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Long-term U.S. infrastructure returns and portfolio selection

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ABSTRACT

Our understanding of the long-term return behavior and portfolio characteristics of public infrastructure investments is limited by a relatively short history of empirical data. We re-construct U.S. listed infrastructure index returns by mapping their monthly performance to received systematic and industry risk factors from 1927 through 2010. Our findings reveal that the infrastructure returns in recent years may understate the tail-risk that investors could experience over the long-term, however, this tail-risk is commensurate with holding a broad portfolio of U.S. stocks. For mean-variance and mean-CVaR investors, we report the benefits of holding public infrastructure assets in investment portfolios.

1. Introduction

The OECD (2007) has reported a U.S.$1.8 trillion per annum projected requirement for global infrastructure spending through to 2030, yet there is a paucity of research on the portfolio benefits of these types of investments. From a United States perspective, the Department of the U.S. Treasury (2012) is allocating $476 billion in the coming years towards the development of new infrastructure initiatives which require both public and private investment. To better understand the characteristics of infrastructure, it is imperative that investors (such as pension funds) understand the long-term reward/risk behavior of infrastructure and its portfolio diversification characteristics. Furthermore, pension plan sponsors have a fiduciary duty to understand the role of infrastructure investment in a portfolio context. For most investments, this is achieved by evaluating the indexes that track the performance of a particular asset class. The challenge with infrastructure is the limited number of indexes (and associated history) with which to evaluate this asset class over the long-term. The challenge becomes more formidable in an asset allocation framework, as portfolio selection models require a large number of data observations that are simply not available for infrastructure investments.

Our study addresses these empirical challenges by investigating five U.S. listed infrastructure indexes. This research employs the methodology that follows Agarwal and Naik (2004) by utilizing the Fama and French (1993)/Carhart (1997) asset pricing models as the foundations to construct monthly returns for these U.S. listed infrastructure indexes over the long-term. By mapping U.S. infrastructure returns onto the Fama and French (1993)/Carhart (1997) risk factors and industry returns, we reconstruct U.S. listed infrastructure index monthly returns from 1927 to 2010. We acknowledge that any approach to the backfilling of data has limitations. This study takes the approach of Agarwal and Naik (2004), a methodology that allows researchers to construct historical infrastructure index returns based on the assumption that short-term empirical returns modeled on systematic risk factors and industry returns are a good proxy of their behavior over the long-term.

From an asset pricing perspective, this study shows that a significant proportion of the variation of U.S. listed infrastructure index returns can be explained by systematic risk factors and industry returns. We use a five-factor asset pricing model which shows that approximately half of the total variation of returns can be explained by the four Carhart (1997) risk factors while the remaining variation of returns can be explained by the U.S. utilities industry returns orthogonalized to the Fama and French (1993)/Carhart (1997) factors. The asset pricing analysis in this study suggests that U.S. listed infrastructure index returns do not exhibit statistically significant excess returns.

We model these indexes from 1927 through 2010 and find that, in general, U.S. listed infrastructure exhibit similar mean returns,

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correlations and tail-risks as U.S. stocks. Furthermore, we show that the empirical tail-risks from recent empirical infrastructure returns understate their VaR and CVaR estimates over the long-term, however, their levels of tail-risk is commensurate with the systematic risk from U.S. stocks. This commonality between listed infrastructure and broad U.S. stocks is an interesting finding given that infrastructure indexes are heavily concentrated in sufficiently different industries including oil/gas storage and transportation, electricity and other broad based utilities. The risk estimates calculated in this study perhaps challenge the perception of infrastructure as a low-risk and steady-return investment. Our findings support the notion that U.S. listed infrastructure is perhaps not a separate asset class, but rather, a sub-set of the wider universe of U.S. stocks.

From an investors' perspective, we employ these long-term U.S. infrastructure returns to the problem of portfolio selection. We are motivated here to evaluate the long-term portfolio diversification benefits of publicly listed infrastructure. In a post Global Financial Crisis (GFC) world, tail-risk analysis is important within the Markowitz (1952, 1959) Mean-Variance framework. The estimation of tail-risk motivates us to examine these investments in the Mean-Variance (MV) and Mean-Conditional-Value-at-Risk (M-CVaR) portfolio selection settings. In general, we find that most infrastructure indexes exhibit characteristics that can improve the risk/reward profile of an investment portfolio. While the various infrastructure indexes exhibit common risk factors, their desirability in a portfolio context is a function of the mean returns, volatilities, correlations and tail-risks of each index.

This study is structured as follows. Section 2 reviews the relevant literature, Section 3 describes the data, and Section 4 outlines the methodology employed to evaluate listed infrastructure returns over the long-term. Section 5 presents the empirical analysis and Section 6 offers concluding remarks.

2. Related literature

The OECD (2007) and the U.S. Treasury (2012) note the current deficit in infrastructure investment in electricity transmission, roads, rail, telecommunication and water (in addition to the need for critical maintenance of other sectors including ports, bridges and airports). However, against this imperative for infrastructure investment globally, there is a paucity of studies that consider the behavior of infrastructure returns over time (and associated characteristics for portfolio investors). The lack of literature may stem from the debate regarding whether infrastructure is, or is not an asset class distinct from listed stocks (Finkenzeller et al., 2010). Beeferman (2008) emphasizes that infrastructure returns are derived mainly from large individual idiosyncratic projects which increase the difficulty for investors to evaluate infrastructure as an asset class in a conventional portfolio analysis.

Infrastructure investments are potentially attractive to pension funds because these long-term income generating assets complement the long duration of pension fund liabilities (Croce, 2011). Beeferman (2008) notes that infrastructure appears to be an attractive investment proposition for pension funds, however, the lack of knowledge of the reward and risk characteristics complicates the assessment of their diversification benefits. Furthermore, Inderst (2009) acknowledge that there is confusion with the investments options available, the expected and realized returns, the diversification benefits and the specific risks associated with infrastructure investments.

One of the few studies that have considered the behavior of infrastructure returns was contributed by Bird et al. (forthcoming). The work of Bird et al. (forthcoming) take an augmented Fama and French (1993) approach to the asset pricing problem and find that infrastructure investments exhibit low systematic risks and high idiosyncratic risks. We contribute to the debate by extending the work of Bird et al. (forthcoming) by examining the role of industry returns on the performance of listed infrastructure. Evidence from Fama and French (1997) and Chou et al. (2012) suggest that conventional asset pricing models cannot sufficiently capture the variation of industry returns. One of the contributions of this study is the evaluation of the effect of the U.S. Utilities industry on U.S. listed infrastructure indexes for the first time in an asset pricing framework.

From a portfolio diversification perspective, the literature to date provides limited information for investors to alleviate the confusion of the efficacy of infrastructure investments. Newell and Peng (2008) estimate a significant 0.70 correlation between U.S. listed infrastructure and stocks from 2000 to 2006, however, the reward for risk characteristics dramatically changed across sub-periods. Newell et al. (2011) report a 0.48 correlation between Australian listed infrastructure and stocks from 1995 through 2009. In the unlisted infrastructure setting, Hartigan et al. (2011) reveal portfolio diversification benefits for a balanced investment portfolio over a ten year sample period to 2008. However, despite the important insights that this literature brings to the field of infrastructure investing, the short observation periods considered in these studies may limit its usefulness to long-term investors (such as pension funds).

Another challenge for investors considering infrastructure investment are the wide range of sub-segments within the investment universe (such as transport, water, airports and utilities). For example, the Australian study of Newell and Peng (2007) from 1995 through 2006 finds that toll roads exhibited the highest raw returns for investors. However, toll roads delivered inferior returns on a risk-adjusted basis when compared to utilities, infrastructure and infrastructure/utility composites. In short, the performance of infrastructure investments is not homogenous. To capture these ideas, we investigate the effect of the U.S. utilities industry returns across a variety of broad infrastructure indexes.

A key challenge facing investors is the absence of long-term data. For instance, there are no infrastructure index returns available prior to the 1990s. To address this concern, we follow the two-step methodology of Agarwal and Naik (2004). We follow an in-sample/out-of-sample procedure, which employs recent empirical data to construct a dataset of historical returns for many decades. Our study will employ this procedure to construct long-term infrastructure returns which can be used as the inputs in the Markowitz (1952, 1959) mean-variance framework to construct optimal and minimum-variance portfolios.

An assumption of the Markowitz (1952, 1959) framework is that investors define risk as the variability of expected returns of a portfolio. One of the limitations of employing the volatility of returns as a measure of risk is that it does not account for the extreme losses or tail-risk that occurs during times of financial crisis. The evolution from the mean-variance analysis has seen the development of the mean-VaR portfolio selection frameworks from Alexander and Baptista (2002), Campbell et al. (2001) among others. This approach of managing portfolio VaR has been critiqued by Acerbi and Tasche (2002), Artzner et al. (1997, 1999) and Szego (2002) who argued that VaR exhibits discontinuities in the loss distributions, and thus cannot yield a coherent measure of risk.

To overcome the limitations of the mean-VaR framework, Uryasev (2000), Rockafellar and Uryasev (2000, 2002), Krokhmal et al. (2002) and Topaloglou et al. (2002) have developed the portfolio optimization problem in a Mean-Conditional Value-at-Risk (M-CVaR) framework. The recognized limitations of VaR in the tail-risk literature motivates this study to evaluate infrastructure investments in a M-CVaR portfolio optimization framework.

As discussed, this study contributes to the infrastructure finance literature by employing the Agarwal and Naik (2004)