Determinants of Credit Spread Changes: Evidence from the Australian Bond Market

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Abstract

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Evidence from the Australian Bond Market

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ABSTRACT

This paper is one of the first to examine the empirical determinants of credit spread changes on corporate bonds in the Australian market. Eight different credit spread changes are analysed corresponding to bonds of four different credit ratings and four different maturity ranges. We investigate the explanatory power of several variables derived from structural models of corporate default. Also included in the analysis are variables designed to capture the liquidity component of the credit spread. Results indicate that changes in the spot rate and changes in the slope of the yield curve are the most important determinants of credit spread changes. Overall, the model is able to describe a large proportion of the variation in credit spread changes – up to 60 percent. The model provides the best fit for credit spreads in well established bond markets.

Keywords: Credit Spreads; Bonds; Liquidity

1. INTRODUCTION
Much academic, industry and media attention has focused on the impact that credit has had on the recent financial climate. For the middle part of the 2000s, historically low credit spreads provided institutions, private equity groups and corporations with an inexpensive source of capital, a phenomenon which partially contributed to a concurrent wave of merger and acquisition activity (Demchuk and Gibson, 2006). During 2007 and 2008, lack of freely available credit, arising from the effects of the sub-prime mortgage crisis, had an incredible effect on business viability, economic growth and the stock market (Rappaport and Ng, 2009). In very recent times, the resumption of normal lending conditions has coincided with positive stock market returns and improved business and consumer confidence (Rappaport and Ng, 2009). In all instances, changes in credit market conditions have preceded significant changes in stock markets and the wider economy. Therefore, an understanding of the determinants of credit spread changes is particularly important.

The purpose of this study is to examine the empirical determinants of credit spread changes in the context of the Australian bond market using yields derived from bond indexes. We examine several variables that are hypothesised to influence the spread under structural models of corporate default. Several liquidity related variables are also included since it is shown that some portion of the spread arises to compensate for relative differences in liquidity between the two securities upon which the spread is measured (Chen, Lesmond and Wei, 2007). The third component of the spread, a tax-premium, documented in studies of U.S. credit spreads (e.g. Elton, Gruber, Agrawal and Mann, 2004) is not relevant in the Australian context. Income from corporate and government bonds attracts the same rate of tax for Australian residents. A study of credit spreads in Australia therefore, has the natural advantage in that a potential confounding factor – tax differences between securities – is absent.

This paper is one of very few to document the determinants of credit spread changes in the Australian market. Batten and Hogan (2003) examine credit spread innovations on Australian dollar denominated Eurobonds. They find that changes in the risk free rate are negatively correlated with credit spreads and that during the period June 1997 to August 1998 stock market returns also exhibit a negative relation with spreads. Investigating bonds partitioned by maturity and rating, they find that other explanatory variables have little influence on the spread except in isolated circumstances. This paper adds new perspective to the issue of credit spreads in Australia by examining fixed income securities traded in the domestic market, rather than Australian dollar denominated Eurobonds. We also broaden the analysis contained in Batten and Hogan (2003) by utilising variables that attempt to capture the liquidity premium inherent in the spread.

Results indicate that the variables are able to explain a large proportion of the changes in the credit spread when bonds are partitioned according to credit rating. We achieve adjusted R-squared values of up to 0.60. Innovations to interest rate factors are the most important determinants of credit spread changes, specifically changes in the spot rate and changes in the slope of the yield curve. When partitioned by varying levels of maturity the model does not explain much of the variation in spread changes for spreads involving bonds maturing beyond three years. We hypothesise that this may have to do with the lack of outstanding bonds with maturities beyond three years in the Australian market.

The rest of this paper is organised as follows. Section 2 presents the variables that are incorporated in the model. Section 3 describes the data, while Section 4 presents the results of the analysis. Section 5 concludes.

2. THEORY AND VARIABLE SELECTION

The variables considered in this analysis are designed to capture the default risk and liquidity premium components of the spread. The time period of analysis is weekly observations (Friday) during the period 29 June, 2003 to 2 March, 2007. [1]

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[1] Data are available on a daily basis for the following variables: Credit spreads, the spot rate, yield curve slope, market capitalisation of the Financials (excluding property trusts) index, SPI 200™ Index Futures returns, and option implied volatilities. However, certain variables are only available on a monthly basis: the dollar value of outstanding government and corporate securities, the liabilities of Australian institutions and fund flows of bond investment managers. A tradeoff exists between incorporating more observations (by using daily data) versus incorporating more explanatory variables (by using monthly data). A compromise is made by using weekly observations with cubic-spline interpolation of monthly data.

2.1 Default risk

Structural models of default provide insight into the determinants of the credit spread. Beginning with the work of Merton (1974), the basic framework of these studies involves modelling the processes that describe firm value and the default threshold. In Merton's seminal work, the firm value process follows a geometric Brownian motion, under certain stylised assumptions, with a fixed default threshold equal to the face value of promised payments. Subsequent studies have sought to generalise Merton's model to include, for example, different conditions for the default threshold whether exogenous (Black and Cox, 1976) or endogenous (Leland, 1994; Leland and Toft, 1996), stochastic interest rates (Longstaff and Schwartz, 1995), stationary leverage ratios (Collin-Dufresne and Goldstein, 2001) and the information contained in stock market returns (Demchuk and Gibson, 2006). Any changes in factors that cause the firm value and the default threshold to converge (or diverge) are, theoretically, determinants of changes in the credit spread. Collin-Dufresne, Goldstein and Martin (2001) perform an empirical study on the determinants of credit spread changes and utilise variables that feature prominently in structural models of default. Most of the variables considered in this analysis are drawn from their study and are adjusted to reflect institutional differences between the U.S and Australian bond market.

The spot rate is a fundamental variable in structural models of default, though only relatively recent literature in this area allows for time variation in the spot rate (e.g. Longstaff and Schwartz, 1995, Collin-Dufresne and Goldstein, 2001). Longstaff and Schwartz (1995) argue that spreads and the risk free rate should exhibit a negative relationship, since an increase in the risk free rate increases the risk-neutral drift of the process that describes firm value and thus reduces the probability of default. The yield on the 10 year government bond rate (from the Reserve Bank of Australia Statistical Tables) proxies for the spot rate. Following Collin-Dufresne *et al.* (2001) and Batten and Hogan (2003), the squared value of this variable is also included to account for non-linear effects in the term structure.

Spot rate determinants also feature in empirical studies of credit spreads. The slope of the yield curve is defined as the difference between the ten year government bond yield and the three year government bond yield. This variable incorporates information about future spot rates and provides an indication of broader economic conditions. Changes in the slope of the yield curve should be negatively related to credit spreads.

Longstaff and Schwartz (1992) include short run interest rate volatility in their model of the term structure. We use the volatility implied from options on three year government bond futures contracts to capture interest rate uncertainty. This data is sourced from Bloomberg and represents the average of the implied volatility from the nearest-to-expiry at-the-money put and call option. Since the spot rate and volatility are positively correlated, following from arguments above, changes in implied volatility should be negatively related to changes in credit spreads.

Firm leverage is an important factor in default. In Australia, bonds are predominantly issued by the major retail banks and other financial institutions with very few 'true corporates' seeking capital via the bond market. As of June 2006, outstanding debt from non-financial institutions totalled only 6.3% of the Australian bond market (Bush, 2006). Therefore, despite the aggregated nature of bond indexes it is possible to proxy (albeit with noise) the leverage ratio of firms within the index using data on aggregate liabilities of banks, financial corporations and money market issuers. Leverage ratios are calculated as follows:

$$Leverage\ Ratio = \frac{Liabilities}{Liabilities + Market\ Cap}$$

where *Liabilities* are measured as the sum of monthly totals on liabilities from banks, financial corporations and money market issuers from Reserve Bank of Australia statistical tables and *Market Cap* is the market capitalisation of the Financials Index (excluding listed property trusts) produced by Standard & Poor's. Since data on liabilities are only available on a monthly basis, cubic-spline interpolation is used to generate higher frequency observations.

Finally, several equity market variables are used to capture various elements of the default process. The return on the market provides an indication of business conditions and expected recovery rates during default. Demchuk and Gibson (2006) use stock market performance as a factor in their structural model of corporate default and predict that in times of negative stock market returns, credit spreads widen. The proxy for the market performance is the weekly return calculated using prices on SPI 200™ Index Futures obtained from Bloomberg.

We also incorporate the average volatility implied from the nearest-to-expiry at-the-money put and call options on SPI 200™ Index Futures. Since the contingent-claims approach of Merton (1974) treats debt as writing a put option, increases in underlying asset volatility increase the value of this option and hence implies an increase in the probability of default. Therefore changes in implied volatility should increase credit spreads under structural models of default.

2.2 Liquidity risk

Amihud and Mendelson (1986) argue that investors require compensation for the costs associated with trading securities. Since liquidity and transaction costs are directly related, their hypothesis predicts that less liquid securities will have lower prices, all things equal. In the context of fixed income securities, this implies higher yields on less liquid securities (Amihud and Mendelson, 1991) and wider credit spreads for less liquid corporate bonds (Chen, Lesmond and Wei, 2007). The liquidity variables considered in this analysis are available only on a monthly basis and therefore cubic-spline interpolation is used to generate higher frequency observations.

If transaction costs and liquidity are directly linked to the supply of corporate bonds, then the value of outstanding corporate bonds should be related to the liquidity premium. We anticipate that positive changes in the value of outstanding corporate bonds will reduce credit spreads. To capture demand side effects of liquidity we also employ a metric from Fridson and Jonsson (1995)[2]. Building on the intuition that institutional investors are the primary participants in bond markets, they find that aggregate fund flows into high-yield bond mutual funds, standardised by net assets, are negatively related to spreads on high-yield bonds.[3] If fund flows

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[2] And subsequently used in Barnhill, Joutz and Maxwell (2000), Joutz and Maxwell (2002) and Huang and Kong (2003).

[3] Unlike Fridson and Jonsson (1995) the focus of this study is on the investment grade sector of the bond market. The reason for this is that the high yield bond market is not well established in Australia. There is no reason to expect that the Fridson and Jonsson (1995) metric will have a different effect, in terms of direction, for investment grade bonds. In terms of magnitude, however, one might expect that the effect of fund flows on credit spreads is more pronounced for the high yield bond market.

cause corporate bond fund managers to increase their trading activity[4] this improvement in liquidity should be reflected in corporate bond markets with higher prices, lower yields and tighter credit spreads. Our sample compromises all bond investment funds available from Morningstar Direct which are domiciled in Australia, trade domestic securities and are labelled by Morningstar as having predominantly institutional shareholders. We calculate a fund's monthly standardised fund flows (*SFF*) as follows:

$$SFF_t = \frac{Size_t - Size_{t-1}(1 + return_t)}{Size_{t-1}}$$

and sum across all funds that have data in a given month, *t*. The number of funds in our sample is 109.

3. DATA

Credit spreads are calculated using bond index data. Bond index levels and corresponding yields are provided by Australian Financial Markets Association Services (AFMA). The use of bond index data is motivated by several factors. Firstly, transaction data for individual bonds in Australia is not easily accessible. Secondly, if it were available infrequent trading would most likely render analysis of such data problematic. In contrast, the bond indexes are constructed daily using indicative prices obtained from bond market participants.[5] This mechanism ensures that the bond indexes reflect new information in a timely manner and thus enables accurate calculation of the credit spread at a given point in time. Finally our sample of bond indexes incorporates information from the entire universe of investment grade fixed income securities in the Australian market, ensuring completeness.

AFMA bond indexes are partitioned by S&P credit rating (AAA, AA, A, BBB) or by maturity (AFMA defined maturity ranges of 1 to 3 years, 3 to 5 years, 5 to 7 years and 7 to 10 years). In this study therefore, we investigate eight different credit spreads. The data set provided to us does not have indexes partitioned by both credit rating and maturity over the relevant time period. The credit spread is simply the difference between a corporate bond index yield and a government bond index yield of the same maturity range.

Summary statistics of the eight credit spreads analysed in this study are presented in Table 1. As expected, spreads increase monotonically as credit rating falls or maturity lengthens. When divided by rating, average credit spreads range from 44.75 basis points for AAA rated bonds to 83.19 basis points for BBB rated bonds. For different maturity lengths, average spreads range from 55.62 basis points for bonds maturing in 1 to 3 years, to 76.91 basis points for bonds maturing in 7 to 10 years. These values are towards the lower end of historical long run averages. Interestingly, examination of mean and median first differences in spreads shows that there is no general trend in terms of spread movement across credit rating or maturity. According to both mean and median statistics AAA and A spreads increase over the period of analysis, while BBB spreads decrease. There is no consensus between mean and median values (in terms of sign) for AA spreads or any of the spreads is Panel B of Table 1. The volatility of credit spread movement,

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[4] Edelen (1999) finds that for every dollar of fund flows into equity mutual funds incremental trading activity increases by seventy cents. It is not unreasonable to infer that a similar phenomenon might exist for fixed income investment managers.

[5] The prices are provided by certain bond market participants to AFMA in an anonymous manner and are not available individually. The information contained in these prices is only available in an aggregate nature via the bond indexes provided by AFMA.

as measured by standard deviation, tends to be higher for spreads on lower rated bonds and bonds with longer maturities, though the relationship is not monotonic increasing.

Table 1
Summary Statistics

This table presents the mean, median and standard deviation of the credit spreads analysed in this study. The spreads are partitioned according to Standard & Poor's credit rating (Panel A) or by maturity (Panel B). All values are in basis points and differences are based on weekly (Friday) values. The period of analysis is 29 June, 2003 to 2 March, 2007.

	Levels			Differences		
	Mean	Median	Std Dev	Mean	Median	Std Dev
Panel A: Rating						
AAA	44.75	45.31	9.41	0.08	0.14	1.68
AA	49.99	51.68	13.89	0.05	-0.06	2.40
A	66.22	69.90	14.44	0.11	0.12	2.19
BBB	83.19	86.10	14.16	-0.12	-0.05	4.01
Panel B: Maturity						
1-3 years	55.62	54.48	5.63	0.02	-0.02	1.51
3-5 years	61.69	61.66	3.41	-0.04	0.03	1.45
5-7 years	72.61	73.25	8.66	0.14	-0.16	3.23
7-10 years	76.91	74.69	9.78	0.18	-0.21	5.10

4. EMPIRICAL RESULTS

The variables included in the regression, their expected sign and unit of measurement are summarised in Table 2. For each credit spread j, the following regression is estimated:

$$\Delta CS_t^j = \alpha + \beta_1 \Delta r_t^{10} + \beta_2 \Delta (r_t^{10})^2 + \beta_3 \Delta slope_t + \beta_4 \Delta \sigma_t^3 + \beta_5 \Delta lev_t +$$
$$\beta_6 r_t^{spi} + \beta_7 \Delta \sigma_t^{spi} + \beta_8 \Delta out_t + \beta_8 \Delta SFF_t + \varepsilon_t \qquad (1)$$

The results of the regression for each credit rating and maturity range are presented in Panels A and B, respectively, of Table 3.

Table 2
Description of Explanatory Variables and Expected Sign of Coefficients
This table presents the variables contained in the regression model, their unit of measurement and expected sign.

Variable	Description	Unit	Expected Sign
ΔCS_t^j	Changes in credit spread j	Basis points	n/a
Δr_t^{10}	Changes in the 10 year government bond yield	%	-
$\Delta (r_t^{10})^2$	Changes in the squared value of the 10 year government bond yield	%²	-
$\Delta slope_t$	Changes in the yield of 10 year government bonds minus the yield of 3 year government bonds	%	-
$\Delta \sigma_t^3$	Changes in the volatility implied by options on 3 year government bond futures	%	-
Δlev_t	Changes in the leverage ratio of banks and financial institutions	n/a	+
r_t^{spi}	Returns on SPI 200™ Index Futures	%	-
$\Delta \sigma_t^{spi}$	Changes in the volatility implied by options on SPI 200™ Index futures	%	+
Δout_t	Changes in the dollar value of outstanding corporate bonds	AUD billions	-
ΔSFF_t	Changes in the total net fund flow to bond mutual funds, standardised by net assets	n/a	-

As expected, spreads on investment grade bonds are most sensitive to interest rate rather than asset factors. All spreads across the credit rating spectrum (Panel A, Table 3) are negatively related to changes in the spot rate, consistent with theoretical predictions (Longstaff and Schwartz, 1995) and empirical findings of previous studies (Batten and Hogan, 2003; Huang and Kong, 2003; Collin-Dufresne et al., 2001; Kao, 2000). Interestingly, changes in the slope of the yield curve also possess a significant amount of explanatory power for changes in AAA, AA and A spreads – a finding inconsistent with previous work.[6] For changes in AA and A spreads, innovations to market volatility are also statistically significant at the 10% level. A notable result is that the liquidity variables are poor explanators of changes in credit spreads, with all coefficients lacking statistical significance or the expected sign, or both. This might be due to the fact that the liquidity variables are constructed from monthly data and lack the required precision, or that the indicative prices provided by the market participants do not reflect temporary liquidity constraints.

It is apparent that the explanatory power of the model (as measured by model R-squared), when spreads are divided by maturity, is not as large as when spreads are divided by credit rating. When divided by maturity, the results indicate that the spot rate is an important determinant for spreads on bonds in the shortest maturity categories. For the remaining statistically significant coefficients, there appears to be no discernible pattern across the term structure. However, almost all significant coefficients possess the sign predicted by theory. Finally, the covariates as a whole are best able to describe changes in spreads at the short end of the maturity curve, but possess less explanatory power as the maturity of corporate bonds increases.

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[6] Batten and Hogan (2003) and Collin-Dufresne et al. (2001) find that the coefficient on the changes of the slope of the yield curve are not significant explanators of changes in the credit spread.

Table 3
Regression Coefficients

This table presents the results of the regression on various credit spreads. Credit spreads are partitioned by credit rating (Panel A) or maturity (Panel B). Coefficient values are presented (t-statistics in parentheses).

Variable	AAA	AA	A	BBB
Panel A – Credit Ratings				
α	0.36	0.36	0.59	0.40
	(2.00)**	(1.59)	(2.77)***	(0.74)
Δr_t^{10}	-5.59	-11.12	-9.94	-16.44
	(-6.13)***	(-9.55)***	(-8.87)***	(-6.05)***
$\Delta (r_t^{10})^2$	-7.87	-10.32	-20.91	5.02
	(-1.48)	(-1.52)	(-2.98)***	(0.32)
$\Delta slope_t$	-22.03	-27.07	-24.29	-7.62
	(-8.60)***	(-8.28)***	(-7.86)***	(-1.00)
$\Delta \sigma_t^3$	0.26	-0.25	0.32	-0.30
	(0.42)	(-0.32)	(0.45)	(-0.16)
Δlev_t	-329.83	-3771.56	-2397.43	-9970.01
	(-0.14)	(-1.24)	(-0.86)	(-1.41)
r_t^{spi}	-8.95	-0.37	-3.31	-22.62
	(-0.67)	(-0.02)	(-0.19)	(-0.56)
$\Delta \sigma_t^{spi}$	-0.10	0.40	0.20	0.70
	(-0.59)	(1.78)*	(0.91)	(1.33)
Δout_t	-0.14	-0.12	-0.17	-0.35
	(-1.19)	(-0.82)	(-1.24)	(-1.01)
ΔSFF_t	-0.02	0.08	0.36	0.03
	(-0.09)	(0.24)	(1.21)	(0.04)
Adj. R^2	0.504	0.605	0.605	0.230
Panel B – Maturity				
	1 to 3 years	3 to 5 years	5 to 7 years	7 to 10 years
α	0.58	0.26	0.74	0.92
	(2.86)***	(1.26)	(1.54)	(1.18)
Δr_t^{10}	-5.04	-3.74	0.53	-1.88
	(-4.88)***	(-3.49)***	(0.22)	(-0.47)
$\Delta (r_t^{10})^2$	-14.81	-6.11	-15.04	-16.41
	(-2.46)**	(-0.98)	(-1.05)	(-0.71)
$\Delta slope_t$	4.34	3.52	-16.26	-4.89
	(1.49)	(1.16)	(-2.35)**	(-0.44)
$\Delta \sigma_t^3$	-0.88	0.31	1.24	-1.89
	(-1.26)	(0.42)	(0.75)	(-0.70)
Δlev_t	-4039.38	-5065.99	2332.27	-11158.00
	(-1.50)	(-1.81)*	(0.36)	(-1.07)
r_t^{spi}	-51.17	-9.97	-40.61	-43.73
	(-3.36)***	(-0.63)	(-1.12)	(-0.74)
$\Delta \sigma_t^{spi}$	-0.37	0.11	-0.74	0.43
	(-1.83)*	(0.52)	(-1.56)	(0.55)
Δout_t	-0.16	-0.15	-0.29	-0.38
	(-1.18)	(-1.07)	(-0.92)	(-0.76)
ΔSFF_t	0.14	0.17	0.37	-0.47
	(0.49)	(0.58)	(0.54)	(-0.43)
Adj. R^2	0.214	0.075	0.019	0.032

*** Significant at the 1% level
 ** Significant at the 5% level
  * Significant at the 10% level

At this point it is worth noting that the model appears to be the best fit for spreads on lower risk bonds – corporate bonds at the short end of the term structure or with AAA, AA and A ratings. When divided by credit rating the model is able to explain a large proportion of the variation in credit spreads for AAA, AA and A bonds, with adjusted R-squared values of 0.504, 0.605 and 0.597 respectively. The model describes only 23% of the variation in the dependent variable for changes in BBB spreads. Furthermore, as previously noted, there is a monotonic decrease in model fit as maturity range increases.

There is no *a priori* reason why there should be a difference in model explanatory power based on risk. We suspect that this difference is actually related to the sophistication of the Australian bond market for corporate bonds with high credit ratings and short maturities. For most of the period of analysis between 50-70 percent of outstanding corporate debt had maturities less than three years (Bush, 2006) and it is well known that AAA, AA and A-rated bonds are the most prevalent in the Australian market. It is this prevalence that implies that these types of bonds have greater analyst coverage, informational transparency and trading activity. Bonds outside this concentration, therefore, represent atypical securities and may have greater incidence of mispricing or experience liquidity effects not captured by the liquidity variables in the model. In their analysis of credit spreads on Australian Eurobonds, Batten and Hogan (2003) note that their highest R-squared values are obtained for regressions involving the most liquid bonds in their sample.

Another explanation for the relationship between model explanatory power and the various credit spread classes might lie in the nature of the index composition. The yields in this study represent a weighted average of the bond yields that compose the relevant index. Indexes that have fewer securities, such as the BBB index or the longer term indexes are more sensitive to idiosyncratic movements in the constituents. Therefore, it is possible that the yields and spreads derived from these indexes are not completely explained by the broad market and macroeconomic variables contained in this study.

5. Conclusion

This study examines the determinants of changes in the credit spreads of Australian investment grade corporate bonds over the period 29 June, 2003 to 2 March, 2007. The variables analysed in this study include several factors designed to capture the default risk component and liquidity components of the spread. Credit spreads are calculated using bonds partitioned by four categories of credit rating or four categories of maturity. Results indicate that changes in the spot rate and changes in the slope of the yield curve are the most important determinants of credit spreads overall, with both variables exhibiting a negative relationship with credit spreads. The importance of the spot rate as a determinant of credit spread changes has been documented previously, however the slope of the yield curve has been found to be of little significance. The other variables do not seem to be systematically related to credit spread changes across the rating classes or term structure. In particular, the liquidity variables examined in this study do not appear to be significantly related to changes in credit spreads. We suspect that this is due to the fact that the liquidity variables considered in this analysis lack the required precision, since they are constructed from monthly data.

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