Determinants of Credit Default Swap Spread: Evidence from Japan

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Abstract

In this paper, we investigate the determinants of credit default swap (CDS) spread for the Japanese market, which is one of the major CDS markets in the world. Our assessment of literature indicates that there is a lack of related empirical research using data from the Japanese market. By analyzing data from 2001 to 2004, the empirical results show that the theoretical determinants, including leverage, historical volatility, and risk-free rate, perform well in explaining cross-sectional variation in the level of CDS spread. We also find that the effects of the theoretical determinants are more sensitive for lower credit rating firms than those with a higher credit rating. Finally, our findings remain robust for different sub-sample periods.

JEL Classification: G00; G19

Keywords: Credit Default Swap Spread; Credit Risk; Structure Model

1. Introduction

Credit derivative market, which emerged at the beginning of the 1990's, has grown rapidly. In 2007, the market exceeded 60 trillion dollars in outstanding notional principal.[1] The credit derivative instruments enable market participants to manage credit risk in much the same way as market risk. Among various types of credit derivative, single-name credit default swap (CDS) is one of the most popular types. It provides a payoff equal to the loss-given default on bonds or loans of a reference entity (obligor), triggered by credit-related events such as default, bankruptcy, failure to pay, and restructuring. The buyer pays a premium as a percentage of the notional value of the bonds or loans each quarter, denoted as an annualized spread in basis points, and receives the payoff from the seller should a credit-related event occur prior to the expiration of the contract.

Following Merton's (1974) pathbreaking work, the basic structure model has been extended in different ways.[2] Many papers have studied the theoretical determinants of corporate credit spread for structural model, including leverage, asset volatility, and interest rate (see Collin-Dufresne, Goldstein, and Martin (2001); Boss and Scheicher (2002); Van Landschoot (2004); Shinsuke and Takuya (2007)). These studies use corporate bond data to estimate and analyze credit spreads. In addition, recent availability of CDS data provides researchers a more accurate way to study credit risk (see Hull, Predescu, and White (2004); Longstaff, Mithal, and Neis (2005); Fabozzi, Cheng and Chen (2007); Ericsson, Jacobs, and Oviedo (2009)). Apart from the above studies based on the U.S. data, there are also related studies using non-U.S. data. Specifically, Cossin, Hricko, Aunon-Nerin, and Hyang (2002) analyze 392 CDS quotes using international data, majority of which are the U.S. companies. In addition, Jakovlev (2007) contributes the literature by focusing on 50 European companies. His empirical results concerning theoretical determinants are mixed, but mainly in line with the previous studies.

Although there are many empirical studies on the determinants of CDS spread in the

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[1] Useful survey can be found in International Swaps and Derivatives Association, Inc. (ISDA) Market Survey Report (http://www.isda.org/statistics/pdf/ISDA-Market-Survey-annual-data.pdf).

[2] See Black and Cox (1976), Geske (1977), Longstaff and Schwartz (1995), Anderson and Sundaresan (1996), Leland and Toft (1996), Leland (1998), Duffie and Lando (2000), Collin-Dufresne and Goldstein (2001).

U.S and Europe, to the best of our knowledge, there is no empirical study on CDS spread in Japan, given that it is one of the major credit derivative markets in the world. We thus contribute the related literature by studying the determinants of CDS spread for Japanese market for the first time. The aim of this study is to test how well theoretical determinants suggested by the structural approach are able to explain credit spread in Japanese market.

The CDS market in Japan has grown tremendously during the past years. Although credit derivatives are traded over the counter, which makes the market size difficult to estimate, the Japanese credit derivative market appears to grow significantly over the past years. For example, according to the Bank of Japan's regular derivatives market statistics (Yoshikuni statistics), the notional principal was 17.48 billion dollars in December 2001 and surged to 30.47 billion in June 2004. In addition, in July 2004, credit Japan (CJ50) and TRAC-X Japan combined into the Dow Jones iTraxx CJ, which provide evidence that Japan plays an important role in the credit derivatives market.[3] Remolona and Shim (2008) shows that Asia-Pacific single-name CDS contracts comprise almost 25% of all those traded around the world, and most of the CDS contracts are traded in Japan. Apart from the important role of Japanese CDS market both regionally and globally, Japanese economy has been mired in the low interest rate situation since 1995. Most of the large Japanese enterprises follow a Keiretsu system, and Japanese firms have close relation with main banks. Therefore, it would be intriguing to study whether the determinants of CDS spread for Japanese markets would be different from those for the U.S. and European markets.

We carry out a panel regression analysis on the relationship between CDS spread based on the economic theory of the structure model. Our findings show that the leverage and implied volatility are positively related to CDS spread, while the sign of the estimated coefficients of the risk-free rate is negative. The above results are consistent with the theory with statistical significance. Overall, we find that the CDS spread for Japanese markets shares the same characteristics as those in the U.S. and Europe (see Jakovlev (2007); Ericsson, Jacobs and Oviedo (2009)). By separating our sample based

[3] In Japan, the indexation of CDS prices (premiums) began in September 2002 when Morgan Stanley Securities developed the MSJ-CDS index with 25 constituents. Later in January 2003 J.P. Morgan Securities developed JANICE, an index with 45 constituents, while BNP Paribas and others developed the CJ50 with 50 constituents in February. In July 2003, MSJ-CDS and JANICE combined to form TRAC-X Japan.

on credit rating, we find that the effect of leverage, historical volatility, and risk-free rate are larger for lower credit rating firms than those with a higher credit rating. Finally, our findings remain robust for different sub-sample periods in Japanese market.

The rest of this paper is organized as follows. In Section 2, we describe related literature review. In Section 3, we describe the data used in this study and present the methodology. In Section 4 we analyze the empirical results. We report the results on the robustness check in Section 5, and finally Section 6 concludes the paper.

2. Literature Review

There are two major models for credit spread dynamics: (i) structure model and (ii) reduced-form model. Structure model derives from Black and Scholes (1973) and Merton (1974). This model assumes that a firm's value follows a stochastic process and the default occurs when the firm value falls below a certain threshold, such as the nominal value of debt. Therefore, the model's link with a firm's economic fundamentals is explicit. Ericsson, Jacobs, and Oviedo (2009) suggest certain theoretical determinants of credit spread. First, leverage is the center of the model. The higher leverage of a firm, the higher the probability of default. Second, the structure model implies that the debt claim has features similar to short position in a put option. Increasing in volatility leads to higher option value and lower value of debt claim, resulting in higher credit spread. This prediction is intuitive, since higher volatility increases the probability of default. Third, the level of the risk-free rate also affects the value of option. The risk-free rate determines the risk-adjusted drift of the firm value, and thus an increase in the risk-free rate tends to decrease risk-adjusted default probabilities and the spread as well. The same argument has been shown in models in Longstaff and Schwartz (1995). Consequently, there is a negative relation between risk-free rate and credit spread.

On the other hand, a reduced-form model (see Litterman and Iben (1991); Jarrow and Turnbull (1995)) assumes that the mechanism governing a default process is unobservable and a latent factor known as default intensity determines the probability of default. In this paper, we apply the structure model to the empirical examination of the Japan CDS market, because it explicitly describes the default mechanism and enables us to analyze the relationship between credit spread and financial and macroeconomic variables.

We now briefly review some of the prior research regarding the theoretical determinants of corporate credit spread based on structure models. Collin-Dufresne, Goldstein, and Martin (2001) investigate the determinants of credit spread changes. They use monthly data of U.S. industrial bonds from July 1988 to December 1997 and find that the effects of changes in leverage and implied volatility are positive on credit spread changes. The sign of the estimated coefficients of changes in risk-free rate is significantly negative. Collin-Dufresne, Goldstein and Martin (2001) further consider several financial and economic variables to the regression model; this model has slightly higher explanatory power, and the main results still hold. They also suggest that credit spread differences in the corporate bond market are mainly driven by local supply/demand shocks.

Unlike Collin-Dufresne, Goldstein and Martin (2001), Campell and Taksler (2003) and Cremers, Driessen, Maenhout, and Weinbaum (2008) study the effect of volatility on corporate bond spreads using different measures of volatility. Both studies confirm that volatility is an important determinant of credit spread. In addition to the U.S. market, Van Landschoot (2004) studies credit spreads in the European market to confirm the validity of the structure model. He reports that short-term interest rate, the slope of the government bond yield curve, and the stock returns are negatively correlated with credit spread, while the implied volatility of stock options is positively correlated with credit risk. Shinsuke and Takuya (2007) also studies credit spreads in the Japanese bond market, and their results are consistent with the implications of structure models and with the related literatures in the U.S. and Europe.

The above research uses corporate bond data to estimate credit spreads. Although there is a close relation between corporate bond and CDS spreads (see Duffee (1998) and Blanco, Brennan, and Marsh (2005)), the latter are preferable from several perspectives when analyzing the determinants of the shape of the credit curve (see Hull, Predescu, and White (2004); Blanco, Brennan, and Marsh (2005); Longstaff, Mithal, and Neis (2005); Fabozzi, Cheng and Chen (2007), Ericsson, Jacobs, and Oviedo (2009)). Zhang, Zhou and Zhu (2006) study the CDS spreads on 307 reference entities from 2001 to 2003, and their results show that volatility and jump variables alone explain 54% of the credit spreads. In addition, they find that the sensitivity of volatility and jump is clearly higher among lower rated entities. Overall, their results are consistent with the implications from structure models, which incorporate stochastic volatility and jumps. Ericsson, Jacobs, and Oviedo (2009) use a new dataset of bid and offer quotes for daily credit default swaps on the U.S. companies from year 1999-2002 and investigate the relationship between theoretical determinants of default risk and actual market premia. The empirical results show that there is a positive relationship between CDS spread and leverage and volatility. In addition, there is a negative relation between CDS spread and risk-free rate. Overall, the results are robust across various specifications.

As for the studies using non-U.S. data, Cossin et al. (2002) use international data to analyze 392 CDS quotes, majority of which are U.S. companies. They find that all of the theoretical factors have a significant influence and that taken together these factors drive much of the variation in the pricing of credit default swaps. Jakovlev (2007) contributes the literature by focusing on 50 European companies. His empirical results show that, in line with the theory, leverage ratio, risk-free interest rate, and historical equity volatility are statistically significant determinants in level regressions.

3. Data and Methodology

3.1 Credit Default Swap

For our empirical analysis, we use the weekly composite spread of five-year single-name CDS ($spread_{it}$), which is the most liquid and most common credit derivative in recent years (see Benkert (2004); Jakovlev (2007); Ericsson, Jacobs, and Oviedo (2009)). We obtain the CDS data from a comprehensive database from the Markit Group. This database provides international daily CDS composite spreads on more than 3,000 individual obligors starting from 2001. The daily composite spreads are computed from quotes contributed by more than 30 banks and are undergone a statistical procedure where outliers and stale quotes are removed. In addition, three or more contributors are needed before a daily composite spread is calculated, ensuring a reasonable quality of the data. The sample period for Japan is from January 2001 to December 2004.

3.2 Firm-Level and Market-Level Variables

The data for the theoretical determinants of the CDS spread and other variables in the regression model are constructed as follows and are summarized in Table 1.

Leverage ($leverage_{it}$): The leverage ratio is defined as book value of debt divided by the sum of market value of equity and book value of debt. The Japanese market value of equity and book value of total liabilities are obtained from PACAP database. In structure approach, a firm assumed to default when its asset value drops below value of debt that is when its leverage ratio exceeds one. Increase leveraged leads to higher default probability and thus to higher CDS spread.

Historical Volatility (vol_{it}): The time series of Japanese equity volatility is compute for each company using a shifting window of 180 daily returns obtained from PACAP database for every week. In the empirical literature on the determinants of CDS spread, our approach is similar to that of Campbell and Taksler (2003), Jakovlev (2007), and Cremers et al. (2008). The structure approach implies that the debt claim has features similar to short position in a put option. Increase in volatility leads to higher option value and lower value of debt claim, resulting in higher CDS spread. This prediction is intuitive since higher volatility makes assets value more likely to reach default boundary.

Risk-Free Rate ($r_t^{2\text{-}year}$): Weekly data on 2-year Japanese government bond yields are collected from Datastream database. The level of the riskless rate also affects the value of the option. Although the correlation between the risk free rate and the bond spread is, strictly speaking, not part of Merton's (1974) analysis which relies on a constant interest rate, the framework does predict a negative relationship between these two variables. The reason is that the risk free rate determines the risk adjusted drift of firm value, and thus an increase in the risk free rate would tend to decrease risk adjusted default probabilities and CDS spreads. The same result has been shown in models where the dynamics of the risk free rate have been modelled explicitly.[4]

Square of Treasury Bond Yield ($r_t^{2-year^2}$): To capture potential nonlinear effects due to convexity, we also include the squared level of the term structure for Treasury bond.

Slope of Yield Cure ($slope_t$): In order to measure the slope of the yield curve, we calculate the difference between 10-year and 2-year Japanese government bond yields also obtained from Datastream database. We interpret the economic influence of the yield curve as conveying information on business conditions. For example, in Longstaff and Schwartz's (1995) model with stochastic interest rate, short-term interest rates are in the

[4] See Longstaff and Schwartz (1995) and Collin-Dufresne, Goldstein, and Martin (2001)

long run expected to converge to long-term interest rate. Hence, an increase in the slope should lead to an increase in the expected future spot rate and lower CDS spread. On the other hand, an increase in yield curve slope may also imply an improving economy and thus lead to lower CDS spread.

Market Return ($mrktret_t$): We use weekly return on NIKKEI 225 index obtained form PACAP database as a proxy for the overall business climate.

【Insert Table 1】

3.3 Summary Statistics

To be included in the final sample, we require the obligors have at least 252 observations of the CDS spread. These requirement ensure that each obligor have at least one year of weekly data for the firm-level time-series regression analysis. This leaves us with a final sample of 106 firms from January 2001 to December 2004. To better illustrate the features of CDS data in Japan, we graphically present in Figure 1 time-series trend of CDS spread for our sample period. We observe that during the first half of our sample period, the CDS spread moves upwards. However, there is a downward trend for the CDS spread during the second half of the sample period. Furthermore, it is intuitive that low credit rating firms have larger CDS spread, while firms have high credit rating have smaller CDS spread.

【Insert Figure 1】

Panel A of Table 2 presents the cross-sectional summary statistics of the time-series mean of the variables. We observe that mean CDS spread is 53.7665 basis points, and the standard deviation is 70.9347 basis points, indicating that there are firms with very high levels of CDS spreads. Panel B of Table 2 reports the correlation among variables. The preliminary results show that financial leverage, firm specific volatility, and the risk-free rate, suggested by economic theory, seem to be more closely related to the CDS spread.

【Insert Table 2】

3.4 Regression Models

Since our data contain both cross-sectional and time-series dimensions, we apply a panel data regression framework with fixed effect (see Campbell and Taksler (2003); Jakovlev (2007); Cremers et al. (2008)). First, we run univariate regressions for the CDS spread on each of the explanatory variables based on the theoretical determinants of credit spread, i.e., leverage, historical volatility, and risk-free rate. The univariate regressions for level data of CDS spread are as follows.

$$spread_{it} = \alpha_{0i} + \alpha_1 leverage_{it} + \varepsilon_{it}\,; \tag{1}$$

$$spread_{it} = \alpha_{0i} + \alpha_1 vol_{it} + \varepsilon_{it}\,; \tag{2}$$

$$spread_{it} = \alpha_{0i} + \alpha_1 r_t^{2-year} + \varepsilon_{it}\,. \tag{3}$$

Next, we run a multivariate regression for the CDS spread on all the three variables, as shown in Equation (4). Finally, we include other market-level explanatory variables, such as square of Treasury bond yield, slope of yield curve, and market return, for completeness. The model is shown as Equation (5).

$$spread_{it} = \alpha_{0i} + \alpha_1 leverage_{it} + \alpha_2 vol_{it} + \alpha_3 r_t^{2-year} + \varepsilon_{it}\,; \tag{4}$$

$$\begin{aligned} spread_{it} = \alpha_{0i} + \alpha_1 leverage_{it} + \alpha_2 vol_{it} + \alpha_3 r_t^{2-year} + \alpha_4 r_t^{2-year^2} \\ + \alpha_5 slope_t + \alpha_6 mrktret_t + \varepsilon_{it} \end{aligned}\,. \tag{5}$$

4. Regression Results

4.1 Regression Analysis on the Whole Sample

We report the empirical results for the whole sample in Table 3. A number of important findings are obtained. First, we find that the coefficients on leverage are significant and positive. Second, the coefficients on historical volatility are also positively significant. Third, the results on the risk-free rate confirm the theoretical expectation, because there is a significant negative relation between CDS spread level and risk-free rate. Our results are consistent with the implications of structure model and with prior literature in the U.S. and Europe (see Ericsson, Jacobs, and Oviedo (2005); Jakovlev (2007)). We note that the negative correlation between spreads and the risk-free rate discussed above has also been documented for bond yield spreads by Longstaff and Schwtz (1995) and Duffee(1998).

Furthermore, for the multivariate regression, we show that the coefficient on the slope of the yield curve in Model (5) is negative, being consistent with the theoretical predictions. Longstaff and Schwartz (1995) suggest that short-term interest rate is, in the long run, expected to converge to long-term interest rate. Hence, an increase in the slope should lead to an increase in the expected future spot rate and to a lower CDS spread.

【Insert Table 3】

4.2 Regression Analysis Based on Credit Rating and Sub-Sample Period

We observe a broad spectrum of different credit quality, rating from AAA (investment-grade) to B (speculative-grade), among our sample firms. An important question is whether the determinants of credit spread would vary across firms with different credit ratings. Since the credit rating is related to the overall level of credit risk of a firm, firm with lower credit ratings are expected to have higher CDS spreads. This intuition motivates us to divide our sample firms by credit rating. We partition our sample into two subgroups: A and above and BBB and below.

Panel A of Table 4 reports level panel data regression results partitioned by credit rating. We find different results across firms with different credit ratings. For lower credit rating firms, leverage and historical volatility are more sensitive to CDS spread than those with a higher credit rating. These effects are intuitive and consistent with the predictions of the structure credit risk model. In addition, similar results are found for risk-free rate. Our evidence shows that the CDS spread for lower credit rating firms are more sensitive to risk-free rate than higher credit rating firms. This is consistent with the empirical findings in Duffee (1998) for the corporate bond yield spread and in Ericsson, Jacobs, and Oviedo (2009) for the U.S. CDS spread.

As we can see from Figure 1, the CDS spread has an upward trend in the first half of our sample period, while it is in a downward trend during the second half. Therefore, in this section, we split our sample on two sub-sample periods evenly through our whole sample period. Panel B of Table 4 report level regression results partitioned by sample period. We find that, in general, the results for the sub-sample periods are very similar to each other and to the whole sample period results. The coefficient estimates on leverage and historical volatility are positively significant, and the coefficient estimates on the risk-free rate are negatively significant.

【Insert Table 4】

5. Robustness Check

We mention earlier that our data are cross-sectional as well as time-series data. Therefore, in the previous section, we apply a panel data regression framework with fixed effect on coefficient estimation following Campbell and Taksler (2003), Jakovlev (2007) and Cremers et al. (2008). In this section, we conduct a robustness check using an alternative approach. Following Collin-Dufresne, Goldstein, and Martin (2001) and Ericsson, Jacobs, and Oviedo (2009), we estimate the coefficients by first running the time-series regressions for each firm and then calculate the cross-sectional mean of the estimated coefficients. In Table 5, it is clear that the results from this alternative estimating approach are similar to those in the previous section. Leverage, historical volatility, and the risk-free rate are all significant, and the signs of the coefficient estimates are consistent with the theory. The percentage for leverage with t-statistic greater than 1.96 is around 63%, the percentage for historical volatility with t-statistic greater than 1.96 is about 75%, and the percentage for risk-free rate with t-statistic smaller than -1.96 is lower at 47%. In other words, the regression results hold regardless of the estimation method.

【Insert Table 5】

6. Conclusion

This study investigates the determinants of CDS spread for the Japanese markets. Japanese CDS market is one of the major markets in the world. While there are many prior studies on the determinants of CDS spread in the U.S. and Europe, to the best of our knowledge, there is no empirical study on CDS spread for Japan. Our study contributes the literature by filling the above gap and by studying the role of financial and macroeconomic variables in determining the dynamics of CDS spreads in Japanese market.

We use the Japanese CDS data from 2001 to 2004 and apply a panel data regression approach with fixed effect. Our univariate regression analysis focuses on the three theoretical determinants on CDS spread: firm leverage, firm historical volatility, and the risk-free rate. We further take into account other explanatory variables in the multivariate regression analysis. Our findings show that the effects of leverage and historical volatility on CDS spread are positively significant. On the other hand, there is a negative relation between risk-free rate and CDS spread. In general, our findings are consistent with the theory with statistical significance. Our results also indicate that the CDS spread in Japanese market shares similar characteristics as those in the U.S. and Europe.

We further separate the whole sample into sub-samples by various criteria. By separating our sample based on credit rating, we find that the effect of leverage, historical volatility, and risk-free rate are larger for lower credit rating firms than for those with a higher credit rating. Next, we separate our sample into two sub-sample periods evenly through our whole sample period. We find that, in general, the results for the sub-sample periods remain robust in Japan.

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Figure 1 Time Series Trend of CDS Spread for Japan

This figure depicts the weekly composite spread of Japanese Yen-denominated five-year single-name CDS from January 2001 to December 2004.

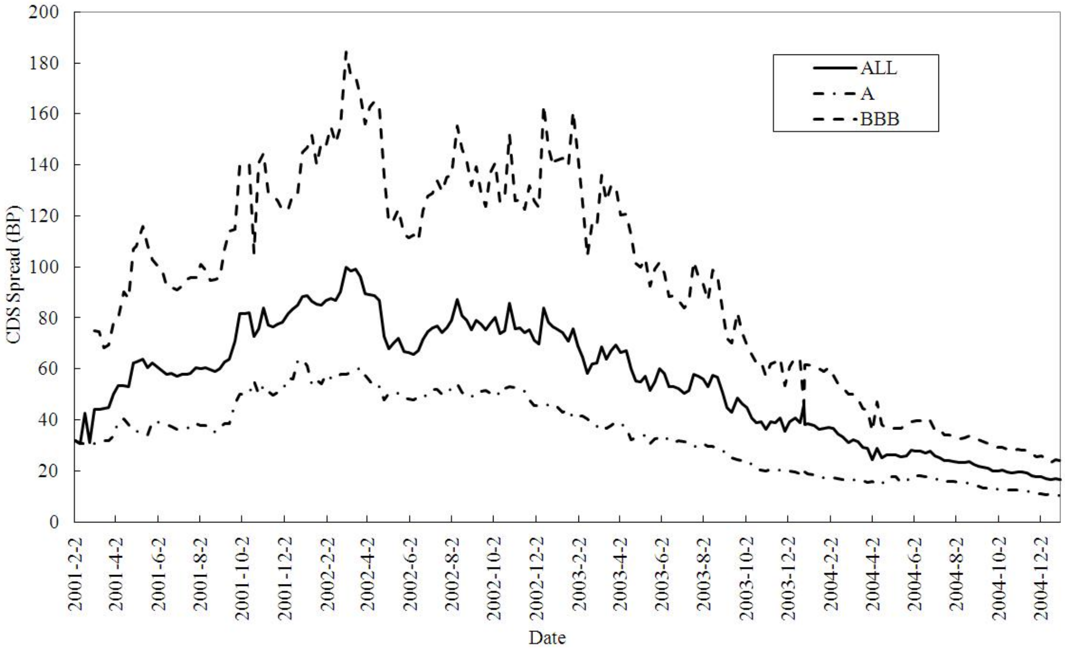

Table 1 Explanatory Variables and Their Predicted Signs

The table reports the explanatory variables used in this study and their predicted signs of the coefficients in the regressions.

Variables	Description	Predicted Sign
$leverage_{it}$	Firm's leverage ratio.	$+$
vol_{it}	Firm's equity historical volatility.	$+$
$r_t^{2\text{-}year}$	Yield on 2-year government bond.	$-$
$r_t^{2-year^2}$	Squared level of the 2-year government bond yield.	?
$slope_t$	Difference between 10-year and 2-year government bond yields.	$-$
$mrktret_t$	Return on market index.	$-$

Table 2 Cross-sectional statistics for time-series means for the Variables

This table reports summary statistics for the variables used in this study. Variables definitions are detailed in Sections 3.1 and 3.2. Panel A reports the mean, Q1 (25th percentile), median, Q3 (75th percentile) and standard deviation for each variable. We first obtain the time-series average of the variables for each firm and then average across firms. Panel B reports average (across firms) correlation among variables used in this study.The sample period is from January 2001 to December 2004 for Japan.

Panel A

Variables	Mean	Q1	Median	Q3	Standard Deviation
CDS Spread (basis point)	53.7665	18.9803	33.0262	55.2798	70.9347
Leverage	0.5387	0.3843	0.5607	0.7181	0.1996
Historical Volatility (%)	2.1533	1.7890	2.2560	2.5188	0.6711
Risk-Free Rate (%)	0.1118	0.1003	0.1051	0.1274	0.0145
Slope of Yield Curve (%)	1.2083	1.1678	1.1757	1.2531	0.0722
Market Return (%)	0.3705	0.2400	0.3229	0.5262	0.1806

Panel B

	spread	*leverage*	*vol*	$r^{2\text{-}year}$	*slope*	*mrktret*
spread	1.0000					
leverage	0.3849	1.0000				
vol	0.4297	0.0790	1.0000			
$r^{2\text{-}year}$	-0.3713	-0.3170	-0.1644	1.0000		
slope	0.3299	0.4829	0.1091	-0.6451	1.0000	
mrktret	-0.0616	-0.0430	-0.0366	0.1609	-0.1219	1.0000

Table 3 Regressions Results for Whole Sample

The table reports the regression results of weekly data for the 106 Japanese firms over the period from January 2001 to December 2004. Variables definitions are detailed in Section 3.1 and 3.2. Standard errors are reported in parentheses. ***, **, and * indicate significance at the 1, 5, and 10 percent levels, respectively. The regression coefficients are estimated under a panel data regression framework with fixed effect.

Variables	(1)	(2)	(3)	(4)	(5)
Intercept	-0.0166	-0.0061	0.0047	-0.0182	-0.0201
	(0.0007)***	(0.0005)***	(0.0005)***	(0.0008)***	(0.0009)***
Leverage	0.0425			0.0336	0.0377
	(0.0013)***			(0.0013)***	(0.0014)***
Historical Volatility		0.0058		0.00497	0.0046
		(0.0001)***		(0.0001)***	(0.0001)***
Risk-Free Rate			-2.9636	-1.3234	-6.5775
			(0.1248)***	(0.1264)***	(0.4418)***
Square of Treasury Bond Yield					1711.62
					(154.80)***
Slope of Yield Curve					-0.3172
					(0.0306)***
Market Return					-0.0015
					(0.0018)
Adjusted R^2	52.49%	53.19%	51.09%	56.18%	56.76%

Table 4 Regressions Results by Credit Rating and Sub-Sample Periods

Panel A reports the regression results of weekly data for the 106 Japanese firms over the period from January 2001 to December 2004. We separate our whole sample into two sub-groups based on credit rating: A and above and BBB and below for Japan. Panel B reports the regression results of separating our whole sample into two sub-groups based on sample period: 2001 to 2002 and 2003 to 2004. Variables definitions are detailed in Section 2.1 and 2.2. Standard errors are reported in parentheses. ***, **, and * indicate significance at the 1, 5, and 10 percent levels, respectively. The regression coefficients are estimated under a panel data regression framework with fixed effect.

Panel A: Credit Rating

Variables	A and above	BBB and below
Intercept	-0.0089	-0.0393
	(0.0003)***	(0.0027)***
Leverage	0.0194	0.0534
	(0.0006)***	(0.0029)***
Historical Volatility	0.0019	0.0089
	(0.0001)***	(0.0003)***
Risk-Free Rate	-3.6628	-14.102
	(0.1623)***	(1.1134)***
Square of Treasury Bond Yield	872.21	3749.04
	(56.44)***	(393.70)***
Slope of Yield Curve	-0.2034	-0.6183
	(0.0113)***	(0.0768)***
Market return	-0.0011	-0.0043
	(0.0007)	(0.0042)
Number of firms	57	49
Adjusted R^2	67.03%	55.59%

Panel B: Sub-Sample Periods

Variables	2001~2002	2003~2004
Intercept	-0.0247	-0.0121
	(0.0024)***	(0.0007)***
Leverage	0.0333	0.0295
	(0.0035)***	(0.0011)***
Historical Volatility	0.0111	0.0030
	(0.0005)***	(0.0001)***
Risk-Free Rate	-7.6517	-2.0073
	(0.8180)***	(0.4750)***
Square of Treasury Bond Yield	1849.49	822.55
	(260.20)***	(165.00)***
Slope of Yield Curve	0.2028	0.0987
	(0.1155)*	(0.0245)***
Market return	0.0127	-0.0006
	(0.0103)	(0.0010)
Adjusted R^2	59.35%	80.96%

Table 5 Robustness Check for Regression Analysis

The table reports the regression results of weekly data for the 106 Japanese firms over the period from January 2001 to December 2004. Variables definitions are detailed in Section 3.1 and 3.2. Standard errors are reported in parentheses. ***, **, and * indicate significance at the 1, 5, and 10 percent levels, respectively. The regression coefficients are obtained first by running the time-series regressions for each firm and then calculate the cross-sectional mean of the estimated coefficients. Adjusted R^2 is the mean of the adjusted R^2s for each firm regression. The entries under t (explanatory variables)>1.96 (<-1.96) is the percentage of explanatory variables with t-statistics greater (less) than 1.96 (-1.96).

Variables	(4)	(5)
Intercept	-0.01475	-0.0170
	(0.0042)***	(0.0052) **
Leverage	0.02162	0.0249
	(0.0060)***	(0.0065)***
Historical Volatility	0.0028	0.0026
	(0.0006)***	(0.0007) ***
Risk-Free Rate	-1.0110	-4.4809
	(0.4177)***	(1.7372) ***
Square of Treasury Bond Yield		-2.3674
		(1.7372)
Slope of Yield Curve		1330.09
		(680.21)**
Market Return		-0.0030
		(0.0061)
Percentage of t (*leverage*) > 1.96	63.21%	61.32%
Percentage of t (*leverage*) < -1.96	6.60%	9.43%
Percentage of t (*vol*) > 1.96	75.47%	69.81%
Percentage of t (*vol*) < -1.96	10.38%	12.26%
Percentage of t ($r_t^{2\text{-}year}$) > 1.96	12.26%	6.60%
Percentage of t ($r_t^{2\text{-}yea}$) < -1.96	47.17%	50.94%
Adjusted R^2	60.55%	68.07%