CSIRO-Monash Superannuation Research Cluster

WORKING PAPER SERIES: SUPERANNUATION AND THE ECONOMY

CLUSTER PROJECT 1: INFRASTRUCTURE INVESTMENT AND SUPERANNUATION: INFRASTRUCTURE AS AN ASSET CLASS, PUBLIC PRIVATE PARTNERSHIPS (PPPS)

THE BEHAVIOR OF LISTED TOLL ROAD PUBLIC-PRIVATE PARTNERSHIPS: A FIRST LOOK AT THE AUSTRALIAN EVIDENCE

ROBERT J. BIANCHI, MICHAEL E. DREW AND TIMOTHY WHITTAKER

GRIFFITH BUSINESS SCHOOL
DEPARTMENT OF ACCOUNTING, FINANCE AND ECONOMICS,
GRIFFITH UNIVERSITY

27 AUGUST 2013
PRELIMINARY DRAFT – NOT FOR PUBLIC DISTRIBUTION

ABSTRACT

A common assumption for PPPs is that risk is highest during the construction phase and decreases once operations begin. We test this hypothesis by examining the population of listed toll roads that used the PPP financing structure in Australia for the period 1996 through 2010. Our findings reveal that there are high levels of firm-specific risk for toll roads in Australia. Importantly, we report that this firm-specific risk is time-varying, with the idiosyncratic risk of listed toll roads being relatively low during the construction phase and subsequently increasing during the operations phases. The evidence presented in this study provides new insights regarding the risk of PPPs.

The Behavior of Listed Toll Road Public-Private Partnerships: A First Look at the Australian Evidence

Robert J. Bianchi*, Michael E. Drew and Timothy Whittaker,

Griffith Business School
Department of Accounting, Finance and Economics,
Griffith University
Brisbane, Queensland, Australia

Working Paper
Preliminary Draft – Not for Public Distribution
Version: 27 August 2013

Abstract

A common assumption for PPPs is that risk is highest during the construction phase and decreases once operations begin. We test this hypothesis by examining the population of listed toll roads that used the PPP financing structure in Australia for the period 1996 through 2010. Our findings reveal that there are high levels of firm-specific risk for toll roads in Australia. Importantly, we report that this firm-specific risk is time-varying, with the idiosyncratic risk of listed toll roads being relatively low during the construction phase and subsequently increasing during the operations phases. The evidence presented in this study provides new insights regarding the risk of PPPs.

---

* Corresponding author: Email: r.bianchi@griffith.edu.au; Tel: +61-7-3735 7078; Fax: +61-7-3735 3719; Postal address: Griffith Business School, Department of Accounting, Finance and Economics, Nathan campus, Griffith University, 170 Kessels Road, Nathan, Brisbane, Queensland, 4111, Australia. We gratefully acknowledge the Australian Research Council Grant LP0989743 for financial assistance. Any remaining errors are our own.

1 Introduction

Current thinking suggests that the equity financing of a Public Private Partnership (PPP) is riskier during the construction phase than the operations phase, due to the absence of revenue streams in the early stages of a PPP project (Blanc-Brude and Strange, 2007). However, to date, there has been no empirical literature that has examined the equity investment risk of PPPs. Previous literature by Grimsey and Lewis (2002) and Bain (2010) have shown that different risks are present during the two distinct phases of a PPP, that is, the construction period and the operations period. However, this research has not considered the role that systematic risk factors play in explaining PPP stock returns. This lack of research is surprising given the widespread prevalence of PPPs within Australia and around the world.[1]

Australia is recognised as a leader in providing infrastructure through PPPs. The wide-spread acceptance of the ability of the private sector to provide infrastructure as well as historical financing decisions have resulted in Australia having a history of listed PPPs that exists nowhere else in the world. It is for this reason we will examine the Australian listed PPPs in our attempt to address the paucity of research on the risks and returns of the equity of PPPs. We examine the nature of both systematic and idiosyncratic risk of a unique sample of four Australian PPPs listed on the Australian Securities Exchange (ASX).

This study provides three original contributions to the literature. First, this study is the first that examines whether asset pricing models can explain the variation of PPP equity returns. Second, this study examines the time-variation of idiosyncratic risk of publicly listed PPPs. By examining the idiosyncratic risk of individual PPP projects, it is possible to discover company specific risk estimates independent of systematic risk factors. These risk estimates provide an insight into the changing risk of PPPs through time. This is the first time that such an analysis has been applied to PPPs. We show that the time-variation of idiosyncratic risk at the commencement of PPP projects tends to be low. When PPPs progress from the construction phase to the operations phase, we demonstrate empirical evidence of an increase in the idiosyncratic risk of PPPs. More specifically, when demand for the services of these PPP projects does not meet ex-ante expectations at the commencement of the operations phase, we document an increase in idiosyncratic risk. This research provides an in-depth perspective of the time-variation of idiosyncratic risk of Australian listed PPPs.

[1] Infrastructure Australia (2013a) reports that since 2005 more than $34 billion has been invested in 51 PPPs in Australia.

The third and final contribution of this study is the evaluation of liquidity biases on the estimation of idiosyncratic risk on PPPs. This study orthogonalises the idiosyncratic risk estimates by employing two common liquidity proxies. It is demonstrated that the increase in idiosyncratic risk observed in two of the three PPPs is the result of liquidity effects. Furthermore, this study demonstrates that the increase in idiosyncratic risk of one of the PPPs examined is due to changes in company specific risk of the project at the beginning of the operations phase.

The remainder of this study is organised as follows. Section 2 reviews the related literature while Section 3 discusses the methodology of the study. In Section 4, the data employed in this study is discussed. Section 5 presents the results of the analysis and Section 6 concludes with a synopsis of the key findings and areas for future research.

2 Related Literature

PPPs are designed and built to provide infrastructure or a service for a pre-specified period of time. According to English (2006), once this period of time has passed, ownership of the infrastructure or the facilities employed to provide the service reverts back to the public sector. According to Grimsey and Lewis (2002), this lifecycle of design, construction, operation and transfer of the assets exposes PPP investors to a variety of risks. The risks during the design and construction period according to Grimsey and Lewis (2002) are different to the risks encountered during the operations period. These changing risks lead to the conclusion that the equity risk in PPPs is time-varying.

The question therefore arises, in which stage of the lifecycle of a PPP, the construction or operations phase, exhibits the higher risk? Evidence provided by the pricing of debt for project finance and PPPs suggests that the construction period is expected to exhibit the higher risk. Sorge (2004) finds that credit risk for project finance loans is highest at the beginning of the project and reduces throughout the life of the project.

Empirical research on PPP debt by Blanc-Brude and Strange (2007) found that the average spread of PFI (the term employed for PPPs in the United Kingdom) debt decreases over the life of the PPP.[2] The higher interest rate at the beginning of the PPP implies that the construction phase of the PPP exhibits the highest risk. The rationale behind these findings is

[2] According to Spackman (2002) PFI (Private Finance Initiative) projects are a form of PPP specific to the United Kingdom.

questioned by Bain (2010) which found that the construction period is not very risky in practice. In a survey of recent literature on PPP cost overruns, Bain (2010) found that just 14% of the PPPs examined exhibited a cost overrun in the construction period. Instead, Bain (2010) argues that the risks in the operations phase are far greater and this should be reflected in the pricing of both debt and equity returns.

The review of literature raises three questions that have not been addressed. To date, no literature has examined whether systematic risk factors in Australian equity returns can explain the variation in returns of individual PPPs in Australia. Therefore, the first question that this study aims to answer is, do systematic risk factors explain the variation of individual PPP equity returns in Australia?

Second, prior literature has shown that risks in PPPs change through time. The work of Sorge (2004) and Blanc-Brude and Strange (2007) found that the cost of financing is higher in the construction phase compared to the operations phase. This implies that the risk of a PPP is higher in the construction period rather than the operations period. However, Bain (2010) challenges this evidence with regards to cost overruns and the issue of PPP failures. To the author's knowledge, no study has quantified the risk of a PPP through time in an asset pricing framework. Therefore, it is currently impossible to identify or measure whether the construction or operations phase exhibits the higher risk. This study makes an original contribution to the asset pricing and infrastructure literature by measuring the idiosyncratic of Australian PPPs through time to determine whether the construction or operations phases exhibit the higher risk.

The third and final contribution of this study is that it quantifies the proportion of idiosyncratic risk that can be explained by liquidity variables. Research on idiosyncratic risk by Han and Lesmond (2011) demonstrated that liquidity factors can bias estimates of idiosyncratic risk. As a result of these findings, this study will examine whether liquidity effects do impact on the estimates of idiosyncratic risk of PPPs and whether these liquidity variables can explain the changing idiosyncratic risk of PPPs. To the author's knowledge, this is the first study that quantifies the idiosyncratic risk of PPPs and its effects due to liquidity biases.

3 Methodology

Due to the paucity of literature on infrastructure investment and PPPs, it is important to first examine whether conventional asset pricing methods can explain Australian PPP returns. This is achieved by employing the Fama and French (1993) three-factor model described in Eq. (1) below. This study examines whether the Fama and French (1993) three-factor model can explain value-weighted portfolio of equity PPP returns as well as individual PPP returns. The Fama and French (1993) model can be mathematically expressed as:

$$r_{i,t} - r_{f,t} = a_i + b_i\left(R_{m,t} - r_{f,t}\right) + s_i SMB_t + h_i HML_t + \varepsilon_{i,t} \tag{1}$$

where:

$r_{i,t}$ is the daily return of stock i;

$r_{f,t}$ is the risk-free rate;

$R_{m,t}$ is the market return;

SMB_t is the Australian Fama and French (1993) size factor; and,

HML_t is the Australian Fama and French (1993) book-to-market factor.

Following the examination of whether systematic risk factors can explain the variation of returns of individual PPPs and the value-weighted PPP portfolio, this study next turns to analysing the time-varying firm specific risk of the PPP. Specifically, this study is seeks to determine whether there are differing levels of risk in a PPP between the construction and operations periods. More specifically, this study employs idiosyncratic risk to identify whether there are differences in risk between these two periods in individual PPP equity returns.

In the context of this study, the idiosyncratic risk of the PPPs is estimated over time. The time period which exhibits the lowest idiosyncratic risk is identified as the period of time in a PPP's life cycle with the lowest risk. Idiosyncratic risk in this study is estimated consistent with the methodology employed Ang, Hodrick, Xing and Zhang (2006, 2009), Fu (2009) and Han and Lesmond (2011) and measures idiosyncratic risk with the following regression equation:

$$r_{i,\tau} - r_{f,\tau} = a_{i,t} + b_{i,t}\left(R_{m,\tau} - r_{f,\tau}\right) + s_{i,t}SMB_{\tau} + h_{i,t}HML_{\tau} + \varepsilon_{i,t} \quad (2)$$

where:

$r_{i,\tau}$ is the daily return of stock i;

$r_{f,\tau}$ is the risk-free rate;

$r_{f,\tau}$ is the market return;

SMB_{τ} is the Australian Fama and French (1993) size factor; and,

HML_{τ} is the Australian Fama and French (1993) book-to-market factor.

Following the notation of Fu (2009), τ is the subscript for the day and t is the subscript for the month, $\tau \in t$ and $b_{i,t}$, $s_{i,t}$, and $h_{i,t}$ are factor sensitivities or loadings. The idiosyncratic volatility is calculated as the standard deviation of the regression residuals $\varepsilon_{i,t}$ which is consistent with Ang *et. al.,* (2006, 2009) and Han and Lesmond (2011). Idiosyncratic volatility is only estimated when there is a minimum of thirteen days where trading volume is greater than zero per month, this reduces the impact of infrequent trading. The standard deviation of daily return residuals is transformed into a monthly return residual by multiplying the daily standard deviation by the square root of the number of trading days in that month, which is consistent with Fu (2009).

Tests for breaks in idiosyncratic risk

Having established estimates of the idiosyncratic risk of the PPPs, five tests are performed to empirically measure whether a significant change exists between the construction and operations phase. The first of these is a test for a difference in means of idiosyncratic risk between the construction and operations phase. Owing to the different variance in idiosyncratic risk, the Welch (1947) *t-test* is employed. The *t-test* test statistic is described in Eq. (3) below:

$$t = \frac{\overline{X}_1 - \overline{X}_2}{s_{\overline{X}_1 - \overline{X}_2}} \quad (3)$$

where:

$$s_{\bar{X}_1-\bar{X}_2} = \sqrt{\frac{s_1^2}{n_1}+\frac{s_2^2}{n_2}}$$

s_1^2 is the variation of idiosyncratic risk during the construction phase;

s_2^2 is the variation of idiosyncratic risk during the construction phase;

n_1 is the number of observations of idiosyncratic risk during the construction phase;

n_2 is the number of observations of idiosyncratic risk during the operations phase;

Welch (1947) argues that the degrees of freedom for the *t-test* are obtained from the following equation:

$$d.f. = \frac{\left(\frac{s_1^2}{n_1}+\frac{s_2^2}{n_2}\right)^2}{\frac{\left(\frac{s_1^2}{n_1}\right)^2}{(n_1 - 1)}+\frac{\left(\frac{s_2^2}{n_2}\right)^2}{(n_2 - 1)}} \quad (4)$$

The second test employed to determine whether a difference in idiosyncratic risk is present is the Wilcoxon (1945) signed rank test. To estimate the test critical value first the difference between the observations in the first group and second group need to be calculated. The absolute values of these differences are then ranked with any difference value equal to zero discarded. The number of observations in this ranking is equal to n'. Once these scores are ranked, the sign from the original difference calculation are then reassigned. Only the positive ranked differences are then employed to calculate the test statistic below:

$$\mathrm{W} = \sum_{i=1}^{n'} Rank_i^+ \quad (5)$$

where:

n' is the number of nonzero observations in the sample; and,

$Rank_i^+$ is the rank of positive observation i in the difference calculation.

The standard deviation of the test statistic is given by:

$$\sigma_W = \sqrt{\frac{n'(n'+1)(2n'+1)}{24}} \qquad (6)$$

The third difference test employed in this sample is the test for a difference in variance described in Equation 7 below.

$$F = s_L^2/s_S^2 \qquad (7)$$

where:

s_L^2 is the variance of the subgroup with the largest variance,

s_S^2 is the variance of the subgroup with the smaller variance,

The degrees of freedom for this *F*-test are obtained by $n_L - 1$ and $n_S - 1$ where n_L is the number of observations in the subgroup with the highest variance and n_S is the number of observations in the subgroup with the lowest variance.

The fourth and fifth tests examine whether an autoregressive model of idiosyncratic risk exhibits a difference between the construction and operations periods. Autoregressive models have been employed previously to model idiosyncratic risk. Chua, Goh, and Zhang (2010) employ a rolling autoregressive model of idiosyncratic risk to develop an estimate of expected idiosyncratic risk.[3] This study will employ two autoregressive models to determine whether there is a break in idiosyncratic risk between the construction and operations periods.

The fourth test employs an AR (2) process regression with a dummy variable equalling one when the PPP is in the operations phase and zero otherwise. The equation for the regression is represented below:

$$IRisk_{i,t} = \beta_0 + \beta_1 Irisk_{i,t-1} + \beta_2 Irisk_{i,t-2} + \beta_3 OpsDummy_{i,t} + \varepsilon_t \qquad (8)$$

where:

$IRisk_{i,t}$ is the idiosyncratic risk estimate for PPP *i* at time *t*; and,

[3] Chua *et. al.,* (2010) employ the autoregressive regression to obtain an expected idiosyncratic risk variable. This study employs the same methodology to examine idiosyncratic risk during the construction and operations phase of a PPP. It is important to be aware that unexpected changes in idiosyncratic risk may impact on our ability to identify whether there is a difference in between these two phases, therefore, we have chosen to employ the Chua *et. al.,* (2010) methodology to model expected idiosyncratic risk.

$OpsDummy_{i,t}$ is a dummy variable which equals 1 when the PPP is in the operations period and 0 otherwise.

The fifth and final test to measure the difference in idiosyncratic risk between the construction and operations periods is a Chow test on the AR(2) regression. The equation for the regression is mathematically expressed as:

$$IRisk_{i,t} = \beta_0 + \beta_1 Irisk_{i,t-1} + \beta_2 Irisk_{i,t-2} + \varepsilon_t \qquad (9)$$

where:

$IRisk_{i,t}$ is the idiosyncratic risk estimate for PPP *i* at time *t*.

The Chow (1960) test is defined below as:

$$F = \frac{RSS_c - (RSS_1 + RSS_2) / k}{(RSS_1 + RSS_2) / (n_1 + n_2 - 2k)} \qquad (10)$$

where:

RSS_c is the Residual Sum of Squares for the regression described in Eq. (9) estimated on the idiosyncratic risk for both the construction and operations periods;

RSS_1 is the Residual Sum of Squares for the regression described in Eq. (9) estimated on the idiosyncratic for the construction period;

RSS_2 is the Residual Sum of Squares for the regression described in Eq. (9) estimated on the idiosyncratic for the operations period;

k is the number of parameters employed in Eq. (9);

n_1 is the number of observations within the construction period; and,

n_2 is the number of observations within the operations period.

The Chow (1960) test follows a *F*-distribution with k and $n_1 + n_2 - 2k$ degrees of freedom.

Liquidity and idiosyncratic risk of PPPs

Han and Lesmond (2011) show that idiosyncratic risk estimates can be biased due to liquidity factors. For this reason, the idiosyncratic risk estimates employed earlier in the study are transformed to remove the possibility of liquidity effects. Han and Lesmond (2011) estimate a cross-sectional regression to orthagonalise idiosyncratic risk to remove liquidity effects. As this study is examining only four PPPs (see the data section) and in some time periods only one PPP is listed on the ASX, a cross-sectional methodology will not adequately remove the liquidity effects. Therefore, this study will remove the liquidity estimates on a time-series basis rather than cross-sectionally. This study will employ the liquidity proxies which are the proportional bid-ask spread and the percentage of zero returns days consistent with Han and Lesmond (2011). Two further liquidity proxies were employed in Han and Lesmond (2011), which are the squared proportional bid-ask spread and the spread multiplied by the percentage of zero return days. Han and Lesmond (2011) employ two further variables in the orthagonalisation process, namely, $Spread^2$ and *Zero Returns*Spread*. Both variables exhibit a high correlation between the variables, *Spread* and *Zero Returns* we therefore seek to minimise the problems of collinearity in our regressions and both are excluded from this analysis.[4]

The general form of the time-series regressions is mathematically expressed as:

$$IRisk_{i,t} = \alpha_0 + \alpha_1 Spread_{i,t} + \alpha_2 \%ZeroReturns_{i,t} + \varepsilon_{i,t} \quad (11)$$

where:

$IRisk_{i,t}$ is the estimated idiosyncratic volatility for firm i at time t;

$Spread_{i,t}$ is the average proportional bid-ask spread for firm i at time t; and,

$\%ZeroReturns_{i,t}$ is the percentage of zero returns for stock i within month t.

[4] One approach of removing the problem of mulicollinearity would be to orthagonalise the independent variables of the regression. However, given that the $Spread^2$ and *Zero Returns*Spread* independent variables are transformations and interaction variables of *Spread* and *Zero Returns,* the information content of these variables is already present in the regression.

4 Data

This study seeks to examine both the systematic and idiosyncratic risk of road PPPs in Australia. Four PPPs listed on the ASX are identified in the period to January 1991 December 2010 sample period, namely, Connecteast, Hills Motorway, Rivercity Motorways and Transurban. At the time of this study, one other PPP is listed on the ASX, namely, Brisconnections, however, this PPP is tightly held with 98% of the shares held by four institutions (Brisconnections, 2011). With such a concentrated ownership, the ability to draw any meaningful conclusions from Brisconnections is limited. This next section will examine the individual PPPs separately and provides a brief background. The first PPP examined is ConnectEast.

ConnectEast

In 2004, ConnectEast was awarded a 39 year concession to build and operate the Mitcham – Frankston Freeway Project (MFP). The required $2,088 million in debt funding for the project was provided by a syndicate of banks through three senior bank debt facilities (ConnectEast, 2004.) The facilities were underwritten by the Joint Lead Arrangers, BOS International (Australia) Limited, Commonwealth Bank of Australia, Société Générale Australia Branch and United Overseas Bank Limited (ConnectEast, 2004). According to ConnectEast (2004), to fund the construction of the road $1,120 million of equity was to be raised via an Initial Public Offering. Construction was completed in 2008 and the road opened on 28 June 2008, with an initial one month toll-free period. The average expected vehicles in 2008, according to ConnectEast's Product Disclosure Statement (PDS) (2004), was to be 258,200 vehicles per day. This figure is undiscounted for a period of 'ramp-up'.[5] The 'ramp-up' period was expected to be a 15 month period where initial traffic on the road was expected to be 72% of the steady state traffic forecast (ConnectEast, 2004). By October 2008, four months after opening, ConnectEast was reporting that the average number of trips per day was 147,414 (ConnectEast, 2008b) which was significantly less than the expected traffic figures. On 24 November 2008, ConnectEast announced its intention to raise approximately $450 million through a rights issue and reduce distributions to 2 cents a year to conserve capital (ConnectEast, 2008a.) The rights issue, according to ConnectEast

[5] The term "ramp up" refers to the period of time between initial opening of the road and when the road is carrying its expected traffic figures.

(2008a), would reduce the company's gearing level from 45% to between 33% and 34%. This was followed by another rights issue for $421 million announced on 24 August 2009 (ConnectEast, 2009.) The second rights issue occurred after the write down in the value of ConnectEast's tolling rights for the freeway, and a mandatory repayment of $250 million of debt (ConnectEast, 2009.) The objective of the 2009 rights issue was to reduce gearing from 46% to 35% and to repay all debt that was to mature in 2010.

Hills Motorway

On 26 August 1994, Hills Motorway entered into contracts with the New South Wales State Government for the construction and operation of the M2 Motorway (Hills Motorway, 1994). The concession required the provision of 20 kilometres of roadway between the Lower North Shore and the North West Sydney Region until 2042 (Hills Motorway, 1994). To fund the concession, Hills Motorway raised $155 million in equity with an additional $30 million from the project sponsors (Hills Motorway, 1994).

The Hills Motorway opened in May 1997 and actual usage missed the prospectus estimates. The prospectus estimated that by 1998, an average of 78,287 vehicles per day will be using the toll road (Hills Motorway, 1994). According to the 1998 annual report, for the period July 1997 to June 1998, the average usage of the motorway was 56,751 vehicles per day (Hills Motorway, 1998). Two years later, the average number of vehicles using the motorway had increased to 66,299 (Hills Motorway, 2000). The overestimation of traffic usage did not result in the company entering financial distress. By 2002, Hills Motorway was cash flow positive (Hills Motorway, 2002) and in 2003, Hills Motorway produced its first profit (Hills Motorway, 2003). In January 2005 Transurban issued a takeover of Hills Motorway (Transurban, 2005). The bid was increased in April 2005 and was subsequently accepted and the takeover finalised (Transurban, 2005).

Rivercity Motorway

Rivercity Motorways won the 45 year concession to build the North-South Bypass Tunnel in Brisbane in 2006 (Leighton, 2006). The North-South Bypass tunnel is a 6.8 kilometre tunnel linking the north and south banks of the Brisbane River. It is the first PPP in Queensland to be listed on the Australian Securities Exchange, and debt funding for the project was provided by a syndicate of banks (Rivercity Motorways, 2006.) In order to fund the tunnel, Rivercity Motorways issued $724 million in equity and organised debt facilities of $1,434 million (Rivercity Motorways, 2006.)

Construction was completed in 2010 and the tunnel was opened to traffic on 16 March 2010. There was an initial three week toll-free period during which an average of 59,109 vehicles a day used the tunnel (Rivercity Motorways, 2010a.) The toll was introduced from 6 April 2010 and the average daily number of vehicles fell to 22,559 for June 2010 (Rivercity Motorways, 2010b.) According to Rivercity Motorways (2010b), the original forecast was for 60,451 vehicles a day to use the tunnel and it was subsequently disappointed with the significant shortfall in vehicle numbers. Subsequently, the toll was reduced to $2 per car from 1 July 2010 (Rivercity Motorways, 2010b.) The shortfall in vehicle numbers led to speculation as to whether the company would survive. Subsequently, on 25 February 2011, Rivercity Motorways entered into Voluntary Administration (Rivercity, Motorways 2011). Whilst this fate appears typical of economic infrastructure PPPs developed in the early 2000s, other PPPs have survived.[6]

Transurban

On 29 May 1995, the Transurban Consortium was selected as the preferred tenderer for the Melbourne City Link Project (Transurban, 1996). The Melbourne City Link Project is a concession to build, operate and maintain a 22 kilometre toll road in Melbourne until 2034 (Transurban, 2011). To fund the building of the project, Transurban equity investors provided $455 million for infrastructure bonds, units and shares for Transurban (Transurban, 1996). Furthermore, a total of $1,321 million was raised from debt facilities (Transurban, 1996).

The road began to open in segments in 1999, however, construction and delivery difficulties delayed tolling and full operation of the road (Transurban, 2000). Traffic underperformance and warranty claims on the constructor of the road continued to impact on the financial performance of Transurban in subsequent years (Transurban, 2001). The traffic performance for the CityLink toll-road was mixed. Myer (2003) shows that traffic was overestimated in some sections of the toll road and underestimated in others. The overestimation of demand for some sections of the City Link toll road did not pose dire financial implications as it did for both Rivercity Motorways and ConnectEast.

[6] Other instances of failures of road PPPs for investors include the Lane Cove Tunnel and the Cross City Tunnel in Sydney, Australia.

Over subsequent years, Transurban expanded from a one toll road asset in Melbourne to several toll roads in Sydney and roads in the United States (Transurban, 2011). This expansion began with a 40% investment in the Sydney M7 toll road in October 2002 (Transurban, 2003). The M7 toll road subsequently opened in October 2005, ahead of schedule (Transurban, 2006). Prior to the opening of the M7 toll road, Transurban completed the takeover of the Hills M2 Motorway in Sydney (Transurban, 2005). Subsequent expansions have included the purchase of the Sydney Roads Group in 2006 (John, 2006). The Sydney Roads Group was a portfolio of three toll roads, 51% of the M4 motorway, 50% of the M5 motorway and 71% of the Eastern Distributor (John, 2006). In 2010, two major corporate actions occurred. First, Transurban purchased the Lane Cove tunnel out of receivership. The Lane Cove tunnel, opened in 2007, is a 3.6 kilometre toll road that connects to the Hills M2 Motorway (Transurban, 2010a). The second major corporate action occurred in May 2010 with Transurban being the subject of an unsuccessful takeover bid by a consortium composed of the Canada Pension Plan Investment Board, CP2 Limited and Ontario Teachers' Pension Plan Board (Transurban, 2010b). Transurban is a partner in the introduction of High Occupancy Toll lanes in the United States (Transurban, 2011). Transurban is a partner in two projects, namely, Capital Beltway (I-495) in Washington D.C. and the I-95 in Virginia and these are expected to open in 2013 and 2012, respectively (Transurban, 2011).

Table 1 PPP Return Descriptive Statistics

This table presents the monthly mean, median, standard deviation, maximum and minimum observations and skewness for the value-weighted PPP portfolio and individual PPPs returns examined in this study. The sample period is from January 2006 to December 2010 for ConnectEast, January 1996 to May 2005 for Hills Motorway, August 2007 to December 2010 for Rivercity Motorways, and from April 1996 to December 2010 for Transurban.

	Value-Weighted PPP Portfolio	ConnectEast	Hills Motorway	Rivercity Motorways	Transurban
Mean	0.0118	-0.0101	0.0217	-0.0368	0.0120
Median	0.0162	0.0000	0.0181	-0.0351	0.0148
St Dev	0.0707	0.0946	0.0829	0.1880	0.0773
Maximum	0.2321	0.2458	0.3507	0.3858	0.2122
Minimum	-0.2964	-0.3578	-0.2306	-0.4419	-0.3335
Skewness	-0.5684	-1.005	0.4912	3.4667	-0.6458

Table 1 reports the summary statistics of the four individual publicly listed PPPs and the value-weighted PPP portfolio. The average return for the value-weighted PPP portfolio is positive, however, this is not the case for the PPPs. Two PPPs, (ConnectEast and Rivercity

Motorways) exhibit an average negative return over the sample period. In the case of Rivercity Motorways, the average return observed is -3.68% per month. The low return observed for these two PPPs is consistent with the observation that the financial viability of both PPPs was questioned when traffic forecasts were lower than expected at the commencement of the operations phase.

Table 2 Liquidity Descriptive Statistics

This table presents the monthly mean, median, standard deviation, maximum and minimum observations and skewness for the liquidity variables for individual PPPs returns examined in this study. Two liquidity variables are examined in this study. The first is the percentage of zero return days which is defined as the number of trading days within a month where no return was observed. The second is the proportional bid-ask spread. Panel A presents the summary statistics for the percentage of zero return days. Panel B presents the summary statistics for the proportional bid-ask spread. The descriptive statistics are calculated for the periods from January 2006 to December 2010 for ConnectEast, January 1996 to May 2005 for Hills Motorway August 2007 to December 2010 for Rivercity Motorways, and from April 1996 to December 2010 for Transurban.

	ConnectEast	Hills Motorway	Rivercity Motorways	Transurban
Panel A: Percentage of Zero Return Days				
Mean	0.1243	0.0113	0.1978	0.0662
Median	0.1250	0.0000	0.1875	0.0606
Standard Deviation	0.0862	0.0596	0.1112	0.0640
Maximum	0.4516	0.4063	0.4688	0.3226
Minimum	0.0000	0.0000	0.0000	0.0000
Skewness	0.9488	4.6404	0.3752	1.3836
Panel B: Proportional Bid-Ask Spread				
Mean	0.0112	0.0143	0.0362	0.0084
Median	0.0113	0.0134	0.0308	0.0076
Standard Deviation	0.0043	0.0052	0.0220	0.0050
Maximum	0.0236	0.0288	0.1147	0.0283
Minimum	0.0048	0.0057	0.0087	0.0021
Skewness	0.7283	0.8655	1.2143	1.4424

The summary statistics for the liquidity variables employed in this study are presented in Table 2. Following Han and Lesmond (2011), this study employs the percentage of zero returns days, (that is, the percentage of days in a month where no return is observed) and the monthly proportional bid-ask spread as liquidity variables. Panel A of Table 2 reports the summary statistics for the percentage of zero returns days for each PPP included in this study. Panel B of Table 2 presents the summary statistics for the monthly proportional bid-ask spread. The statistics reported in Table 2 imply that Rivercity Motorways is the most illiquid of the publicly listed PPP stocks examined as it exhibits the highest average proportional bid-ask spread (3.62%), and the highest percentage of zero return days (19.78%). Table 2 also shows that Hills Motorways exhibits the lowest percentage of zero return days (1.13%) whilst Transurban exhibits the lowest proportional bid-ask spread (0.84%). As a result, identifying the PPP that is the most liquid is difficult to infer, however, it is clear that Rivercity Motorways is the most illiquid PPP traded on the ASX.

This section examined the publicly listed individual PPPs stocks and presented the returns and liquidity variables employed in this study. The next section examines the systematic risk factors employed in this study. These factors are important for two reasons. First, these systematic risk factors are employed to estimate the idiosyncratic risk of the PPPs. Second, these factors will be employed to determine whether systematic risk factors can explain the variation of PPP returns.

Systematic Risk Factors

The sample employed to construct the systematic risk factors for the Australian Fama and French (1993) model is from the top 300 companies by market capitalisation listed on the ASX on the last trading day of each December for the years 1991 to 2010.[7] Any shares not fully paid are excluded from the analysis. For the identified companies, the daily returns, turnover, price and market capitalisation are all obtained from Datastream. The daily bid and ask close prices are obtained from Thompson Reuters Tick History database maintained by SIRCA from 1 January 1996.[8] Companies that do not exhibit a record in each of the data fields obtained were excluded from this study resulting in a total of 778 companies included in the analysis. Australia's equities markets are dominated by a small number of large firms and this feature drives the decision to focus only on the top 300 companies by market capitalisation. Prior studies by Demir, Muthuswamy and Walter (2004) and Hurn and Pavlov (2004) employ the ASX top 200 stocks and similar filters for the same reason.

The SMB and HML factors are calculated in the manner described in Fama and French (1993). In December of each year, the firms for the subsequent year's analysis are ranked by size and separated into two portfolios, Small and Big. At the same time, the book values from the Worldscope database were obtained for all companies included in the sample.[9] The book-to-market ratio is obtained by dividing the book value by the market value. Companies

---

[7] The sample period begins in December 1991 to identify and rank the firms to estimate the SMB, HML and WML factors. Once the firms are identified and ranked, the portfolio returns are calculated from January 1992.
[8] The daily bid and ask close prices are not available before 1 January 1996 in the Thompson Reuters Tick History database maintained by SIRCA.
[9] Following Han and Lesmond (2011), the book value is equal to the Total Assets - Total Liabilities + Deferred Taxes + Preferred Stock. In Worldscope, the Preferred Stock line is null for the companies examined.

with negative book-to-market ratios are excluded from the analysis. The Small portfolio is divided into three portfolios based on the ranking of the book-to-market ratio with the spilt of 30/40/30 and the value-weighted returns of each portfolio are obtained. This process is repeated for the Big portfolio. The SMB factor is the simple average of the daily returns for all the Small firm portfolios less the simple average of the daily returns for all Big firm portfolios. This methodology follows the work of Fama and French (1993).

The HML factor is estimated by calculating the simple average of the returns for the Small and Big portfolios with a Low book-to-market ratio. This is then subtracted from simple average of the returns for the Small and Big portfolios with a High book-to-market ratio. This methodology follows the work of Fama and French (1993). The Market, HML and SMB factors are estimated on a daily and monthly basis.

Table 3 Systematic Risk Factors Descriptive Statistics

This table presents the descriptive statistics of the Australian systematic risk factors included in this study for the period February 1992 to December 2010. Panel A presents the daily mean, median, standard deviation, maximum and minimum observations and skewness for the market excess return, SMB and HML factors. Panel B presents the monthly mean, median, standard deviation, maximum and minimum observations and skewness for these variables. In Panel A, the market excess return is the difference between the daily All Ordinaries index return and the effective daily 90 day bank accepted bill rate. The daily SMB and HML factor returns are calculated from the daily portfolio returns where the portfolios are formed according to the Fama and French (1993) methodology. In Panel B, the market excess return is the difference between the monthly All Ordinaries Accumulation index return and the effective monthly 90 day bank accepted bill rate. The monthly SMB and HML factor returns are calculated following the Fama and French (1993) methodology.

	Rm-Rf	SMB	HML
Panel A: Daily Returns			
Mean	-0.000001	-0.000028	0.000126
Median	0.000203	0.000147	0.000124
St Dev	0.009356	0.005965	0.006512
Max	0.060471	0.030630	0.053592
Min	-0.085772	-0.045270	-0.047915
Skew	-0.5772	-0.4651	0.2802
Panel B: Monthly Returns			
Mean	0.000128	-0.001195	0.002114
Median	0.005991	0.000467	0.002337
St Dev	0.039097	0.027086	0.034648
Max	0.074515	0.060199	0.120727
Min	-0.155669	-0.152923	-0.165521
Skew	-0.8700	-0.9674	-0.2024

The Market factor is the returns of the Australian Securities Exchange All Ordinaries Accumulation Index. Data for this factor is obtained from Datastream on a daily basis. Finally, the short-term risk-free rate is the 90 day bank accepted bill (BAB) rate sourced from the Reserve Bank of Australia. This follows the work of Brailsford, Handley and Maheswaran (2008) and removes the need to estimate an Australian federal government risk-free rate for a significant period of the analysis.[10]

Table 3 reports the descriptive statistics for both the daily and monthly Fama and French (1993) factors employed in this study. The daily return series reported in Table 3 are employed to estimate the idiosyncratic risk of the PPPs. The monthly return series in Table 3 are employed to examine the ability of systematic risk factors to explain the returns of PPPs in Australia. Panel A of Table 3 presents the daily descriptive statistics for the market excess returns, SMB and HML factors. Panel B of Table 3 reports the monthly descriptive statistics for the market excess returns, SMB and HML factors. The average daily returns, reported in Panel A of Table 3 indicates that the average daily return for the market risk premium and SMB factor is small and negative. However, when the median return is considered, all factors exhibit positive returns over the sample period. The rationale to explain the negative mean returns observed in the market risk premium and SMB factor is provided in the following paragraph.

The average monthly returns for the systematic risk factors, presented in Panel B of Table 3 are interesting. The market risk premium and HML factor exhibit a positive average and median monthly return. This contrasts with the SMB factor which exhibits a negative average and median monthly return. The mean and median returns for the Fama and French (1993) are consistent however, with Faff (2001). The average SMB and HML factor returns discovered by Faff (2001) were -0.3163% and 0.4620% per month, respectively. The period of analysis in Faff (2001) was from January 1991 to April 1999. This suggest that the negative mean returns in Table 3 are consistent with the findings in Faff (2001). The method employed to construct the Fama and French (1993) SMB and HML factors according to Faff (2001), may result in an underrepresentation of the small firms. As this study limits the analysis to the top 300 firms by market capitalisation, a similar underrepresentation of the small firms may be impacting on the SMB factor. Furthermore, this study includes the period

[10] Following the election of the Howard Government in 1996 there was a policy choice to reduce Government debt levels. Budget surpluses were produced and the Australian federal government debt was reduced resulting in Treasury notes no longer being issued by the Government in 2003. http://www.aofm.gov.au/content/_download/Historical_tables/Historical_07_08/TableH14.pdf

of the Global Financial Crisis in 2008 where the Australian equity market experienced large negative returns.

Having described the data that is employed in this study the next section will report the results of the analysis. This analysis begins first with an analysis of whether systematic risk factors can explain the variation of PPP returns.

Table 4 Fama and French (1993) PPP regression coefficients

This table presents the regression coefficients for the following regression $r_{i,t} - r_{f,t} = a_i + b_i\left(R_{m,t} - r_{f,t}\right) + s_i SMB_t + h_i HML_t + \varepsilon_{i,t}$ where $r_{i,t}$ is the monthly return of the portfolio or stock of interest, $r_{f,t}$ is the 90 day Bank Accepted Bill rate obtained from the Reserve Bank of Australia and $R_{m,t}$ is the monthly return of the ASX All Ordinaries Accumulation index obtained from DataStream. SMB_t is the monthly Australian Fama and French (1993) size factor, HML_t is the monthly Australian Fama and French (1993) book-to-market factor. Regressions are estimated for the period for January 2006 to December 2010 for ConnectEast, January 1996 to May 2005 for Hills Motorway, August 2007 to December 2010 for Rivercity Motorways, and from April 1996 to December 2010 for Transurban. The value-weighted PPP portfolio regression is for the period January 1996 to December 2010. *, ** and ^ denote statistical significance at the 10%, 5% and 1% levels, respectively.

	Value-Weighted PPP Portfolio	ConnectEast	Hills Motorway	Rivercity Motorways	Transurban
Panel A: Regression Coefficient					
Intercept	0.0067	-0.0080	0.0192	-0.0414	0.0071
Market	0.5099	0.9686	0.2496	-0.5650	0.5337
SMB	0.0770	0.1133	-0.0002	0.8654	-0.0602
HML	0.1684	0.7498	-0.4657	0.0903	0.1482
Panel B: Standard Error					
Intercept	0.0049	0.0105	0.0074	0.0367	0.0057
Market	0.1327	0.2623	0.2256	0.8570	0.1512
SMB	0.1895	0.4046	0.2966	1.2959	0.2163
HML	0.1376	0.2472	0.2237	0.8045	0.1552
Panel C: t-statistic					
Intercept	1.3548	-0.7518	2.5790^	-1.1283	1.2455
Market	3.8416^	3.6923^	1.1064	-0.6593	3.5290^
SMB	0.4061	0.2800	-0.0008	0.6678	-0.2782
HML	1.2234	3.0329^	-2.0815	0.1123	0.9548
Panel D: Adjusted R^2					
	0.0679	0.2799	0.0246	-0.0967	0.0552

5 Results

The first analysis in this study examines whether the variation of PPP equity returns can be explained by generally accepted asset pricing models. This is achieved by employing the Fama and French (1993) three-factor model. The results of the Fama and French (1993) regressions described in Eq. (1) are presented in Table 4 for the value-weighted portfolio of PPPs as well as each individual PPP examined in this study.

The regression results presented in Table 4 show that the market factor is statistically significant for the value-weighted PPP portfolio. The intercept term (alpha) is statistically insignificant for the value-weighted PPP portfolio. The insignificant intercept term suggests (as in Griffin (2002)) that the Fama and French (1993) three-factor model includes all of the systematic risk factors that explain the variation of PPP equity returns. However, the low r-square value suggests that the PPP portfolio exhibits high levels of idiosyncratic risk.

When the individual PPP equity regressions are considered the conclusion that the systematic risk factors explain the variation of returns of PPPs is difficult to sustain. The regression coefficients for Rivercity Motorways in Table 4 are all statistically insignificant. The lack of significant risk factors is further highlighted by the negative adjusted r-square value. Furthermore, the statistically significant alpha for Hills Motorway implies that there are other undiscovered systematic risk factors with an ability to explain returns. In untabulated results, the Carhart (1997) four-factor model reports similar results. The insignificant alphas reported and the low adjusted r-square values reflect high levels of idiosyncratic risk for the PPPs examined. These individual regression results should be treated with caution as Black , Jensen and Scholes (1972) demonstrated that regressions for individual assets are econometrically inefficient. Instead, Black *et. al.,* (1972) recommend that asset pricing models should be evaluated by employing a portfolio approach. This is the rationale for combining the four individual PPP equity returns into a value-weighted PPP portfolio in Table 4.

The results in Table 4 establish that the Fama and French (1993) three-factor model can explain the systematic risks of PPP portfolio returns despite the presences of high idiosyncratic risk. As a result, the Fama and French (1993) three-factor model will be employed to estimate the idiosyncratic risk of PPP returns. The next section will graphically illustrate these estimates of idiosyncratic risk for PPPs through time.

5.1 Idiosyncratic risk of Australian Public Private Partnerships

Figures 1 to 4 illustrate the idiosyncratic risk estimates of the four PPPs examined in this study. The idiosyncratic risk estimates are calculated using daily time series employed in Eq. (2). Each graph clearly differentiates the idiosyncratic risk of the construction and operations phases separately. The first PPP examined is Rivercity Motorways.

Figure 1: Rivercity Motorways Idiosyncratic Risk (Std. Dev. of Residuals)

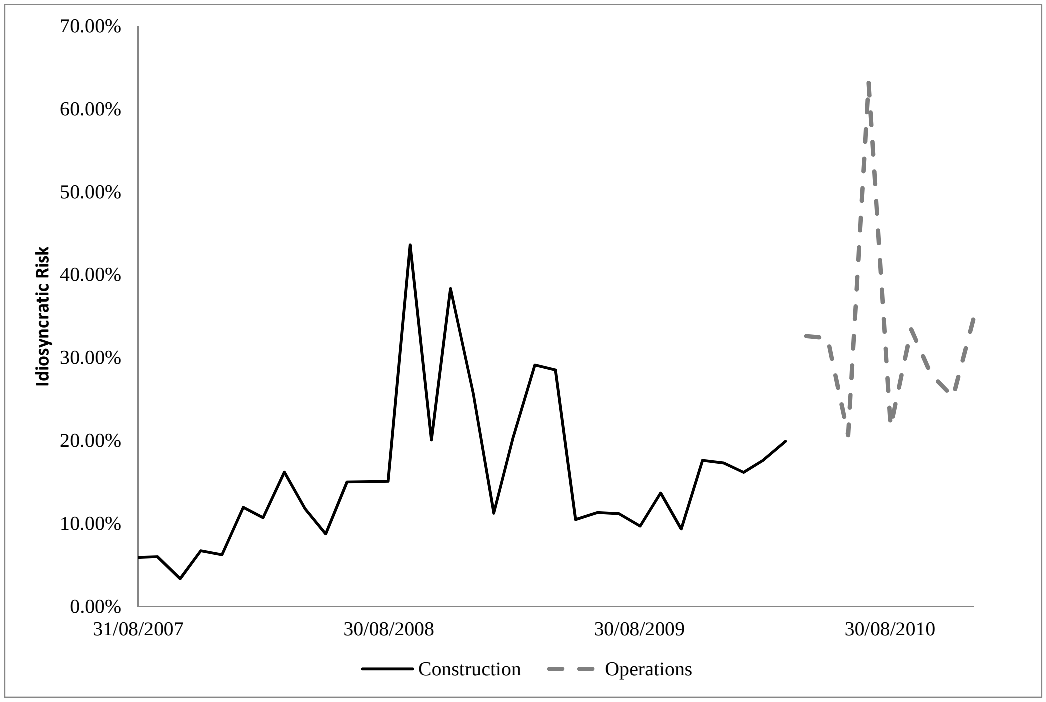
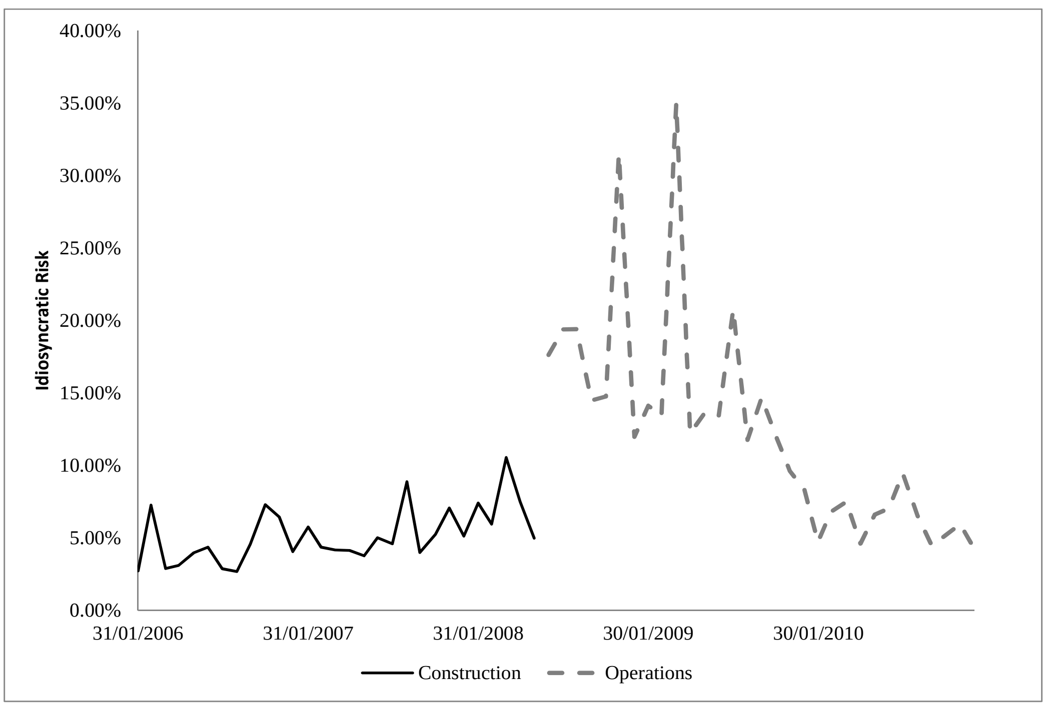


Figure 1 displays the idiosyncratic risk for Rivercity Motorways from the time fully paid shares first traded in August 2007 to December 2010. On first inspection, the idiosyncratic risk for Rivercity Motorways during the construction period was lower than the operations period. The major spikes in idiosyncratic risk during the construction period correspond with the collapse of Bear Stearns and Lehman Brothers investment banks in March and September 2008, respectively. The collapse of these banks resulted in periods of significant disruption in financial markets. Following these periods, the idiosyncratic risk of Rivercity Motorways decreases until October 2009. Once operations begin, idiosyncratic risk rises again. In April 2010, where tolling was introduced, idiosyncratic risk jumps as actual traffic failed to meet projections.[11] Figure 1 illustrates for the first time, that the construction phase for this PPP exhibits relatively low idiosyncratic risk compared to the operations period. This is in contrast with the findings of Sorge (2004) and Blanc-Brude and Strange (2007) where risk is considered highest during the construction period of a project. The differences in findings can be explained by the two methodologies employed to assess the risk of PPPs. Sorge (2004) and Blanc-Brude and Strange (2007) employ debt spreads to identify the perceived risk of a project. Both studies find that interest rates for project finance loans are highest during the construction phase and decrease during the operations phase. The examination of loan interest rates is, as result a point estimate. Loan interest rates are constant for the term of the loan. As a result, it is difficult to observe the time-variation in risk of project finance and PPP investments from interest rates from the Sorge (2004) and Blanc-Brude and Strange (2007) studies. In an alternative methodology, this study empirically examines the idiosyncratic risk of the equity issued by PPPs in an asset pricing framework. This approach allows the assessment of the time-variation of idiosyncratic risk for PPP equity returns. Overall, it is argued that the empirical evidence presented in this study is more robust than the evidence provided previously.

Figure 2: ConnectEast Idiosyncratic Risk (Std. Dev. of Residuals)



[11] Rivercity Motorways, (2010b)

The Rivercity Motorways case study is affected by the fact that the firm entered voluntary administration in early 2011, and is considered a financial failure for equity investors. Whilst this fate appears typical of economic infrastructure PPPs developed in the early to mid-2000s, other road PPPs have been able to avoid voluntary administration or receivership.[12] The remaining PPPs examined in this study concentrate on those who have survived and were listed on the Australian Securities Exchange for a significant period of time. The first PPP examined that has not entered into voluntary administration or receivership is ConnectEast.

Figure 2 illustrates the idiosyncratic risk of ConnectEast from January 2006, which was the first full month the shares commenced trading on a fully paid basis, to December 2010. Figure 2 shows that like Rivercity Motorways, the idiosyncratic risk of ConnectEast is lower during the construction phase. Once operations began, the estimate of idiosyncratic risk increased as the realised traffic demand was significantly lower than the expected traffic demand. This is demonstrated by the jump in idiosyncratic risk in July 2008 when tolling commenced. This jump in idiosyncratic risk is then followed by three significant spikes. The first of these extreme spikes in idiosyncratic risk occurred in November 2008 when a capital raising was announced and the road's asset value was significantly written down.[13] The second of these extreme spikes occurred in March 2009 and was due to major price changes that ConnectEast were unable to explain to the ASX.[14] The third and final significant jump in idiosyncratic risk corresponded with the announcement of a second capital raising and a second write-down of the road asset value in August 2009.[15]

The graph of ConnectEast's idiosyncratic risk demonstrates a similar profile to that of Rivercity Motorways. During the construction phase, the idiosyncratic risk is lower in comparison to the operations phase. One reason for this may be that once construction is completed and the operations phase commences, the true demand for the road is revealed. If the realised demand is significantly lower than forecast demand (as was the case with both ConnectEast and Rivercity Motorways), the idiosyncratic risk increases at the commencement of the operations phase and remains significantly higher than the construction phase.

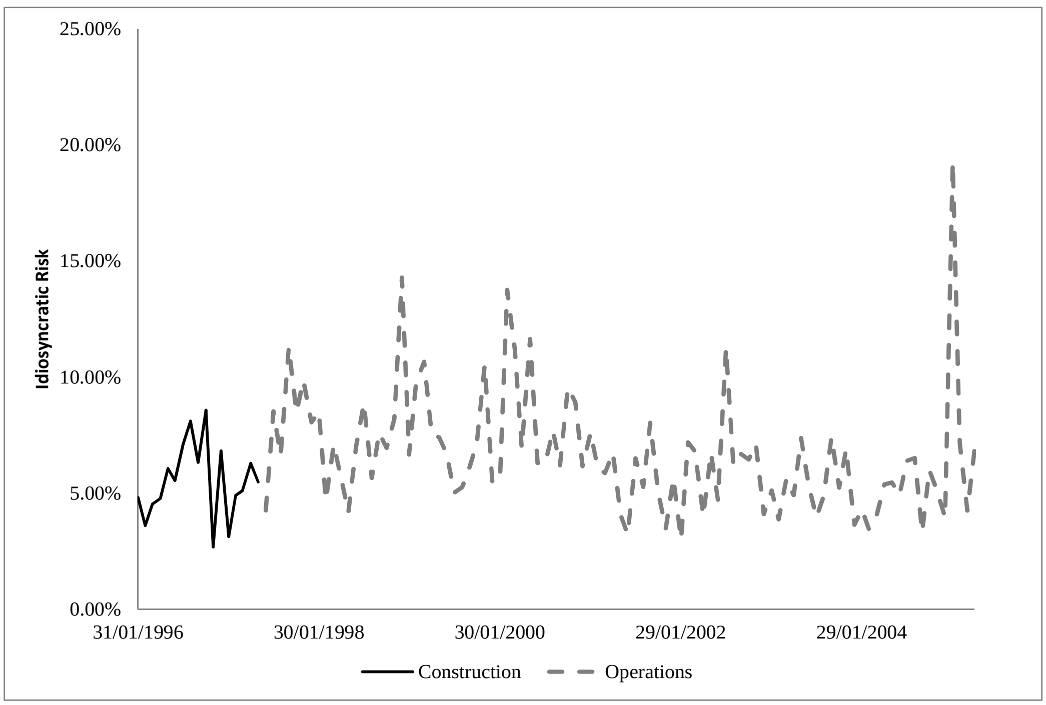
---

[12] Other instances of failures of road PPPs for investors include the Lane Cove Tunnel and the Cross City Tunnel in Sydney, Australia.
[13] ConnectEast, (2008a)
[14] ConnectEast, (2009a)
[15] ConnectEast, (2009)

Once investors become comfortable that the PPP will not enter bankruptcy, idiosyncratic risk decreases. Whilst it is easy to explain that the cause for the spike in idiosyncratic risk is wholly due to the lower than expected traffic demand, there could be another factor influencing this analysis. ConnectEast began tolling during the Global Financial Crisis where liquidity in financial markets was negatively affected. This period of major financial market disruption may have exacerbated the increase in idiosyncratic risk. To better understand the negative effect of the GFC, we can examine the remaining two PPPs which were constructed and commenced operations before 2008. As a result, both should provide guidance as to whether the increase in idiosyncratic risk during the operations phase is typical of PPPs in Australia.

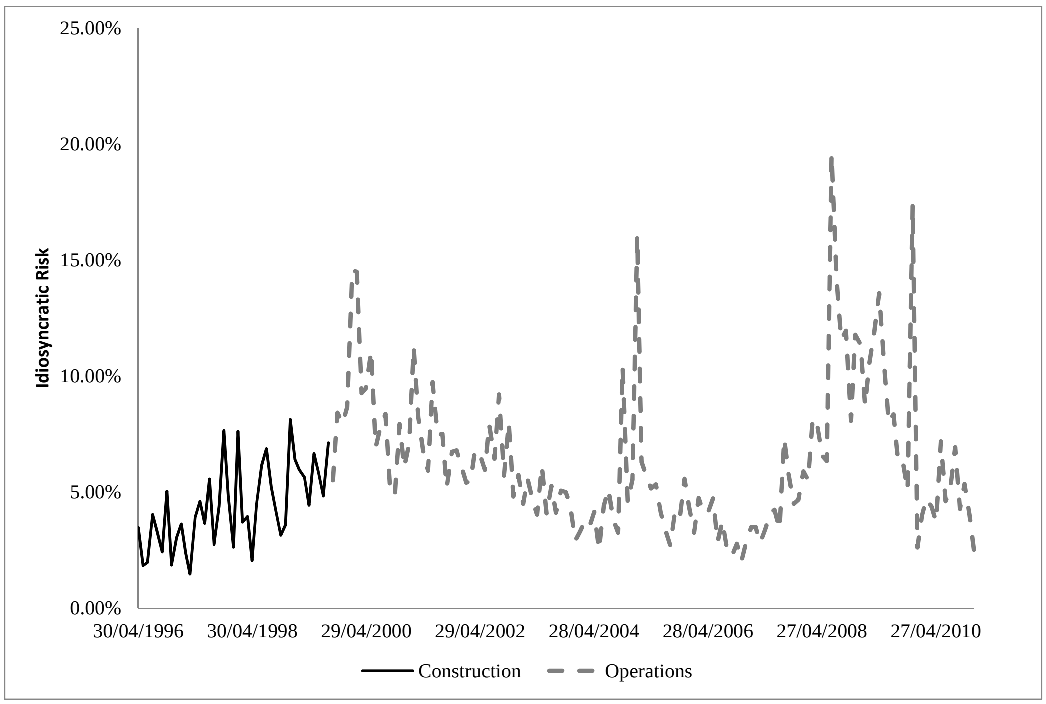
Having examined the idiosyncratic risk of two PPPs that performed poorly, this study now examines a PPP which did not enter receivership nor was it required to recapitalise. Figure 3 illustrates the idiosyncratic risk of the Hills Motorway from January 1996 until it was delisted following Transurban's takeover in March 2005.

Figure 3: Hills Motorway Idiosyncratic Risk (Std. Dev. of Residuals)



The idiosyncratic risk of Hills Motorway illustrated in Figure 3 shows that there was little discernible difference in idiosyncratic risk between the construction and operations phases. There is a slight increase in idiosyncratic risk when operations began in May 1997, however, this increase was not as severe as seen in both Rivercity Motorways and ConnectEast. Idiosyncratic risk increased as a result of traffic forecasts not being realised.[16] As this traffic shortfall did not impact the solvency of the firm as significantly as witnessed with Rivercity Motorways and ConnectEast, the increase in idiosyncratic risk between the construction and operations phases was not as pronounced. There were only two instances of the idiosyncratic risk increasing significantly after traffic 'ramp-up' (after July 2000). The first occurred in July 2002, which corresponds to a surprise decrease in the amount of traffic using the Hills Motorway.[17] The second major spike occurred in March 2005, which corresponds with the takeover bid by Transurban that was ultimately successful.[18]

Figure 4: Transurban Idiosyncratic Risk (Std. Dev. of Residuals)



By examining the four PPPs listed on the Australian Securities Exchange, the findings reveal that the riskiest period for PPP equity returns occur at the end of the construction phase and the commencement of the operations phase. It is during this time period that construction issues are discovered, in the case of Transurban, or actual demand for the infrastructure is less than expected, as in the case of Rivercity Motorways, ConnectEast and Hills Motorway. Bain (2010) suggests that the reason for the low idiosyncratic risk during the construction period is that well-structured PPPs with fixed price construction contracts insulate the

[16] Hills Motorway, (1998)
[17] Hills Motorway, (2002)
[18] Transurban, (2005)

investors from material cost overruns. The idiosyncratic risk illustrated in Figures 1 to 4 supports the analysis of Bain (2010). Once operations commence, the ability to protect investors is limited, and when realised traffic demand is significantly less than expected demand, as in the case of Rivercity Motorways, idiosyncratic risk increases dramatically.

Our findings reveal that there is time-variation in the idiosyncratic risk of PPPs equity returns. The next section will present a variety of hypothesis tests employed to determine whether there is a statistically significant difference in the idiosyncratic risk of PPP equity returns between the construction and operations phases. Where possible, the hypothesis tests will employ an equal number of observations of idiosyncratic risk for both the construction and operations phases. This is completed to ensure that the analysis is limited to the construction and operations phases and to limit the contamination of other corporate activities.[19]

Table 5 Descriptive Statistics of Idiosyncratic Risk

This table presents the descriptive statistics for the monthly idiosyncratic risk for four listed Australian Public Private Partnerships (PPPs). Idiosyncratic risk is estimated as the standard deviation of the residuals from a Fama and French (1993) three-factor model regression employing end of day closing prices from Datastream. Panel A reports the descriptive statistics for every PPP during the construction phase. Panel B reports the descriptive statistics for the operations phase. Panel C reports the test statistics for a difference in means, median and variance in idiosyncratic volatility between the construction and operations phase for every PPP. *, ** and ^ denote statistical significance at the 10%, 5% and 1% levels, respectively.

	ConnectEast	Hills Motorway	Rivercity Motorways	Transurban
Panel A: Construction Period				
Mean	0.0520	0.0552	0.1574	0.0441
Median	0.0460	0.0548	0.1434	0.0417
St Dev	0.0194	0.0162	0.0914	0.0177
Max	0.1055	0.0858	0.4361	0.0813
Min	0.0268	0.0268	0.0334	0.0148
Observations	29	17	32	41
Panel B: Operations Period				
Mean	0.1279	0.0725	0.3246	0.0750
Median	0.1210	0.0709	0.3236	0.0694
St Dev	0.0734	0.0197	0.1264	0.0231
Max	0.3499	0.1129	0.6316	0.1457
Min	0.0448	0.0416	0.2064	0.0449
Observations	29	17	9	41
Panel C: Tests of Equality				
Difference in Mean	5.3849^	2.8062^	4.4498^	6.8145^
Difference in Median	5.1319^	2.3766**	3.6694^	5.7592^
Difference in Variance	14.3071^	1.4741	1.9134	1.7042*

[19] Following corporate activity, Transurban ceases to be a single PPP from October 2002 (Transurban, (2003)).

5.2 Tests for a difference in idiosyncratic risk

We proceed to examine whether there are statistical differences in idiosyncratic risk between the construction and operations phases. To estimate the possibility of statistical differences, three hypothesis tests are calculated. The first test is a *t-test* which examines whether there is a difference in mean in the idiosyncratic risk between the sub-sample two periods. The results for the *t-test* for a difference between two means is presented in Panel C of Table 5. Furthermore, Panels A and B of Table 5 presents the descriptive statistics for idiosyncratic risk for the four PPPs for both the construction and operations phases, respectively.

The mean, median, standard deviation of idiosyncratic risk for all PPPs reported in Table 5 is lower during the construction phase in comparison to the operations phase. The tests for equality presented in Panel C of Table 5 are more revealing. For all PPPs examined, the test for a difference in mean and median report a statistically significant difference in the mean and median idiosyncratic risk between the construction and operations phases. Furthermore, for two PPPs (ConnectEast and Transurban) the difference in variance test identifies a statistically significant difference in the variance of idiosyncratic risk between the construction and operations phases.

The findings in Table 5 suggest that the idiosyncratic risk is greater during the operations period than during the construction period for all the PPPs examined. This finding appears counter-intuitive given the prior work of Sorge (2004) and Blanc-Brude and Strange (2007) which demonstrated that interest rates on loans during the construction phase are higher than during the operations phase. However, the evidence presented in Table 5 lends support to the previous work of Bain (2010).

Following the tests for equality, two further tests are calculated to examine the whether there are differences in idiosyncratic risk between the construction and operations phases. The first test employs the dummy variable regression described in Eq. (8). of this study. The dummy variable employed in this analysis equals one during the operations phase and zero otherwise. The results of the PPP regressions described by in Eq. (8) are reported in Table 6.

Table 6 Idiosyncratic Risk Difference Results

This table presents the regression coefficients for the following regression $Irisk_{i,t} = \beta_0 + \beta_1 Irisk_{i,t-1} + \beta_2 Irisk_{i,t-2} + \beta_3 OpsDummy_{i,t} + \varepsilon_t$ where $Irisk_{i,t}$ is the monthly idiosyncratic risk estimate at time t. $OpsDummy_{i,t}$ is a dummy variable equalling one if the PPP is operational and 0 otherwise. Regressions are estimated for the period from January 2006 to October 2010 for ConnectEast, January 1996 to October 1998 for Hills Motorway, August 2007 to December 2010 for Rivercity Motorways, and from April 1996 to January 2003 for Transurban. *, ** and ^ denote statistical significance at the 10%, 5% and 1% levels, respectively.

	ConnectEast	Hills Motorway	Rivercity Motorways	Transurban
Panel A: Regression Coefficient				
Intercept	0.0493	0.0349	0.1138	0.0253
$Irisk_{i,t-1}$	0.1178	0.0213	0.0416	0.3428
$Irisk_{i,t-2}$	0.0953	0.3805	0.2802	0.1092
Operations Dummy	0.0512	0.0091	0.1142	0.0166
Panel B: Standard Error				
Intercept	0.0150	0.0133	0.0367	0.0064
$Irisk_{i,t-1}$	0.1234	0.1682	0.1581	0.1175
$Irisk_{i,t-2}$	0.1242	0.1679	0.1536	0.1158
Operations Dummy	0.0199	0.0071	0.0475	0.0061
Panel C: t-statistic				
Intercept	3.2859^	2.6207**	3.1030**	3.9403^
$Irisk_{i,t-1}$	0.9551	0.1269	0.2630	2.9175^
$Irisk_{i,t-2}$	0.7674	2.2668**	1.8235	0.9424
Operations Dummy	2.5786**	1.2725	2.4036**	2.7043^
Panel D: Adjusted R^2				
	0.1687	0.2196	0.3386	0.4530

The regression results reported in Table 6 shows that the operations dummy is positive and statistically significant for ConnectEast, Rivercity Motorways and Transurban with the coefficients of 0.0199, 0.0475 and 0.0166, respectively. This implies that there is a statistically significant increase in idiosyncratic risk in the operations phase of these three PPPs. For Hills Motorways, the operations dummy remains statistically insignificant. This suggests that this dummy regression finds no differences in idiosyncratic risk between the construction and operations periods for Hills Motorway.

The finding that there was no change in idiosyncratic risk for Hills Motorways is expected given its experience and that of the other PPPs within the sample. ConnectEast, Rivercity Motorways and Transurban all suffered from substantial differences between expected and actual traffic patronage. In addition to the negative patronage shock, Transurban encountered difficulties during construction. Conversely, Hills Motorways did not suffer from construction difficulties, nor was patronage forecast overly optimistic. As a result, the financial viability of Hills Motorways was never in question.

The third and final hypothesis test employed to estimate whether there are differences in idiosyncratic risk is the Chow (1960) test on the autoregressive equation described in Equations (9) and (10). The Chow (1960) test is used to examine whether there is a difference in the idiosyncratic risk from the construction phase to the operations phase. The results of the Chow (1960) tests are presented in Table 7.

Table 7 Idiosyncratic Risk Difference Results

This table presents the *F*-statistics for the Chow test for structural breaks for idiosyncratic risk for four PPPs in Australia. For each PPP, the regression is estimated as $Irisk_{i,t} = \beta_0 + \beta_1 Irisk_{i,t-1} + \beta_2 Irisk_{i,t-2} + \varepsilon_t$ where $Irisk_{i,t}$ is the monthly idiosyncratic risk estimate at time t. Regressions are estimated for the period from January 2006 to October 2010 for ConnectEast, January 1996 to October 1998 for Hills Motorway, August 2007 to December 2010 for Rivercity Motorways, and from April 1996 to January 2003 for Transurban. The break-point is the first month after the road commences operations. *, ** and ^ denote statistical significance at the 10%, 5% and 1% levels, respectively.

ConnectEast	Hills Motorway	Rivercity Motorways	Transurban
3.1277**	0.5311	4.4512^	3.0790**

Table 7 shows that the Chow (1960) test identifies statistically significant differences for Rivercity Motorways, ConnectEast and Transurban. The finding is consistent with the previous two tests reported earlier in this study. The Chow (1960) test does not find a statistically significant difference in the idiosyncratic risk between the construction and operations periods for the Hills Motorway. The result for Hills Motorways may be due to the difference between forecast and actual traffic projections were not that large and the financial viability of the PPP was never in question.

The analysis so far suggests that the idiosyncratic risk of a PPP is greatest during the operations period rather than the construction period. For all PPPs examined, the mean and median of idiosyncratic risk is greater during the operations phase. The differences in means are statistically significant for all of the PPPs examined in this study.

This study then examined whether there is a difference in idiosyncratic risk between the construction and operations periods of the PPP. To achieve this, this study employed two methods. First, an AR(2) regression was estimated on idiosyncratic risk with a dummy variable for the operations period. For ConnectEast, Rivercity Motorways and Transurban, this dummy variable is positive and statistically significant indicating idiosyncratic risk is higher in the operations phase than the construction phase. For Hills Motorways, this dummy variable is insignificant.

Finally, a Chow (1960) test was employed to determine whether there was a statistically significant difference in the AR(2) regression. The Chow (1960) test found a statistically significant break point in idiosyncratic risk between the construction and operations phases in ConnectEast, Rivercity Motorways and Transurban. For Hills Motorways, the Chow (1960) test revealed no statistically significant difference in idiosyncratic risk between the construction and operations phases.

By identifying a difference in idiosyncratic risk, the next section examines whether the idiosyncratic risk estimates, consistent with Han and Lesmond (2011) are influenced by liquidity bias. Specifically, this section will examine whether the difference in idiosyncratic risk between the construction and operations periods remains after correcting for liquidity biases for ConnectEast, Rivercity Motorways and Transurban.

5.3 Liquidity-adjusted idiosyncratic risk

Han and Lesmond (2011) demonstrated that idiosyncratic risk estimates can be biased due to liquidity factors. As a result, corrections need to be applied when examining idiosyncratic risk in Australia. In this study, a bias correction is estimated by orthogonalising the idiosyncratic risk estimates by contemporaneous liquidity measures. The general form of the regression estimated to remove the liquidity bias is described in Eq. (11). The results of these regressions are reported in Table 8.

Table 8 Coefficients for Liquidity-adjustment of idiosyncratic risk

This table presents the regression coefficients for a time series regression of the idiosyncratic volatility on liquidity proxies. Idiosyncratic risk is estimated from the Fama and French (1993) three-factor model. 'Spread' is the proportional spread, calculated as the monthly average of the daily close ask price less the daily close bid price divided by the daily close quoted midpoint. '% Zero Return Days' is the percentage of trading days within a month that experience no price movement. Regressions are estimated for the period from January 2006 to December 2010 for ConnectEast, January 1996 to May 2005 for Hills Motorway, August 2007 to December 2010 for Rivercity Motorways, and from April 1996 to December 2010 for Transurban. *t*-statistics are reported in brackets *, ** and ^ denote statistical significance at the 10%, 5% and 1% levels, respectively.

Intercept	Spread	%Zero Returns Days	Adjusted R^2
Panel A: ConnectEast			
-0.0240	9.9313^		0.4393
[-1.3433]	[6.7417]		
0.1101^		-0.1710	0.0395
[7.2401]		[-1.7092]	
0.0016	9.9114^	-0.2151^	0.5124
[0.0833]	[7.1522]	[-2.9227]	
Panel B: Hills Motorway			
0.0450^	1.4266^		0.0846
[6.6634]	[3.1882]		
0.0638^		-0.1286	0.0087
[27.3045]		[-1.0376]	
0.0447^	1.4672^	-0.1381	0.0881
[6.6044]	[3.2388]	[-0.6473]	
Panel C: Transurban			
0.0329^	3.0744^		0.2549
[8.4159]	[7.7150]		
0.0644**		-0.0833*	0.0291
[19.5310]		[-2.2829]	
0.0385^	3.0868^	-0.0861**	0.2860
[8.8680]	[7.8895]	[-2.7448]	
Panel D: Rivercity Motorways			
0.0772^	3.4114**		0.2688
[2.2081]	[3.7868]		
0.1624^		0.1628	0.0223
[4.2132]		[0.9434]	
0.0953^	4.2220^	-0.2356	0.3004
[2.5550]	[3.8867]	[-1.3097]	

Table 9 Descriptive Statistics Liquidity-adjusted Idiosyncratic Risk

This table presents the descriptive statistics for the monthly idiosyncratic volatility for four listed Australian Public Private Partnerships (PPP). Idiosyncratic volatility is estimated as the residual from the Fama and French (1993) three-factor model regression employing end of day close prices from Datastream. Panel A reports the descriptive statistics for each PPP during the construction phase, Panel B reports the descriptive statistics for the operations phase. Panel C reports the test statistics for a difference in means, median and variances in idiosyncratic volatility between the construction and operations phases for every PPP. *, ** and ^ denote statistical significance at the 10%, 5% and 1% levels, respectively.

	ConnectEast	Hills Motorway	Rivercity Motorways	Transurban
Panel A: Construction Period				
Mean	-0.0063	0.0357	0.0746	0.0250
Median	-0.0057	0.0323	0.0742	0.0248
St Dev	0.0237	0.0174	0.0765	0.0171
Max	0.0414	0.0690	0.3752	0.0636
Min	-0.0776	0.0101	-0.0445	-0.0199
Observations	29	17	32	41
Panel B: Operations Period				
Mean	0.0098	0.0480	0.1687	0.0480
Median	-0.0013	0.0501	0.0999	0.0485
St Dev	0.0602	0.0173	0.1434	0.0244
Max	0.1939	0.0957	0.4931	0.1063
Min	-0.0881	0.0241	0.0142	-0.0284
Observations	29	17	9	41
Panel C: Tests of Equality				
Mean	-1.3351	-2.1353**	-2.6464**	-5.3798^
Median	0.5443	1.9977**	2.1575**	4.7854^
Variance	6.4345^	1.7001	3.5149*	1.7413*

For all PPPs examined in Table 8, the regression that includes the intercept, *Spread* and *%ZeroReturnDays* as explanatory variables produces the highest adjusted r-square value, indicating the best fit for the data. This functional form is applied in this study to orthogonalise the idiosyncratic risk of the PPPs to remove the liquidity bias.

After the idiosyncratic risk estimates are orthgonalised, the three tests for statistically significant difference in idiosyncratic risk are then re-estimated. Table 9 presents the descriptive statistics as well as the tests of equality of the mean, median and variance of idiosyncratic risk between the construction and operations periods.

Table 9 presents some revealing results. Again, for all PPPs examined, the mean and median idiosyncratic risk is higher in the operations phase than in the construction phase. The removal of liquidity effects does not alter the previous conclusions. It is interesting to note that for ConnectEast, there is no longer a statistically significant difference in the mean idiosyncratic risk between the construction and operations periods. However, for Hills Motorway, Rivercity Motorways and Transurban, there remains a statistically significant difference in the idiosyncratic risk means and medians. The tests for a difference in the liquidity-adjusted idiosyncratic risk are now re-estimated. The first test includes a dummy variable for the operations period, as described in Equation (8), for the liquidity-adjusted idiosyncratic risk. These regression results are reported in Table 10.

Table 10 Liquidity-adjusted Idiosyncratic Risk Difference Results

This table presents the regression results for the following regression $Irisk_{i,t} = \beta_0 + \beta_1 Irisk_{i,t-1} + \beta_2 Irisk_{i,t-2} + \beta_3 OpsDummy_{i,t} + \varepsilon_t$ where $Irisk_{i,t}$ is the monthly liquidity-adjusted idiosyncratic risk estimate at time t. $OpsDummy_{i,t}$ is a dummy variable equalling one when the PPP is operational and 0 otherwise. Regressions are estimated for the period from January 2006 to October 2010 for ConnectEast, January 1996 to October 1998 for Hills Motorway, August 2007 to December 2010 for Rivercity Motorways, and from April 1996 to January 2003 for Transurban. *, ** and ^ denote statistical significance at the 10%, 5% and 1% levels, respectively.

	ConnectEast	Hills Motorway	Rivercity Motorways	Transurban
Panel A: Regression Coefficient				
Intercept	-0.0074	0.0252	0.0731	0.0174
$Irisk_{i,t-1}$	-0.1356	0.0243	-0.0474	0.2562
$Irisk_{i,t-2}$	-0.1450	0.3180	0.1309	0.0809
Operations Dummy	0.0200	0.0067	0.0792	0.0156
Panel B: Standard Error				
Intercept	0.0090	0.0097	0.0260	0.0047
$Irisk_{i,t-1}$	0.1378	0.1769	0.1710	0.1198
$Irisk_{i,t-2}$	0.1369	0.1776	0.1768	0.1217
Operations Dummy	0.0128	0.0068	0.0464	0.0061
Panel C: t-statistic				
Intercept	-0.8257	2.5859*	2.8097^	3.6738^
$Irisk_{i,t-1}$	-0.9869	0.1374	-0.2770	2.1373*
$Irisk_{i,t-2}$	-1.0594	1.7901**	0.7404	0.6644
Operations Dummy	1.5672	0.9904	1.7047	2.5719*
Panel D: Adjusted R^2				
	0.0087	0.0993	0.0866	0.3193

The results presented in Table 10 show that for ConnectEast, Hills Motorway and Rivercity Motorways, the operations dummy variable is insignificant. However, for Transurban, the operations dummy remains positive and statistically significant. This finding is interesting as it implies that there has been a structural increase in idiosyncratic risk for the project. This increase in risk may be the result of either the construction issues identified in 2001, or the lower than expected traffic demand resulting in investors reassessing the risk of the project.

Overall the differences in the dummy regression results in Table 10 and the earlier results in Table 6 suggest that the changes in idiosyncratic risk are the result of changes in liquidity in these PPP equity returns.

Finally, the Chow (1960) test is employed to identify a statistically significant difference in the liquidity-adjusted idiosyncratic risk between the construction and operations phases. The form of the regression is described in Equation (9) and the results are presented in Table 11.

Table 11 Liquidity-adjusted Idiosyncratic Risk Difference Results

This table presents the *F*-statistics for the Chow test for a difference in idiosyncratic risk for four PPPs in Australia. For each PPP, the regression is estimated $Irisk_{i,t} = \beta_0 + \beta_1 Irisk_{i,t-1} + \beta_2 Irisk_{i,t-2} + \varepsilon_t$ where $Irisk_{i,t}$ is the monthly liquidity-adjusted idiosyncratic risk estimate at time *t*. Regressions are estimated for the period from January 2006 to October 2010 for ConnectEast, January 1996 to October 1998 for Hills Motorway, August 2007 to December 2010 for Rivercity Motorways, and from April 1996 to January 2003 for Transurban. The break-point is the first month after the road commences operations. *, ** and ^ denote statistical significance at the 10%, 5% and 1% levels, respectively.

ConnectEast	Hills Motorway	Rivercity Motorways	Transurban
1.4385	0.9099	1.0480	3.2950*

The results in Table 11 show that for all PPPs examined, there is no statistically significant difference in the liquidity-adjusted idiosyncratic risk for ConnectEast, Hills Motorway and Rivercity Motorways. The Chow (1960) test finds a statistically significant difference in the liquidity-adjusted idiosyncratic risk for Transurban which is consistent with the findings from the dummy variable regression.

In summary, this section employed liquidity-adjusted idiosyncratic risk estimates to remove the liquidity biases observed by Han and Lesmond (2011). The tests found no difference in liquidity-adjusted idiosyncratic risk for ConnectEast, Hills Motorway and Rivercity Motorways. However, the hypothesis tests for Transurban identify a clear difference in idiosyncratic risk between the construction and operations phases.

A summary of the findings of this study is presented in Table 12. This table displays the results for the three tests conducted to examine the hypothesis that idiosyncratic risk is higher in the operations phase of a PPP than the construction phase. Panel A reports the hypothesis test results for the raw idiosyncratic risk estimates whilst Panel B reports the results for the liquidity-adjusted idiosyncratic risk estimates.

Table 12 Summary of Test Results

This table presents a summary of the conclusions for the tests performed on idiosyncratic risk of the four PPPs (ConnectEast, Hills Motorways, Rivercity Motorways and Transurban) examined in this study. ✓ indicates that the test identified a difference in idiosyncratic risk between the construction and operations phases whilst – indicates that no difference was identified. The Table Number column presents the table that displays the results summarised in that row. Panel A summarises the results for the raw idiosyncratic risk estimates whilst Panel B presents the results for the liquidity-adjusted idiosyncratic risk.

	ConnectEast	Hills Motorway	Rivercity Motorways	Transurban	Table Number
Panel A: Raw Idiosyncratic Risk					
Difference in Mean	✓	✓	✓	✓	5
Difference in Median	✓	✓	✓	✓	5
Difference in Variance	✓	-	-	✓	5
Dummy Variable	✓	-	✓	✓	6
Chow	✓	-	✓	✓	7
Panel B: Liquidity-Adjusted Idiosyncratic Risk					
Difference in Mean	-	✓	✓	✓	9
Difference in Median	-	✓	✓	✓	9
Difference in Variance	✓	-	✓	✓	9
Dummy Variable	-	-	-	✓	10
Chow	-	-	-	✓	11

Panel A of Table 12 demonstrates that of the four PPPs examined in this study, three PPPs (ConnectEast, Rivercity Motorways and Transurban) all exhibit clear differences in the initial idiosyncratic risk estimates between the construction and operations phases. When the idiosyncratic risk estimates are adjusted for liquidity biases, it was found that only Transurban exhibited a statistically significant difference in idiosyncratic risk between the construction and operations phases for all tests employed.

The findings of this study indicate that the difference in idiosyncratic risk, for ConnectEast and Rivercity Motorways identified earlier in this study, is due to liquidity effects instead of the risk of the project changing.[20] This finding suggests that as these PPPs commenced their operations phases during the market dislocation of the Global Financial Crisis, the liquidity

[20] The tests for a difference in idiosyncratic risk for ConnectEast identify statistically significant differences in all five of tests conducted on the raw idiosyncratic risk whilst, only one difference was identified in the liquidity-adjusted idiosyncratic risk. For Rivercity Motorways a statistically significant difference in idiosyncratic risk was identified in four of the five tests conducted on the raw idiosyncratic risk. When the liquidity-adjusted idiosyncratic risk was examined only three of the five tests identified a statistically significant difference in risk between the construction and operations phases.

effects were the transmission mechanism of the changes in the idiosyncratic risk of the projects. In the case of Transurban, the higher idiosyncratic risk identified in the operations phase is the result of project risk.

6 Conclusion

This study examined the systematic and idiosyncratic risk of four individual PPPs listed on the Australian Securities Exchange. As such, this study provides three original contributions to the literature. The first original contribution found that the Fama and French (1993) three-factor model explained the systematic risks of a value-weighted portfolio of listed PPP stocks. When the individual PPPs were examined this study found that the systematic risk factors in the Fama and French (1993) three-factor model are able to explain the systematic risks for three of the four individual PPPs. Furthermore, the Fama and French (1993) three-factor model implied that significant idiosyncratic risk was present in the returns of all individual PPPs.

The second original contribution of this study was the analysis of idiosyncratic risk of PPPs through time. To the author's knowledge, this is the first study that attempts to quantify the time-variation of PPP equity risk. Of the four PPPs examined, it was possible to observe similar patterns in risk. During the construction phase, idiosyncratic risk was low. As the PPP moved from the construction phase to the operations phase, idiosyncratic risk increased and for three PPPs examined, idiosyncratic risk was significantly higher in the operations phase.

The third and final original contribution of this PPP study was the analysis of idiosyncratic risk which was free of liquidity biases. When the liquidity biases were removed from the estimated idiosyncratic risk, this study found that that the risk during the construction period was not significantly different from the operations period for three of the four PPPs examined. The finding implies that the PPP with an identified difference in idiosyncratic risk, Transurban, experienced an increase in project specific risk from the construction to the operations periods. Furthermore, this finding implies that the difference observed in the idiosyncratic risk of ConnectEast and Rivercity Motorways was driven by changes in liquidity of these stocks.

The findings of this study provide a number of avenues for future research. First, this study is confined to examining the risk of four listed PPPs within Australia. It would be a worthwhile exercise to examine the risk of other publicly listed PPPs, around the world to examine whether these findings are consistent in other capital markets. Finally, this study confirms previous literature which suggests that there is a relationship between idiosyncratic risk and liquidity. Future research has the opportunity to examine these two variables and examine what factors are driving this relationship.

References

Amihud, Y 2002, ‘Illiquidity and Stock Returns: Cross-Section and Time Series Effects’, *Journal of Financial Markets*, 5, pp. 31–56.

Ang, A, Hodrick, R J, Xing, Y and Zhang, X 2006, ‘The Cross-Section of Volatility and Expected Returns,’ *Journal of Finance*, 61(1), pp. 259–299.

Ang, A, Hodrick, R J, Xing, Y and Zhang, X 2009, ‘High Idiosyncratic Volatility and Low Returns: International and Further U.S. Evidence’, *Journal of Financial Economics*, 91(1), pp. 1–23.

Bain, R. 2010, ‘Construction risk – what risk?’, *Project Finance*, 10 February, pp. 46-50.

Black, F Jensen, M C and Scholes, M 1972 ‘The Capital asset pricing model: Some empirical tests’, *Studies in the Theory of Capital Markets,* pp.79-121. New York: Praeger.

Blanc-Brude, F and Strange, R 2007, ‘How Banks Price Loans to Public-Private Partnerships: Evidence from the European Markets’ *Journal of Applied Corporate Finance*, Vol. 19, Iss. 4, pp. 94-106.

Brailsford, T Handley, J C and Maheswaran, K 2008, ‘Re-examination of the historical equity risk premium in Australia’, *Accounting & Finance*, Vol. 48, Iss. 1, pp. 73-97.

Brisconnections, 2011, BrisConnections Investor Forum, viewed 16 December 2011, <http://www.brisconnections.com.au/sites/default/files/1050612.pdf>

Carhart, M M 1997, ‘On Persistence in Mutual Fund Performance’, *Journal of Finance*, 52, pp. 57-82.

Chow, G C 1960, ‘Tests of Equality Between Sets of Coefficients in Two Linear Regressions’, *Econometrica,* Vol. 28, Iss.3, pp. 591–605.

Chua, C T, Goh, J and Zhang, Z 2010, ‘Expected Volatility, Unexpected Volatility, and the Cross-section of Stock Return’, *Journal of Financial Research*, 33, pp. 103-123.

ConnectEast, 2004. Product Disclosure Statement, date 10 July 2011, <http://www.connecteast.com.au/page.aspx?cid=533>.

ConnectEast, 2008a, ConnectEast Group – Accelerated Non-Renounceable Pro-Rata Entitlement Offer, viewed 1 August 2011, <http://www.connecteast.com.au/downloadFile.aspx?file_id=726>.

ConnectEast, 2008b, Eastlink traffic and revenue – October 2008, viewed 2 August 2011, <http://www.connecteast.com.au/downloadFile.aspx?file_id=680>.

ConnectEast, 2009. Equity Raising, viewed 2 August 2011, <http://www.connecteast.com.au/downloadFile.aspx?file_id=877>.

English L 2006, 'Public Private Partnerships in Australia: An Overview of Their Nature, Purpose, Incidence and Oversight', *UNSW Law Journal*, Vol.29, Iss.3, pp. 250-262.

Faff, R 2001, 'An Examination of the Fama and French Three-Factor Model Using Commercially Available Factors', *Australian Journal of Management,* Vol. 26, No. 1, pp. 1-17.

Fama, E F and French K R 1993, 'Common Risk Factors in the Returns on Stocks and Bonds', *Journal of Financial Economics*, Vol. 33, Iss. 1, pp. 3–56.

Fu, F 2009, 'Idiosyncratic Risk and the Cross-Section of Expected Stock Returns', *Journal of Financial Economics*, 91, pp. 24–37.

Grimsey, D and Lewis, M K 2002 ' Evaluating the risks of public private partnerships for infrastructure projects', *International Journal of Project Management*, Vol. 20, Iss. 2, pp. 107-118.

Grigg, A 2012, 'Tunnel investors back in a hole', viewed 1 January 2013, <http://www.afr.com/p/national/tunnel_investors_back_in_hole_4BPDRw8Q4c3K28iH9eTxAL>.

Han, Y and Lesmond D A 2011, 'Liquidity biases and the pricing of cross-sectional idiosyncratic volatility', *Review of Financial Studies*, Vol. 24 no.5, pp. 1590-1629.

Hills Motorway, 1994, 'Product Disclosure Statement', viewed December 16, 2011, via Connect4 database.

Hills Motorway, 1995, 'Annual Report', viewed December 16, 2011, via Connect4 database.

Hills Motorway, 1997, 'Annual Report', viewed December 16, 2011, via Connect4 database.

Hills Motorway, 1998, 'Annual Report', viewed December 16, 2011, via Connect4 database.

Hills Motorway, 2000, 'Annual Report', viewed December 16, 2011, via Connect4 database.

Hills Motorway, 2002, 'Annual Report', viewed December 16, 2011, via Connect4 database.

Hills Motorway, 2003, 'Annual Report', viewed December 16, 2011, via Connect4 database.

Huang, W, Liu Q, Rhee, S G and Zhang, L. 2010, 'Return Reversals, Idiosyncratic Risk, and Expected Returns', *Review of Financial Studies*, Vol. 23 no.1, pp. 147-168.

Infrastructure Australia, 2013a, 'Contracted PPPs Jan 2013', viewed 31 March 2013, http://www.infrastructureaustralia.gov.au/public_private/files/Contracted_PPPs_Jan_2013.pdf

Infrastructure Australia, 2013b, 'PPP Projects in the Market as at December 2012', viewed 31 March 2013, http://www.infrastructureaustralia.gov.au/public_private/market.aspx

Jensen, M C and Meckling, W H 1976, 'Theory of the Firm: Managerial Behavior, Agency Costs and Ownership Structure', *Journal of Financial Economics,* Vol. 3, No. 4, pp. 305-360.

John, D 2006, Transurban takeover bid for Sydney Roads, viewed December 20, 2011, <http://www.smh.com.au/news/business/transurban-takeover-bid-for-sydney-roads/2006/12/13/1165685752801.html>.

Lee, T and Ahmed, N 2011, 'End of the road as RiverCity Motorway sinks owing $1.3bn', viewed 2 January 2013, <http://www.theaustralian.com.au/archive/business-old/end-of-the-road-as-rivercity-motorway-sinks-owing-13bn/story-e6frg9i6-1226011606877>.

Leighton, 2006, 'Rivercity Motorway to List on ASX Tomorrow', viewed December 16, 2011, http://www.leighton.com.au/__data/assets/pdf_file/0006/9186/020806_mr.pdf.

Linking Melbourne Authority in conjunction with the Department of Treasury and Finance Partnerships Victoria. 2010, 'Partnerships Victoria Project Summary: The Peninsula Link Project' viewed 2 January 2013, <http://www.partnerships.vic.gov.au/CA25708500035EB6/WebObj/ThePeninsulaLinkProject-ProjectSummary/$File/The%20Peninsula%20Link%20Project-%20Project%20Summary.pdf>.

Myer, R 2003, More City Link traffic drives up Transurban revenue, viewed December 20, 2011, <http://www.theage.com.au/articles/2003/01/07/1041566408238.html>.

O'Sullivan, M 2010, 'Lane Cove Tunnel operator hits the wall' viewed 1 January 2013, <http://www.smh.com.au/business/lane-cove-tunnel-operator-hits-the-wall-20100120-mkca.html>.

Queensland Treasury, 2012, 'Examples of previous Queensland public private partnership projects', viewed 30 September 2012, http://www.treasury.qld.gov.au/projects-queensland/projects/examples.shtml.

Rivercity Motorway, 2010a, 1.24 Million vehicles use Clem7 During Toll-Free Period viewed 20 July 2011, <http://www.rivercitymotorway.com.au/userfiles/file/ASX%20Announcements/Toll-free%20Traffic%20Volumes_060410.pdf>.

Rivercity Motorway 2010b, viewed 20 July 2011, <http://www.rivercitymotorway.com.au/userfiles/file/ASX%20Announcements/ASX%20Announcements%202009/Investor%20Update_28%20June%202010_Final%20(2).pdf>.

Rivercity Motorways, 2006. 'Product Disclosure Statement', viewed 19 June 2011, <http://www.rivercitymotorway.com.au/userfiles/file/Product%20Disclosure%20Statement.pdf>.

Rivercity Motorways, 2011, 'Rivercity Motorway Group (ASX:RCY) Appointment Of Voluntary Administrator', viewed 30 June 2011, <http://www.rivercitymotorway.com.au/userfiles/file/ASX%20Announcements/2011/RCY%20AppointmentVoluntaryAdministrator20110225.pdf, Accessed>.

RTA, 2007, 'Lane Cove Tunnel: Updated summary of contracts. Incorporating summaries of all contract changes to 25 March 2007', viewed 30 September 2012, http://www.treasury.nsw.gov.au/__data/assets/pdf_file/0006/3111/LCT_contracts_summary_2007.pdf.

Sorge, M 2004, 'The nature of credit risk in project finance', *BIS Quarterly Review*, pp. 91-104, viewed 11 December 2012, <http://www.bis.org/publ/qtrpdf/r_qt0412h.pdf>.

Transurban, 1996, ‘Product Disclosure Statement’, viewed December 16, 2011, via Connect4 database.

Transurban, 2000, ‘Annual Report’, Retrieved viewed December 16, 2011, via Connect4 database.

Transurban, 2001, ‘Annual Report’, viewed December 16, 2011, via Connect4 database.

Transurban, 2003, ‘Annual Report’, Retrieved viewed December 16, 2011, via Connect4 database.

Transurban, 2005, ‘Annual Report’, Retrieved viewed December 16, 2011, via Connect4 database.

Transurban, 2006, ‘Annual Report’, Retrieved viewed December 16, 2011, via Connect4 database.

Transurban, 2010a, ‘Transurban announced as acquirer of Lane Cove Tunnel’, viewed 16 December 2011, <http://www.transurban.com/Sale_to_Transurban.pdf>.

Transurban, 2010b, ‘Transurban Board Response To Proposals From Canada Pension Plan Investment Board, CP2 Limited And Ontario Teachers’ Pension Plan Board’, viewed 16 December 2011, <http://www.transurban.com/846541.pdf>.

Transurban, 2011, ‘Our projects’, viewed 16 December 2011, <http://www.transurban.com/62.htm>.

Transurban, 2010, ‘Transurban announced as acquirer of Lane Cove Tunnel’ viewed 2 January 2013) <http://www.transurban.com/Sale_to_Transurban.pdf>.

Welch, B L 1947, ‘The generalization of "Student's" problem when several different population variances are involved’, *Biometrika* Vol. 34 Iss. 1–2, pp. 28-35

Wilcoxon, F 1945, ‘Individual comparisons by ranking methods’, *Biometrics Bulletin,* Vol 1. Iss. 6, pp. 80–83.