# Why is US dollar bond funding for Australasian banks more expensive?

## 1. Introduction

Australasian banks typically raise a significant portion of their long-term funding from offshore markets such as the US bond market. The global financial crisis has led to a permanent increase in the cost of this funding: the cost of long-term US dollar funds, expressed as a spread over the US swap rate, is estimated to have increased by approximately 100 basis points between mid-2007 and mid-2010. Both the Reserve Bank of Australia and the Reserve Bank of New Zealand have attributed this increase in funding costs to an increase in the risk premium demanded by bond investors (Brown et al., 2010; Reserve Bank of New Zealand, 2010).[i] This paper examines the validity of this interpretation.

**[insert Figure 1 about here]**

Figure 1 below displays the yield for three-year US dollar bonds issued by domestic and foreign AA-rated institutions expressed as a spread over the swap rate. We use this as a representative spread facing banks raising funds from the US bond market because most major banks have a AA rating. Prior to August 2007 this yield spread tracked around 0-10 basis points. The spread began rising after August 2007 and increased sharply in late 2008 following the collapse of Lehman Brothers. At times the spread was in excess of 400 basis points. During this time the US bond market was virtually shut to non-sovereign borrowers. The spread remained elevated during early 2009 before declining throughout the remainder of 2009, falling to approximately 80 basis points by the end of October 2009. The spread began rising again in the second quarter of 2010, reaching nearly 100 basis points, principally in response to market concerns over the exposure of banks to the sovereign debt of a number of fiscally-challenged European countries.[ii]

Our research seeks an explanation for the widening of the spread on US dollar-denominated bonds issued by banks. This is an important issue because an increase in the cost of wholesale funding for Australasian banks will have real economic impacts as higher funding costs will inevitably be passed onto borrowers, making credit more expensive and potentially constraining economic activity. We collect data on the issue spread of 163 US dollar-denominated bond issues by our sample of international banks – including the major Australasian banks – over a five-year period between mid-2005 and mid-2010. Our approach is to decompose this spread into credit risk and liquidity premia and then examine if the behavior of each component is consistent with proxies for credit risk and liquidity premia. We use CDS premia used as a proxy for the credit risk component and the difference between the issue spread and CDS premium is treated as the liquidity component of the spread.

We find that the behaviour of each component is consistent with theoretical predictions. For example, we find evidence that variations in the credit risk component of the spread can be explained by variations in standard proxies for credit risk, namely bank stock prices, stock price volatility and the risk free rate, consistent with the predictions of the structural model of default. We also find evidence that the non-default component of the spread can be partially explained by the bid/ask spread in the secondary market, consistent with the liquidity premium impounding future illiquidity. We also find that the liquidity premium partially prices default risk in that the liquidity premium is higher for more vulnerable banks. Perhaps not surprisingly, this effect is negated by the presence of a government guarantee.

Our research shows that we can be more definite about the source of the "increase in the risk premium demanded by bond investors". During the height of the financial crisis investors in the US bond market demanded extra compensation for the rise in perceived default risk of banks and the deterioration in liquidity in the secondary market. Analysis of the spread decomposition over the sample period shows that the liquidity premium on bond issues towards the end of the sample period is broadly similar to the observed liquidity premium at the start of the sample period. However the credit risk premium is noticeably higher at the end of the sample period. This suggests that the increase in long-term funding costs experienced by Australasian banks raising funds in the US bond market is largely attributable to the investor perception that banks are less creditworthy than in the past.

The remainder of this paper is organised as follows. Section 2 outlines the sample of bond issues and the research methodology based around the decomposition of the issue spread into default and non-default components. Section 3 discusses the data collected for the study. Section 4 presents and discusses the empirical results. Section 5 summarises the findings, discusses the limitations of the research and future research opportunities.

## 2. Sample and Methodology

### 2.1 Sample

We draw our sample of data from all banks issuing US dollar-denominated bonds in the US bond market in the period from Monday 4 July 2005 to Friday 25 June 2010. We restrict our sample to bonds issued by the major Australian banks and their New Zealand subsidiaries – ANZ (and ANZ National), Commonwealth Bank of Australia, National Australia Bank, and Westpac (and Westpac Securities New Zealand Ltd) – and twelve large international banks from the US dollar LIBOR panel.[iii] A full list of these banks is reported in Table 1. Data were collected from Thomson Reuters Tick History (TRTH) database of Securities Industry Research Centre Asia-Pacific (SIRCA). In order to be included in the study, a bond issue had to be denominated in US dollars, classified as a straight issue with a clearly observable fixed coupon (i.e. not a floating rate) and an explicit maturity date. A total of 163 bond issues meet these criteria. Of these, 34 issues made between the fourth quarter of 2008 and the fourth quarter of 2009 were government-guaranteed.

## 2.2 Decomposition of the spread

We decompose the spread on these issuances into two components, a default component and a non-default component. This is based on the intuition that the bond spread represents compensation for two factors: (i) default-related or credit risks i.e. the risk arising from the possibility that corporate bonds may not be repaid in full or on time (Fisher, 1959), and (ii) the illiquidity of corporate bonds relative to treasury bonds. Corporate bonds must offer investors a liquidity premium for bearing the risk that they might not always be able to sell their claim immediately without incurring a substantial price discount (Longstaff, 2002).

The decomposition of corporate spreads into default and non-default components arose from the recognition spreads seemed to be too high for default risk to be the only contributing factor (Elton et al., 2001) and that changes in the spreads on corporate bonds are not well explained solely by changes in the factors affecting default risk (Collin-Dufresne et al., 2001). The results in these studies show that non-default risk is an important factor affecting corporate bond spreads. Using CDS premia as a proxy for default risk, Longstaff et al. (2005) show that the default risk component comprises only 49% of the spread over treasuries for AAA/AA-rated issuers in the US, rising to 68% for BBB-rated issuers and 84% for BB-rated issuers.

The decomposition approach is represented by the following relation:

$$SPRD_i = CRD_i + LIQ_i \qquad (1)$$

where $SPRD_i$ is the yield on bond i at issuance less the yield on a treasury bond with an equivalent term to maturity, $CRD_i$ is the credit risk associated with bond i and $LIQ_i$ is the liquidity premium on bond i demanded by investors.

Following Longstaff et al. (2005) we use the premia on a CDS written on the issuer as a proxy for $CRD_i$ and compute $LIQ_i$ as the residual. When the issue is government-guaranteed we measure $CRD_i$ using the premia on a CDS contracts written on the sovereign guarantor.[iv]

**[insert Table 3 about here]**

Over the sample of 129 non-government guaranteed issues *SPRD* ranges between 37 basis points and 562.5 basis points with a mean (median) of 158.8 (130) basis points. *CRD* ranges between 5 basis points and 341.5 basis points with a mean (median) of 69.8 (61) basis points. *LIQ* ranges between 9.2 basis points and 356.6 basis points with a mean (median) of 89.0 (72.3) basis points. At a glance this data shows that the average non-default component exceeds the default component of the issue spread.

**[insert Figure 2 about here]**

Of more importance is the variation in *SPRD*, *CRD* and *LIQ* over the sample period. Figure 2 shows that there has been a marked increase in the *CRD* following the onset of the financial crisis in August 2007. *CRD* tracked around 10 – 20 basis prior to August 2007 but rose to over 200 basis points at the height of the financial crisis. Although *CRD* has abated from its peak levels, it is still at least 70 basis points. The conventional wisdom is that the upward shift in *CRD* reflects market perceptions of a deterioration in the creditworthiness of banks over the sample period. In contrast *LIQ* has returned to pre-crisis levels despite the large increase that occurred at following the collapse of Lehman Brothers in September 2008. The increase in *LIQ* that occurred during late 2008 and early 2009 suggests that bond market liquidity became impaired at this time. Two likely sources of impaired liquidity are the more stringent constraints on bank balance sheets which limited the trading activities of the major dealers (Bank of England, 2009) and the likely impairment to the marketability of bonds issued by vulnerable issuers (Longstaff et al., 2005).

Comparison of the credit and liquidity components of the issue spread over the course of the sample period shows that the liquidity premium had returned to its pre-crisis level by the end of the sample period while the credit risk component had remained above its pre-crisis level. Thus the decomposition analysis suggests that the fundamental source of the permanently higher funding costs faced by international banks, including Australasian banks, in the US bond market is the investor perception that banks are less creditworthy than in the past. Our challenge is to account for the variation in *CRD* and *LIQ* on an issue-by-issue basis and to determine whether this variation is consistent with fundamental economic forces.

Section 2.3 describes the structural model which we use to explain the behaviour of the default risk component of the spread. Section 2.4 describes the model we employ to explain the behaviour of the non-default component of the spread.

### 2.3 The structural model of the default risk component

We use the following structural model of default to explain the behaviour of CRD for the 129 bond issues that were not government-guaranteed:

$$CRD_i = \alpha_0 + \alpha_1 STKPR_i + \alpha_2 IVOL_i + \alpha_3 RATE_i + \alpha_4 SLOPE_i + \varepsilon_i \qquad (2)$$

where $CRD_i$ is the CDS premium of issuer i (measured by the premium on a CDS contract written on the debt of the issuer with a similar term to the bond being issued), $STKPR_i$ is the stock price of issuer i, $IVOL_i$ is the implied volatility on the date of issue i, $RATE_i$ is the risk free rate on the date of issue i, $SLOPE_i$ is the slope of the yield curve on the date of issue i and $\varepsilon_i$ is a random error term..

The dependent variable $CRD_i$ is measured by the premium on a CDS contract written on the debt of the issuer with a similar term to the bond being issued. The first explanatory variable, *STKPR*, is measured by the normalised stock price of issuer i on the date of the issue relative to the stock price at the beginning of the sample period. The normalised stock price captures changes in credit quality and the perceived financial stability of the issuer. We expect a decline in the stock price of an issuer will be associated with an increase in the CDS premium since there is a greater chance that the bank will default on its credit obligations (Collin Dufresne et al., 2001; Blanco et al., 2005; Ericsson et al., 2009; Cao et al., 2010). Hence, we expect $\alpha_1 < 0$.

The next explanatory variable, *IVOL*, represents the implied volatility of put options on the stocks of the banks in the sample. Implied volatility is used rather than historical volatility because prior research finds that implied volatility explains variations in CDS premia better than historical volatility (Cao et al., 2010). We expect that an increase in volatility will increase the volatility of the issuing banks assets, increasing the probability of default (Collin Dufresne et al., 2001; Blanco et al., 2005; Ericsson et al., 2009; Cao et al., 2010). Therefore, we hypothesize a positive relationship between implied volatility and default risk i.e. $\alpha_2 > 0$.

The third explanatory variable, *RATE*, is the yield on one-year treasury bonds. Longstaff and Schwartz (1995, p 808) state that "an increase in the interest rate increases the drift rate of the risk-neutral process for firm value, which in turn makes the risk-neutral probability of default lower". We hypothesize a negative relationship between *RATE* and *CRD* i.e. $\alpha_3 < 0$. Prior research confirms a negative relationship between treasury yields and default risk (Blanco et al., 2005; Ericsson et al., 2009; Cao et al., 2010).

The last explanatory variable employed in the empirical literature is *SLOPE*, the slope of the yield curve (Collin Dufresne et al., 2001). *SLOPE* is designed to capture the term structure of interest rates and is constructed by subtracting the yield on one-year treasury bonds from the yield on ten-year treasury bonds. An upward-sloping yield curve implies higher short-term interest rates in the future, while a downward-sloping yield curve implies lower short-term interest rates in the future. Following the argument of Longstaff and Schwartz (1995), we hypothesize that an increase in interest rates should lower the probability of default. Hence, we expect to observe a negative relationship between *SLOPE* and *CRD* i.e. $\alpha_4 < 0$.

## 2.4 Modelling the liquidity component

The liquidity component is obtained by subtracting the default component of the spread from the total issue spread. Longstaff et al. (2005) report that the non-default component of the yield spread in the secondary market is well-explained by various proxies for liquidity including the bid/ask spread on the bond and the issue size. Accordingly, we specify our model as follows:

$$LIQ_i = \beta_0 + \beta_1 BAS_i + \beta_2 SIZE_i + \beta_3 TTM_i + \beta_4 COUPON_i + u_i \qquad (3)$$

where $LIQ_i$ is the spread on issue *i* less the CDS premium on the bank making issue *i* (or the government guaranteeing issue *i*), $BAS_i$ is the mean secondary market spread on the date of issue *i*, $SIZE_i$ is size of the issue *i*, $TTM_i$ is the term to maturity of issue *i*, $COUPON_i$ is the coupon of issue *i* and $u_i$ is a random error term.

The first liquidity proxy is the average bid/ask spread in the secondary market on bonds issued by the banks in my sample. In contrast to Longstaff et al. (2005) who use the spread on a specific bond in the secondary market to proxy for the liquidity of that particular issue, we define *BAS* as a market-wide liquidity proxy. We still assume that primary issues will price the likely level of liquidity currently present in the secondary market into the spread at issuance. We hypothesize that an increase in the bid/ask spread will increase the non-default component of the issue spread i.e. $\beta_1 > 0$

The second liquidity proxy is the size of the issue. We can expect that smaller issues will face higher spreads because investors face greater price risk in holding smaller issues due to the fact that they trade less frequently and price discovery is hampered (Amihud and Mendelson, 1991) and that this risk will be factored into the spread at issuance.[v] However, the alternative "price pressure hypothesis" suggests that the larger the issue in the primary market, the higher the non-default premium required to attract enough investors to ensure the entire issue is sold. On balance we have no prior expectation as to the sign of $\beta_2$.

We also introduce two variables to control for the effect of other unique features of the bond on the liquidity premium. The first control variable is the term to maturity of the issue, represented by *TTM*. Longstaff et al. (2005) suggest that there may be maturity clienteles for corporate bonds. If so, then the difference in maturities across issues may be related to differences in the non-default component. Although we have no prior expectation regarding investor preferences with respect to maturities, we also recognise that investors in longer term bonds face greater price risk and could demand compensation for this extra risk. This also suggests that the issue spread will be increasing in the term to maturity of the bond. Thus, on balance, we expect $\beta_3 > 0$.

Our second control variable is the coupon rate on the bond issue. Longstaff et al. (2005) include this variable to allow for the possibility of a tax-related component of the bond spread, expecting to observe a positive relationship between *COUPON* and the non-default component of the spread. We also acknowledge that the price risk of a bond, measured by the duration of the bond, is inversely related to the coupon rate on the bond. If investors require compensation for this risk we should observe a negative relationship between *COUPON* and *LIQ*. On balance we have no prior expectation as to the sign of $\beta_4$.

## 3. Data

### 3.1 Data for Structural Model

Data on premia of CDS contracts written on the banks and sovereign guarantors in the sample are obtained from DataStream. The observations used in the regression model represent the premium of the CDS contract on the day of the bond issue. This premium is matched to the issue based on the priority of the bonds – i,e. whether the issue is for senior or subordinate bonds – and the term to maturity of the bonds.[vi]

Stock price data for all banks in the sample are collected for the entire sample period. Because the study makes use of levels data, the share prices of all banks in the sample are indexed at 100 as at Monday 4 July 2005. Expressing *STOCKPR* in relative terms enables comparisons to be made from bank-to-bank. Stock price data are collected from DataStream.

Our *IVOL* variable is constructed from implied volatility data on put options on the stocks of LIBOR panel banks where the options satisfies two criteria: the term to expiration is between 61 and 120 days and the ratio of the exercise price-to-stock price is between 0.85 and 1.15. *IVOL* is the median implied volatility of near-the-money put options on the date of issue. Of the LIBOR banks in the sample only a small number of implied volatility observations are available on options written on Mitsubishi UFJ, the parent company of Bank of Tokyo-Mitsubishi UFJ. We calculate the mean implied volatility for each of the remaining 12 banks from data on the implied volatility of individual option series.

The yield on one-year treasury bonds is used to proxy for *RATE*. *SLOPE* is measured as the yield on ten-year treasury bond rate less the yield on one-year treasury bonds. The data are collected from DataStream.

Table 3 reports summary data on the structural model variables for the sample period. *CRD* has a mean (median) of 69.8 (61.0) basis points and ranges between 5.0 basis points and 341.5 basis points. *STKPR* has a mean (median) of 101.7 (110.3) versus a maximum of 198.2 for Commonwealth Bank of Australia and a minimum 7.0 for Citibank following the fallout from the global financial crisis. The large differences between the maximum and minimum values illustrate the dramatic differences in the fortunes of some of the sample banks during the sample period. *IVOL* has a mean (median) of 20.1% (19.4%) and ranges between a maximum of 54.9% and a minimum of 10.3%. The large difference between the maximum and minimum also illustrate the large swings that occurred in investor sentiment over the sample period. Large changes also occurred in the level and slope of the yield curve during the sample period. *RATE* ranges between 5.23% and 0.28% while *SLOPE* ranges between 3.50% and -0.43%.

**[insert Table 3 about here]**

Table 4 reports the correlations between the structural model variables over the sample period. *CRD* is highly positively correlated with *IVOL* and *SLOPE* and highly negatively correlated with *STKPR* and *RATE*. These correlations are significant at the 0.001 level. These correlations are also consistent with those reported by Ericcson et al. (2009) in their study of the determinants of CDS premia. The correlations between *CRD*, *STKPR* and *IVOL* are also as predicted by the structural model.

*STKPR*, *IVOL*, *RATE* and *SLOPE* are all highly correlated with each other – most notably *RATE* and *SLOPE* which have a correlation of -0.985 - with all correlations again significant at the 0.001 level. The high correlations between the explanatory variables of the structural model suggest that multicollinearity could be an issue if most or all of these variables are included as explanatory variables in the same regression model.

In light of the high correlations between the structural model explanatory variables evident in Table 4 we conduct variance inflation factor (VIF) analysis. Each explanatory variable is regressed on all other explanatory variables and the variance inflation factor calculated. A common rule of thumb is that multicollinearity could be influencing OLS estimates if the VIF exceeds 10 (Neter at al., 1989). The analysis yielded VIFs of 46.40 and 41.52 for the RATE and SLOPE regressions, suggest that either *RATE* or *SLOPE* should be removed from the structural regression model. As *RATE* is a fundamental variable in the structural model we decide to remove the *SLOPE* variable. When we re-estimate the VIF regressions without the *SLOPE* variable all VIFs are below 1.60. This suggests that removing *SLOPE* resolves the potential for multicollinearity.

### 3.2 Data for liquidity model

To measure the *BAS* variable we collect data from TRTH for all straight, US dollar-denominated bonds issued by banks in the sample and currently trading in the over-the-counter (OTC) market. For each day in the sample period we calculate the mean quoted bid/ask spread across these bonds to obtain a measure of market-wide liquidity for that day. Data for the issuer-specific *SIZE*, *TTM* and *COUPON* variables are also collected from the records in TRTH.

**[insert Table 5 about here]**

Table 5 reports summary data on *LIQ* and the explanatory variables for our sample of 129 non-government guaranteed issues. *LIQ* has a mean (median) of 89.0 (72.3) basis points and ranges between 9.2 basis points and 356.4 basis points. *BAS* has a mean (median) of 0.571% (0.540%) and ranges between 0.796% and 0.301%. *SIZE* has a mean (median) of $1,693 million ($1,500 million) and a maximum and minimum $5,000 million and $250 million respectively. *TTM* ranges between two and ten years with a mean (median) of 6.59 (5.00) years. COUPON has a mean (median) of 5.07% (5.38%) and ranges between 1.90% and 8.50%.

Table 6 reports the correlations between *LIQ* and the explanatory variables. *LIQ* is positively and significantly correlated with *BAS*, *SIZE*, *TTM* and *COUPON*. *BAS* is positively and significantly correlated with *SIZE*. *TTM* is positively and significantly correlated with *COUPON*. We test for potential multicollinearity between explanatory variables by using VIF analysis. None of the VIFs exceed 1.61 suggesting that multicollinearity amongst the four explanatory variables is not an issue.

**[insert Table 6 about here]**

## 4. Results

### 4.1 Structural model regression estimates

The regression estimates for the structural model are reported in Table 7. Columns (1) – (3) present the bivariate regressions of each explanatory variable with the dependent variable *CRD*. In all three bivariate regressions the explanatory variable – either *STKPR*, *IVOL* or *RATE* – has the expected sign and is highly significant. Column (4) reports the estimation results for the full structural model. The estimation results show that *STKPR* and *RATE* have the expected negative signs and the estimates are significant at the 0.001 level. *IVOL* has the expected positive sign and is also significant at the 0.001 level. The explanatory power of the full structural model is an impressive 73.9%.

Overall, the estimation results provide strong support for the predictions of the structural model: the credit risk component of the issue spread is increasing in volatility and decreasing in the stock price and interest rate. Overall the regression estimates are broadly consistent with the results of earlier research such as Blanco et al (2005), Ericcson et al., (2009) and Cao et al., (2010).

**[insert Table 7 about here]**

In order to test the robustness of the structural model we employ alternative measures of implied volatility. Our first alternative, *IVOLA*, is the median implied volatility measure calculated from all put options written on LIBOR panel banks regardless of their term to expiration and moneyness. Our second alternative, *IVOLB*, is the median implied volatility calculated from put options written on the five UK-based banks on the LIBOR panel satisfying the moneyness and term to expiration criteria used originally. The five UK-based banks on the LIBOR panel account for nearly three-quarters of the individual option implied volatility estimates. Our third alternative, *IVOLC*, is a market-wide measure of implied volatility. We use the Chicago Board Options Exchange Market Volatility Index (VIX) as our market-wide measure of implied volatility. VIX measures the implied volatility of options written on the S&P 500. VIX data are collected from Yahoo! Finance. The regression estimates are presented in Table 8.

**[insert Table 8 about here]**

The estimation results reported in Table 8 show that all three alternative measures of implied volatility have the expected positive sign and are highly significant. The results show that market-wide implied volatility proxied by VIX performs satisfactorily as a proxy for the implied volatility of bank stock prices.

### 4.2 Liquidity model regression estimates

The regression estimates for the liquidity model are reported in Table 9. Columns (1) – (4) present the bivariate regressions of each explanatory variable with the dependent variable *LIQ*. The results show that *BAS*, *SIZE*, *TTM* and *COUPON* have positive and significant, consistent with the results of the correlation analysis.

Column (5) presents the estimation results when all four explanatory variables are combined in a single model. The estimation results show that whilst *BAS*, *SIZE* and *COUPON* retain their positive signs and levels of significance, *TTM* is now negative estimate and significant at the 0.001 level. The full model has relatively high explanatory power, with an adjusted $R^2$ of 69.8%.

**[insert Table 9 about here]**

Although the VIF analysis did not indicate the likely presence of multicollinearity between *TTM* and *COUPON*, we ponder the effects of the reported high correlation between *TTM* and *COUPON* compared to the correlation between either variable and *LIQ*. We re-estimate the liquidity model deleting each of these two variables in turn. The estimation results reported in columns (6) and (7) show that *TTM* is positive and significant at the 0.05 level when *COUPON* is absent from the model although the explanatory power of the model is much reduced, with an adjusted $R^2$ of 26.6%. *COUPON* retains its positive sign and level of significance when it replaces *TTM*. The explanatory power of the liquidity model is much great with *COUPON* replacing *TTM*, with an adjusted $R^2$ of 64.2%.

Do our results make sense and how do they compare with those reported in prior research? The positive and significant estimates of *BAS* suggest that greater liquidity in the secondary market – as evidenced by a narrower spread - is reflected in lower liquidity premia, consistent with the results of Longstaff et al. (2005). This result confirms that the issue spread incorporates investor perceptions regarding future illiquidity in the secondary market. The positive and significant estimates of *SIZE* are consistent with the "price pressure" argument that investor demand for bonds in the primary market is not perfectly elastic and that price concessions in the form of a greater liquidity premium must be offered to sell a larger issue.

The positive and significant estimates of *COUPON* are consistent with the results of Longstaff et al. (2005). This earlier study recognised that this could simply reflect tax effects or the preference of investors for low coupon bonds. The mixed estimates for *TTM* are a puzzle. Longstaff et al. (2005) report positive estimates for *TTM*, consistent with a liquidity premium on longer term bonds. Our results in column (5) suggest the presence of a liquidity premium on shorter term bonds.

We also investigate the explanatory power of alternative issuer-specific measures of the bid/ask spread. First we measure the bid/ask spread associated with a particular issue by the mean bid/ask spread in the secondary market across all US dollar-denominated bonds issued by that particular issuer. This measure of the bid/ask spread is denoted *IBASA*. The untabulated results show that the estimate of *IBASA* is positive but not significantly different from zero in a bivariate regression with *LIQ* as the dependent variable. We get a similar result when we measure the bid/ask spread associated with a particular issue by the mean bid/ask spread in the secondary market across all US dollar bonds issued by the issuer subject to the bond having a remaining term to maturity of between two and ten years. This measure of the bid/ask spread is denoted

*IBASB*. These results suggest that the liquidity premia component of the issue spread prices market-wide liquidity risk rather than issuer-specific liquidity risk.

We conduct several robustness tests. First we re-estimate the liquidity model adding *STKPR* and *IVOL* to the model. We add these two structural model variables to check whether the liquidity premium also prices default risk. We conjecture that bonds issued by more vulnerable banks will be less marketable than bonds issued by healthier banks and investors may demand compensation for bearing this reduction in liquidity.

The estimation results for this simple extension to the liquidity model for the 129 non-government guaranteed bonds are reported in column (1) of Table 10. Column (2) reports the estimation results for the full sample of 163 bonds. The estimation results in columns (1) and (2) show that *IVOL* is only positive and significant at the 0.10 level for the non-government guaranteed sample of bonds. These results show that the issue spread is marginally positively associated with higher stock price volatility of non-government guaranteed bonds.

**[insert Table 10 about here]**

We acknowledge that when the liquidity model is estimated over the full sample of bonds the model should include a control for the potential impact of the government guarantee on the liquidity premium. Following Longstaff et al. (2005), we conjecture that a government guarantee could enhance the marketability of a bond, especially during times of a financial crisis.[vii] This is likely to be reflected in a lower liquidity premium on the issue. We add *GTEE* to our model where *GTEE* takes the value 1 when the issue is government-guaranteed, 0 otherwise. However the estimation results reported in column (3) show that the presence of a government guarantee does not affect the liquidity premium.

The estimation results for an alternative specification of the liquidity model employing the *GTEE* variable are presented in column (4) of Table 10. Here we include two interaction terms, *GTEE*STKPR* and *GTEE*IVOL*, to allow for the differential impact of *STKPR* and *IVOL* on the liquidity premium when a government guarantee is in place. The estimation results show that *IVOL* is positive and significant at the 0.10 level but although *GTEE*IVOL* is negative, it is not significant. However when we conduct a Wald test on the sum of *IVOL* and *GTEE*IVOL* we cannot reject the null hypothesis that the sum equals zero. These results show that whilst bank vulnerability proxied by implied volatility is weakly priced into the liquidity premium, the impact of this vulnerability is negated by the presence of a government guarantee.

## 5. Summary and conclusions

We examine the behaviour of issue spreads on USD-denominated bonds issued by a sample of international banks in order to explain why the cost of long-term debt sourced from the US bond market has increased. We decompose the issue spread on a sample of bond issues into credit or default risk and non-default or liquidity components. CDS premia are used as a proxy for the credit risk component and the residual issue spread is treated as the liquidity component of the spread. Our results show that the behaviour of each component is consistent with theoretical predictions. For example, we find evidence that variations in the credit risk component of the spread can be explained by variations in standard proxies for credit risk, namely bank stock prices, stock price volatility and the risk free rate, consistent with the predictions of the structural model of default (Merton, 1974). We also find evidence that the non-default component of the spread can be explained by liquidity variables such as the bid/ask spread in the secondary market. We also find that the liquidity premium partially prices default risk in that the liquidity premium is higher for vulnerable banks. However this effect is negated by the presence of a government guarantee.

Since comparison of the credit and liquidity components of the issue spread over the course of the sample period show that the liquidity premium had returned to its pre-crisis level by the end of the sample period while the credit risk component had remained above its pre-crisis level, we conclude that the fundamental source of the permanently higher funding costs faced by Australasian banks in the US bond market is the investor perception that banks are less creditworthy than in the past.

Our research suffers from several limitations. First, the data collected from TRTH quotes the spread on primary issues as being against treasury bonds. However the existence of a “flight to quality” effect in treasury yields (Longstaff et al., 2002) suggest that the corresponding swap rate could be a more appropriate benchmark, particular during times of a financial crisis. Second, the CDS data we use could contain a liquidity premium and thus are not a pure measure of default risk. The early part of the sample period includes a time when the CDS market was relatively new and a number of studies note that search frictions and adverse selection could have affected CDS premia (Longstaff et al., 2005; Ericsson et al., 2009). An area of interest for future research would be to use a similar framework on data from the secondary market for US dollar-denominated bonds issued by international banks. This would enable both cross-sectional and time series analysis of the CRD and LIQ components to be conducted.

## 7. References


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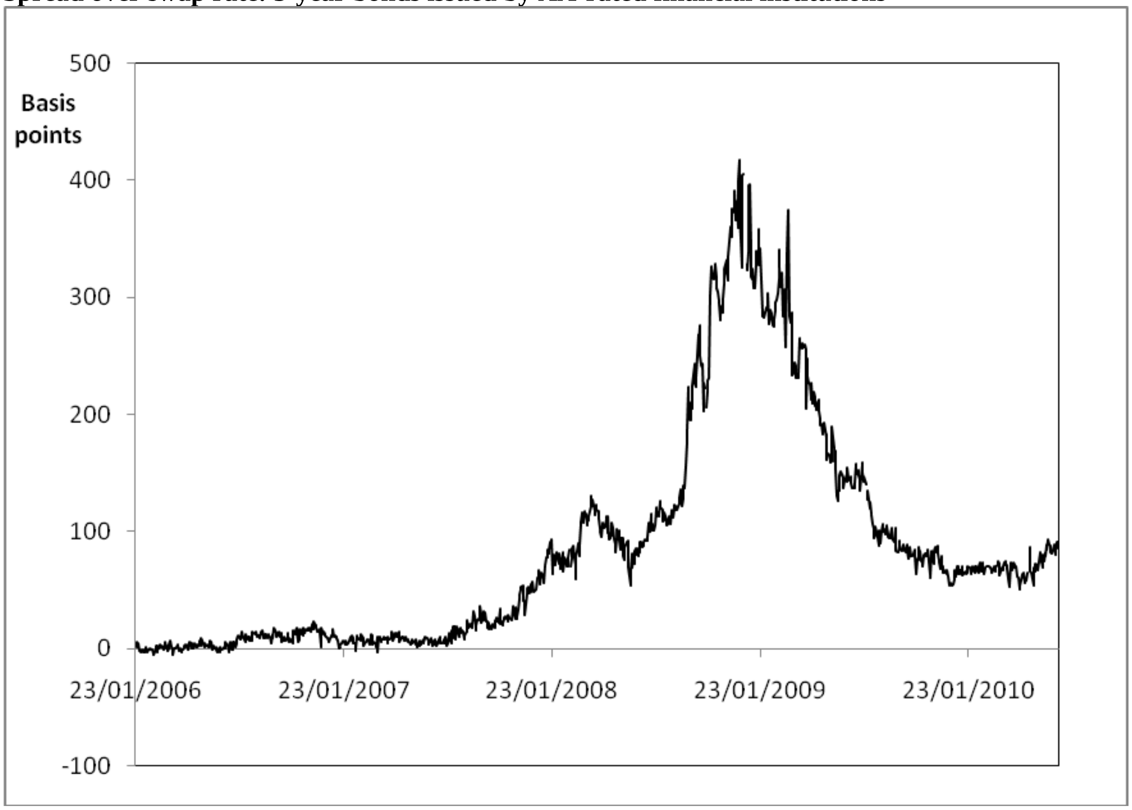
**Figure 1**
**Spread over swap rate: 3-year bonds issued by AA-rated financial institutions**




3

**Figure 2**
**Decomposition of issue spread into credit risk (CRD) and liquidity (LIQ) components**
**Non-guaranteed bonds (n = 129)**

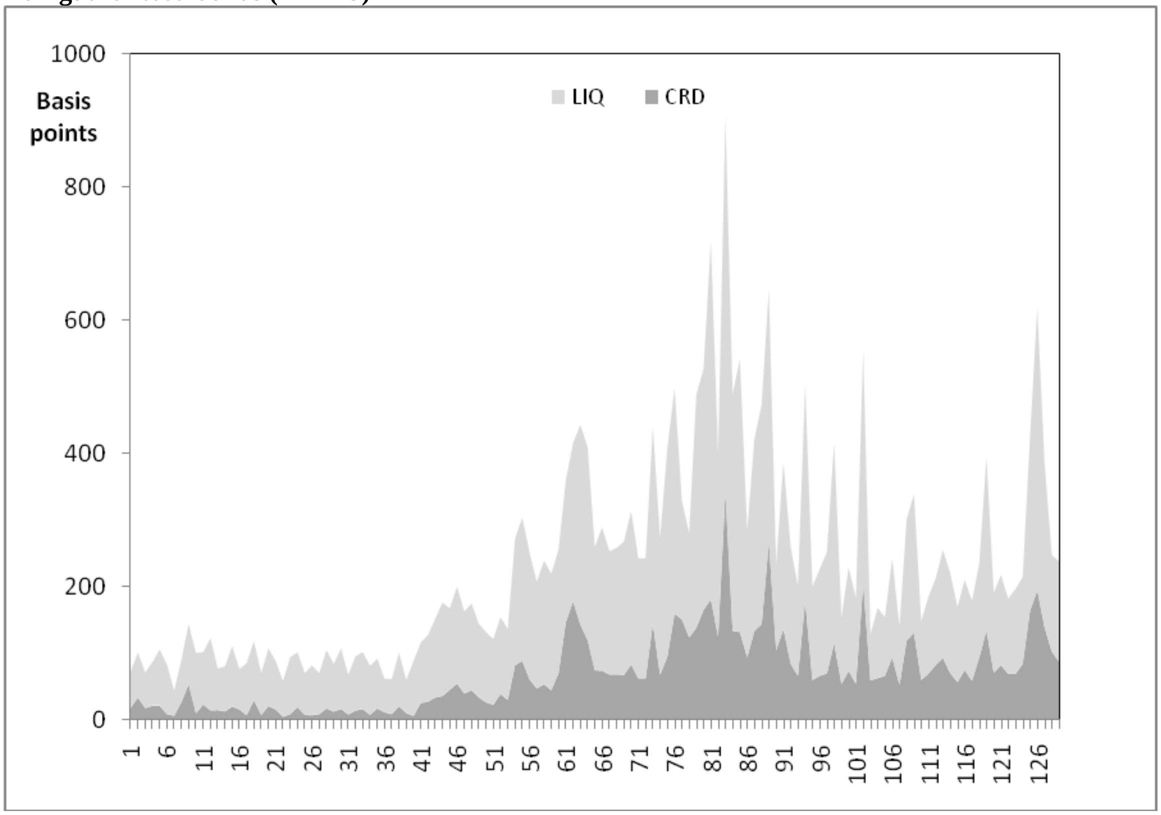


**Table 1**
**Sample banks**

| Bank | Country | No. of bond issues | Government guaranteed | Non-govt guaranteed |
|---|---|---|---|---|
| Bank of America | US | 19 | 1 | 18 |
| Citibank | US | 37 | 14 | 23 |
| JP Morgan Chase | US | 20 | 2 | 18 |
| Barclays | UK | 8 | 1 | 7 |
| HBOS | UK | 3 | 0 | 3 |
| HSBC | UK | 9 | 1 | 8 |
| Lloyds TSB | UK | 2 | 0 | 2 |
| Royal Bank of Scotland | UK | 7 | 4 | 3 |
| Deutsche Bank | Germany | 6 | 0 | 6 |
| Credit Suisse | Switzerland | 13 | 0 | 13 |
| UBS | Switzerland | 4 | 0 | 4 |
| Bank of Tokyo-Mitsubishi UFJ | Japan | 2 | 0 | 2 |
| ANZ | Australia | 4 | 1 | 3 |
| CBA | Australia | 12 | 6 | 6 |
| NAB | Australia | 5 | 0 | 5 |
| Westpac | Australia | 6 | 2 | 4 |
| ANZ National | New Zealand | 4 | 1 | 3 |
| Westpac NZ | New Zealand | 2 | 1 | 1 |
| | | 163 | 34 | 129 |

**Table 2**
**Descriptive statistics on components of issue spread**
**Non-guaranteed bonds (n = 129)**

| | *SPRD* | *CRD* | *LIQ* |
|---|---|---|---|
| Mean | 158.8 | 69.8 | 89.0 |
| Median | 130.0 | 61.0 | 72.3 |
| Maximum | 562.5 | 341.5 | 356.4 |
| Minimum | 37.0 | 5.0 | 9.2 |
| Std. Dev. | 101.5 | 58.0 | 55.7 |

**Table 3**
**Descriptive statistics for structural model variables**
**Non-guaranteed bonds (n = 129)**

| | *CRD* | *STKPR* | *IVOL* | *RATE* | *SLOPE* |
|---|---|---|---|---|---|
| Mean | 69.8 | 101.7 | 38.4 | 2.48 | 1.58 |
| Median | 61.0 | 110.3 | 37.5 | 2.08 | 1.75 |
| Maximum | 341.5 | 198.2 | 107.5 | 5.23 | 3.50 |
| Minimum | 5.0 | 7.0 | 16.2 | 0.28 | -0.43 |
| Std. Dev. | 58.0 | 43.3 | 18.8 | 1.96 | 1.41 |

**Table 4**
**Correlations between structural model variables**
**Non-guaranteed bonds (n = 129)**

| | *CRD* | *STKPR* | *IVOL* | *RATE* |
|---|---|---|---|---|
| *STKPR* | -0.651*** | | | |
| *IVOL* | 0.721*** | -0.358*** | | |
| *RATE* | -0.704*** | 0.359*** | -0.734*** | |
| *SLOPE* | 0.653*** | -0.351*** | 0.664*** | -0.984*** |

*** Significant at the 0.1% level

**Table 5**
**Descriptive statistics for liquidity model variables**
**Non-guaranteed bonds (n = 129)**

| | *LIQ* | *BAS* | *SIZE* | *TTM* | *COUPON* |
|---|---|---|---|---|---|
| Mean | 89.0 | 0.571 | 1,693 | 6.59 | 5.07 |
| Median | 72.3 | 0.540 | 1,500 | 5.00 | 5.38 |
| Maximum | 356.4 | 0.796 | 5,000 | 10.09 | 8.50 |
| Minimum | 9.2 | 0.301 | 250 | 2.25 | 1.90 |
| Std. Dev. | 55.7 | 0.126 | 951 | 2.64 | 1.17 |

**Table 6**
**Correlations between liquidity model variables**
**Non-guaranteed bonds (n = 129)**

| | *LIQ* | *BAS* | *SIZE* | *TTM* |
|---|---|---|---|---|
| *BAS* | 0.384*** | | | |
| *SIZE* | 0.410*** | 0.240** | | |
| *TTM* | 0.169 | -0.148 | 0.150 | |
| *COUPON* | 0.584*** | -0.217 | 0.145 | 0.605*** |

*** Significant at the 0.001 level ** Significant at the 0.01 level

**Table 7**
**Structural model estimation results**
**Non-guaranteed bonds (n = 129)**

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| Constant | 155.958 | -13.374 | 122.003 | 108.053 |
| | (11.87)*** | (-1.39) | (15.77)*** | (6.34)*** |
| *STKPR* | -0.847 | | | -0.556 |
| | (-7.32)*** | | | (-6.11)*** |
| *IVOL* | | 2.243 | | 1.112 |
| | | (7.63)*** | | (3.67)*** |
| *RATE* | | | -21.007 | -8.545 |
| | | | (-11.87)*** | (-4.03)*** |
| Adjusted $R^2$ | 0.395 | 0.516 | 0.501 | 0.729 |
| F-statistic | 84.51*** | 126.86*** | 129.28*** | 106.62*** |

*** Significant at the 0.001 level

**Table 8**
**Structural model robustness test results**
**Non-guaranteed bonds (n = 129)**

| | (1) | (2) | (3) |
|---|---|---|---|
| Constant | 94.345 | 100.024 | 90.706 |
| | (5.02)*** | (4.94)*** | (5.57)*** |
| *STKPR* | -0.564 | -0.546 | -0.524 |
| | (-5.99)*** | (-5.61)*** | (-5.77)*** |
| *IVOLA* | 1.291 | | |
| | (4.38)*** | | |
| *IVOLB* | | 1.219 | |
| | | (3.70)*** | |
| *IVOLC* | | | 2.947 |
| | | | (5.02)*** |
| *RATE* | -7.438 | -7.974 | -10.813 |
| | (-3.84)*** | (-3.49)*** | (8.01)*** |
| Adjusted $R^2$ | 0.727 | 0.731 | 0.739 |
| F-Statistic | 107.69*** | 100.64*** | 121.93*** |

*** Significant at the 0.001 level

**Table 9**
**Liquidity model estimation results**
**Non-guaranteed bonds (n = 129)**

| | **(1)** | **(2)** | **(3)** | **(4)** | **(5)** | **(6)** | **(7)** |
|---|---|---|---|---|---|---|---|
| Constant | -7.991 | 48.291 | 65.468 | -51.887 | -210.777 | -50.284 | -210.805 |
| | (-0.36) | (5.65)*** | (5.10)*** | (-2.68)** | (-7.97)*** | (-1.93) | (-7.28)*** |
| *BAS* | 170.020 | | | | 207.125 | 149.073 | 212.207 |
| | (3.99)*** | | | | (7.66)*** | (3.74)*** | (7.16)*** |
| *SIZE* | | $2.405 \times 10^{-2}$ | | | $1.299 \times 10^{-2}$ | $1.779 \times 10^{-2}$ | $1.169 \times 10^{-2}$ |
| | | (4.06)*** | | | (4.21)*** | (3.35)** | (3.69)*** |
| *TTM* | | | 3.571 | | -6.315 | 3.659 | |
| | | | (1.98)* | | (-3.77)*** | (-2.06)* | |
| *COUPON* | | | | 27.775 | 39.676 | | 31.336 |
| | | | | (6.65)*** | (8.94)*** | | (9.94)*** |
| Adjusted $R^2$ | 0.140 | 0.162 | 0.021 | 0.336 | 0.698 | 0.266 | 0.642 |
| F-statistic | 21.91*** | 25.71*** | 3.75 | 65.83*** | 74.84*** | 16.44*** | 77.60*** |

*** Significant at the 0.001 level ** Significant at the 0.01 level * Significant at the 0.05 level

**Table 10**
**Liquidity model robustness test results**

| | **(1)** | **(2)** | **(3)** | **(4)** |
|---|---|---|---|---|
| Constant | -203.285 | -238.535 | -233.642 | -209.446 |
| | (-4.40)*** | (-7.68)*** | (-7.09)*** | (-4.98)*** |
| *BAS* | 149.000 | 217.915 | 217.584 | 157.800 |
| | (2.18)* | (5.51)*** | (5.47)*** | (2.53)* |
| *SIZE* | $0.832 \times 10^{-2}$ | $0.780 \times 10^{-2}$ | $0.757 \times 10^{-2}$ | $0.666 \times 10^{-2}$ |
| | (2.45)* | (2.49)* | (2.41)* | (2.29)* |
| *TTM* | -5.624 | -6.633 | -6.546 | -6.411 |
| | (-3.40)*** | (-4.04)*** | (-3.91)*** | (-3.94)*** |
| *COUPON* | 39.987 | 43.329 | 42.486 | 41.566 |
| | (8.09)*** | (11.31)*** | (10.05)*** | (9.055)*** |
| *STKPR* | -0.015 | 0.018 | 0.007 | -0.005 |
| | (-0.20) | (0.32) | (0.12) | (-0.07) |
| *IVOL* | 0.740 | 0.264 | 0.288 | 0.741 |
| | (1.78)+ | (1.60) | (1.71)+ | (1.91)+ |
| *GTEE* | | | -5.394 | 32.640 |
| | | | (-0.57) | (1.15) |
| *GTEE*STKPR* | | | | 0.044 |
| | | | | (0.30) |
| *GTEE*IVOL* | | | | -0.628 |
| | | | | (-1.46) |
| Adjusted $R^2$ | 0.716 | 0.710 | 0.709 | 0.715 |
| F-statistic | 50.60*** | 62.70*** | 53.51*** | 43.10*** |

*** Significant at the 0.001 level ** Significant at the 0.01 level * Significant at the 0.05 level + Significant at the 0.10 level

[i] The increase in funding costs in local currency terms is even higher after taking into account the increased cost of hedging the foreign exchange risk with a cross-currency interest rate swap.

[ii] It should be noted that these spread changes have been a global phenomenon and not limited solely to the US dollar bond market. For instance, spreads on sterling-denominated bonds issued by financial institutions also widened abruptly during the financial market turmoil that followed the collapse of Lehman Brothers (Bank of England, 2009).

[iii] The US dollar LIBOR panel comprises 16 banks. Of these four banks were excluded from our sample. Three banks - Norinchukin Bank, Rabobank, and West Landesbank - are excluded from the sample because they are not publicly-listed and a fourth bank, Royal Bank of Canada, is excluded due to the absence of CDS data.

[iv] The collapse of Lehman Brothers was followed by the virtual closure of the bond markets to non-sovereign borrowers. This led governments in a number of countries to introduce guarantees on wholesale market bond issue to ensure that banks could continue to raise long-term funding on reasonable terms. The effect of the introduction of government guarantees is to significantly lower the spread on bond issues. For example on the 23rd of March 2009 Citibank issued $1,000m worth of bonds at a spread over the treasury bond rate of 75.1 basis points, while the comparable CDS (trading on unguaranteed Citibank debt) was priced at 785 basis points.

[v] In their study of bond spreads in the secondary market Longstaff et al. (2005) consider the size of the issue as indicator of the volume available for trading in the secondary market. They conjecture a negative relationship between the size of an issue and the liquidity component of the bond's spread.

[vi] Senior bonds have a superior claim on the issuers' assets and income than other (subordinate) bonds issued by the same entity. Subordinate bonds are ranked below senior bonds. Therefore the CDS premia for contracts written on senior bonds is lower than CDS premia for contracts written on subordinate bonds (Campbell and Tasker, 2003).

[vii] Longstaff et al. (2005) use a similar argument to justify the inclusion of a dummy variable for highly-rated issuers.