

Is “Listed Infrastructure” a fake asset class?

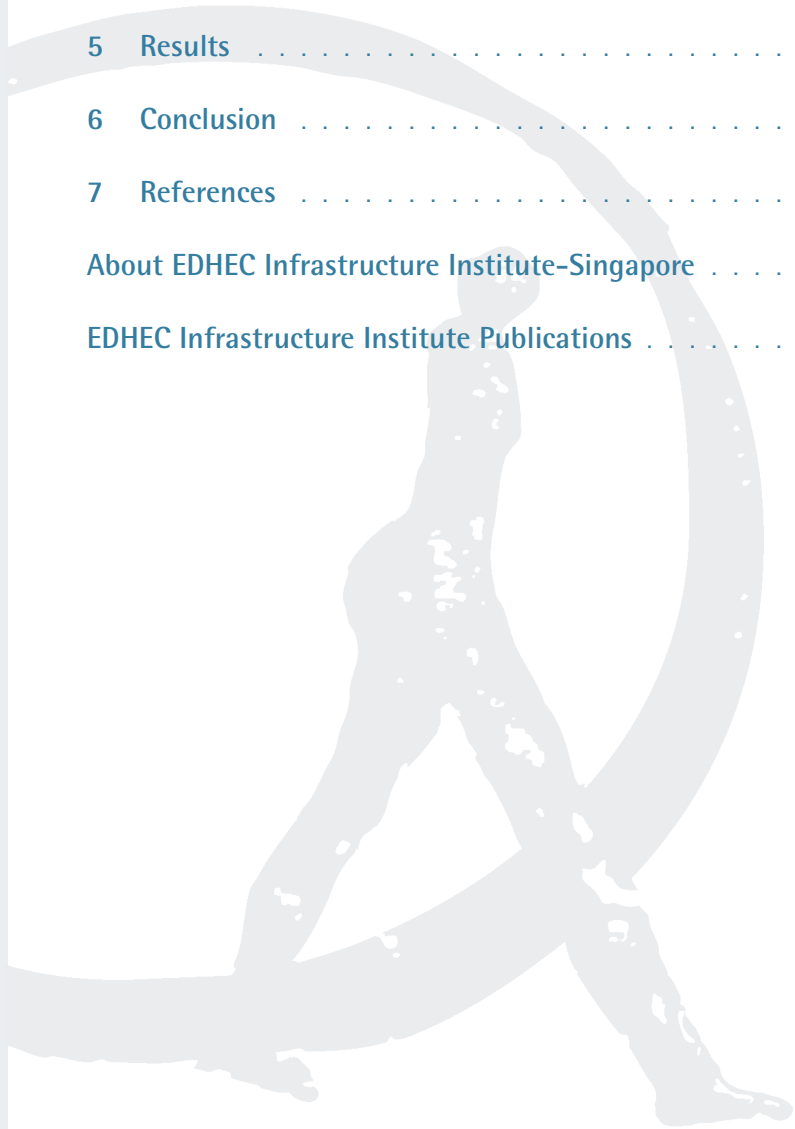
An asset pricing approach

July 2017



Table of Contents

1	Introduction	5
2	Related Literature	8
3	Methodology	12
4	Data	15
5	Results	20
6	Conclusion	30
7	References	32
	About EDHEC Infrastructure Institute-Singapore	34
	EDHEC Infrastructure Institute Publications	37



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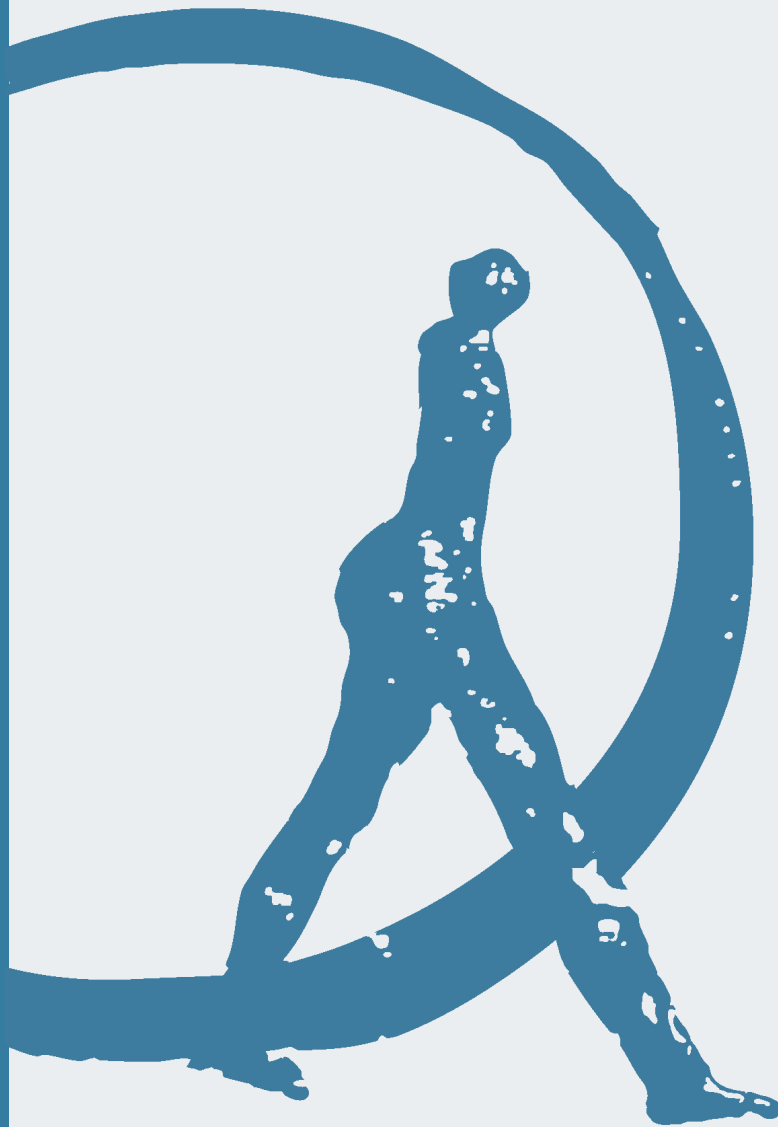


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1. Introduction



Chapter 1. Introduction

Over the past decade, pension and superannuation funds have developed a growing interest in infrastructure related investments.

The OECD (2013) survey reports that large pension funds hold an average asset allocation of 15.6% to alternative asset classes, such as infrastructure and private equity.

The rising interest in these types of assets has seen a number of studies suggest that infrastructure investments are an asset class in their own right. For instance, Idzorek and Armstrong (2009) argue that infrastructure is a logical grouping of assets that share similar characteristics, and therefore, should be regarded as an asset class.

Studies such as Newbery (2002) and Rothballer and Kaserer (2012) view infrastructure as low-risk investments due to their regular income stream based on the higher regulatory structure and lowly competitive environment with infrastructure firms (Regan, Smith and Love (2011). Conversely, other researchers such as Inderst (2010) take a taxonomy approach to the issue and argues that infrastructure investments are simply a sub-sector within current asset classes such as stocks, bonds, private equities and real estate.

Despite the arguments of infrastructure as an asset class and their counter-claims, there is a paucity of finance theory employed in the literature to address this issue.

This study extends the literature by taking an asset pricing approach to examine whether infrastructure is indeed an asset class or otherwise. The question posed in this study has important implications in portfolio management and to long-term investors (such as pension and superannuation funds).

If infrastructure assets offer superior risk-adjusted returns over and above other asset classes (such as stocks, bonds, real estate, cash) then these investments will become the dominant asset class going forward. Conversely, if infrastructure assets do not exhibit return, risk and correlation characteristics which are not distinguishable from other asset classes then it can be argued that they may be classified as investment substitutes for current investments and they cannot be deemed as an asset class.

Our study presents evidence that global and regional publicly listed infrastructure index returns cannot be considered as a separate asset class.

Our results suggest that listed infrastructure does not exhibit sufficient differences in their return, risk and correlations to warrant the classifications a separate asset class.

Instead, our findings suggest that listed infrastructure asset exhibit commonalities with global listed stocks and exposure to the global utilities industry.

The remainder of the paper is structured as follows. Section 2 reviews the literature

Chapter 1. Introduction

relating to the definition of an asset class and the context with infrastructure investments.

Section 3 explains the methodology employed in this study. Section 4 describes the data used while Section 5 summarises the analysis in this study.

Finally, Section 6 provides concluding remarks and the implications that these findings have on investors.

2. Related Literature



Chapter 2. Related Literature

Despite the extensive use of the term 'asset class' in modern finance vernacular, there is a paucity of academic and industry literature which genuinely attempts to define and classify its meaning.

Markowitz (1952, 1959) developed the foundations of modern portfolio theory based on the optimal allocation of capital to an investment universe exhibiting varying expected return, risk and correlation characteristics.

Despite the development of modern portfolio theory over many decades, there is paucity of literature to assist investors in defining and classifying an asset class or whether an investment is a sub-set of an already established investment opportunity set.

The related literature that is most useful to investors in defining asset classes comes from the seminal work of Merton (1973). The zero-intercept criterion of Merton (1973) argues that the systematic risk factors of an asset are captured in a multi-factor asset pricing model when two conditions are met, namely, when you identify the statistically significant independent variable(s), and you achieve an insignificant intercept term.

The statistical independent variable represents the systematic risk factor that explains the source of return of the asset while the insignificant intercept term suggests that there is no other additional risk premium that is generated from the asset that cannot be explained by the multifactor model.

The Merton (1973) zero-intercept criterion approach has been employed in various asset studies in Australia and globally including Griffith (2002), Fama and French (2004) and Limkriangkai, Durand and Watson (2008).

Whilst the academic literature provides a theoretical foundation to assist us in defining whether infrastructure is an asset class, industry researchers have considered alternative approaches in how to address this problem.

Ankrim and Hensel (1993) examined commodities and defined an asset class as an investment which provides the four characteristics, namely, (i) a long position; (ii) a fully collateralised investment; (iii) infrequently traded and (iv) provides the investor with a broad based exposure. A subsequent study by Greer (1997) examined listed and unlisted U.S. real estate and defines an asset class as "An asset class is a set of assets that bear some fundamental economic similarities to each other, and that have characteristics that make them distinct from other asset that are not part of that class." [p.86]. Greer (1997) employs correlation analysis as the primary method of evaluating and differentiating various asset classes.

A more detailed viewpoint comes from Oberhofer (2001) who examined whether hedge funds are an asset class of a sub-set of other assets.

Chapter 2. Related Literature

Oberhofer (2001) argues that an asset class must exhibit the six characteristics, namely, (i) securities in the class must be similar; (ii) returns must be highly correlated with each other; (iii) the asset class should represent a material fraction of the investment opportunity set; (iv) price and composition data should be readily available; (v) it is possible to invest useful amounts in the asset class passively, at the quoted prices; and, (vi) all defined asset classes should sum to an approximation of the entire investment opportunity set. The Oberhofer (2001) approach considers correlations similar to Greer (1997) but requires more information on the investability aspects of the asset under examination.

More recently, Mongars and Marchal-Dombrat (2006) examine commodities and argue that an asset class must exhibit three characteristics, that is (i) the asset exhibits the ability to outperform the risk-free rate; (ii) the asset reports low or negative correlation with other asset classes; and, (iii) it cannot be replicated with a simple linear combination of assets.

The Mongars and Marchal-Dombrat (2006) approach of examining the linear combination of assets is indirectly related to the criteria of the Merton (1973) methodology.

Whilst the abovementioned studies and papers examine how to define an asset class, recent literature has emerged that assist us in understanding the investment behaviour of infrastructure assets.

For instance, Finkenzeller, Dechant and Schafers (2010) employs a portfolio analysis and argues that Australian infrastructure is a separate asset class because it does not exhibit the same return and risk properties as real estate, however, a comparison with listed stocks was not considered.

Newell, Peng and DeFrancesco (2011) show that listed infrastructure is highly correlated to Australian stock returns. Rothbaler and Kaserer (2012) examines listed infrastructure firms and demonstrates the low systematic risk and high idiosyncratic risk of these firms. They argue that infrastructure investments are exposed to peculiar risk profiles due to the construction risk, high operating leverage, low market competition and high levels of asset specificity.

The current literature provides insights to the behavior of infrastructure investments, however, they do not consider an asset pricing approach to the problem and they do not examine the possible exposure of infrastructure assets to industry related risks and returns.

Studies by Fama and French (1997) and Chou, Ho and Ko (2012) show that asset-pricing models are efficient, however, they do not sufficiently capture the variation of industry returns. The work of Bianchi, Bornholt, Drew and Howard (2014) demonstrates that the variation of U.S. infrastructure index returns can be readily explained by a holding of broad U.S. stocks and the U.S. utilities industry.

Chapter 2. Related Literature

More recently, Blanc-Brude et. al. (2017) study the mean-variance spanning properties of 22 listed infrastructure proxies in global, U.S. and U.K. markets and find little evidence of a persistent listed infrastructure asset class.

In this study, we extend the knowledge of Bianchi et. al., (2014) and Blanc-Brude et. al. (2017) by examining global infrastructure index returns and country returns by taking an asset pricing approach to uncover the systematic risk factors and industry exposures that explain the returns of these types of investments.

3. Methodology



Chapter 3. Methodology

We model the various global infrastructure returns by augmenting the methodological approaches of Carhart (1997), Fama and French (2012) and Bianchi et. al., (2014).

To model these global indices, we follow Fama and French (2012) by employing the global version of the Carhart (1997) four-factor asset pricing model.

Bianchi et. al., (2014) discover that the U.S. utilities industry exposure can significantly explain the variation of U.S. infrastructure index returns, which is not captured by conventional asset pricing models.

As a result of this literature, we include the MSCI World Utilities Index as a fifth independent variable in the asset-pricing model which is orthogonal to the other independent variables.

This orthogonal variable of the world utilities industry provides us with the marginal effect of this industry sector in explaining the variation of the various global infrastructure index returns.

We estimate the following ordinary least squares (OLS) regressions:

$$R_t - Rf_t = \alpha + \beta_1(R_{m,t} - Rf_t) + \beta_2(SMB_t) + \beta_3(HML_t) + \beta_4(WML_t) + \varepsilon_t \quad (3.1)$$

$$R_t - Rf_t = \alpha + \beta_1(R_{m,t} - Rf_t) + \beta_2(SMB_t) + \beta_3(HML_t) + \beta_4(WML_t) + \beta_5(UTIL_t - Rf_t) + \varepsilon_t \quad (3.2)$$

where R_t is the return of the respective global infrastructure index; Rf_t is the risk-free rate estimated from the U.S. government 1 month Treasury Bill; α is the intercept term or constant; $\beta_{1\text{ to }5}$ is the first to the fifth regression coefficient; $R_{m,t}$ is the world stock market proxy from the Kenneth French data website; SMB_t is the Fama and French (2012) global risk factor pertaining to portfolio size; HML_t is the Fama and French (2012) global risk factor pertaining to the book-to-market value ratio; WML_t is the Fama and French (2012) global risk factor pertaining to the 12 month return momentum; $UTIL - Rf_t$ is the MSCI World Utilities Index industry return orthogonal to $R_{m,t}$, SMB_t , HML_t and WML_t ; and, ε_t is the regression error terms.

Effectively, Eq 3.1 is the Fama and French (2012) global version of the Carhart (1997) four-factor asset pricing model while Eq 3.2 is a five-factor asset pricing model which includes the orthogonalised returns of the MSCI World Utilities Index.

By employing the Merton (1973) zero-intercept criterion, a valid asset pricing model estimated from Equations 3.1 and 3.2 would capture the systematic risks of these infrastructure returns (ie. we would observe significant betas), report high values and insignificant intercept terms.

Chapter 3. Methodology

As a test of robustness, we report the results for the full sample period and we divide the sample in half to show in-sample (95 months from January 1999 to November 2006) and out-of-sample (95 months from December 2006 to October 2014) regression estimates.

4. Data



Chapter 4. Data

Table 1 summarises the global listed infrastructure index returns and global risk factors employed in this study. Please refer to the Appendix for a summary of the details and constituents of each MSCI global/regional infrastructure index.

This study focuses on global and regional infrastructure indices (rather than country indices) in an effort to estimate the systematic returns of infrastructure without the contamination of idiosyncratic risk factors such as country risk and asset specificity risk in various country infrastructure index returns.

Panel A shows that the various market value-weighted investable global and regional infrastructure indices report an annualised return from 3.6% to 5.6% per annum.

Panel B reports that world stocks earned 6.96% p.a., therefore, a portfolio of global stocks outperformed the various global infrastructure indices over the full sample period.

From a risk perspective, we can observe that the standard deviations and 5th percentiles of the various infrastructure indices are marginally higher or lower than world stocks and is dependent on the index of interest.

Panel B of Table 1 reports the various global risk factors we employ as independent variables in this study. As expected, world bonds report lower return and risk return

characteristics in comparison to world stocks, the Fama and French (2012) world equity risk factors and world utilities.

Another interesting observation is that the MSIC World Utilities Index exhibits marginally lower return and risk characteristics than world stocks. Put simply, the World Utilities Index is not a safe investment, but rather, exhibits similar characteristics as world stocks.

Overall, Table 1 summarises the salient empirical characteristics of our data sample and reflects the typical characteristics of financial market returns.

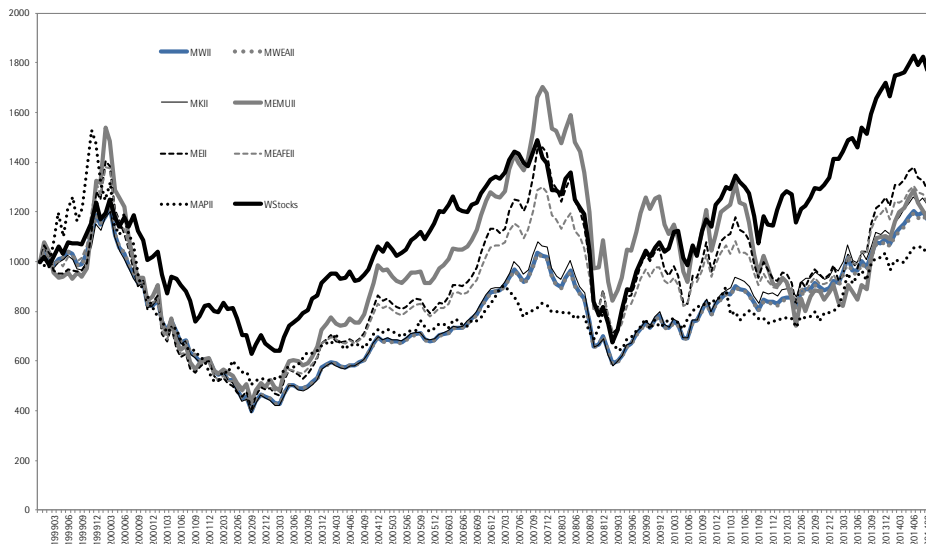
Figure 1 illustrates the growth of \$1,000 invested in world stocks (thick black line) versus the seven world and regional infrastructure indices being examined in this study from January 1999 to October 2014.

Figure 1 shows that world and regional infrastructure indices tend to co-move in a similar fashion as world stocks. To examine the co-movement more closely, we proceed to perform a correlation analysis on the returns of these indices.

Table 2 presents the correlations of the various infrastructure indices and global risk factors employed in this study. It is clear that all of the MSCI world and regional infrastructure indices are significantly and positively correlated with each other with correlations ranging from 0.50 to 1.00.

Chapter 4. Data

Figure 1: Growth of \$1,000 Invested in World Stocks & Infrastructure Indices



Furthermore, all of the MSCI infrastructure indices are significantly and positively correlated with the MSCI World Utilities Index with correlations ranging from 0.43 to 0.75.

The various MSCI infrastructure indices report significant and positive correlations with world stocks of between 0.50 to 0.83. Overall, these preliminary results suggest that global infrastructure indices tend to co-move together with world stocks and world utility industry returns.

Chapter 4. Data

Table 1: Descriptive Statistics

	Start	Mean	Std. Dev.	5th Perc.	Median	95th Perc.
Panel A: International Listed Infrastructure Indices (USD Returns)						
MWII	Jan-99	0.35% (4.20%)	4.21% (14.58%)	-7.29%	0.78% (9.36%)	6.40%
MWEAI	Jan-99	0.35% (4.20%)	4.21% (14.58%)	-7.32%	0.80% (9.60%)	6.42%
MKII	Jan-99	0.39% (4.68%)	4.43% (15.35%)	-7.65%	0.93% (11.16%)	6.48%
MEMUI	Jan-99	0.46% (5.52%)	6.55% (22.69%)	-11.46%	0.44% (5.28%)	10.81%
MEII	Jan-99	0.47% (5.64%)	5.84% (20.23%)	-10.31%	0.54% (6.48%)	9.49%
MEAFEII	Jan-99	0.41% (4.92%)	5.01% (17.36%)	-8.49%	0.70% (8.40%)	8.67%
MAPII	Jan-99	0.3 (3.60%)	4.50% (15.59%)	-7.09%	0.35% (4.20%)	7.38%
Panel B: Global Risk Factors and Risk-Free Rate						
World Stocks	Jan-99	0.58% (6.96%)	4.60% (15.93%)	-8.43%	1.28% (15.36%)	7.43%
SMB	Jan-99	0.19% (2.28%)	2.13% (7.38%)	-2.76%	0.00% -	3.01%
HML	Jan-99	0.46% (5.52%)	2.66% (9.21%)	-3.06%	0.34% (4.08%)	5.11%
WML	Jan-99	0.55% (6.60%)	4.63% (16.04%)	-7.59%	0.87% (10.44%)	6.68%
World Utilities	Jan-99	0.54% (6.48%)	3.89% (13.48%)	-5.88%	0.98% (11.76%)	6.02%
World Bonds	Jan-99	0.42% (5.04%)	0.80% (2.77%)	-0.98%	0.49% (5.88%)	1.63%
U.S. T-Bills	Jan-99	0.17% (2.04%)	0.17% (0.59%)	0.00%	0.11% (1.32%)	0.45%

This table presents the summary statistics and distributions of the data employed in this study expressed in US dollar returns for the sample period January 1999 to October 2014 consisting of 190 monthly observations. In Panel A, MWII denotes the MSCI World Infrastructure Index. MWEAI denotes the MSCI World excluding Australia Infrastructure Index. MKII denotes the MSCI Kokusai Infrastructure Index (which is the MSCI World excluding Japan Infrastructure Index). MEMUI denotes the MSCI European Monetary Union Infrastructure Index. MEII denotes the MSCI Europe Infrastructure Index. MEAFEII denotes the MSCI EAFE infrastructure Index. MAPII denotes the MSCI Asia-Pacific Infrastructure Index. In Panel B, World Stocks denotes the Fama and French global market-value weighted stock return. SMB denotes the Fama and French (2012) Small-Minus-Big risk factor portfolio return which captures the global size premium. HML denotes the Fama and French (2012) High-Minus-Low risk factor portfolio return which captures the global value premium. WML denotes the Fama and French (2012) Winners-Minus-Losers risk factor portfolio return which captures the global momentum anomaly. World Utilities refers to the MSCI World Utilities Index. World bonds denotes the Citigroup World Broad Investment Grade (WBIG) Bond Index. U.S. T-bills denotes the U.S. government 1 month Treasury-Bill return which is the proxy for the risk-free rate. The heading Start denotes the commencement month and year of the respective time series. Mean denotes the mean monthly rate of return. Std. Deviation denotes the standard deviation of monthly returns. The 5th percentile, median and 95th percentile headings denote the 5th, median and 95th percentile rates of returns of the empirical distribution of returns of the time series. The numbers reported in parentheses are annualised statistics

Chapter 4. Data

Table 2: Correlations

	WI	WEA	K	EMU	EUR	EAFE	AP	WS	SMB	HML	WML	UT	WB
WI	--												
WEA	1	--											
K	0.99	0.99	--										
EMU	0.87	0.87	0.88	--									
EUR	0.92	0.92	0.93	0.97	--								
EAFE	0.94	0.94	0.93	0.95	0.98	--							
AP	0.56	0.56	0.47	0.39	0.42	0.58	--						
WS	0.83	0.82	0.83	0.77	0.79	0.8	0.5	--					
SMB	-0.1	-0.11	-0.11	0.03	-0.03	-0.02	0	0.06	--				
HML	-0.25	-0.25	-0.24	-0.25	-0.27	-0.29	-0.16	-0.14	-0.24	--			
WML	-0.16	-0.16	-0.16	-0.11	-0.13	-0.12	-0.02	-0.27	0.29	-0.27	--		
UT	0.75	0.74	0.74	0.65	0.67	0.68	0.43	0.73	-0.01	0.15	-0.19	--	
WB	-0.01	-0.01	-0.03	-0.04	-0.03	0	0.13	-0.13	-0.01	0.06	0	0.09	--

This table presents the correlation coefficients of the various time series employed in this study for the period January 1999 to October 2014. Returns in excess of the U.S. government 1 month Treasury-Bill are used to estimate the correlations. The term WI denotes the MSCI World Infrastructure Index. WEA denotes the MSCI World ex Australia Infrastructure Index. K denotes the MSCI Kokusai Infrastructure Index. EMU denotes the MSCI EMU Infrastructure Index. EUR denotes the MSCI Europe Infrastructure Index. EAFE denotes the MSCI EAFE Infrastructure Index. AP denotes the MSCI Asia-Pacific Infrastructure Index. WS denotes the Fama and French (2012) World Stock Index. SMB denotes the Fama and French (2012) Small-Minus-Big risk factor portfolio return which captures the global size premium. HML denotes the Fama and French (2012) High-Minus-Low risk factor portfolio return which captures the global value premium. WML denotes the Fama and French (2012) Winners-Minus-Losers risk factor portfolio return which captures the global momentum anomaly. UT denotes the MSCI World Utilities Index. WB denotes the Citigroup World Broad Investment Grade (WBIG) Bond Index. Numbers highlighted in bold represent correlations at the 5% statistical significance level or lower.

5. Results



Chapter 5. Results

The results section of this study is divided into two sections based on the global and regional infrastructure indices. We report the regression estimates of the Fama and French (2012) global four-factor model and the five-factor model which is the Fama and French (2012) four-factor model augmented with the MSCI World Utilities Index as the fifth independent variable.

5.1 Global Infrastructure Indices

Tables 3, 4 and 5 present the regression results of the three MSCI World infrastructure indices, namely, the MSCI World Infrastructure Index, MSCI World ex Australia Infrastructure Index and MSCI Kokusai Infrastructure Index, respectively.¹

As expected, the results reveal that world infrastructure index returns exhibit a low market beta. The returns report a negative factor loading to the SMB factor, which suggests the large market capitalisation characteristics of infrastructure returns.

An interesting observation is the negative factor loadings on the HML factor, which suggests that world infrastructure returns exhibit the growth market characteristic. The WML momentum factor is insignificant across the full sample period.

The MSCI Utilities Industry return is significant and improves the models' coefficients of determination by approximately 10%. It is clear that the variation of world infrastructure index returns can be readily explained by low market beta, large-cap

returns, a negative HML factor loading and exposure to the world utilities industry.

When these findings are examined using the Merton (1973) zero-intercept criterion, we can declare that global listed infrastructure index returns cannot be defined as a separate asset class.

These returns do not constitute a separate asset class because these regressions can identify the source of systematic risk of each infrastructure index and these investments do not exhibit an additional risk premium that has not already been identified in global listed stock returns.

5.2 Regional based Infrastructure Indices

We proceed to examine the various regional based global infrastructure indices. Tables 6 and 7 report the regression results of the two MSCI Europe indices, namely, the MSCI EMU Infrastructure Index and MSCI Europe Infrastructure Index.²

Both tables reveal the characteristics of low market beta and negative SMB factor loadings (ie. large-cap returns).

An interesting observation is the insignificance of the MSCI World Utilities Index until the recent out-of-sample test period.

Overall, we can conclude that as infrastructure investments are being examined more closely in Europe, the pricing of these types of equities are becoming more

1 - The MSCI World Index is a free float-adjusted market capitalization weighted index that is designed to measure the equity market performance of developed markets. The MSCI World Index consists of the following 23 developed market country indexes: Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Hong Kong, Ireland, Israel, Italy, Japan, Netherlands, New Zealand, Norway, Portugal, Singapore, Spain, Sweden, Switzerland, the United Kingdom, and the United States. The MSCI KOKUSAI Index is a free float-adjusted market capitalization index designed to measure the equity market performance of developed markets in the MSCI World Index excluding Japan.

2 - The MSCI Europe Index is a free float-adjusted market capitalization weighted index that is designed to measure the equity market performance of the developed markets in Europe. The MSCI Europe Index consists of the following 15 developed market country indexes: Austria, Belgium, Denmark, Finland, France, Germany, Ireland, Italy, the Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, and the United Kingdom. The MSCI EMU (European Economic and Monetary Union) Index is a free float-adjusted market capitalization weighted index that is designed to measure the equity market performance of countries within EMU. The MSCI Europe Index consists of the following

Chapter 5. Results

Table 3: MSCI World Infrastructure Index (MWII) Regressions

Variables	Constant	RM- RF	SMB	HML	WML	UTIL-RF	Adj R2
Panel A: Four-Factor Model							
<i>A1: Full sample (190 months)</i>							
Coefficient	0.0003	0.7676	-0.4379	-0.2542	0.0765		0.7372
Std. Error	0.0017	0.038	0.1183	0.0541	0.0499		
t-statistic	0.1497	20.2054	-3.7021	-4.6965	1.5322		
p-value	0.8812	0	0.0003	0	0.1272		
<i>A2: In-sample (95 months)</i>							
Coefficient	0.0003	0.7868	-0.3932	-0.2608	0.031		0.6881
Std. Error	0.003	0.0869	0.1675	0.077	0.0777		
t-statistic	0.0837	9.0578	-2.3469	-3.3894	0.3996		
p-value	0.9335	0	0.0211	0.001	0.6904		
<i>A3: Out-of-sample (95 months)</i>							
Coefficient	0.0002	0.7563	-0.4263	-0.1246	0.1613		0.7885
Std. Error	0.0018	0.0472	0.1217	0.1343	0.0489		
t-statistic	0.1316	16.0137	-3.503	-0.9278	3.3012		
p-value	0.8956	0	0.0007	0.356	0.0014		
Panel B: Five-Factor Model							
<i>B1: Full sample (190 months)</i>							
Coefficient	0.0009	0.7409	-0.4255	-0.454	0.0368	0.4768	0.814
Std. Error	0.0015	0.0293	0.114	0.0589	0.0537	0.0622	
t-statistic	0.6012	25.2433	-3.7335	-7.7046	0.6856	7.6702	
p-value	0.5484	0	0.0003	0	0.4939	0	
<i>B2: In-sample (95 months)</i>							
Coefficient	0.0019	0.7427	-0.432	-0.4846	0.0117	0.3713	0.7333
Std. Error	0.0028	0.0715	0.1643	0.074	0.0825	0.0805	
t-statistic	0.6857	10.3909	-2.6297	-6.5468	0.1421	4.6134	
p-value	0.4947	0	0.0101	0	0.8873	0	
<i>B3: Out-of-sample (95 months)</i>							
Coefficient	0.001	0.6708	-0.2608	-0.0621	0.0887	0.7327	0.9421
Std. Error	0.0011	0.0186	0.0605	0.0554	0.027	0.0588	
t-statistic	0.9361	36.0195	-4.3114	-1.1205	3.282	12.4714	
p-value	0.3518	0	0	0.2655	0.0015	0	

This table presents the regression results of the Fama and French (2012) global four-factor model and five-factor model on the MSCI World Infrastructure Index (MWII). Panel A reports the Fama and French (2012) four-factor model regression estimates. Panels A1, A2 and A3 are the regression estimates for the full sample, in-sample and out-of-sample periods. Panel B reports the five-factor model which is the four-factor model with the additional factor being the MSCI World Utilities Index orthogonal to the previous four factors. Panel B1, B2 and B3 are the regression estimates for the full sample, in-sample and out-of-sample periods. The table reports the regression estimates with the intercept (C) and the Fama and French (2012) four factors abbreviated as RM-RF, SMB, HML and WML. UTIL-RF is the MSCI World Utilities Industry Index orthogonal to the other four risk factors and the adjusted R2 for each regression is reported in the final column. The table displays the slope coefficients, Newey and West (1987) heteroskedasticity and autocorrelation-consistent standard errors, t-statistics and the p-values for the five risk factors. Numbers in bold represent statistical significance at the 5% level or lower

Chapter 5. Results

Table 4: MSCI World ex Australia Infrastructure Index (MWEAI) Regressions

Variables	C	RM- RF	SMB	HML	WML	UTIL-RF	Adj R2
Panel A: Four-Factor Model							
<i>A1: Full sample (190 months)</i>							
Coefficient	0.0002	0.7661	-0.4435	-0.257	0.0775		0.7342
Std. Error	0.0017	0.0383	0.1191	0.0548	0.0501		
t-statistic	0.1337	20.0148	-3.7238	-4.6873	1.548		
p-value	0.8938	0	0.0003	0	0.1233		
<i>A2: In-sample (95 months)</i>							
Coefficient	0.0003	0.7877	-0.3984	-0.2638	0.0324		0.687
Std. Error	0.0031	0.0877	0.1681	0.0783	0.0779		
t-statistic	0.0853	8.9784	-2.3705	-3.3701	0.4156		
p-value	0.9322	0	0.0199	0.0011	0.6787		
<i>A3: Out-of-sample (95 months)</i>							
Coefficient	0.0002	0.7525	-0.4343	-0.1207	0.1621		0.7841
Std. Error	0.0018	0.0474	0.1243	0.1359	0.0493		
t-statistic	0.0987	15.8615	-3.4945	-0.8885	3.2871		
p-value	0.9216	0	0.0007	0.3767	0.0014		
Panel B: Five-Factor Model							
<i>B1: Full sample (190 months)</i>							
Coefficient	0.001	0.4437	-0.4311	-0.4588	0.0374	0.4815	0.8173
Std. Error	0.0015	0.0475	0.1146	0.0597	0.0539	0.0622	
t-statistic	0.5869	9.3456	-3.7605	-7.6826	0.6941	7.747	
p-value	0.558	0	0.0002	0	0.4885	0	
<i>B2: In-sample (95 months)</i>							
Coefficient	0.002	0.5121	-0.4377	-0.4907	0.0128	0.3765	0.7333
Std. Error	0.0028	0.078	0.1647	0.0748	0.0827	0.0809	
t-statistic	0.6957	6.5662	-2.6582	-6.5599	0.1544	4.6517	
p-value	0.4884	0	0.0093	0	0.8777	0	
<i>B3: Out-of-sample (95 months)</i>							
Coefficient	0.001	0.2124	-0.2672	-0.0576	0.0887	0.7398	0.9413
Std. Error	0.0011	0.0465	0.0599	0.0564	0.0263	0.0577	
t-statistic	0.8721	4.5682	-4.4609	-1.0211	3.3762	12.8197	
p-value	0.3855	0	0	0.31	0.0011	0	

This table presents the regression results of the Fama and French (2012) global four-factor model and five-factor model on the MSCI World ex Australia Infrastructure Index (MWEAI). Panel A reports the Fama and French (2012) four-factor model regression estimates. Panels A1, A2 and A3 are the regression estimates for the full sample, in-sample and out-of-sample periods. Panel B reports the five-factor model which is the four-factor model with the additional factor being the MSCI World Utilities Index orthogonal to the previous four factors. Panel B1, B2 and B3 are the regression estimates for the full sample, in-sample and out-of-sample periods. The table reports the regression estimates with the intercept (C) and the Fama and French (2012) four factors abbreviated as RM-RF, SMB, HML and WML. UTIL-RF is the MSCI World Utilities Industry Index orthogonal to the other four risk factors and the adjusted R2 for each regression is reported in the final column. The table displays the slope coefficients, heteroskedasticity and autocorrelation-consistent standard errors, t-statistics and the p-values for the five risk factors. Numbers in bold signify statistically significant independent variables

Chapter 5. Results

Table 5: MSCI Kokusai Infrastructure Index (MKII) Regressions

Variables	C	RM- RF	SMB	HML	WML	UTIL-RF	Adj R2
Panel A: Four-Factor Model							
<i>A1: Full sample (190 months)</i>							
Coefficient	0.0005	0.8063	-0.4496	-0.2604	0.0745		0.7346
Std. Error	0.0018	0.0413	0.1384	0.0598	0.0522		
t-statistic	0.2797	19.5276	-3.2491	-4.3566	1.4279		
p-value	0.78	0	0.0014	0	0.155		
<i>A2: In-sample (95 months)</i>							
Coefficient	0.0009	0.7856	-0.3961	-0.2919	0.0183		0.6584
Std. Error	0.0032	0.0952	0.187	0.0898	0.0802		
t-statistic	0.2865	8.2501	-2.1176	-3.2485	0.2277		
p-value	0.7751	0	0.037	0.0016	0.8204		
<i>A3: Out-of-sample (95 months)</i>							
Coefficient	0.0003	0.8162	-0.4629	-0.1513	0.165		0.8115
Std. Error	0.0019	0.0514	0.12	0.1262	0.045		
t-statistic	0.1807	15.8696	-3.8572	-1.1994	3.666		
p-value	0.857	0	0.0002	0.2335	0.0004		
Panel B: Five-Factor Model							
<i>B1: Full sample (190 months)</i>							
Coefficient	0.0012	0.7789	-0.4369	-0.4653	0.0339	0.4888	0.8076
Std. Error	0.0016	0.0316	0.1304	0.0658	0.0572	0.0643	
t-statistic	0.7554	24.6834	-3.351	-7.0719	0.5923	7.6036	
p-value	0.451	0	0.001	0	0.5544	0	
<i>B2: In-sample (95 months)</i>							
Coefficient	0.0028	0.7356	-0.44	-0.5455	-0.0036	0.4211	0.7125
Std. Error	0.0029	0.0765	0.1794	0.0879	0.0869	0.0881	
t-statistic	0.9637	9.6218	-2.4522	-6.2037	-0.0419	4.7806	
p-value	0.3378	0	0.0161	0	0.9667	0	
<i>B3: Out-of-sample (95 months)</i>							
Coefficient	0.0011	0.7353	-0.3064	-0.0923	0.0963	0.6928	0.9325
Std. Error	0.0011	0.0242	0.0699	0.0605	0.029	0.071	
t-statistic	0.9478	30.3359	-4.3862	-1.5236	3.326	9.7526	
p-value	0.3458	0	0	0.1312	0.0013	0	

This table presents the regression results of the Fama and French (2012) global four-factor model and five-factor model on the MSCI Kokusai Infrastructure Index (MKII). Panel A reports the Fama and French (2012) four-factor model regression estimates. Panels A1, A2 and A3 are the regression estimates for the full sample, in-sample and out-of-sample periods. Panel B reports the five-factor model which is the four-factor model with the additional factor being the MSCI World Utilities Index orthogonal to the previous four factors. Panel B1, B2 and B3 are the regression estimates for the full sample, in-sample and out-of-sample periods. The table reports the regression estimates with the intercept (C) and the Fama and French (2012) four factors abbreviated as RM-RF, SMB, HML and WML. UTIL-RF is the MSCI World Utilities Industry Index orthogonal to the other four risk factors and the adjusted R2 for each regression is reported in the final column. The table displays the slope coefficients, Newey and West (1987) heteroskedasticity and autocorrelation-consistent standard errors, t-statistics and the p-values for the five risk factors. Numbers in bold represent statistical significance at the 5% level or lower

Chapter 5. Results

integrated with global infrastructure index returns.

Table 8 reports the regressions of the MSCI EAFE Infrastructure Index, which represents publicly listed infrastructure-related stocks listed in Europe, Australasia and the Far East (EAFE).³ The results again show that these infrastructure stocks exhibit low market beta, negative SMB factor loadings and a positive and strong relation to the MSCI World Utilities Industry Index.

Again, the MSCI EAFE Infrastructure Index regressions report insignificant intercept terms thereby adhering to the Merton (1973) zero-intercept criterion. Overall, the findings suggest that the MSCI EAFE Infrastructure Index can be replicated by the linear combination of market beta, large-cap returns and a long position of world utility investments.

Table 9 presents the regressions of the MSCI Asia-Pacific Infrastructure Index which is the final regional based infrastructure index considered in this analysis. Unlike the previous indices, all six regressions in Table 9 report very low coefficients of determination.

The MSCI Asia-Pacific Infrastructure Index exhibits low market beta with no other systematic risk factor as a consistent and significant explanatory variable.

This finding is contrary to the previous regressions estimated in this study. An interesting observation is the MSCI World

Utilities Index which is an insignificant explanatory variable during the in-sample period and then becomes statistically significant in the out-of-sample period.

Despite the low number of systematic risk factors to explain the excess returns from this Asian index, the insignificant intercept term suggests that there are no unexplained systematic risk factors (risk premia) left in the variation of returns of this index.

As a result, the regressions in Table 8 adhere to the Merton (1973) zero-intercept criterion. These findings suggest that the MSCI Asia-Pacific infrastructure Index exhibits significant levels of idiosyncratic risk or there is an omitted variable in Asian infrastructure indices that is not significant in other regional infrastructure markets.

3 - The MSCI EAFE Index (Europe, Australasia, Far East) is a free float-adjusted market capitalization index that is designed to measure the equity market performance of developed markets, excluding the US Canada. The MSCI EAFE Index consists of the following 21 developed market country indexes: Australia, Austria, Belgium, Denmark, Finland, France, Germany, Hong Kong, Ireland, Israel, Italy, Japan, the Netherlands, New Zealand, Norway, Portugal, Singapore, Spain, Sweden, Switzerland, and the United Kingdom.

Chapter 5. Results

Table 6: MSCI Europe Infrastructure Index (MEII) Regressions

Variables	Constant	RM- RF	SMB	HML	WML	UTIL-RF	Adj R2
Panel A: Four-Factor Model							
<i>A1: Full sample (190 months)</i>							
Coefficient	0.001	0.9419	-0.4366	-0.4	0.081		0.7764
Std. Error	0.0022	0.043	0.1133	0.1046	0.0574		
t-statistic	0.4601	21.9292	-3.8551	-3.8223	1.4105		
p-value	0.646	0	0.0002	0.0003	0.1601		
<i>A2: In-sample (95 months)</i>							
Coefficient	0.0064	0.8951	-0.4862	-0.6735	0.0907		0.755
Std. Error	0.0038	0.0892	0.1554	0.0892	0.065		
t-statistic	1.6972	10.0358	-3.1287	-7.5478	1.3955		
p-value	0.0931	0	0.0024	0	0.1663		
<i>A3: Out-of-sample (95 months)</i>							
Coefficient	0	0.8238	-0.4572	0.1062	0.0884		0.8401
Std. Error	0.0025	0.0507	0.1318	0.1222	0.0814		
t-statistic	0	16.2522	-3.4687	0.869	1.086		
p-value	0.9999	0	0.0008	0.3872	0.2804		
Panel B: Five-Factor Model							
<i>B1: Full sample (190 months)</i>							
Coefficient	0.0012	0.9327	-0.4364	-0.4334	0.0701	0.157	0.7801
Std. Error	0.0023	0.0448	0.1114	0.1039	0.0587	0.1056	
t-statistic	0.51	20.8289	-3.9181	-4.1726	1.1952	1.4869	
p-value	0.6107	0	0.0001	0	0.2335	0.1388	
<i>B2: In-sample (95 months)</i>							
Coefficient	0.0064	0.8954	-0.4855	-0.6723	0.0908	-0.0029	0.7523
Std. Error	0.0036	0.0847	0.1521	0.0941	0.0642	0.1098	
t-statistic	1.7468	10.5759	-3.1917	-7.1453	1.4146	-0.0263	
p-value	0.0841	0	0.002	0	0.1607	0.9791	
<i>B3: Out-of-sample (95 months)</i>							
Coefficient	0.0007	0.7544	-0.2884	0.1431	0.0444	0.6656	0.9003
Std. Error	0.002	0.0244	0.083	0.0763	0.0557	0.0835	
t-statistic	0.3616	30.9745	-3.4748	1.8757	0.7982	7.9753	
p-value	0.7185	0	0.0008	0.064	0.4269	0	

This table presents the regression results of the Fama and French (2012) global four-factor model and five-factor model on the MSCI Europe Infrastructure Index (MEII). Panel A reports the Fama and French (2012) four-factor model regression estimates. Panels A1, A2 and A3 are the regression estimates for the full sample, in-sample and out-of-sample periods. Panel B reports the five-factor model which is the four-factor model with the additional factor being the MSCI World Utilities Index orthogonal to the previous four factors. Panel B1, B2 and B3 are the regression estimates for the full sample, in-sample and out-of-sample periods. The table reports the regression estimates with the intercept (C) and the Fama and French (2012) four factors abbreviated as RM-RF, SMB, HML and WML. UTIL-RF is the MSCI World Utilities Industry Index orthogonal to the other four risk factors and the adjusted R2 for each regression is reported in the final column. The table displays the slope coefficients, Newey and West (1987) heteroskedasticity and autocorrelation-consistent standard errors, t-statistics and the p-values for the five risk factors. Bold numbers signify statistically significant independent variables.

Chapter 5. Results

Table 7: MSCI EMU Infrastructure Index (MEII) Regressions

Variables	Constant	RM- RF	SMB	HML	WML	UTIL-RF	Adj R2
Panel A: Four-Factor Model							
<i>A1: Full sample (190 months)</i>							
Coefficient	-0.0003	1.0462	-0.3781	-0.3305	0.1194		0.7327
Std. Error	0.0029	0.0556	0.133	0.1612	0.0738		
t-statistic	-0.0898	18.812	-2.843	-2.0504	1.6167		
p-value	0.9286	0	0.005	0.0417	0.1076		
<i>A2: In-sample (95 months)</i>							
Coefficient	0.0074	0.9802	-0.3615	-0.7393	0.1316		0.7389
Std. Error	0.0041	0.0929	0.1524	0.1311	0.08		
t-statistic	1.7957	10.5525	-2.3719	-5.6372	1.645		
p-value	0.0759	0	0.0198	0	0.1035		
<i>A3: Out-of-sample (95 months)</i>							
Coefficient	-0.0017	0.863	-0.5486	0.423	0.1055		0.8095
Std. Error	0.0029	0.0481	0.1522	0.1617	0.0983		
t-statistic	-0.5637	17.9345	-3.6032	2.6154	1.0732		
p-value	0.5744	0	0.0005	0.0105	0.2861		
Panel B: Five-Factor Model							
<i>B1: Full sample (190 months)</i>							
Coefficient	-0.0001	1.0362	-0.3778	-0.3668	0.1076	0.1702	0.7359
Std. Error	0.0029	0.0597	0.1293	0.1586	0.0767	0.1207	
t-statistic	-0.0453	17.355	-2.9211	-2.3121	1.4023	1.4103	
p-value	0.9639	0	0.0039	0.0219	0.1625	0.1601	
<i>B2: In-sample (95 months)</i>							
Coefficient	0.0073	0.9833	-0.3559	-0.73	0.1323	-0.0238	0.7361
Std. Error	0.004	0.0877	0.1536	0.1426	0.0782	0.1246	
t-statistic	1.835	11.2089	-2.3169	-5.1179	1.692	-0.1911	
p-value	0.0698	0	0.0228	0	0.0941	0.8489	
<i>B3: Out-of-sample (95 months)</i>							
Coefficient	-0.0008	0.7805	-0.3476	0.4669	0.0531	0.7921	0.8725
Std. Error	0.0025	0.0345	0.0985	0.1163	0.076	0.1114	
t-statistic	-0.3141	22.631	-3.5301	4.0158	0.6981	7.1093	
p-value	0.7542	0	0.0007	0.0001	0.4869	0	

This table presents the regression results of the Fama and French (2012) global four-factor model and five-factor model on the MSCI EMU Infrastructure Index (MEMUII). Panel A reports the Fama and French (2012) four-factor model regression estimates. Panels A1, A2 and A3 are the regression estimates for the full sample, in-sample and out-of-sample periods. Panel B reports the five-factor model which is the four-factor model with the additional factor being the MSCI World Utilities Index orthogonal to the previous four factors. Panel B1, B2 and B3 are the regression estimates for the full sample, in-sample and out-of-sample periods. The table reports the regression estimates with the intercept (C) and the Fama and French (2012) four factors abbreviated as RM-RF, SMB, HML and WML. UTIL-RF is the MSCI World Utilities Industry Index orthogonal to the other four risk factors and the adjusted R2 for each regression is reported in the final column. The table displays the slope coefficients, Newey and West (1987) heteroskedasticity and autocorrelation-consistent standard errors, t-statistics and the p-values for the five risk factors. Bold numbers signify statistically significant independent variables.

Chapter 5. Results

Table 8: MSCI EAFE Infrastructure Index (MEAFEII) Regressions

Variables	Constant	RM- RF	SMB	HML	WML	UTIL-RF	Adj R2
Panel A: Four-Factor Model							
<i>A1: Full sample (190 months)</i>							
Coefficient	0.0005	0.8809	-0.3332	-0.3557	0.0966		0.6923
Std. Error	0.0022	0.0397	0.1426	0.0818	0.0541		
t-statistic	0.228	22.1921	-2.3365	-4.3476	1.7877		
p-value	0.8199	0	0.0205	0	0.0755		
<i>A2: In-sample (95 months)</i>							
Coefficient	0.0039	0.8224	-0.3202	-0.4843	0.072		0.659
Std. Error	0.0033	0.0904	0.16	0.0923	0.0724		
t-statistic	1.1839	9.1019	-2.0009	-5.2465	0.9954		
p-value	0.2396	0	0.0484	0	0.3222		
<i>A3: Out-of-sample (95 months)</i>							
Coefficient	-0.0013	0.8599	-0.4255	-0.0724	0.1154		0.7329
Std. Error	0.0026	0.0434	0.2061	0.1649	0.0788		
t-statistic	-0.4988	19.7944	-2.0645	-0.4394	1.465		
p-value	0.6191	0	0.0489	0.6615	0.1464		
Panel B: Five-Factor Model							
<i>B1: Full sample (190 months)</i>							
Coefficient	0.0011	0.8562	-0.3218	-0.5399	0.0601	0.4394	0.7377
Std. Error	0.0022	0.0388	0.1327	0.0862	0.0603	0.0787	
t-statistic	0.5145	22.0694	-2.4246	-6.2628	0.9953	5.5799	
p-value	0.6075	0	0.0163	0	0.3209	0	
<i>B2: In-sample (95 months)</i>							
Coefficient	0.0054	0.7832	-0.3546	-0.6831	0.0549	0.3299	0.6827
Std. Error	0.0033	0.0811	0.1549	0.1055	0.0755	0.0941	
t-statistic	1.6325	9.6528	-2.2895	-6.4721	0.7262	6.5067	
p-value	0.1061	0	0.0244	0	0.4696	0.0007	
<i>B3: Out-of-sample (95 months)</i>							
Coefficient	-0.0005	0.7666	-0.2451	-0.0043	0.0362	0.7985	0.8584
Std. Error	0.0022	0.0359	0.1229	0.1181	0.0571	0.0922	
t-statistic	-0.2074	21.3609	-1.9945	-0.0367	0.6344	8.657	
p-value	0.8362	0	0.0492	0.9708	0.5275	0	

This table presents the regression results of the Fama and French (2012) global four-factor model and five-factor model on the MSCI EAFE Infrastructure Index (MEAFEII). Panel A reports the Fama and French (2012) four-factor model regression estimates. Panels A1, A2 and A3 are the regression estimates for the full sample, in-sample and out-of-sample periods. Panel B reports the five-factor model which is the four-factor model with the additional factor being the MSCI World Utilities Index orthogonal to the previous four factors. Panel B1, B2 and B3 are the regression estimates for the full sample, in-sample and out-of-sample periods. The table reports the regression estimates with the intercept (C) and the Fama and French (2012) four factors abbreviated as RM-RF, SMB, HML and WML. UTIL-RF is the MSCI World Utilities Industry Index orthogonal to the other four risk factors and the adjusted R2 for each regression is reported in the final column. The table displays the slope coefficients, Newey and West (1987) heteroskedasticity and autocorrelation-consistent standard errors, t-statistics and the p-values for the five risk factors. Bold numbers signify statistically significant independent variables.

Chapter 5. Results

Table 9: MSCI Asia-Pacific Infrastructure Index (MAPII) Regressions

Variables	Constant	RM- RF	SMB	HML	WML	UTIL-RF	Adj R2
Panel A: Four-Factor Model							
<i>A1: Full sample (190 months)</i>							
Coefficient	-0.0028	0.3523	-0.1023	-0.0273	0.1179		0.1971
Std. Error	0.0033	0.0613	0.1159	0.1445	0.0828		
t-statistic	-0.8403	5.7424	-0.8826	-0.1892	1.4238		
p-value	0.4018	0	0.3786	0.8501	0.1562		
<i>A2: In-sample (95 months)</i>							
Coefficient	-0.0061	0.6004	0.0454	-0.2257	0.1138		0.34
Std. Error	0.0047	0.1219	0.1484	0.1559	0.114		
t-statistic	-1.3007	4.9272	0.306	-1.4474	0.9991		
p-value	0.1967	0	0.7603	0.1513	0.3204		
<i>A3: Out-of-sample (95 months)</i>							
Coefficient	0.0001	0.2556	-0.1801	0.215	0.0798		0.1376
Std. Error	0.0037	0.0535	0.1345	0.2335	0.1004		
t-statistic	0.0331	4.7778	-1.3384	0.9206	0.7945		
p-value	0.9737	0	0.1841	0.3597	0.429		
Panel B: Five-Factor Model							
<i>B1: Full sample (190 months)</i>							
Coefficient	-0.0028	0.3501	-0.0969	-0.031	0.1093	0.1592	0.2017
Std. Error	0.0034	0.0656	0.1179	0.1449	0.0848	0.1606	
t-statistic	-0.8438	5.3335	-0.822	-0.2139	1.2892	0.9909	
p-value	0.3999	0	0.4122	0.8309	0.1989	0.323	
<i>B2: In-sample (95 months)</i>							
Coefficient	-0.0059	0.5953	0.0463	-0.2214	0.1142	-0.0557	0.3337
Std. Error	0.0049	0.1158	0.1471	0.1523	0.1142	0.1458	
t-statistic	-1.2201	5.1408	0.3147	-1.4538	1.0006	-0.3821	
p-value	0.2256	0	0.7537	0.1495	0.3197	0.7033	
<i>B3: Out-of-sample (95 months)</i>							
Coefficient	0.0011	0.1962	-0.0898	0.256	0.0055	0.8376	0.3572
Std. Error	0.0033	0.0425	0.1078	0.1521	0.0797	0.1798	
t-statistic	0.333	4.617	-0.8333	1.6828	0.0686	4.6594	
p-value	0.7399	0	0.4069	0.0959	0.9454	0	

This table presents the regression results of the Fama and French (2012) global four-factor model and five-factor model on the MSCI Asia-Pacific Infrastructure Index (MAPII). Panel A reports the Fama and French (2012) four-factor model regression estimates. Panels A1, A2 and A3 are the regression estimates for the full sample, in-sample and out-of-sample periods. Panel B reports the five-factor model which is the four-factor model with the additional factor being the MSCI World Utilities Index orthogonal to the previous four factors. Panel B1, B2 and B3 are the regression estimates for the full sample, in-sample and out-of-sample periods. The table reports the regression estimates with the intercept (C) and the Fama and French (2012) four factors abbreviated as RM-RF, SMB, HML and WML. UTIL-RF is the MSCI World Utilities Industry Index orthogonal to the other four risk factors and the adjusted R2 for each regression is reported in the final column. The table displays the slope coefficients, Newey and West (1987) heteroskedasticity and autocorrelation-consistent standard errors, t-statistics and the p-values for the five risk factors. Bold numbers signify statistically significant independent variables.

6. Conclusion



Chapter 6. Conclusion

Infrastructure is seen as a separate asset class due to the unique investment characteristics such as their long-life assets, regular income streams, low competitive market structure, regulatory regimes and high barriers to entry.

Whilst these financial and economic characteristics are the endearing features of infrastructure assets, it is the capital growth of the equity and dividend distributions that is the ultimately earned by the investor.

In this study, we examine whether world infrastructure index returns exhibit a systematic risk and return that is sufficiently different to other asset classes to justify their classification as a separate asset class.

To answer this question, this paper develops an asset pricing approach to address this issue. We employ a conventional global multi-factor asset-pricing model and demonstrate that the variation of returns of publicly listed global and regional infrastructure indices can be explained by exposures to market beta, large-cap returns, and exposure to the world utility industry sector.

Furthermore, our empirical findings show that publicly listed infrastructure index returns do not exhibit an additional risk premium that cannot already be earned by investing in world stocks and stocks in the global utilities industry.

Put simply, listed world infrastructure assets do not offer superior risk-adjusted returns over and above other asset classes such as a broad and diversified portfolio of world stocks.

The Merton (1973) zero-intercept criterion suggests that the returns of global infrastructure index returns can be replicated with the linear combination of world stocks and global utility industry stocks. The conclusions from this study suggest that listed infrastructure cannot be defined as a separate asset class.

The empirical findings from this study raise new questions in the relationship between listed and unlisted infrastructure. Publicly listed infrastructure equity returns do not earn excess returns than what can already be earned in world stocks.

This means that the potential additional return from unlisted infrastructure returns is a function of one of the following risks, namely, idiosyncratic risk, infrastructure asset selection (known as alpha), liquidity risk, equity valuation model risk, or a combination of these.

We leave these issues as avenues for future research.

7. References



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About EDHEC Infrastructure Institute-Singapore



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EDHEC*infra* addresses the profound knowledge gap faced by infrastructure investors by collecting and standardising private investment and cash-flow data and running state-of-the-art asset pricing and risk models to create the performance benchmarks that are needed for asset allocation, prudential regulation, and the design of new infrastructure investment solutions.

Origins

In 2012, EDHEC-Risk Institute created a thematic research program on infrastructure investment and established two Research Chairs dedicated to long-term investment in infrastructure equity and debt, respectively, with the active support of the private sector.

Since then, infrastructure investment research at EDHEC has led to more than 20 academic publications and as many trade press articles, a book on infrastructure asset valuation, more than 30 industry and academic presentations, more than 200 mentions in the press, and the creation of an executive course on infrastructure investment and benchmarking.

A testament to the quality of its contributions to this debate, EDHEC*infra*'s research team has been regularly invited to contribute to high-level fora on the subject, including G20 meetings.

Likewise, active contributions were made to the regulatory debate, in particular directly supporting the adaptation of the Solvency-II framework to long-term investments in infrastructure.

This work has contributed to growing the limited stock of investment knowledge in the infrastructure space.

A Profound Knowledge Gap

Institutional investors have set their sights on private investment in infrastructure equity and debt as a potential avenue toward better diversification, improved liability-hedging, and reduced drawdown risk.

Capturing these benefits, however, requires answering some difficult questions:

1. **Risk-adjusted performance measures** are needed to inform strategic asset allocation decisions and monitor performance;
2. **Duration- and inflation-hedging properties** are required to understand the liability-friendliness of infrastructure assets;
3. **Extreme risk measures** are in demand from prudential regulators, among others.

Today none of these metrics is documented in a robust manner, if at all, for investors in privately held infrastructure equity or debt. This has left investors frustrated by an apparent lack of adequate investment solutions in infrastructure. At the same time, policy-makers have begun calling for a widespread effort to channel long-term savings into capital projects that could support long-term growth.

To fill this knowledge gap, EDHEC has launched a new research platform, EDHEC*infra*, to collect, standardise, and produce investment performance data for infrastructure equity and debt investors.

Mission Statement

Our objective is the creation of a global repository of financial knowledge and investment benchmarks about infrastructure equity and debt investment, with a focus on delivering useful applied research in finance for investors in infrastructure.

We aim to deliver the best available estimates of financial performance and risks of reference portfolios of privately held infrastructure investments and to provide

About EDHEC Infrastructure Institute-Singapore

investors with valuable insights about their strategic asset allocation choices in infrastructure, as well as to support the adequate calibration of the relevant prudential frameworks.

We are developing unparalleled access to the financial data of infrastructure projects and firms, especially private data that is either unavailable to market participants or cumbersome and difficult to collect and aggregate.

We also bring advanced asset pricing and risk-measurement technology designed to answer investors' information needs about long-term investment in privately held infrastructure, from asset allocation to prudential regulation and performance attribution and monitoring.

What We Do

The EDHEC*infra* team is focused on three key tasks:

1. **Data collection and analysis:** we collect, clean, and analyse the private infrastructure investment data of the project's data contributors as well as from other sources, and input it into EDHEC*infra*'s unique database of infrastructure equity and debt investments and cash flows. We also develop data collection and reporting standards that can be used to make data collection more efficient and more transparently reported. This database already covers 15 years of data and hundreds of investments and, as such, is already the largest dedicated database of infrastructure investment information available.
2. **Cash-flow and discount-rate models:** Using this extensive and growing

database, we implement and continue to develop the technology developed at EDHEC-Risk Institute to model the cash flow and discount-rate dynamics of private infrastructure equity and debt investments and derive a series of risk and performance measures that can actually help answer the questions that matter for investors.

3. **Building reference portfolios of infrastructure investments:** Using the performance results from our asset pricing and risk models, we can report the portfolio-level performance of groups of infrastructure equity or debt investments using categorisations (e.g., greenfield vs. brownfield) that are most relevant for investment decisions.

Partners of EDHEC*infra*

Monetary Authority of Singapore

In October 2015, Deputy Prime Minister of Singapore Tharman Shanmugaratnam announced officially at the World Bank Infrastructure Summit that EDHEC would work in Singapore to create "usable benchmarks for infrastructure investors."

The Monetary Authority of Singapore is supporting the work of the EDHEC Singapore Infrastructure Investment Institute (EDHEC*infra*) with a five-year research development grant.

Sponsored Research Chairs

Since 2012, private-sector sponsors have been supporting research on infrastructure investment at EDHEC with several Research Chairs that are now under the EDHEC Infrastructure Investment Institute:

About EDHEC Infrastructure Institute-Singapore

1. The EDHEC/NATIXIS Research Chair on the Investment and Governance Characteristics of Infrastructure Debt Instruments, 2012-2015
 2. The EDHEC/Meridiam/Campbell Lutyens Research Chair on Infrastructure Equity Investment Management and Benchmarking, 2013-2016
 3. The EDHEC/NATIXIS Research Chair on Infrastructure Debt Benchmarking, 2015-2018
 4. The EDHEC/Long-Term Infrastructure Investor Association Research Chair on Infrastructure Equity Benchmarking, 2016-2019
 5. The EDHEC/Global Infrastructure Hub Survey of Infrastructure Investors' Perceptions and Expectations, 2016-2017
- An honorary member of the Long-term Infrastructure Investor Association

Partner Organisations

As well as our Research Chair Sponsors, numerous organisations have already recognised the value of this project and have joined or are committed to joining the data collection effort. They include:

- The Global Infrastructure Hub;
- The European Investment Bank;
- The World Bank Group;
- The European Bank for Reconstruction and Development;
- The members of the Long-Term Infrastructure Investor Association;
- Over 20 other North American, European, and Australasian investors and infrastructure managers.

EDHEC*infra* is also :

- A member of the Advisory Council of the World Bank's Global Infrastructure Facility

EDHEC Infrastructure Institute Publications



EDHEC Infrastructure Institute

Publications

EDHEC Publications

- Blanc-Brude, F., A. Chreng, M. Hasan, Q. Wang, and T. Whittaker. "Private Infrastructure Equity Indices: Benchmarking European Private Infrastructure Equity 2000-2016" (June 2017).
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EDHEC Infrastructure Institute Publications

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