-2018, the DJ Brookfield has delivered the most effective performance of the listed indices.

B. *Risk level*

Volatility is used as the primary measure of risk in the portfolio and is measured by the annualized standard deviation. Unlisted infrastructure has overall a lower volatility compared to listed infrastructure and global equities, as shown in Table 3. The risk level of the EDHEC*infra* universe contains standard deviations consistently around 1%, whereas the listed proxies report volatility levels between 4.8% and 11.4% and between 10.3% and 12% for listed infrastructure and global equities, respectively.

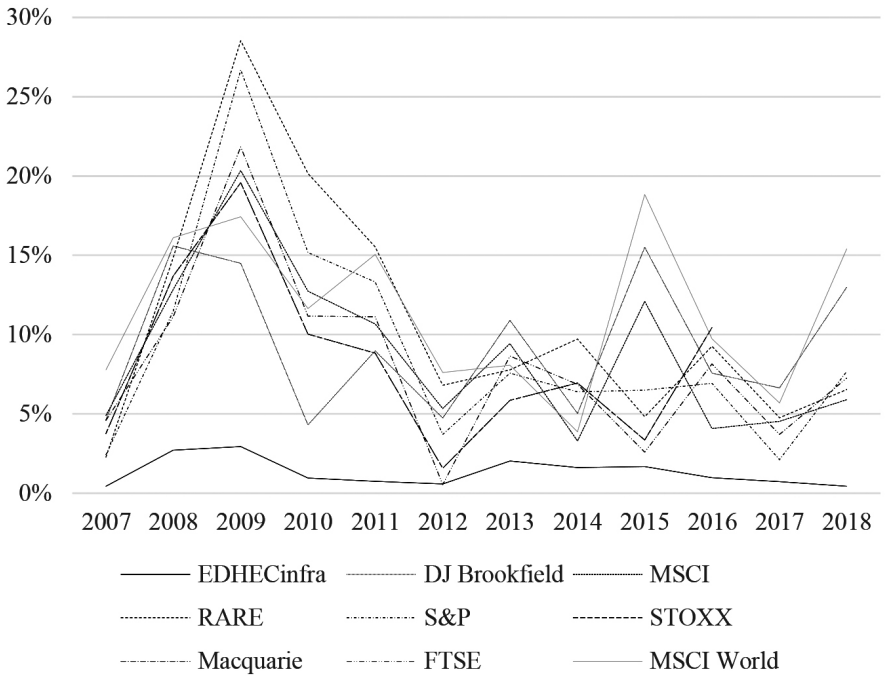
Table 3. Annualized Risk

	3 years	5 years	10 years	12 years	18 years
EDHEC*infra*	0.7%	1.1%	1.3%	1.3%	1.2%
DJ Brookfield	9.1%	9.5%	9.1%	9.3%	9.1%
MSCI	4.8%	6.0%	8.8%	8.8%	10.7%
RARE	6.2%	6.1%	9.2%	9.1%	9.1%
S&P	6.9%	7.0%	11.4%	10.9%	10.7%
STOXX	5.6%	5.9%	9.6%	9.2%	9.2%
Macquarie	10.4%	6.9%	8.3%	8.4%	9.0%
FTSE	6.4%	5.7%	8.2%	8.1%	8.0%
MSCI World	10.3%	10.7%	11.3%	11.4%	12.0%

Source: Author's calculation based on Bloomberg (2019).

The rolling 12-month annualized standard deviation in Figure 3 shows that both listed infrastructure and global equities (i.e., MSCI World) have been consistently riskier than the unlisted EDHEC*infra* infrastructure index. However, the volatility of the global listed infrastructure indices is not constant and has shown considerable variation since 2007, particularly during the height of GFC.

Figure 2. Rolling 12-Month Annualized Risk since 2007



Source: Author's calculation based on Bloomberg (2019).

C. *Risk-adjusted Performance*

Given the strong performance and lower volatility, EDHEC*infra* unlisted infrastructure has outperformed its listed proxies (both MSCI World and global infrastructure indices) on a risk-adjusted performance basis rated by the Sharpe ratio. Also known as the Sharpe index (named after William F. Sharpe), this ratio measures the excess return or risk premium per unit of deviation (Chan, 2009). It is a calculation of return simply divided by volatility and taking into account a risk-free rate of -0.346% as of 1st July 2019. Table 4 shows that EDHEC*infra* unlisted infrastructure delivers the highest risk-adjusted return ratios over all periods covered by this analysis. Looking further into the Sharpe ratio during the 2001-2018 period, the global stock index MSCI World achieves at times a better risk-adjusted performance comparted to listed infrastructure; global stocks tend to react positively in the short term to a rising rates environment, while listed infrastructure stocks have shown less resilience to rising rates.

Table 4. Risk-Adjusted Performance

	3 years	5 years	10 years	12 years	18 years
EDHEC*infra*	18.56	15.03	16.38	16.27	20.58
DJ Brookfield	0.75	1.59	2.03	1.59	1.98
MSCI	-0.27	0.88	0.53	0.42	0.54
RARE	1.51	0.70	0.94	1.16	1.16
S&P	1.33	0.59	0.81	1.22	1.65
STOXX	2.70	1.79	1.69	1.69	1.69
Macquarie	0.74	0.48	1.10	1.09	1.36
FTSE	1.99	0.90	2.73	2.32	2.44
MSCI World	0.78	1.56	1.52	1.04	1.14

Source: Author's calculation based on Bloomberg (2019).

D. *Downside Protection*

Investment's performance is often measured in down-markets. Table 5 indicates the downside capture ratios for infrastructure indices, measured against the MSCI World index.

The downside capture ratio measures the percentage of decline in the MSCI World index (using quarterly time series) compared to both listed and unlisted global indices. The ratio is calculated by dividing the returns by the returns of the market index (i.e., MSCI World in this paper) during the down-market periods (Cox & Goff, 2013). Over the study period (2001-2018), listed infrastructure indicated resilient returns to periods of downturns of the global MSCI equity index. On average, listed infrastructure reported a downside ratio of approx.

52% (average figure for listed data starting 2001), which indicates that those indices declined only 52% as much as the MSCI World index during the entire study period. These ratios further improve in the short term (e.g., 3-year period). Meanwhile, the EDHEC*infra* reported virtually no declines when the global equities experienced down-times.

Table 5. Downside Capture Ratio Against MSCI World

	3 years	5 years	10 years	12 years	18 years
EDHEC*infra*	-56%	-62%	-97%	-73%	-59%
DJ Brookfield	47%	73%	32%	52%	29%
MSCI	24%	34%	84%	77%	78%
RARE	-36%	-5%	45%	44%	26%
S&P	-25%	8%	69%	70%	36%
STOXX	-3%	17%	57%	55%	32%
Macquarie	-36%	-5%	34%	39%	38%
FTSE	-30%	1%	30%	32%	17%

Source: Author's calculation based on Bloomberg (2019).

The paper analysis uses another measure of downside risk, namely the maximum drawdown, as shown in Table 6, which captures the maximum loss from a peak to trough of the index. As expected, the biggest drawdowns were reported during the GFC period (i.e., 2007-2008) while most of the listed infrastructure and the global equities lost half of their value (S&P suffered the biggest drawdown, dropping 49% from its peak). Interestingly, all global listed indices encountered negative returns with fairly similar magnitude and recovery time. Meanwhile, the unlisted global infrastructure EDHEC*infra* index reported no drawdowns during the entire period of study.

Table 6. Maximum Drawdown

	3 years	5 years	10 years	12 years	18 years
EDHECinfra	0%	0%	0%	0%	0%
DJ Brookfield	-12%	-14%	-37%	-37%	-37%
MSCI	-21%	-28%	-46%	-46%	-46%
RARE	-6%	-10%	-38%	-38%	-38%
S&P	-10%	-14%	-49%	-49%	-49%
STOXX	-7%	-8%	-43%	-43%	-43%
Macquarie	-6%	-7%	-38%	-38%	-38%
FTSE	-4%	-11%	-34%	-34%	-34%
MSCI World	-12%	-12%	-47%	-47%	-47%

Source: Author's calculation *based on* Bloomberg (2019).

E. *Diversification*

Diversification is one of the key considerations for long-term investors when contemplating infrastructure investments. When sufficiently diversified from global equities, listed infrastructure can be used as a defensive equity strategy, targeted to provide strong returns and reduce overall portfolio risk. As illustrated in Table 7, listed infrastructure has shown less than perfect, but relatively high correlation to global equities (DJ Brookfield reports the highest correlation of 0.83 relative to MSCI World). This correlation further decreases to approx. 0.21 for unlisted infrastructure when compared to MSCI World global equities. In particular, the analysis reports that EDHEC*infra* has indicated a fairly similar correlation to other listed infrastructure proxies, varying between 0.06 and 0.19 for MSCI, RARE and DJ Brookfield indices, respectively.

Please note that all correlation coefficients are calculated based on quarterly total return data for the period from 30th June 2007 to 30th April 2019.

Table 7. Correlation Matrix (since 2007)

	EDHEC *infra*	DJ Brookfield	MSCI	RARE	S&P	STOXX	Macquarie	FTSE	MSCI World
EDHEC*infra*	1.00	0.19	0.06	0.06	0.12	0.10	0.11	0.09	0.21
DJ Brookfield	0.19	1.00	0.61	0.66	0.63	0.66	0.72	0.75	0.83
MSCI	0.06	0.61	1.00	0.72	0.75	0.78	0.77	0.66	0.70
RARE	0.06	0.66	0.72	1.00	0.98	0.96	0.94	0.96	0.63
S&P	0.12	0.63	0.75	0.98	1.00	0.97	0.92	0.92	0.65
STOXX	0.10	0.66	0.78	0.96	0.97	1.00	0.94	0.94	0.70
Macquarie	0.11	0.72	0.77	0.94	0.92	0.94	1.00	0.95	0.64
FTSE	0.09	0.75	0.66	0.96	0.92	0.94	0.95	1.00	0.67
MSCI World	0.21	0.83	0.70	0.63	0.65	0.70	0.64	0.67	1.00

Source: Author's calculation based on Bloomberg (2019).

Table 8. Beta and Systematic Risk Compared to MSCI World Index

	EDHEC *infra*	DJ Brookfield	MSCI	RARE	S&P	STOXX	Macquarie	FTSE	MSCI World
Return	15.9%	9.2%	1.0%	6.4%	5.7%	6.6%	3.6%	7.9%	7.5%
Volatility	3.0%	14.0%	13.3%	13.2%	16.5%	14.1%	12.1%	12.0%	15.6%
Sharpe ratio	5.33	0.68	0.10	0.51	0.37	0.49	0.33	0.69	0.51
Downside	0.5%	5.0%	5.2%	4.9%	5.9%	5.6%	4.8%	4.3%	5.5%
VaR	2.5%	-8.2%	-11.2%	-11.8%	-15%	-12.1%	-12%	-8.6%	-11.3%
Variance	0.0002	0.0049	0.0044	0.0044	0.0068	0.0050	0.0037	0.0036	0.0060
Beta	0.04	0.74	0.60	0.54	0.69	0.63	0.49	0.52	n/a
Unsystematic	1.50%	3.99%	4.79%	5.18%	6.35%	5.08%	4.74%	4.50%	n/a

Source: Author's calculation *based on* Bloomberg (2019).

F. *Equity Market Beta*

Usually, benchmarks are expected to represent the broad characteristics of individual asset classes over a certain period of time in order to determine the overall portfolio weights and the corresponding asset allocations. Beta represents the volatility of an investment to movements in equity markets. A beta of more than 1 represents greater volatility or sensitivity to the market investments; in other words, it means that if the market moves up or down by 1%, the investment will move by more than 1%, and vice versa. Calculating equity market beta is considered a valuable sensitivity of an investment shift within the equity market. The linear regression method helps determine the beta with the dependent variable performance and the performance of the index.

Using a regression model of the indices' data as of 30th July 2007, analysis shows that infrastructure stocks have consistently maintained a beta of less than 0.75, as indicated in Table 8. The calculation was done by computing the excess return of each index and the excess market return (i.e., MSCI World), and by subtracting the risk-free benchmark (i.e., 3-month Euribor of -0.346 as of 1st July 2019). Please note that approximately half of the calculated data as a percentage of variation in excess returns could be explained by the regression model. For investors seeking low-risk investment strategies, a beta of less than 1 would be highly advisable.

Following the logic of the capital asset pricing model (CAPM, see Milne, 1995), which provides a diversified portfolio in a perfect and efficient economic system solely based on the systematic risk of the return, the underlying analysis looks further into the measure of variation in risk index returns that are not explained by the beta calculation. As illustrated in Table 8, the EDHEC*infra* index has shown the lowest unsystematic risk of 1.50% when compared to the global listed proxies reported between 4% and 6.38%.

Conclusion

Listed infrastructure indices are often considered the preferred relative benchmarks for many investors (Amenc et al., 2019). Empirical findings struggle to support the definition of infrastructure as an asset class (Bianchi & Drew, 2014), while others go even further by calling investments in the listed infrastructure universe a 'fake' infrastructure (Amenc et al., 2017). This paper shows the misrepresentation of commonly used global listed infrastructure indices and the significance of implying proper benchmarking across the investment portfolio.

The comparison of global listed infrastructure indices with the unlisted EDHEC*infra* index has highlighted the importance of a multicriteria classification system, which is focused specifically on infrastructure-related industrial activities (including the various levels of complexity, size and scale). A review of listed infrastructure index constituents has indicated that the GICS standard industrial classification can be inferiorly positioned to represent the different types of infrastructure companies, often including companies with broad industrial nature and less relevant business activities to infrastructure. The newly introduced TICCS system used in the EDHEC*infra* index methodology allows for building more adequate benchmarks. A proper benchmark should warrant various industrial activities with individual classifications as the role of difference business models and types of regulation in the segmentation of the infrastructure sectors can be substantially different.

Pricing across illiquid asset classes such as infrastructure equity is often driven by systematic factors, including investors making choices based on perceived risk and the respective price in exchange for that risk. The paper indicates that listed infrastructure has a significantly higher correlation than EDHEC*infra* unlisted index relative to the broad market MSCI World index. The unlisted universe of stocks

in the EDHEC*infra* index has consistently delivered superior risk-adjusted returns and lower volatility when compared to the listed proxies.

Current listed benchmarks are flawed in their ability to identify the systematic rewarded risks, monitor the risk-adjusted performance or set risk budgets, as the unlisted benchmark has provided better downside protection in falling equity markets and better diversification to global equities. The performance of global listed indices has not delivered an adequate representation of the asset class when compared with an unlisted infrastructure proxy. Amid the growing popularity of infrastructure investments among investors, the overall representation of the asset class may be diminished in search of yield. This paper sets the groundwork for further research possibilities on benchmarking infrastructure investments by examining the unlisted investment space.

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Appendix A: TICCS Classification (EDHEC Institute)

Superclass	Class	Sub-Class	Example
Business risk (BR)	BR1 - contracted	BR10 - fully contracted	availability-based, take-or-pay offtake agreements, feed-in tariff
		BR11 - partially contracted	(shadow) toll, partial capacity, partial power purchase agreement
	BR2 - merchant	BR20 - variable	real toll roads, merchant power plants
	BR3 - regulated	BR30 - rate-of-return regulation	cost-of-service regulation, commission regulation (US)
		BR31 - price-cap regulation	incentive regulation
Industrial (IC)	IC10 - power generation	IC1010 - independent power	nuclear, gas, coal, combined heat and power generation
		IC1020 - independent water and power	power and water production
	IC20 - environmental services	IC2010 - solid waste treatment	(non)hazardous waste treatment, waste-to-power generation
		IC2020 - water treatment	potable & industrial water, sea water desalination, water supply dams
		IC2030 - wastewater treatment	residential & industrial wastewater and reuse
		IC2040 - environmental management	flood control, coastal and riverine locks, energy efficiency
	IC30 - social infrastructure	IC3010 - defence services	strategic transport and refueling, training facilities, barracks
		IC3020 - education services	schools, universities, student accommodation
		IC3030 - government services	police stations, courts of justice, prisons, street lighting, offices
		IC3040 - health 6 social care services	hospitals, clinics, residential and assisted living
		IC3050 - recreational facilities	stadiums, convention centers, public parks, libraries, museums
	IC40 - energy and water resources	IC4010 - pipeline	gas, oil, water, wastewater pipelines
		IC4020 - energy resource processing	liquefied natural gas (LNG) liquefaction and regasification
		IC4040 - energy resource storage	gas, liquid storage
	IC50 - data infrastructure	IC5010 - data transmission	telecom towers, long-distance cables, satellites
		IC5020 - data storage	data centers
	IC60 - transport	IC6010 - airport	airports
		IC6020 - car park	car parks
		IC6030 - port	tool ports, container ports
		IC6040 - rail	heavy rail lines
		IC6050 - road	motorways, roads, tunnels, bridges
		IC6060 - urban commuter	urban light-rail, bus, underground/overground mass transit
	IC70 - renewable power	IC7010 - wind power generation	on-shore, off-shore wind
		IC7020 - solar power generation	photovoltaic, thermal solar power
		IC7030 - hydroelectric power generation	dam, run-of-river power, pumped hydroelectric storage
		IC7040 - other renewable power	biomass, geothermal, wave power
		IC7050 - other renewable technologies	battery storage, off-shore transmission (OFTO)
	IC80 - network utilities	IC8010 - electricity distribution	electricity distribution networks
		IC8020 - electricity transmission	electricity transmission networks
		IC8030 - district cooling/heating	district cooling/heating networks
		IC8040 - water and sewerage	water and sewerage networks
		IC8050 - gas distribution	gas distribution networks
Geo-economic (GE)	GE1 - global infrastructure		major transportation hubs, exposure to global commodity prices
	GE2 - regional infrastructure		medium-size container ports, transborder road corridor
	GE3 - national infrastructure		large-scale road or telecommunication networks
	GE4 - subnational infrastructure		municipal or other subsovereign-entity social infrastructure
Corporate-governance (CG)	CG1 - infra project companies	CG10 - monitored project companies	special-purpose vehicle (SPV), single-project company
		CG11 - unmonitored project companies	less than 50% of debt provided by external senior creditors
	CG2 - infrastructure corporates	CG20 - monitored infra corporates	multi-project companies
		CG21 - unmonitored infra corporates	less than 50% of debt provided by external senior creditors

Appendix B: GICS Classification (infrastructure-relevant sectors only)

Sector	Industry Group	Industry	Sub-industry
10 - energy	1010 - energy	101010 - energy equipment & services	oil & gas drilling, equipment services
		101020 - oil, gas and consumable fuels	exploration, production, refining, storage and transportation
	1510 - materials	151010 - chemicals	commodity, agricultural, industrial gases
		151020 - construction materials	construction materials
		151030 - containers and packaging	metal & glass containers, paper packaging
		151040 - metals and mining	aluminum, copper, gold, silver, steel, etc.
		151050 - paper and forest	paper & forest products
20 - industrials	2010 - capital goods	201010 - aerospace & defense	
		201020 - building products	
		201030 - construction and engineering	
		201040 - electrical equipment	(heavy) electrical components and equipment
		201050 - industrial conglomerates	
		201060 - machinery	construction machinery and heavy trucks, industrial, agricultural
		201070 - trading companies & distribute	trading companies and distributors
	2020 - commercial and professional services	202010 - commercial services & supplies	
		202020 - professional services	
	2030 - transportation	203010 - airfreight and logistics	
		203020 - airlines	
		203030 - marine	
		203040 - road and rail	railroads, trucking
		203050 - transportation infrastructure	airport services, highway & railtracks, marine ports and services
25 - consumer discretionary	2510 - automobiles and components	251010 - auto components	auto parts and equipment
		251020 - automobiles	automobile/motorcycle manufacturers
	2520 - consumer durables and apparel	252010 - household durables	
		252020 - leisure products	
		252030 - textiles, apparel & luxury good	
	2530 - consumer services	253010 - hotels, restaurants and leisure	
		253020 - diversified consumer services	
	2550 - retailing	255010 - distributors	
		255020 - internet & direct marketing	
		255030 multiline retail	
		255040 - specialty retail	
30 - consumer staples	3010 - food and staples retailing	301010 - food and staples	drug retail, food distributors, hypermarkets
	3020 - food, beverage and tobacco	302010 - beverages	brewers, soft drinks, distillers and vintners
		302020 - food products	agricultural, packaged foods and meats
		302030 - tobacco	
	3030 - households and personal products	303010 - household products	
		303020 - personal products	
35 - health care	3510 - health care equipment and services	351010 - health care equipment/supply	
		351020 - health care providers/services	
		351030 - health care technology	
	3520 - pharmaceuticals, biotechnology and life sciences	352010 - biotechnology	
		352020 - pharmaceuticals	
		352030 - life science tools & services	
40 - financials	4010 - banks	401010 - banks	
		401020 - trusts and mortgage finance	
	4020 - diversified financials	402010 - diversified financial services	

Appendix B: GICS Classification (infrastructure-relevant sectors only) (continued)

Sector	Industry Group	Industry	Sub-industry
		402020 - consumer finance	
		402030 - capital markets	
		402040 - mortgage REITs	
	4030 - insurance	403010 - insurance	
45 - information technology (IT)	4510 - software and services	451020 - IT services	
		451030 - software	
	4520 - technology hardware	452010 - communication equipment	
		452020 - technology hardware	
		452030 - electronic equipment	
	4530 - semiconductors/equipment	453010 - semiconductors/equipment	
50 - communication services	5010 - telecommunication services	501010 - diversified telecom services	alternative carriers, integrated telecom services
		501020 - wireless telecom services	
	5020 - media and entertainment	502010 - media	advertising, broadcasting, cable and satellite
		502020 - entertainment	movies, entertainment
		502030 - interactive media and services	
55 - utilities	5510 - utilities	551010 - electric utilities	
		551020 - gas utilities	
		551030 - multi-utilities	
		551040 - water utilities	
		551050 - power & renewable producers	independent power producers and energy traders; renewable energy
60 - real estate	6010 - real estate	601010 - REITs	diversified, industrial, office, health care, residential, retail, etc.
		601020 - real estate management and development	RE operating companies, development, services

Indeksi infrastrukture: primerjalna analiza uspešnosti, tveganja in reprezentativnosti globalno objavljenih ocen

Izvleček

Soočeni z zgodovinsko nizkimi obrestnimi merami investitorji v iskanju alternativnih virov zaslužkov, boljše diverzifikacije in dolgoročne investicijske perspektive še nadalje raziskujejo nelikvidno premoženje, kot je infrastruktura. Ta članek analizira ključne značilnosti uspešnosti in tveganj globalno objavljenega infrastrukturnega indeksa EDHEC*infra* v primerjavi s ključnimi globalno objavljenimi infrastrukturnimi indeksi v obdobju 2001–2018. Za določitev reprezentativnosti običajno uporabljenih benchmarkingov infrastrukturnih investicij med investitorji smo uporabili deskriptivno statistiko. Z namenom tržne beta analize v linearnem regresijskem modelu uporabimo tudi MSCI World Index kot oceno globalnih delnic.

V indekse vključena infrastruktura je pogosto obravnavana kot dohodkovni donos in obrambna lastniška strategija, ki zagotavlja likvidno oceno za alternativno premoženje (npr. infrastrukturo). Vendar pa rezultati v članku nakazujejo, da neto učinek investiranja v objavljen infrastrukturni indeks ostaja vprašljiv, celo neznan. Nedavni empirični rezultati kažejo različne poglede na benchmarking infrastrukture. Visoka korelacija ključnih objavljenih indeksov infrastrukture s širokim indeksom lastniškega kapitala MSCI World in nekonsistentnost raziskovalnih rezultatov tako močno nakazujeta, da je infrastruktura šibko definirana investicijska kategorija z manjkajočimi zanesljivimi in uporabnimi benchmarkingi. Običajno uporabljena in daljnosežna razvrstitev podjetij s širokim industrijskim značajem in manj relevantnimi poslovnimi aktivnostmi za infrastrukturo lahko vpliva na splošen prikaz legitimnih značilnosti infrastrukturnega premoženja sredi naraščajočega navdušenja med investitorji.

Ključne besede: infrastruktura, indeks, benchmarking, kotirajoči lastniški kapital, analiza uspešnosti