Is Infrastructure An Asset Class?

An Asset Pricing Approach

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Abstract:

This study employs an asset pricing approach to examine the claim that infrastructure investments are an asset class in their own right. By employing the Merton (1973) zero-criterion approach, we demonstrate that global and national listed infrastructure returns cannot be deemed as a separate asset class. Empirical evidence suggests that listed infrastructure returns are simply a sub-set of listed stocks with significant industry exposure to the utility sector. These findings have important implications to the asset allocation decisions of pension and superannuation funds.

Keywords: Infrastructure, Asset Pricing, Investment Decisions.

JEL Codes: G11, G12, G14

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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 infrastructure do 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 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

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. 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. Rothballer 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 so 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.

In this study, we extend the knowledge of Bianchi *et. al.,* (2014) and Rothballer and Kaserer (2012) 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

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:

$$R_t - R_{f,t} = \alpha + \beta_1(R_{m,t} - R_{f,t}) + \beta_2(SMB_t) + \beta_3(HML_t) + \beta_4(WML_t) + \varepsilon_t \quad (1)$$

$$R_t - R_{f,t} = \alpha + \beta_1(R_{m,t} - R_{f,t}) + \beta_2(SMB_t) + \beta_3(HML_t) + \beta_4(WML_t) + \beta_5(UTIL_t - R_{f,t}) + \varepsilon_t \quad (2)$$

where R_t is the return of the respective global infrastructure index; $R_{f,t}$ is the risk-free rate estimated from the U.S. government 1 month Treasury Bill; α is the intercept term or constant; β_{1to5} 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; $UTIL_t$ 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.(1) is the Fama and French (2012) global version of the Carhart (1997) four-factor asset pricing model while Eq.(2) is the five-factor asset pricing model which includes the orthogonalised returns of the MSCI World Utilities Index.

Table 1
Summary Statistics

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). MEMUII denotes the MSCI European Monetary Union Infrastructure Index. MEII denotes the MSCI Europe Infrastructure Index. MEAFEII denotes the MSCI EAFE infrastructure Index. MAPI 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.

	Start	Mean	Std. Deviation	5th percentile	Median	95th percentile
Panel A: International Listed Infrastructure Indices (USD Returns)						
MWII	1/1999	0.35%	4.21%	-7.29%	0.78%	6.40%
		(4.20%)	(14.58%)		(9.36%)	
MWEAII	1/1999	0.35%	4.21%	-7.32%	0.80%	6.42%
		(4.20%)	(14.58%)		(9.60%)	
MKII	1/1999	0.39%	4.43%	-7.65%	0.93%	6.48%
		(4.68%)	(15.35%)		(11.16%)	
MEMUII	1/1999	0.46%	6.55%	-11.46%	0.44%	10.81%
		(5.52%)	(22.69%)		(5.28%)	
MEII	1/1999	0.47%	5.84%	-10.31%	0.54%	9.49%
		(5.64%)	(20.23%)		(6.48%)	
MEAFEII	1/1999	0.41%	5.01%	-8.49%	0.70%	8.67%
		(4.92%)	(17.36%)		(8.40%)	
MAPII	1/1999	0.30	4.50%	-7.09%	0.35%	7.38%
		(3.60%)	(15.59%)		(4.20%)	
Panel B: Global Risk Factors and Risk-Free Rate						
World Stocks	1/1999	0.58%	4.60%	-8.43%	1.28%	7.43%
		(6.96%)	(15.93%)		(15.36%)	
SMB	1/1999	0.19%	2.13%	-2.76%	0.00%	3.01%
		(2.28%)	(7.38%)		(0.00%)	
HML	1/1999	0.46%	2.66%	-3.06%	0.34%	5.11%
		(5.52%)	(9.21%)		(4.08%)	
WML	1/1999	0.55%	4.63%	-7.59%	0.87%	6.68%
		(6.60%)	(16.04%)		(10.44%)	
World Utilities	1/1999	0.54%	3.89%	-5.88%	0.98%	6.02%
		(6.48%)	(13.48%)		(11.76%)	
World Bonds	1/1999	0.42%	0.80%	-0.98%	0.49%	1.63%
		(5.04%)	(2.77%)		(5.88%)	
U.S. T-Bills	1/1999	0.17%	0.17%	0.00%	0.11%	0.45%
		(2.04%)	(0.59%)		(1.32%)	

By employing the Merton (1973) zero-intercept criterion, a valid asset pricing model estimated from Equations (1) and (2) would capture the systematic risks of these infrastructure returns (ie. we would observe significant betas), report high R_S^2 values and insignificant intercept terms. 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

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 – Growth of $1,000 Invested in World Stocks & Infrastructure Indices

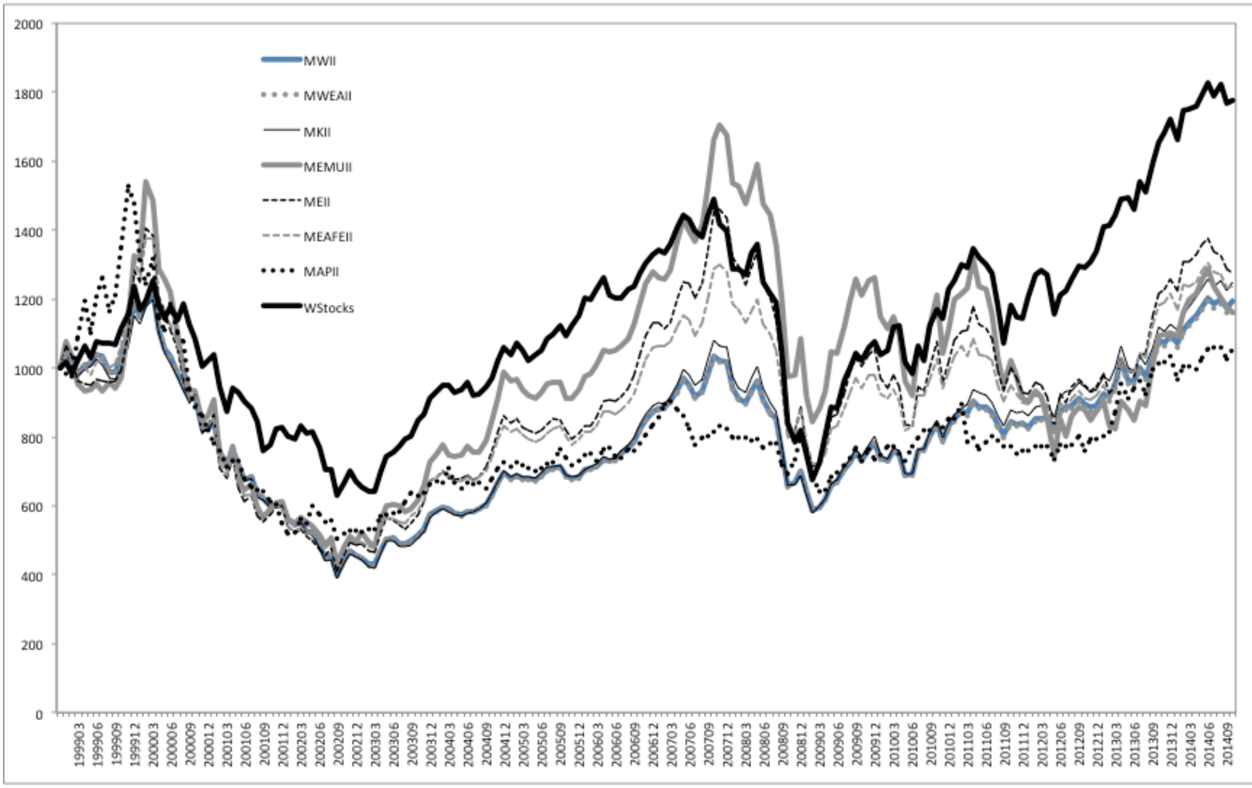

Figure 1 illustrates the growth of $1,000 invested in world stocks (thick black line) versus the seven world and regional infrastructure indices being examined in this study from January 1999 to October 2014. Figure 1 shows that world and regional infrastructure indices tend to co-move in a similar fashion as world stocks. To examine the co-movment more closely, we proceed to perform a correlation analysis on the returns of these indices.

Table 2
Correlations

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.

	WI	WEA	K	EMU	EUR	EAFE	AP	WS	SMB	HML	WML	UT	WB
WI	-----												
WEA	**1.00**	-----											
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**	**0.80**	**0.50**	-----					
SMB	-0.10	-0.11	-0.11	0.03	-0.03	-0.02	0.00	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	0.00	0.13	-0.13	-0.01	0.06	0.00	0.09	-----

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. 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.

Table 3
MSCI World Infrastructure Index (MWII) Regressions

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 R_M-R_F, SMB, HML and WML. UTIL-R_F is the MSCI World Utilities Industry Index orthogonal to the other four risk factors and the adjusted R^2 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.

Variables	C	R_M- R_F	SMB	HML	WML	UTIL-R_F	Adj R^2
Panel A: Four-Factor Model							
A1: Full sample (190 months)							
Coefficient	0.0003	**0.7676**	**-0.4379**	**-0.2542**	0.0765		0.7372
Std. Error	0.0017	**0.0380**	**0.1183**	**0.0541**	0.0499		
t-statistic	0.1497	**20.2054**	**-3.7021**	**-4.6965**	1.5322		
p-value	0.8812	**0.0000**	**0.0003**	**0.0000**	0.1272		
A2: In-sample (95 months)							
Coefficient	0.0003	**0.7868**	**-0.3932**	**-0.2608**	0.0310		0.6881
Std. Error	0.0030	**0.0869**	**0.1675**	**0.0770**	0.0777		
t-statistic	0.0837	**9.0578**	**-2.3469**	**-3.3894**	0.3996		
p-value	0.9335	**0.0000**	**0.0211**	**0.0010**	0.6904		
A3: Out-of-sample (95 months)							
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**	**-3.5030**	-0.9278	**3.3012**		
p-value	0.8956	**0.0000**	**0.0007**	0.3560	**0.0014**		
Panel B: Five-Factor Model							
B1: Full sample (190 months)							
Coefficient	0.0009	**0.7409**	**-0.4255**	**-0.4540**	0.0368	**0.4768**	0.8140
Std. Error	0.0015	**0.0293**	**0.1140**	**0.0589**	0.0537	**0.0622**	
t-statistic	0.6012	**25.2433**	**-3.7335**	**-7.7046**	0.6856	**7.6702**	
p-value	0.5484	**0.0000**	**0.0003**	**0.0000**	0.4939	**0.0000**	
B2: In-sample (95 months)							
Coefficient	0.0019	**0.7427**	**-0.4320**	**-0.4846**	0.0117	**0.3713**	0.7333
Std. Error	0.0028	**0.0715**	**0.1643**	**0.0740**	0.0825	**0.0805**	
t-statistic	0.6857	**10.3909**	**-2.6297**	**-6.5468**	0.1421	**4.6134**	
p-value	0.4947	**0.0000**	**0.0101**	**0.0000**	0.8873	**0.0000**	
B3: Out-of-sample (95 months)							
Coefficient	0.0010	**0.6708**	**-0.2608**	-0.0621	**0.0887**	**0.7327**	0.9421
Std. Error	0.0011	**0.0186**	**0.0605**	0.0554	**0.0270**	**0.0588**	
t-statistic	0.9361	**36.0195**	**-4.3114**	-1.1205	**3.2820**	**12.4714**	
p-value	0.3518	**0.0000**	**0.0000**	0.2655	**0.0015**	**0.0000**	

Table 4
MSCI World ex Australia Infrastructure Index (MWEAII) Regressions

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 (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 R_M-R_F, SMB, HML and WML. UTIL-R_F is the MSCI World Utilities Industry Index orthogonal to the other four risk factors and the adjusted R^2 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.

Variables	C	R_M- R_F	SMB	HML	WML	UTIL-R_F	Adj R^2
Panel A: Four-Factor Model							
A1: Full sample (190 months)							
Coefficient	0.0002	**0.7661**	**-0.4435**	**-0.2570**	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**	1.5480		
p-value	0.8938	**0.0000**	**0.0003**	**0.0000**	0.1233		
A2: In-sample (95 months)							
Coefficient	0.0003	**0.7877**	**-0.3984**	**-0.2638**	0.0324		0.6870
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	**0.0000**	**0.0199**	**0.0011**	0.6787		
A3: Out-of-sample (95 months)							
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	**0.0000**	**0.0007**	0.3767	**0.0014**		
Panel B: Five-Factor Model							
B1: Full sample (190 months)							
Coefficient	0.0010	**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	**7.7470**	
p-value	0.5580	**0.0000**	**0.0002**	**0.0000**	0.4885	**0.0000**	
B2: In-sample (95 months)							
Coefficient	0.0020	**0.5121**	**-0.4377**	**-0.4907**	0.0128	**0.3765**	0.7333
Std. Error	0.0028	**0.0780**	**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	**0.0000**	**0.0093**	**0.0000**	0.8777	**0.0000**	
B3: Out-of-sample (95 months)							
Coefficient	0.0010	**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	**0.0000**	**0.0000**	0.3100	**0.0011**	**0.0000**	

Table 5
MSCI Kokusai Infrastructure Index (MKII) Regressions

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 R_M-R_F, SMB, HML and WML. UTIL-R_F is the MSCI World Utilities Industry Index orthogonal to the other four risk factors and the adjusted R^2 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.

Variables	C	R_M- R_F	SMB	HML	WML	UTIL-R_F	Adj R^2
Panel A: Four-Factor Model							
A1: Full sample (190 months)							
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	0.7800	**0.0000**	**0.0014**	**0.0000**	0.1550		
A2: In-sample (95 months)							
Coefficient	0.0009	**0.7856**	**-0.3961**	**-0.2919**	0.0183		0.6584
Std. Error	0.0032	**0.0952**	**0.1870**	**0.0898**	0.0802		
t-statistic	0.2865	**8.2501**	**-2.1176**	**-3.2485**	0.2277		
p-value	0.7751	**0.0000**	**0.0370**	**0.0016**	0.8204		
A3: Out-of-sample (95 months)							
Coefficient	0.0003	**0.8162**	**-0.4629**	-0.1513	**0.1650**		0.8115
Std. Error	0.0019	**0.0514**	**0.1200**	0.1262	**0.0450**		
t-statistic	0.1807	**15.8696**	**-3.8572**	-1.1994	**3.6660**		
p-value	0.8570	**0.0000**	**0.0002**	0.2335	**0.0004**		
Panel B: Five-Factor Model							
B1: Full sample (190 months)							
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**	**-3.3510**	**-7.0719**	0.5923	**7.6036**	
p-value	0.4510	**0.0000**	**0.0010**	**0.0000**	0.5544	**0.0000**	
B2: In-sample (95 months)							
Coefficient	0.0028	**0.7356**	**-0.4400**	**-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	**0.0000**	**0.0161**	**0.0000**	0.9667	**0.0000**	
B3: Out-of-sample (95 months)							
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	**0.0290**	**0.0710**	
t-statistic	0.9478	**30.3359**	**-4.3862**	-1.5236	**3.3260**	**9.7526**	
p-value	0.3458	**0.0000**	**0.0000**	0.1312	**0.0013**	**0.0000**	

5. Results

The results section of this study is divided into two sections based on the global and regional infrastructure indiices. 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 (2973) 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.

[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.

Table 6
MSCI Europe Infrastructure Index (MEII) Regressions

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 R_M-R_F, SMB, HML and WML. UTIL-R_F is the MSCI World Utilities Industry Index orthogonal to the other four risk factors and the adjusted R^2 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.

Variables	C	R_M- R_F	SMB	HML	WML	UTIL-R_F	Adj R^2
Panel A: Four-Factor Model							
A1: Full sample (190 months)							
Coefficient	0.0010	**0.9419**	**-0.4366**	**-0.4000**	0.0810		0.7764
Std. Error	0.0022	**0.0430**	**0.1133**	**0.1046**	0.0574		
t-statistic	0.4601	**21.9292**	**-3.8551**	**-3.8223**	1.4105		
p-value	0.6460	**0.0000**	**0.0002**	**0.0003**	0.1601		
A2: In-sample (95 months)							
Coefficient	0.0064	**0.8951**	**-0.4862**	**-0.6735**	0.0907		0.7550
Std. Error	0.0038	**0.0892**	**0.1554**	**0.0892**	0.0650		
t-statistic	1.6972	**10.0358**	**-3.1287**	**-7.5478**	1.3955		
p-value	0.0931	**0.0000**	**0.0024**	**0.0000**	0.1663		
A3: Out-of-sample (95 months)							
Coefficient	0.0000	**0.8238**	**-0.4572**	0.1062	0.0884		0.8401
Std. Error	0.0025	**0.0507**	**0.1318**	0.1222	0.0814		
t-statistic	0.0000	**16.2522**	**-3.4687**	0.8690	1.0860		
p-value	0.9999	**0.0000**	**0.0008**	0.3872	0.2804		
Panel B: Five-Factor Model							
B1: Full sample (190 months)							
Coefficient	0.0012	**0.9327**	**-0.4364**	**-0.4334**	0.0701	0.1570	0.7801
Std. Error	0.0023	**0.0448**	**0.1114**	**0.1039**	0.0587	0.1056	
t-statistic	0.5100	**20.8289**	**-3.9181**	**-4.1726**	1.1952	1.4869	
p-value	0.6107	**0.0000**	**0.0001**	**0.0000**	0.2335	0.1388	
B2: In-sample (95 months)							
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	**0.0000**	**0.0020**	**0.0000**	0.1607	0.9791	
B3: Out-of-sample (95 months)							
Coefficient	0.0007	**0.7544**	**-0.2884**	0.1431	0.0444	**0.6656**	0.9003
Std. Error	0.0020	**0.0244**	**0.0830**	0.0763	0.0557	**0.0835**	
t-statistic	0.3616	**30.9745**	**-3.4748**	1.8757	0.7982	**7.9753**	
p-value	0.7185	**0.0000**	**0.0008**	0.0640	0.4269	**0.0000**	

Table 7
MSCI EMU Infrastructure Index (MEII) Regressions

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 R_M-R_F, SMB, HML and WML. UTIL-R_F is the MSCI World Utilities Industry Index orthogonal to the other four risk factors and the adjusted R^2 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.

Variables	C	R_M- R_F	SMB	HML	WML	UTIL-R_F	Adj R^2
Panel A: Four-Factor Model							
A1: Full sample (190 months)							
Coefficient	-0.0003	**1.0462**	**-0.3781**	**-0.3305**	0.1194		0.7327
Std. Error	0.0029	**0.0556**	**0.1330**	**0.1612**	0.0738		
t-statistic	-0.0898	**18.812**	**-2.8430**	**-2.0504**	1.6167		
p-value	0.9286	**0.0000**	**0.0050**	**0.0417**	0.1076		
A2: In-sample (95 months)							
Coefficient	0.0074	**0.9802**	**-0.3615**	**-0.7393**	0.1316		0.7389
Std. Error	0.0041	**0.0929**	**0.1524**	**0.1311**	0.0800		
t-statistic	1.7957	**10.5525**	**-2.3719**	**-5.6372**	1.6450		
p-value	0.0759	**0.0000**	**0.0198**	**0.0000**	0.1035		
A3: Out-of-sample (95 months)							
Coefficient	-0.0017	**0.8630**	**-0.5486**	**0.4230**	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	**0.0000**	**0.0005**	**0.0105**	0.2861		
Panel B: Five-Factor Model							
B1: Full sample (190 months)							
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	**17.3550**	**-2.9211**	**-2.3121**	1.4023	1.4103	
p-value	0.9639	**0.0000**	**0.0039**	**0.0219**	0.1625	0.1601	
B2: In-sample (95 months)							
Coefficient	0.0073	**0.9833**	**-0.3559**	**-0.7300**	0.1323	-0.0238	0.7361
Std. Error	0.0040	**0.0877**	**0.1536**	**0.1426**	0.0782	0.1246	
t-statistic	1.8350	**11.2089**	**-2.3169**	**-5.1179**	1.6920	-0.1911	
p-value	0.0698	**0.0000**	**0.0228**	**0.0000**	0.0941	0.8489	
B3: Out-of-sample (95 months)							
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**	0.0760	**0.1114**	
t-statistic	-0.3141	**22.6310**	**-3.5301**	**4.0158**	0.6981	**7.1093**	
p-value	0.7542	**0.0000**	**0.0007**	**0.0001**	0.4869	**0.0000**	

Table 8
MSCI EAFE Infrastructure Index (MEAFEII) Regressions

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 R_M-R_F, SMB, HML and WML. UTIL-R_F is the MSCI World Utilities Industry Index orthogonal to the other four risk factors and the adjusted R^2 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.

Variables	C	R_M- R_F	SMB	HML	WML	UTIL-R_F	Adj R^2
Panel A: Four-Factor Model							
A1: Full sample (190 months)							
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	0.2280	**22.1921**	**-2.3365**	**-4.3476**	1.7877		
p-value	0.8199	**0.0000**	**0.0205**	**0.0000**	0.0755		
A2: In-sample (95 months)							
Coefficient	0.0039	**0.8224**	**-0.3202**	**-0.4843**	0.0720		0.6590
Std. Error	0.0033	**0.0904**	**0.1600**	**0.0923**	0.0724		
t-statistic	1.1839	**9.1019**	**-2.0009**	**-5.2465**	0.9954		
p-value	0.2396	**0.0000**	**0.0484**	**0.0000**	0.3222		
A3: Out-of-sample (95 months)							
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	1.4650		
p-value	0.6191	**0.0000**	**0.0489**	0.6615	0.1464		
Panel B: Five-Factor Model							
B1: Full sample (190 months)							
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	**0.0000**	**0.0163**	**0.0000**	0.3209	**0.0000**	
B2: In-sample (95 months)							
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	**0.0000**	**0.0244**	**0.0000**	0.4696	**0.0007**	
B3: Out-of-sample (95 months)							
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	**8.6570**	
p-value	0.8362	**0.0000**	**0.0492**	0.9708	0.5275	**0.0000**	

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 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.

[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 EMU Index consists of the following 10 developed market country indexes: Austria, Belgium, Finland, France, Germany, Ireland, Italy, the Netherlands, Portugal, and Spain.

[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.

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

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 R_M-R_F, SMB, HML and WML. UTIL-R_F is the MSCI World Utilities Industry Index orthogonal to the other four risk factors and the adjusted R^2 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.

Variables	C	R_M- R_F	SMB	HML	WML	UTIL-R_F	Adj R^2
Panel A: Four-Factor Model							
A1: Full sample (190 months)							
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	**0.0000**	0.3786	0.8501	0.1562		
A2: In-sample (95 months)							
Coefficient	-0.0061	**0.6004**	0.0454	-0.2257	0.1138		0.3400
Std. Error	0.0047	**0.1219**	0.1484	0.1559	0.1140		
t-statistic	-1.3007	**4.9272**	0.3060	-1.4474	0.9991		
p-value	0.1967	**0.0000**	0.7603	0.1513	0.3204		
A3: Out-of-sample (95 months)							
Coefficient	0.0001	**0.2556**	-0.1801	0.2150	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	**0.0000**	0.1841	0.3597	0.4290		
Panel B: Five-Factor Model							
B1: Full sample (190 months)							
Coefficient	-0.0028	**0.3501**	-0.0969	-0.0310	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**	-0.8220	-0.2139	1.2892	0.9909	
p-value	0.3999	**0.0000**	0.4122	0.8309	0.1989	0.3230	
B2: In-sample (95 months)							
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	**0.0000**	0.7537	0.1495	0.3197	0.7033	
B3: Out-of-sample (95 months)							
Coefficient	0.0011	**0.1962**	-0.0898	0.2560	0.0055	**0.8376**	0.3572
Std. Error	0.0033	**0.0425**	0.1078	0.1521	0.0797	**0.1798**	
t-statistic	0.3330	**4.6170**	-0.8333	1.6828	0.0686	**4.6594**	
p-value	0.7399	**0.0000**	0.4069	0.0959	0.9454	**0.0000**	

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.

6. Concluding Remarks

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.

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Appendix: Definition of MSCI Indices

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*.

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 EMU Index consists of the following 10 developed market country indexes: Austria, Belgium, Finland, France, Germany, Ireland, Italy, the Netherlands, Portugal, and Spain*.

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 KOKUSAI Index is a free float-adjusted market capitalization index that is designed to measure the equity market performance of developed markets excluding Japan. The MSCI KOKUSAI Index consists of the following 22 developed market country indexes: Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Hong Kong, Ireland, Israel, Italy, Netherlands, New Zealand, Norway, Portugal, Singapore, Spain, Sweden, Switzerland, the United Kingdom, and the United States*.

The MSCI Pacific Index is a free float-adjusted market capitalization weighted index that is designed to measure the equity market performance of the developed markets in the Pacific region. The MSCI Pacific Index consists of the following 5 Developed Market countries: Australia, Hong Kong, Japan, New Zealand, and Singapore*.

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*.

Table 10
MSCI Australia Infrastructure Index Regressions

This table presents the regression results of the Fama and French (2012) global four-factor model and five-factor model on the MSCI AUSTRALIA Infrastructure Index. 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 R_M-R_F, SMB, HML and WML. UTIL-R_F is the MSCI World Utilities Industry Index orthogonal to the other four risk factors and the adjusted R^2 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.

Variables	C	R_M- R_F	SMB	HML	WML	UTIL-R_F	Adj R^2
Five-Factor Model							
A1: Full sample							
Coefficient	-0.0022	**0.2776**	-0.0015	-0.0346	-0.0063	**0.4752**	0.2813
Std. Error	0.0033	**0.0732**	0.0434	0.0573	0.0627	**0.1234**	
t-statistic	-0.6614	**3.7930**	-0.0341	-0.6044	-0.0999	**3.8502**	
p-value	0.5094	**0.0002**	0.9729	0.5465	0.9205	**0.0002**	
A2: In-sample							
Coefficient	-0.0022	0.3206	0.0256	-0.1933	-0.0670	0.3454	0.1601
Std. Error	0.0067	0.1990	0.0796	0.1739	0.0675	0.2000	
t-statistic	-0.3332	1.6107	0.3217	-1.1117	-0.9929	1.7273	
p-value	0.7400	0.1116	0.7486	0.2700	0.3241	0.0884	
A3: Out-of-sample							
Coefficient	0.0023	**0.2549**	0.0337	0.0735	0.0847	**0.6515**	0.5038
Std. Error	0.0030	**0.0827**	0.0604	0.0740	0.0806	**0.1266**	
t-statistic	0.7712	**3.0826**	0.5572	0.9941	1.0511	**5.1447**	
p-value	0.4431	**0.0029**	0.5791	0.3235	0.2967	**0.0000**	
Panel B: Five-Factor Model							
B1: Full sample (190 months)							
Coefficient	-0.0028	**0.3501**	-0.0969	-0.0310	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**	-0.8220	-0.2139	1.2892	0.9909	
p-value	0.3999	**0.0000**	0.4122	0.8309	0.1989	0.3230	
B2: In-sample (95 months)							
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	**0.0000**	0.7537	0.1495	0.3197	0.7033	
B3: Out-of-sample (95 months)							
Coefficient	0.0011	**0.1962**	-0.0898	0.2560	0.0055	**0.8376**	0.3572
Std. Error	0.0033	**0.0425**	0.1078	0.1521	0.0797	**0.1798**	
t-statistic	0.3330	**4.6170**	-0.8333	1.6828	0.0686	**4.6594**	
p-value	0.7399	**0.0000**	0.4069	0.0959	0.9454	**0.0000**	