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SYSTEMATIC RISK FACTORS IN THE RETURNS OF AUSTRALIAN PPP BONDS

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ABSTRACT

This research examines the ability of systematic risk factors to explain the returns of bonds issued by Public Private Partnerships (PPPs) in Australia. This study employs the systematic risks of Term, Default and Liquidity factors in an asset pricing model and finds evidence to support the hypothesis that systematic risks can explain between 37% of the variation of bond returns of a toll road PPP to 84% of the variation of bond returns of a hospital PPP. The findings highlight the importance of systematic risk factors in explaining the risk and returns of Australian PPP bonds.

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1 Introduction

What role do commonly accepted systematic risk factors play in explaining the returns of bonds issued by Public Private Partnerships (PPPs)? In light of the proposals to employ PPPs to provide infrastructure in Australia, an analysis of the systematic risk factors that determine their returns is warranted. Prior research on PPPs by Grimsey and Lewis (2002), Quiggin (2005) and Alonso-Conde, Brown and Rojo-Suarez (2007) has focused on project specific risks and how these are allocated between parties. By addressing this question we will help in understanding the relative advantages and investment merits of the ownership of PPP bonds.

A review of the PPP literature reveals that previous studies have examined how the contractual structure of a PPP impacts on the pricing of debt. However, no research has considered whether PPP debt returns can be explained by systematic risk factors or idiosyncratic risks. If increased adoption of PPPs in the provision of infrastructure is to be achieved, the systematic risk factors that explain the variation in PPP bond returns is important information for investors. As such, this study represents an original and critical contribution to the body of knowledge of the determinants of PPP bond returns.

This study demonstrates that systematic risk factors are efficient in explaining the variation of PPP bond returns. This finding is important, as for the first time, the risk factors that explain the majority of the variation of returns for PPPs have been quantified. This study represents an original contribution to the literature as prior studies on PPPs have only examined the pricing of contractual risks and have not considered the systematic risks that explain the common variation of PPP bond returns.

The rest of the study is organised as follows. Section 2 provides a brief review of the related literature. Section 3 reviews the methodology employed in this study. Section 4 describes the data used in this study followed by Section 5 which reviews the results of the analysis. Finally, Section 6 provides concluding remarks.

2 Related Literature

To date, PPP research has examined the historical perspective of PPPs, the motivation of governments to procure infrastructure through PPPs, risk allocation between governments and the private sector, value for money considerations, and issues related to infrastructure procurement through PPPs.[1, 2, 3, 4, 5] The existing research on PPP returns is rooted in the project finance literature. This is understandable as according to both Spackman (2002) and Blanc-Brude and Strange (2007), PPPs are a subset of the project finance industry. Project finance is defined by Esty (2004) as:

> *"creation of a legally independent project company financed with equity from one or more sponsoring firms and non-recourse debt for the purpose of investing in a capital asset" [p. 213]*

Esty (2004) argues that the study of project finance companies can provide tremendous insights into areas including capital structure, agency theory and asymmetric information. When the valuation of project finance investments is considered, previous research has followed the work of Jensen and Meckling (1976), who stated that a firm is a nexus of contracts. Esty (2002) employs this approach to examine both the risk and returns of project finance investments. Esty (2002) first examines the risks of the project and how these risks are mitigated through contractual structures. As a result of this analysis, Esty (2002) finds that the upside returns of a project finance investment are limited. Esty (2002) argues that this is due to the nature of the asset being financed and the contractual structures employed to reduce the risk of the project.

The approach of Esty (2002) is employed by Dailami and Hauswald (2007) to identify and examine the risks being priced by investors in project finance investments. Dailami and Hauswald (2007) hypothesise that investors only demand a return for 'residual risks' in project finance companies. 'Residual risks' according to Dailami and Hauswald (2007), are risks borne by investors because these exposures are not being allocated to parties through

[1] For a discussion on the history of PPPs refer to Spackman (2002) and Broadbent and Laughlin (2003).
[2] For discussion of risk allocation in PPPs see Quiggin (2005), Brown (2005) and Davis (2005).
[3] PPPs and Value for Money has been examined by Grimsey and Lewis (2005), Grout (1997), Hodge (2004) and Hodge and Greve (2007) and Burger and Hawkesworth (2011).
[4] For a review of the economic motivations for governments to enter into PPPs, refer to Hart, Shleifer and Vishny (1997) and Hart (2003). Furthermore, the work of Hammami, Ruhashyankiko and Yehoue (2006) examine the factors that are common for governments that procure infrastructure through PPPs.
[5] Mustafa (1999), Zhang (2005) and Flyvbjerg (2009) review the practical implication of PPPs and discuss options for improvement in the process.

contractual arrangements. An example provided by Dailami and Hauswald (2007) is the risk associated with a default of the primary customer of a 25 year energy supply contract. The project examined was the Ras Gas project in Qatar which issued U.S. dollar denominated bonds. Dailami and Hauswald (2007) identified that investors in the bonds adjust their return expectations as a result of changing expectations of counterparty risk arising from a 25 year sales and purchase agreement. Dailami and Hauswald (2007) demonstrate that investors are unable to enter into a contract to ensure completion of the sales and purchase agreement if the counterparty enters bankruptcy, and as a result, this exposure is referred to as a residual risk.

Blanc-Brude and Strange (2007) draw similar conclusions when examining a large cross-section of infrastructure projects from PPPs in the United Kingdom, to toll roads in Europe. Blanc-Brude and Strange (2007) seek to explain the determinants of the interest rates charged on bank loans to PPPs. The model Blanc-Brude and Strange (2007) present assumes that PPPs, as a project finance investment, can be represented as a nexus of contracts. As a result, Blanc-Brude and Strange (2007) state that banks will only price risks that are uncontrolled by contracting arrangements within the PPP. To examine this hypothesis, Blanc-Brude and Strange (2007) conduct a cross-sectional regression of the loans' interest rate spread on several systematic and project specific risk proxies. Blanc-Brude and Strange (2007) find that the term to maturity, seniority, type of loan facility and whether the purpose of funds (i.e. either to refinance previous borrowings or as a new financial commitment for the infrastructure project) impacted on the cost of funds. Furthermore, Blanc-Brude and Strange (2007) also find that the size of the project's capital spend as well as the riskiness of the revenue also impacted on the pricing of the loans.

Despite the fact that a large number of PPP transactions have been entered into in Australia in recent years to date, there is no study which has examined the systematic risk factors that explain the variation of returns for PPPs in Australia or around the world.[6] Instead, prior studies on the returns of project finance have focused on contractual arrangements and residual risk. The focus on the role of residual risk in the explanation of the variation of returns of project finance investments by Dailami and Hauswald (2007) and Blanc-Brude and Strange (2007) appears inconsistent with asset pricing theories such as the CAPM. Whilst undoubtedly the contractual arrangements are important, no literature has examined the role that systematic risk factors play in the pricing of PPPs. Blanc-Brude and Strange (2007)

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

provides some evidence that systematic risk factors play a role in explaining the pricing on PPP loans. However, there has been no examination of the ability of systematic risk factors to explain the variation of PPP bond returns. The work of Fama and French (1993), Gebhardt, Hvidkjaer, Swaminathan (2005) Lin, Wang and Wu (2011) and Bianchi, Drew and Whittaker (2013) all demonstrate that the variation of bond returns can be explained by three systematic risk factors. This study aims to correct this paucity of research by examining whether the systematic risk factors for the Australian bond market can explain the variation of returns of Australian PPP bonds

3 Methodology

Consistent with the methodology employed in Fama and French (1993), Gebhardt *et. al.,*. (2005) and Lin *et. al.,*. (2011), the following regression for the PPP bond portfolio returns is estimated:

$$R_{i,t}\text{-}R_{f,t} = \alpha_{i,t} + \beta_1 Term_{i,t} + \beta_2 Default_{i,t} + \beta_3 Liquidity_{i,t} + \varepsilon_t \qquad (1)$$

where:

$R_{i,t}$ is the return of the PPP portfolio bond i at time t;

$R_{f,t}$ is the risk-free proxy which is the 90 day bank accepted bill rate sourced from the Reserve Bank of Australia;

$Term_{i,t}$ is the difference between the monthly value weighted returns of Australian Commonwealth government bonds with a maturity greater than ten years and the 90 day bank accepted bill;

$Default_{i,t}$ is the difference in monthly returns of a value-weighted portfolio of all corporate bonds a maturity greater than ten years and a value-weighted portfolio of Australian government bonds with a maturity greater than ten years; and,

$Liquidity_{i,t}$ is the systematic liquidity premium calculated earlier in this study orthogonalised to the Term and Default factors.[7]

[7] There is a high correlation between the liquidity, term and default factors. To remove the term and default factor effects from the systematic liquidity factor, we estimate an orthogonalised systematic liquidity factor. The value-weighted systematic liquidity factor exhibit a correlation with the term and default factors of 0.84, and 0.32, respectively.

4 Data

This study employs the sample of bonds which are the constituents of the UBS Australia All Composite Bond Index. Gallagher and Jarnecic (2002) note that there is extensive use of the UBS index in Australia as a benchmark. This provides some comfort that this index and the bond information from UBS is assembled using the best available price data and is accepted as the bell-weather portfolio for the Australian bond market. As a result, there is some comfort that the bonds included in the index are accurate and the price data is not stale.

In order to identify the systematic risk factors for this study, the daily bond prices of the UBS Australia Composite Bond Index constituents were obtained from Datastream. Where the bond was a constituent of the UBS Australia Composite Bond Index but no data record was present in Datastream, the bond was excluded from the analysis. As a result, this study consists of 640 bonds in the sample.

At the end of each month, the clean price, coupon rate and maturity for all semi-government, corporate and asset-backed bonds were obtained from 1 January 1999 to 31 December 2010. In the interests of obtaining reliable and indicative market prices for Australian bonds, these prices were obtained from UBS Australia, the provider of the UBS Australia All Composite Bond Index. These bond prices are employed in the calculation of returns and the estimation of the systematic risk factors.

The credit ratings for the bonds were obtained from Moody's Investor Services. Where bonds were not rated by Moody's, Standard and Poor's credit rating were employed. The Moody's Investor Services rating was selected where there was a conflict in the credit rating, consistent with Lin *et. al.,*. (2011). Table 1 shows the percentage of bonds in the data sample classified by their Moody's credit rating.

Table 1 Sample Credit Ratings

This table displays the percentage of bonds by credit rating included in the data sample. Only Moody's major credit ratings are employed in the analysis.

Aaa	Aa	A	Baa	Ba	B
44.01%	25.75%	24.27%	5.96%	0.00%	0.01%

Bond returns were calculated using price and yield data obtained on the last day of each month. The return formula is given as:

$$r_t = \frac{(P_t + AI_t) + C_t - (P_{t-1} + AI_{t-1})}{(P_{t-1} + AI_{t-1})} \quad (2)$$

where:

P_t is the clean price of the bond at the end of month t;

AI_t is the accrued interest for the bond at the end of month t;

C_t is any coupon paid during month t;

P_{t-1} is the clean price of the bond at the end of month $t-1$; and,

AI_{t-1} is the accrued interest for the bond at the end of month $t-1$.

The 90 day bank accepted bill rate was sourced from the Reserve Bank of Australia and is employed as the proxy for the risk-free rate. This data was employed to be consistent with Brailsford, Handley and Maheswaran (2008) and removes the need to estimate a risk-free rate for a significant period of analysis.[8]

The systematic default and term risk factors employed in this study are estimated as per the methodology described in Fama and French (1993). The term risk premium is the difference between the monthly value-weighted returns of Australian Commonwealth government bonds with a maturity greater than ten years and the 90 day bank accepted bill rate. The default risk premium is the difference in monthly returns of a value-weighted portfolio of all corporate bonds a maturity greater than ten years and a value-weighted portfolio of Australian Commonwealth government bonds with a maturity greater than ten years. The Australian Commonwealth government bond returns are calculated from prices obtained from the Reserve Bank of Australia website.

Following the methodology in Bianchi *et. al.,* (2013) the systematic liquidity proxy is estimated by calculating the difference in monthly returns between the 30% most illiquid bonds and the 30% most liquid bonds. The liquidity of individual bonds is estimated using the Chen, Lesmond and Wei (2007) methodology. A 12 month formation period is used to determine the liquidity of the bonds. This approach is consistent with the Chen *et. al.,* (2007)

[8] Following the election of the John Howard federal 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 Australian federal government in 2003. http://www.aofm.gov.au/content/_download/Historical_tables/Historical_07_08/TableH14.pdf

methodology. Once the liquidity of bonds is estimated, the subsequent one month return is employed to estimate the liquidity factor.

Table 2 Summary Statistics of Systematic Risk Factors

Panel A of this table presents the summary statistics of the Fama and French (1993) Australian term, default and liquidity systematic risk factors for the period 31 January 2000 to 31 December 2010. The Term factor is the difference between the monthly value weighted returns of Australian Government bonds with a maturity greater than ten years and the 90 day bank accepted bill. Default is the difference in monthly returns of a value weighted portfolio of all corporate bonds a maturity greater than ten years and a value weighted portfolio of Australian Government bonds with a maturity greater than ten years. The Liquidity factor is the difference between the monthly returns of the 30% least liquid bonds and the 30% most liquid bonds employing a twelve month formation period. Panel B of this table presents the correlation coefficients for the Fama and French (1993) Australian term, default and liquidity systematic risk factors. All correlations are for the period 1 January 2000 to 31 December 2010.

	Term Factor	Default Factor	Liquidity Factor
Panel A: Descriptive Statistics			
Mean	0.126%	0.010%	0.036%
Median	-0.023%	0.047%	0.045%
Maximum	5.393%	1.646%	2.661%
Minimum	-5.517%	-3.467%	-3.752%
Standard Deviation	2.053%	0.597%	1.080%
Panel B: Correlation Coefficients			
Term	1.0000		
Default	-0.0563	1.0000	
Liquidity	0.8409	0.3280	1.0000

Table 2 reports the summary statistics for the term, default and liquidity systematic risk factors. The average term factor risk premium in Australia during the sample period was 0.126% per month. Table 2 also reports that the average Australian default factor risk premium was 0.01% per month and a median of 0.05% per month. The term risk factor of 0.126% per month in Australia is largely consistent with other studies such as Fama and French (1993) and Lin *et. al.,* (2011) who estimate a term premium in the U.S. at 0.06% and 0.36% per month, respectively. The Australian default risk factor of 0.01% per month is in line with U.S. studies including Fama and French (1993) and Lin *et. al.,* (2011) who estimate a U.S. default risk factor of 0.02% and 0.12% per month, respectively. Finally, the U.S. studies by Fama and French (1993) and Lin *et. al.,* (2011) measure the correlation between the term factor and default factor at -0.69 and -0.46, respectively. The liquidity factor reported in Table 2 has a mean return of 0.036% per month and a median return of 0.045% a month. Panel B of Table 2 reports the correlation coefficients for the three factors employed in this analysis. The small negative correlation between the term and default factors leads to the conclusion that these two variables are uncorrelated. However, the high correlations between the liquidity factor and the term and default factors violate the Ordinary Least Squares assumptions of independence. In order to reduce the collinearity in the regressions, the liquidity factor is orthagonalised to both the term and default factor.

This study examines the ability of systematic risk factors to explain the variation of returns of three portfolios of PPP bonds. PPPs in Australia have access to a variety of debt funding options, and as a result, not all PPPs in Australia use nominal bonds to provide debt finance. In this sample period (from 1 January 2000 to 31 December 2010), there are only six PPP nominal bonds issued in Australia which are included in the UBS Australia All Composite Bond Index. As a result, these six PPP bonds will be combined into market value-weighted portfolios. Market value-weighted portfolios are employed in this study, so as to create genuine investable portfolios for the analysis. The five PPP bond issuers are Civic Nexus, Lane Cove Tunnel, Praeco, Royal Women's Hospital Finance and Southbank TAFE. This next section of this study will examine the individual PPPs separately and provides a brief background of each project. The first PPP examined is Civic Nexus.

Civic Nexus

According to Partnerships Victoria (2012), the Victorian Government entered into an arrangement with Civic Nexus to design, build, finance and maintain the Spencer Street Station (now Southern Cross Station) for a period of 30 years on 2 July 2002. Civic Nexus was led by ABN Amro Australia which also financed the PPP. Other members included Leighton Contractors, Honeywell and Delaware North Australia whose roles were to construct and operate the PPP. According to the Victorian Auditor General (2007) completion was scheduled to occur in April 2005, with the station entering the operations phase of the PPP. However, as a result of construction delays practical completion occurred in July 2006 (Partnerships Victoria (2012)). The delays in construction resulted in a dispute between Leighton Contractors and the Victorian Government. According to the Victorian Auditor General (2007) the dispute was settled following a $32.25 million payment from the State to the concessionaire and the developer.

In order to finance the development of the station, three lines of bonds were issued. Moody's (2003) identifies two lines of bonds issued in October 2002. The details of the bonds are a $157.9 million issue of nominal bonds maturing on 15 September 2014 and a $135 million issue of CPI Linked bonds maturing on 15 September 2032. Subsequently, in April 2003, a third line of bonds of US$73.9 million of nominal bonds maturing on 15 September 2014 was issued. For the purposes of this study, we examine the $157.9 million issue of nominal bonds maturing on 15 September 2014 only.

Lane Cove Tunnel

On 1 October 2003 the Lane Cove Tunnel Consortium was announced as the winner of a bidding process to finance, design, construct, operate and maintain the Lane Cove Tunnel for 30 years after construction according to RTA (2007). The members of the Lane Cove Tunnel Consortium, according to RTA (2007), were Thiess John Holland, Transfield Holdings Pty Limited, and ABN AMRO. According to RTA (2007), the Lane Cove Tunnel itself is a tolled 3.6 km dual tunnel motorway beneath Sydney. Construction was completed and operations began on 25 March 2007. Herbert (2010) details that subsequent to its opening, traffic revenue failed to meet expectations, and as a result the Lane Cove Tunnel Consortium entered into receivership in January 2010.

Moody’s (2009) reports that the original financing of the Lane Cove Tunnel included approximately $1,140 million worth of bonds that were issued in six tranches and were insured by MBIA Insurance Corporation. Tranche 1 was $127 million of CPI indexed bonds maturing in December 2028. Tranche 2 was $113 million of CPI indexed bonds scheduled to mature in September 2022. Tranche 3 was $259 million of nominal bonds scheduled to mature in December 2015.

Tranche 4 was $192 million of floating rate bonds scheduled to mature in December 2015. Tranches 5 and 6 comprised of $150 million of guaranteed fixed rate bonds due December 2013 and $301 million of guaranteed fixed rate bonds due December 2013, respectively. Not all data is available for every tranche. The only information available is for tranches 3 and 5, therefore only these tranches are included in this sample. These tranches will be denoted Lane Cove 1 for tranche 3 and Lane Cove 2 for tranche 5. Furthermore, owing to the poor performance of the toll road, the bonds issued by the Lane Cove Tunnel were removed from the UBS Australia All Composite index in March 2009. Given the exclusion from the index at this time, it is highly likely that accurate price and return data is lacking. As a result, from March 2009 the bonds are excluded from the sample in this study.

Praeco

According to the Australian National Audit Office (ANAO) (2009), Praeco Pty Limited was awarded a 30 year contract to design, construct, finance, operate and maintain Australia's Joint Operations Command facilities in May 2006. According to ANAO (2009), in return for the provision of the facilities, Praeco Pty Limited were to receive an availability payment. The members of the Praeco Pty Limited consortium were Leighton Contractors, Leighton Services and Boeing Australia Limited, which was later replaced by ABN AMRO. Construction was completed and the facilities entered service in July 2008. Once the contract is completed in July 2036, according to ANAO (2009) the facilities will revert to Australian Government ownership.

In order to finance the development of the facilities, Moody's (2007a) identified two lines of bonds issued by Praeco. These bonds were issued with a guarantee from Financial Guaranty Insurance Company. The first tranche of nominal bullet bonds had a maturity of July 2022 and a face value of $215.69 million. The second tranche of bonds were CPI linked with a face value of $52 million and a July 2020 maturity. For the purposes of this study, only the nominal bonds of Praeco will be included in the sample.[9]

Royal Women's Hospital Partnership (RWHP)

According to Infrastructure Partnerships Australia (2009) the Royal Women's Health Partnership was awarded a concession in 2005 to design, build and provide support services for the women's hospital in Melbourne. The hospital began operations on 22 June 2008 and the concession is set to expire in June 2033. Partnerships Victoria (2011) identifies the members of the Royal Women's Health Partnership as Bilfinger Berger Project Investments, Baulderstone Hornibrook, Design Inc, Woodhead International, United Group Services, ANZ and Macquarie Bank.

To finance the hospital, Moody's (2005) identifies two lines of bonds that were issued. The first nominal bond has a maturity of 26 March 2017 with a face value of $148 million. The second line of bonds are CPI index bonds with a maturity of 2 June 2033 and a face value of $145 million. Only the nominal bonds of the Royal Women's Hospital Partnership are included in the sample.

[9] All PPP bonds examined in this study are nominal bullet bonds. This is to be consistent with the prior research of Fama and French (1993) and Lin *et. al.,* (2011) which examine only nominal bonds.

Axiom Education Queensland (AEQ)

The Queensland Premier Peter Beattie (2005) announced the Axiom Education Queensland Consortium had been awarded the contract to redevelop the Southbank Institute of TAFE site in Brisbane. Axiom Education Queensland, according to Ernst and Young (2008), comprised ABN Amro, John Holland and Spotless Facilities Management. Once the site is redeveloped, the Axiom Education Queensland consortium is then responsible for the operations and maintenance for a period of 30 years. According to Queensland Treasury (2012), the project reached practical completion on 31 October 2008.

To finance the facilities of the PPP, Moody's (2007b) identified three lines of bonds issued by Axiom Education Queensland. The first line was $95 million of CPI Indexed Bonds issued in June 2005. The second line were $127.76 million of nominal bullet bonds issued in June 2006. Finally, the third line of $19.65 million of nominal annuity bonds was issued in January 2007. For the purposes of this study, the $127.76 million of nominal bullet bonds are included in the analysis.

Table 3 Descriptive Statistics of PPP Bonds

Panel A of this table presents the mean, standard deviation, median, maximum and minimum value for the individual PPP bond returns included in the sample. Panel B of this table presents the correlations of the bond returns in this study. Panel C of this table presents the revenue support mechanisms for each of the PPPs. Availability Payment is a revenue mechanism where the government pays the PPP firm for providing the infrastructure. Market Demand is a revenue mechanism where the private users of the infrastructure are the revenue source of the PPP firm. The analysis periods are as follows: Civic Nexus November 2002 to December 2010, Lane Cove Tunnel 1 December 2006 to February 2009, Lane Cove Tunnel 2 December 2006 to February 2009, Praeco December 2007 to December 2010, RWHP July 2005 to December 2010 and AEQ August 2006 to December 2010.

	Civic Nexus	Lane Cove Tunnel 1	Lane Cove Tunnel 2	Praeco	RWHP	AEQ
Panel A: Descriptive Statistics						
Mean	0.49%	-1.08%	-1.11%	0.09%	0.36%	0.31%
Median	0.66%	0.14%	-0.03%	0.17%	0.15%	0.28%
Maximum	5.02%	9.16%	10.63%	5.10%	4.63%	5.39%
Minimum	-3.65%	-31.64%	-32.45%	-6.63%	-3.23%	-5.53%
Standard Deviation	1.74%	6.52%	6.92%	3.31%	1.69%	2.13%
Panel B: Correlation Matrix						
Civic Nexus	1.00					
Lane Cove Tunnel 1	0.24	1.00				
Lane Cove Tunnel 2	0.33	0.96	1.00			
Praeco	0.55	0.60	0.70	1.00		
RWHP	0.77	0.24	0.32	0.69	1.00	
AEQ	0.64	0.37	0.42	0.77	0.87	1.00
Panel C: Revenue Support						
Availability Payment	Y	N	N	Y	Y	Y
Market Demand	N	Y	Y	N	N	N

The summary statistics for the bonds included in this study are presented in Table 3. Panel A Table 3 demonstrates that four of the six PPP bonds included in the sample exhibit positive average returns. The two bonds that exhibit negative average returns are issued by the Lane Cove Tunnel PPP project. This negative return can be explained by the financial troubles experienced by the Lane Cove Tunnel when traffic revenue failed to meet expectations. The highest average returns are exhibited by Civic Nexus. It is interesting to observe a high degree of correlation in returns, in Panel B of Table 3, for bonds issued by Civic Nexus, Praeco, Royal Women's Hospital Partnership and Axiom Education Queensland. This correlation may be due to these PPPs not entering receivership like Lane Cove Tunnel or, as a result of the revenue support mechanism which is common across these PPPs (see Panel C of Table 3).

Table 4 Descriptive Statistics of PPP Bond Portfolios

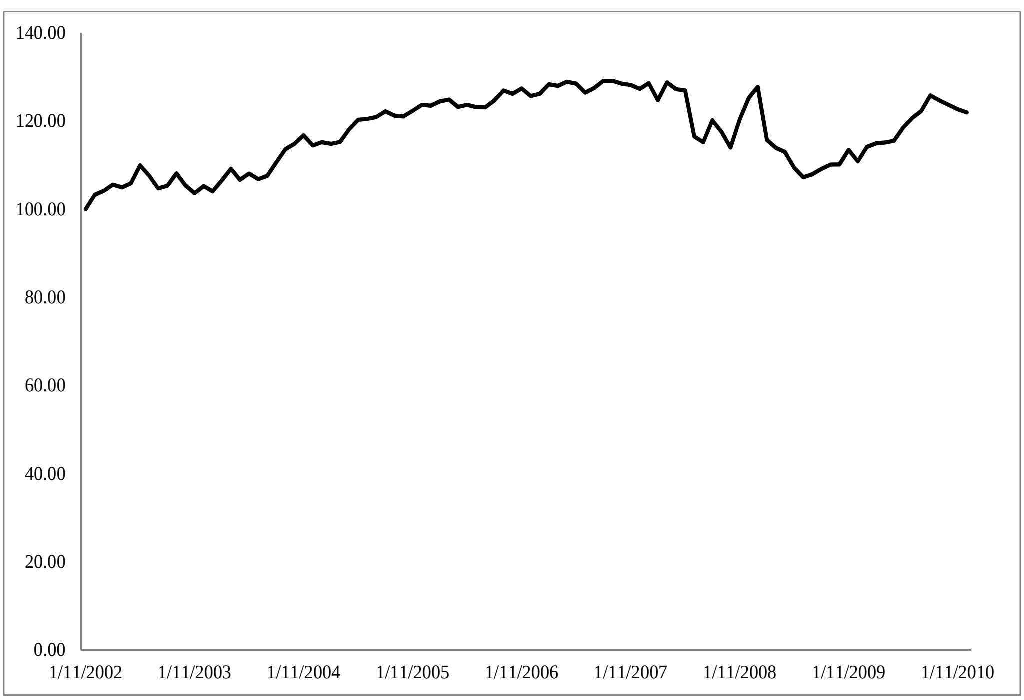
Panel A of this table presents the mean return, standard deviation, median, maximum and minimum value for the value-weighted PPP, all ex-LCT and the LCT PPP bond portfolios between 30 November 2002 and 31 December 2010. The value-weighted LCT PPP portfolio returns are for the period 28 February 2005 to 31 March 2009. Panel B of this table displays the correlation coefficients for all PPP portfolios. The correlations between the value-weighted PPP and all ex-LCT are for the period 1 November 2002 to 31 December 2010. For all correlations that include the LCT PPP portfolio, the period for analysis is from 1 February 2005 to 28 February 2009.

	Value-Weighted PPPs	All ex-LCT PPPs	LCT PPP portfolio
Panel A: Descriptive Statistics			
Mean	0.205%	0.391%	-1.093%
Standard Deviation	2.225%	1.783%	6.697%
Median	0.380%	0.615%	0.006%
Maximum	5.408%	3.811%	10.097%
Minimum	-9.901%	-3.805%	-32.155%
Panel B: Correlation Coefficients			
Value-Weighted PPPs	1.000		
All ex-LCT PPPs	0.857	1.000	
LCT PPP portfolio	0.913	0.484	1.000

The nominal bullet bonds examined in this study are employed to form three value-weighted bond portfolios and three equal-weighted bond portfolios. The first portfolio named 'Value-Weighted PPPs' includes all PPP bonds in the UBS Australia All Composite index. The second portfolio includes every bond except the Lane Cove Tunnel bonds, otherwise described as the 'All ex-LCT' portfolio. The third portfolio comprises of the Lane Cove Tunnel bonds, otherwise described as 'LCT'. The rationale behind these portfolios is simple. First, the inclusion of all bonds issued by PPPs in the first portfolio allows us to test whether the systematic risk factors can explain the variation of PPP bond returns. The subsequent subsets of this portfolio into two other portfolios is due to two reasons. Firstly, the Lane Cove Tunnel obtained the majority of its revenue from customer charges (market demand). This is different to the other PPP bonds examined which all have in some form of government availability payment as a revenue source. As a result, investors may price the Lane Cove Tunnel bonds differently to the other PPP bonds as they are exposed to greater residual risks. To test this, this study will examine whether these residual risks impact on the factor loadings. Secondly, the Lane Cove Tunnel is the only PPP within the sample that entered receivership. As a result, we separate the Lane Cove Tunnel bond from the remaining PPP bonds in the portfolio in order to better understand the conventional pricing of PPP bonds without the impact of financial insolvency. Table 4 reports the mean month return, standard deviation and median for all three PPP portfolios examined in this study.

The mean returns presented in Table 4 show that the average monthly return of the value-weighted PPP portfolio is 0.21%. This low return appears to be driven by the Lane Cove Tunnel bonds, which on average, provided a return of -1.09% per month. The negative return on the Lane Cove Tunnel bond portfolio is understandable given that it entered receivership in January 2010. Having provided a brief description of the data employed in this sample, the next section of this study will employ asset pricing models to explain these PPP returns.

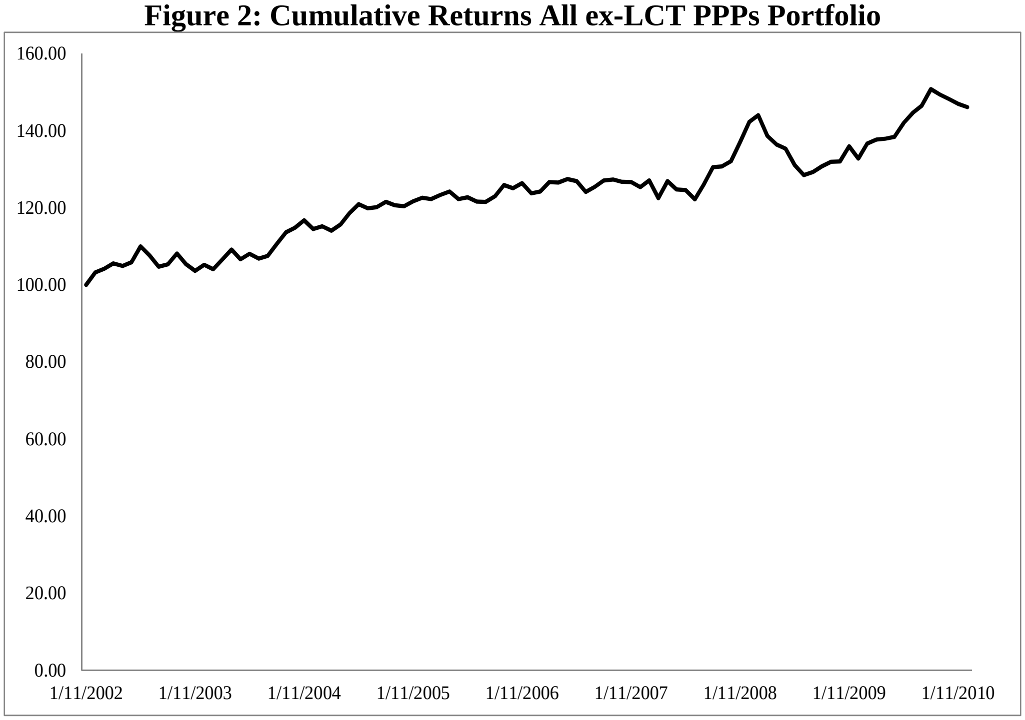
Figure 1: Cumulative Returns All PPPs Portfolio



Figures 1 to 3 display the cumulative returns for each of the portfolios examined in this study. Figure 1 displays the cumulative returns for the “All PPP bond portfolio” from November 2002 to December 2010. Figure 4-2 illustrates the cumulative returns for the All PPP except LCT portfolio from November 2002 to December 2010. Finally, Figure 3 displays the cumulative returns for the LCT bond portfolio from February 2005 to February 2009 which represents the last month before the Lane Cove tunnel’s bonds were removed from the UBS bond index.

Figure 1 shows that from November 2002 to March 2008, the All PPP bond portfolio increases steadily. From April 2008 until July 2009, the bond portfolio reports negative returns except for a sharp jump in January 2009. Finally from July 2009 to December 2010, the bond portfolio exhibits positive returns until the final two months in the sample period. The major decrease in value from April 2008 to July 2009 is due to two factors. The first factor was the Global Financial Crisis and the second was the decrease in value of the Lane Cove Tunnel bonds due to its ongoing financial difficulties. The financial difficulties of the Lane Cove Tunnel resulted in a negative impact on the bond portfolio returns as demonstrated by the strong performance of the ‘All ex-LCT’ PPP portfolio in Figure 2.

Figure 2: Cumulative Returns All ex-LCT PPPs Portfolio



The cumulative portfolio returns illustrated in Figure 2 show that the portfolio increases steadily until July 2007. From July 2007 until June 2008, returns are flat or slightly negative.

This is followed by a sharp increase in value from June 2008 until January 2009. This increase in value is followed by an almost equal decrease in value from January 2009 until July 2009. Following this period, the bond portfolio exhibits positive returns until November and December 2010. Figure 2 shows that the significant negative returns observed in Figure 1 for the All PPP portfolio for the period April 2008 to July 2009 are mostly the result of the Lane Cove Tunnel. We now proceed to examine the Lane Cove Tunnel portfolio in Figure 3.

The cumulative returns for the Lane Cove Tunnel Portfolio presented in Figure 3 show a slight increase in returns until May 2008. From June 2008 there are significant negative returns for the Lane Cove Tunnel. As previously mentioned, the Lane Cove Tunnel opened in March 2007 and the traffic figures were significantly lower than expected. This information drove the large negative returns observed from June 2008 to February 2009. The major negative returns were precipitated by a credit rating down grade issued by Moody's (ABC 2008).

The details of every PPP bond issue in the UBS bond index have been described in this section of this study. This section has also detailed the evolution of $100 invested in various portfolios of PPP bonds. We now proceed to employ the three-factor asset pricing framework to determine whether it can explain the variation of PPP bond returns.

Figure 3: Cumulative Returns LCT Portfolio

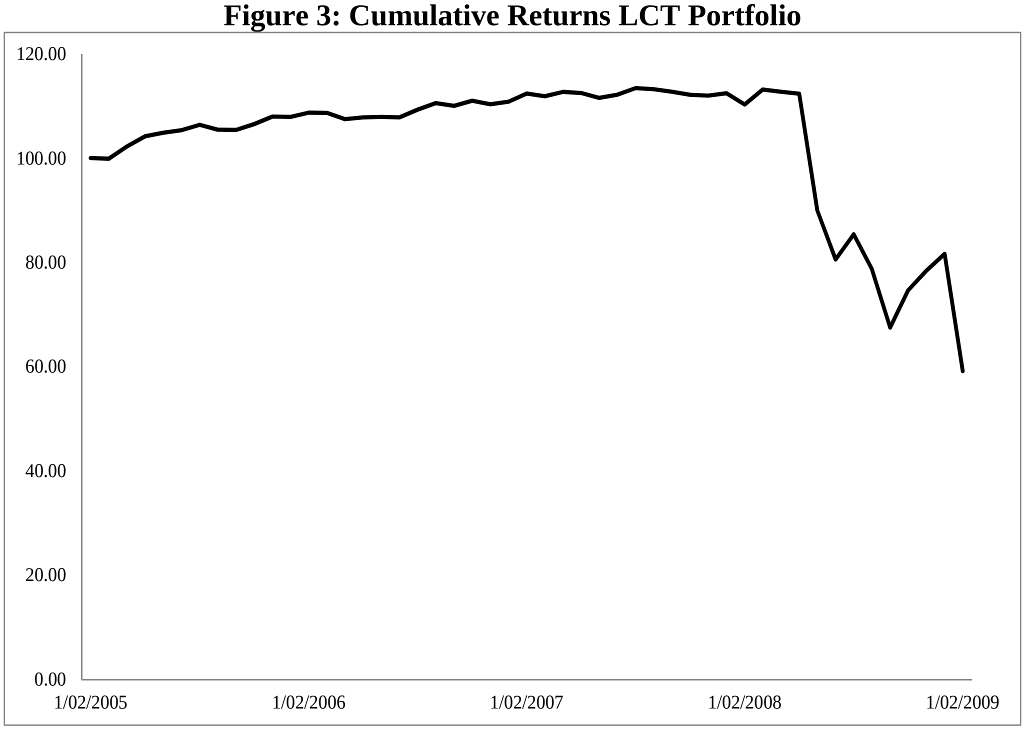


Table 5 PPP Individual Bond Portfolio Regressions

This table presents the regression results for individual bond returns employing the following equation: $R_{i,t}\text{-}R_{f,t} = \alpha_{i,t} + \beta_1 Term_{i,t} + \beta_2 Default_{i,t} + \beta_3 Liquidity_{i,t} + \varepsilon_t$ where $R_{i,t}$ is the return of the portfolio of bonds at time *t*, $R_{f,t}$ is the risk-free rate. $Term_{i,t}$ is the difference between the monthly value weighted returns of Australian Commonwealth government bonds with a maturity greater than ten years and the 90 day bank accepted bill. $Default_{i,t}$ is the difference in monthly returns of a value weighted portfolio of all corporate bonds a maturity greater than ten years and a value weighted portfolio of Australian Commonwealth government bonds with a maturity greater than ten years. $Liquidity_{i,t}$ is the value-weighted systematic liquidity premium calculated in this study orthogonalised to the *Term* and *Default* factors. Panel A reports the regression coefficients, Panel B presents the regression standard error estimates, Panel C reports the coefficient *t* statistic, Panel D presents the regression adjusted r-square values and Panel E presents the bond maturity dates. The analysis periods are as follows: Civic Nexus November 2002 to December 2010, Lane Cove Tunnel 1 December 2006 to February 2009, Lane Cove Tunnel 2 December 2006 to February 2009, Praeco December 2007 to December 2010, RWHP July 2005 to December 2010 and AEQ August 2006 to December 2010. *, ** and ^ denote statistical significance at the 10%, 5% and 1% levels, respectively.

	Intercept	Term	Default	Liquidity
Panel A: Regression Coefficient				
Civic Nexus	0.0004	0.7055	0.7945	0.0358
Lane Cove Tunnel 1	-0.0077	0.9936	4.8602	1.4333
Lane Cove Tunnel 2	-0.0071	1.2104	5.4324	1.6789
Praeco	-0.0073	1.1199	0.9209	1.9759
RWHP	-0.0004	0.7615	0.3269	0.3461
AEQ	-0.0017	0.8532	0.1797	1.1613
Panel B: Standard Error				
Civic Nexus	0.0012	0.0571	0.1727	0.2527
Lane Cove Tunnel 1	0.0078	0.3829	0.9830	1.4492
Lane Cove Tunnel 2	0.0078	0.3838	0.9852	1.4525
Praeco	0.0040	0.1503	0.3377	0.5234
RWHP	0.0010	0.0453	0.1125	0.1763
AEQ	0.0018	0.0793	0.1878	0.2971
Panel C: t-statistic				
Civic Nexus	0.309	12.349^	4.602^	0.142
Lane Cove Tunnel 1	-0.986	2.595**	4.944^	0.989
Lane Cove Tunnel 2	-0.910	3.154^	5.514^	1.156
Praeco	-1.834	7.450^	2.727^	3.775^
RWHP	-0.367	16.795^	2.906^	1.963
AEQ	-0.944	10.756^	0.957	3.909^
Panel D: Adjusted R^2				
Civic Nexus	0.6550			
Lane Cove Tunnel 1	0.3744			
Lane Cove Tunnel 2	0.4410			
Praeco	0.7287			
RWHP	0.8471			
AEQ	0.7544			
Panel E: Bond Maturity Dates				
Civic Nexus	September 2014			
Lane Cove Tunnel 1	December 2013			
Lane Cove Tunnel 2	December 2015			
Praeco	July 2022			
RWHP	March 2017			
AEQ	June 2018			

5 Results

This section will present the results of the analysis conducted to determine whether systematic risk factors can explain the variation of PPP bond returns. The analysis is presented in two parts, namely the first examines the ability of the systematic risk factors to explain the variation of individual PPP bond returns in Australia. The second part of the analysis examines the ability of the systematic risk factors to explain the variation of PPP bond portfolio returns. We report both procedures as prior asset pricing literature has demonstrated that regressions on individual assets are inefficient, and as a result, portfolios are employed to examine the pricing ability of systematic risk factors.[10] The regression described in Eq. (1) was estimated for the six bonds examined in this study and the results are presented in Table 5. The results for the PPP bond portfolio regression analysis are reported in Table 6.

Table 5 shows that the Term systematic risk factor is positive and statistically significant for all six individual bonds examined in this study. With the exception of the two Lane Cove Tunnel bonds, the longer the maturity of the bonds, the larger the term beta. The default beta is positive and statistically significant in five of the six bonds examined. The default factor is statistically insignificant for the bond issued by Axiom Education Queensland. Interestingly, the two bonds issued by the Lane Cove Tunnel, (the only PPP that entered receivership) exhibit the largest coefficients for the default premium.[11] Finally, the systematic liquidity factor is only statistically significant for the bonds issued by Praeco and Axiom Education Queensland. The adjusted r-square values imply that the three systematic risk factors explain between 37% to 84% of the variation of individual PPP bond returns. The lowest r-square values reported are for the Lane Cove Tunnel bonds which eventually were subject to financial insolvency and entered receivership.

One important observation is that the ability of the three-factor model to explain the variation of PPP bond returns is highest for bonds with the availability payment as the revenue mechanism. For Civic Nexus, Praeco, Royal Women's hospital partnership and Axiom Education Queensland, the adjusted r-square values range between 65% and 84%. Where the PPP is exposed to demand risk, as is the case of the Lane Cove Tunnel, the ability of the

[10] Black, Jensen and Scholes (1972) were one of the first studies to adopt this approach for the reasons described.

[11] This finding is consistent with the knowledge that Lane Cove Tunnel was in financial distress in the months preceding its removal from the UBS bond index.

three-factor model to explain the variation of bond returns is reduced as evidenced by the adjusted r-square values for the Lane Cove Tunnel Bonds of 37% and 44%, respectively. Whilst this may be the result of investors pricing a higher probability of default in these securities, the high default risk is a result of the demand risk of the PPP project. This finding is an original contribution to the literature. Previous work by Dailami and Hauswald (2007) and Blanc-Brude and Strange (2007) have examined the pricing of securities as a result of residual risks. These studies however, have not considered the ability of systematic risk factors to explain the variation of returns of PPPs or project finance.

Table 6 PPP Bond Portfolio Regressions

This table presents the following regressions for bond the 'All PPPs' and 'All ex-LCT PPPs' portfolios between November 2002 and December 2010. The LCT PPP portfolio returns are for the period February 2005 to March 2009. The regression is $R_{i,t}$-$R_{f,t} = \alpha_{i,t} + \beta_1 Term_{i,t} + \beta_2 Default_{i,t} + \beta_3 Liquidity_{i,t} + \varepsilon_t$ where $R_{i,t}$ is the return of the portfolio of bonds at time t, $R_{f,t}$ is the risk-free rate. $Term_{i,t}$ is the difference between the monthly value weighted returns of Australian government bonds with a maturity greater than ten years and the 90 day bank accepted bill. $Default_{i,t}$ is the difference in monthly returns of a value weighted portfolio of all corporate bonds a maturity greater than ten years and a value weighted portfolio of Australian government bonds with a maturity greater than ten years. $Liquidity_{i,t}$ is the value-weighted systematic liquidity premium calculated in this study orthogonalised to the *Term* and *Default* factors. *, ** and ^ denote statistical significance at the 10%, 5% and 1% levels, respectively.

	Intercept	Term	Default	Liquidity
Panel A: Regression Coefficient				
All PPPs	-0.0024	0.8055	1.5040	1.0084
All ex-LCT PPPs	-0.0008	0.7807	0.6901	0.6243
LCT PPPs	-0.0073	1.1317	5.2143	1.5888
Panel B: Regression Standard Error				
All PPPs	0.0015	0.0706	0.2134	0.3123
All ex-LCT PPPs	0.0008	0.0410	0.1240	0.1816
LCT PPPs	0.0076	0.3721	0.9552	1.4082
Panel C: t statistic				
All PPPs	-1.622	11.409^	7.049^	3.229^
All ex-LCT PPPs	-0.939	19.023^	5.564^	3.438^
LCT PPPs	-0.963	3.042^	5.459^	1.128
Panel D: Adjusted R^2				
All PPPs	0.6686			
All ex-LCT' PPPs	0.8195			
LCT PPPs	0.4266			

Having examined the ability of the systematic risk factors to explain the variation of individual bond returns, we now turn our attention to portfolio returns. This analysis is performed as prior research by Black, Jensen and Scholes (1972) identified that asset pricing tests on single asset tests are inefficient. As a result, they recommend such analysis should be performed on portfolios of assets. For this section, the three bond portfolios described in the Data section will now be examined.

The regression results of the bond portfolios in Table 6 reveal that term, default and liquidity are priced systematic risk factors in PPP bond returns for the entire sample and for the value-weighted All ex-LCT PPP portfolio. For the financially distressed LCT PPP portfolio, the liquidity risk factors is found to be insignificant in explaining the variation of bond returns. For all portfolios, the term and default factors are positive and statistically significant in explaining the variation of returns.[12] Furthermore, the intercept terms are statistically insignificant, suggesting that there are no omitted systematic risk factors in the model. These findings are broadly consistent with Lin *et. al.,* (2011).

This section has demonstrated that the Australian bond three-factor model explains approximately 82% of the variation in returns of the 'All ex-LCT' PPP bond portfolio and 42% of the variation in returns of the 'LCT' PPP bond portfolio. The evidence in this study suggests that the systematic risk factors of term, default and liquidity can explain the variation of PPP bond returns. Furthermore, the insignificance of the intercept term suggests that there are no excess returns to be gained for owning PPP bonds in the secondary market.

6 Conclusions

This study examined whether the systematic risk factors of term, default and liquidity can explain the variation of PPP bond returns. The analysis presented in this study suggests that these three systematic risk factors do indeed explain the variation of returns of PPP bonds and PPP bond portfolios. To the best knowledge of the authors, this is the first study that has examined whether systematic risk factors can explain the variation of PPP bond returns and therefore, this represents an original contribution to the literature.

Prior studies of project finance and PPP investments, have examined whether investors price debt according to their exposure to the residual risk of the project. This study's unique

[12] In untabulated results, similar findings are produced with an equal-weighted liquidity factor and equal-weighted PPP portfolios.

approach examines whether systematic risk factors can explain the returns of PPP bond investments. This study found that the ability of the systematic risk factors to explain the variation of PPP bond returns is highest when the bonds are issued by PPPs with government revenue support and which do not enter receivership. When investors are exposed to risks that are not managed through the contractual structure of the PPP, as evidenced by the lack of traffic demand in the Lane Cove Tunnel, the ability of the systematic risk factors to explain the variation in returns decreases as the idiosyncratic risk of a failing PPP dominates the pricing of its debt.

The findings of this study provide several avenues for future research. First, this study of PPP bonds and systematic risk factors is limited to six Australian PPPs. Performing a similar analysis on a broader sample of international PPPs would confirm whether these results hold or whether they are an Australian specific phenomenon. Second, this study included a single Australian PPP (i.e. Lane Cove Tunnel) where revenue was not supported by government. This is also the sole PPP in the sample that failed financially. It would be informative to increase this sample size to include other PPPs where the revenues are not supported by government. This will determine whether the lower adjusted r-square values observed for the Lane Cove tunnel bonds (compared to the adjusted r-square values of the other bonds in this study) is common for all PPPs that obtain revenue from user payments or whether it is a result of the tunnel's financial insolvency. Finally, this study concentrated on examining the systematic risk factors that explain nominal bond returns. However, several PPPs issued other forms of bonds such as floating rate bonds and CPI linked bonds. Given that these debt issues have been employed to provide financing for PPPs, further research is required to examine whether systematic risk factors can explain the variation of returns of these bond issues also.

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