Explaining Credit Spread Changes: Some New Evidence from Option-Adjusted Spreads of Bond Indices[1]

Jing-zhi Huang[2]

Penn State University and New York University

Weipeng Kong[3]

Penn State University

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[2]Smeal College of Business, Pennsylvania State University, University Park, PA 16802; (814) 863-3566; jxh56@psu.edu. Stern School of Business, New York University, New York, NY 10012; (212) 998-0925; jhuang0@stern.nyu.edu.

[3]Smeal College of Business, Pennsylvania State University, University Park, PA 16802; Tel: (814) 865-0618; wxk140@psu.edu.

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Abstract

This paper revisits the question of the determinants of corporate bond credit spreads using some new explanatory variables with both weekly and monthly option-adjusted credit spreads of corporate bond indices from Merrill Lynch. We find that among the new variables, the interest rate historical volatility, the Russell 2000 index historical return volatility and Conference Board leading and coincident economic indices have significant power in explaining credit spread changes, especially for high yield bond indices. Furthermore, these four variables plus the interest rate level, the yield curve slope, the Russell 2000 index return, and the Fama-French [1996] high-minus-low factor return could explain more than 40% of credit spread changes in 5 out of 9 rating/maturity indices. In particular, these variables could explain 67.68% of the variation in B rated index credit spreads and 60.82% of the variation in BB rated index credit spreads. The overall explanatory power on credit spread changes achieved here is a notable improvement over most previous studies using either option-adjusted index spreads or individual corporate bond spreads. Our analysis confirms that high-yield credit spread changes are more closely related with equity market factors and also provides evidence in favor of incorporating macroeconomic risk factors into credit risk models.

1 Introduction

Accessing and managing credit risk of corporate bonds has been a major area of interest and concern to academics, practitioners and regulators. One line of research of interest is to investigate and test the implications of credit risk models. Broadly speaking, credit risk models can be classified into two groups: those based on the structural approach of Black and Scholes [1973] and Merton [1974] and those based on the reduced-form approach of Duffie and Singleton [1999] and Jarrow and Turnbull [1995]. (Detailed discussions of credit risk models can be found in Caouette, Altman, and Narayanan [1998], Saunders [1999] and references therein.)

Recent empirical evidence, however, has indicated that variables that in theory determine credit risk could only explain a small portion of the observed credit spread changes. In a study in the spirit of the reduced-form approach, Elton, Gruber, Agrawal and Mann [2001] find that premiums due to expected default losses and state tax are insufficient to explain the corporate bond spreads, and expected default loss can only count for no more than 25% of the observed corporate bond spreads. In a parallel study based on the structural approach, Collin-Dufresne, Goldstein and Martin [2001] regress credit spread changes of individual bonds on various theoretical determinants of spreads, including firm equity return and capital structure, the S&P 500 index return and implied volatility, changes in Treasury yield curve, etc. They find that these variables have low explanatory power and the average adjusted R-squared in each rating/maturity category is mostly below 30%. Even after Treasury and swap markets liquidity measures and the Fama-French [1996] factor premiums are included, the adjusted R-squared is still mostly below 40%. Their residual analysis indicates that unexplained spread changes are mostly driven by one common systematic component. Both these two studies use the Lehman Fixed Income database and focus on investment grade bonds.

The low explanatory power of theoretical determinants, as documented in Collin-Dufresne et al. [2001], could be due to two possible reasons. First, the explanatory variables used by Collin-Dufresne et al. [2001] may not be the best proxies to measure changes in default risk. Second, existing corporate bond pricing models may have missed some important systematic risk factors, such as corporate market liquidity or business cycle factors. For instance, Jarrow and Turnbull [2000] propose that incorporating macroeconomic variables may improve a reduced-form model.

In this paper, we revisit the question of the determinants of credit spread changes using index credit spreads data. We consider five sets of explanatory variables that characterize different aspects of credit risk: (1) changes in realized default rates, (2) changes in interest rate level, slope and volatility, (3) equity market returns, volatility and risk premiums, (4) changes in supply/demand from corporate bond mutual funds, and (5) changes in macroeconomic indicators. We examine the explanatory power of these variables on index credit spread changes, using both Merrill Lynch investment-grade and high-yield monthly option-adjusted index credit spread data from January 1997 to July 2002.

Our main findings are as follows. Among the variables that have not been used in the literature, the historical interest rate volatility, the Russell 2000 historical return volatility and Conference Board leading and coincident indicator indices have significant power in explaining credit spread changes, especially for high-yield bond indices. These 4 variables plus interest rate changes, yield curve slope changes, the Russell 2000 index return, and the Fama-French [1996] high-minus-low factor return, could explain more than 60% of credit spreads changes in BB rated and B rated indices. Also, these 8 variables account for 55.54% of variations in C rated index, 51.4% of variation in BBB-A rated 15+ years index, and 41.58% of variation in BBB-A rated 1-10 years index. The explanatory power of these 8 variables is around 30% for all other 4 indices.

The overall explanatory power on credit spread changes achieved here is a notable improvement over most previous studies using either individual corporate bonds or option adjusted index spreads. More importantly, our results confirm that high-yield corporate bonds behave more like equity of the issuing firm, and credit spread changes of high yield indices are mainly driven by equity related factors. These findings are consistent with predictions from the structural corporate bond pricing models. Our results also suggest that in addition to equity market variables and interest rate variables, both of which enter the existing structural models of risky bond pricing, macroeconomic factors also have power in explaining credit spread changes at least at the aggregate level.

In a study closely related to ours, Brown [2001] examines the explanatory power of changes in 10-year yields, consumer confidence, the VIX index and a Treasury bond liquidity measure on Salomon Brothers index credit spread changes. The R-squared from his analysis has a highest level of 32.79% (for the AAA/AA 3-7 year index), is below 30% for 10 out of 12 investment-grade indices and below 20% for all high-yield indices. In another related study, Kao [2000] finds that changes in interest rate level and slope, implied volatility of OTC interest rate options and Russell 2000 returns, have significant explanatory power on option-adjusted index credit spreads changes. In our analysis, we use some new explanatory variables which have not been considered before and also examine liquidity factors, macroeconomic variables, equity market volatility, and interest rate volatility altogether.

The remainder of this article is organized as follows. Section 2 describes the index credit spreads data and the explanatory variables used in our empirical study. Section 3 reports results from our empirical tests and a variety of robustness tests. Section 4 concludes the paper.

2 Data

In this section, we first describe our credit spread index data and provide some basic summary statistics of spread changes. We then discuss explanatory variables used in our empirical analysis.

2.1 Credit Spread Index Data

Credit spread data used in this study are the Merrill Lynch option-adjusted spreads (OAS) of corporate bond indices from January 1997 to July 2002. These spreads are purged of any embedded options, coupon effects and index re-balancing effects. The use of option-adjusted spread is of importance for empirical analysis at index level. Duffee [1998] demonstrates how the callability of corporate bonds and the coupon effects will strongly influence the relationship between Treasury term structure changes and corporate credit spread changes.

Each index is a market value weighted average of the individual corporate bond credit spread of a given maturity, industry, and credit rating corporate bond portfolio. For investment-grade corporate bonds, we obtain US industrial corporate credit spread indices for three maturities: 1-10 years, 10-15 years, and 15+ years; and two rating groups: AA-AAA and BBB-A. The indices track the performance of US dollar-denominated investment-grade public debt of industrial sector corporate issuers, issued in the US domestic bond market. For high-yield corporate bonds, the Merrill Lynch credit spread indices are available for three credit ratings: BB, B and C. We do not know the industry composition of the high-yield credit spread indices. We have in total 9 different rating and maturity corporate bond index credit spreads.

We use monthly credit spread changes in this analysis mainly because many explanatory variables under consideration are only available at monthly frequency. We construct monthly credit spread changes from the corresponding Merrill daily credit spread series that are re-balanced on the last calendar day of each month.[1] For example, the daily spread time series begins on December 31 of 1996 and the indices are then re-balanced on January 31 of 1997. January 30 of 1997 is the last observation before index re-balancing. The monthly credit spread change for January 1997 is measured as the difference between the credit spread on December 31 1996 and January 30 1997. In another word, for a given month, our measure of monthly credit spread changes is based on the same portfolio, and free of the bias induced by index re-balancing. Each monthly series consists of 67 observations from January 1997 to July 2002.[2]

Table 1 presents summary statistics on changes in index credit spreads, denoted ΔCS. As can be seen from the table, the standard deviation of index credit spread changes increases as the rating deteriorates and maturity gets longer except for the AA-AAA rated 10-15 years index (which has higher standard deviation than AA-AAA rated 15+ years index). Over the sample period, the standard deviation of monthly changes in credit spreads is on the order of 5.07 to 12.21 basis points for the 6 investment-grade indices and 44.82 to 105.91 basis points for the 3 high-yield indices. Changes in index credit spreads have thicker tails than the normal distribution, and extreme movements are observed in some months as indicated by the maximum, minimum, 10% percentile and 90% percentile of the distribution. Credit spread changes are positively serially correlated, albeit insignificant in most cases.

The last row of Table 1 shows the average number of bonds included in a given index over the sample period. These indices are generally constructed based on a large group of bonds except for the AA-AAA rated 10-15 year index. The fact that the three high-yield indices are each based on a large group of high-yield bonds is of particular importance. The Fixed Income Database used by Collin-Dufresne et al. [2001] mainly covers investment-grade bonds. Their results on high-yield credit spreads are based on a limited number of issues which may lack of representativeness. The option-adjusted high-yield index credit spreads used here are based on a large number of typical high-yield issues in each rating grade, and enable us to undercover the typical relationship between high-yield credit spread changes and other financial and economic factors. Meanwhile, the use of index spreads would help identify the systematic

[1]Detailed discussion of the various Merrill Lynch bond indices can be found in *Bond Index Rules & Definitions*, October 2000, Merrill Lynch & Co., Global Securities Research & Economic Group, Fixed Income Analytics.

[2]The inception date of the Merrill Lynch option-adjusted credit spread indices is December 31 of 1996.

factors associated with credit spreads of all risky corporate bonds, and provide insights for any further analysis at the individual bond level.

2.2 Explanatory Variables

The credit spread on corporate bonds (without imbedded options) is the extra yield offered to compensate investors for a variety of risks: (1) expected default loss - the risk that in the event of default, investors will not receive the full amount of the promised cash flows. This component of credit spread is directly related to the default probability of the firm and the recovery rate in the event of default; (2) default risk premium, due to the fact that the default risk on corporate bonds is systematic rather than completely diversifiable; and (3) liquidity and tax premia, which result from the difference in liquidity and tax status of corporate bonds and Treasury bonds.

We will focus on financial markets and macroeconomic variables that are related to the different components of credit spreads. Specifically, we select sets of explanatory variables that characterize (1) the realized overall default rate in the U.S. corporate bond market, (2) the dynamics of the risk free interest rate, (3) the U.S. equity market return and volatility, (4) supply/demand from corporate bond mutual funds, and (5) the state of economy in the US. The first three sets of variables are our proxies for changes in aggregate default risk. The realized overall default rate is directly related to the expected default loss. Interest rate variables and equity return variables are explicit in the structural approach risky bonds pricing models. The supply/demand pressure from corporate bond mutual funds is intended to capture one aspect of the liquidity condition in the corporate bond market. The economic state variables are based on the perception that the default risk of corporate bonds is correlated with the aggregate economic activity.

2.2.1 Realized Default Rates

If historical default rates of corporate issuers predict future default risk in the corporate bond market, we would expect a close positive relationship between changes in realized default rates and changes in credit spreads. We obtain Moody's monthly trailing 12-month default rates for all corporate U.S. issuers, and for speculative grade U.S. issuers over our sample period. Because the effective date of the monthly default rate is on the first day of each month, we take the month t release as the month $t-1$ trailing 12-month default rates. Changes in trailing 12-month default rates for all corporate U.S. issuers, denoted $\Delta df_{a,t}$, will be used in regression analysis of investment-grade index credit spread changes. Changes in trailing 12-month default rate for corporate speculative grade U.S. issuers, denoted $\Delta df_{s,t}$, will be used in regression analysis of high-yield index credit spreads.

2.2.2 Interest Rate Variables

Most empirical studies have used either changes in the very short-end (3-month) or changes in the very long-end (10-year) of the Treasury yield curve, as measures of changes in general interest rate level. However, a Treasury yield index may be a more appropriate proxy for the level. We use the monthly changes in the Merrill Lynch Treasury Master Index yields, $\Delta level$, as the measure of changes in the general interest rate. We use the difference of Merrill Lynch 15+ years Treasury Index yields and Merrill Lynch 1-3 years Treasury Index yields as the measure of yield curve slope. The change in yield curve slope is denoted as $\Delta slope$.

Interest rate volatility has been incorporated in some credit risk models (e.g. Longstaff and Schwartz [1995] and Das and Tufano [1997]). Higher interest rate volatility should be associated with wider credit spreads. However, the empirical relationship of interest rate volatility and credit spread changes has not been studied until most recently. Using changes in the implied volatility of the 3-month OTC option on a 10-year rate, Kao [2000] shows that the option implied interest rate volatility plays an important role in explaining the monthly changes in credit spread indices of both investment-grade and high-yield from March 1991 to December 1998. However, the implied volatility of OTC interest rate options is not directly observable for most market participants. In this paper, we examine two alternative proxies for interest rate volatility that have easily accessible market data. The first one is the monthly change in the annualized implied volatility of 30-year Treasury bond futures options traded on the Chicago Board of Trade (CBOT), $\Delta\sigma^r_{iv,t}$. We obtain the CBOT option implied interest rate volatility series from January 1997 to August 2001. The second measure is the monthly change in the annualized historical volatility of Merrill Lynch Treasury Master Index yields, $\Delta\sigma^r_{hv,t}$. These two measures expect to capture anticipated and realized changes in interest rate volatility, respectively.

2.2.3 Equity Market Variables

Structural models of risky debts pricing indicate that higher asset and equity returns would be associated with narrowing credit spreads. Empirically, it is interesting to find out which equity market index return is more closely correlated with movement of credit spreads, and thus may serve as a better hedging instrument. So far most studies have used the $S\&P$ 500 index return, which is concentrated with large-cap stocks. Kao [2000] shows that credit spread changes of corporate bonds are significantly related to returns of small-cap stocks index such as the Russell 2000 index. We will compare the correlation of credit spread changes with $S\&P$ 500 index return, sp_t, and the correlation of credit spread changes with the Russell 2000 index return rus_t over our sample period.

Structural models also imply that equity return volatility usually increases credit spreads. We consider two measures of equity market volatility: the option implied volatility on the Russell 2000 index, and the historical volatility of the Russell 2000 index return. The monthly changes of these two volatility series are denoted as $\Delta\sigma_{iv,t}^{rus}$ and $\Delta\sigma_{hv,t}^{rus}$ respectively. For comparison, we also look at the change in CBOE VIX index ΔVIX_t, which measures implied volatility of the $S\&P$ 100 index option, and changes in the historical volatility of the $S\&P$ 500 index denoted $\Delta\sigma_{hv,t}^{sp}$.

Elton, Gruber, Agrawal and Mann [2001] show that the Fama-French [1996] three factors are closely related to the portion of credit spreads that could not be explained by expected default loss and tax. Collin-Dufresne, Goldstein and Martin [2001] also show that the small-minus-big, smb_t, and high-minus-low, hml_t, factors are important determinants of credit spread changes of individual corporate bond. Excess returns of small firms over large firms and of high leveraged firms over low leveraged firms might be closely correlated with changes in the default risk premium component of credit spreads. We will examine the incremental explanatory power of these two variables in the presence of equity index returns and volatility.

2.2.4 Supply/Demand from Corporate Bond Mutual Funds

Institutional investors are the major owners of corporate bonds. The net new cash flow of corporate bond mutual funds is an indirect measure of the net demand for corporate bonds from investors. Higher net new cash flows indicate a higher demand and would push down credit spreads. Meanwhile, the portion of liquid asset held by corporate bond mutual funds indicates the selling pressure that comes from potential redemption by investors. Barnhill, Joutz and Maxwell [2000] use the percentage of high-yield mutual fund liquid asset and net fund flow relative to the total net assets of high-yield mutual funds, as proxies of high-yield bond markets liquidity.

We obtain monthly statistics of dollar amount of total net assets, net new cash flow, and liquid assets, of corporate bond mutual fund and high-yield mutual fund from June 1997 through July 2002. These statistics are released by the Investment Company Institute (ICI). The ratio of net new cash flow and liquid assets with respect to total net assets is constructed for corporate bond mutual funds and high-yield mutual funds respectively. The monthly changes in these variables are denoted as ΔNCF_t and $\Delta liquid_t$ respectively. We expect these variables to capture the changing liquidity conditions in corporate bond markets. The measures from corporate bond mutual funds will be used in the analysis of investment-grade indices, and the measures from high-yield mutual funds will be used in the analysis of high-yield indices.

2.2.5 Macroeconomic Indicators

It is well recognized that credit spreads behave cyclically over time [see, e.g., Van Horne, 1998]. During periods of economic downturn, credit spreads are expected to increase as investors become more risk averse and firms have lower asset returns. Fridson and Jonsson [1995] find that an index of lagging economic indicators has significant effects on changes in credit spreads of a high yield bond index. Helwege and Kleim [1997] find that GDP growth rate and recession indicators are important in explaining the aggregate default rates of high yield bonds.

The Conference Board publishes the composite indices of leading, coincident, and lagged indicators as gauges of the state of the U.S. economy.[3] The leading indicator index indicates the future direction of aggregate economic activity. The coincident indicator index measures the current health of the economy. And the lagged indicator index usually reaches its cyclical peaks in the middle of a recession. We use the month-to-month percentage changes in the three indicator indices as measures of the general economic condition. The changes in these three economic indices are denoted as $\Delta lead_t$, Δci_t, and Δlg_t respectively. Although the $S\&P$ 500 index and the yield curve slope are both common measures of the economic condition (in fact,

[3]The leading index is an average of 10 leading indicators; the coincident index is an average of 4 coincident indicators; the lagged index is an average of 7 lagged indicators. Detailed description about the three indices can be found in the web site of Conference Board at http://www.tcb-indicators.org.

both are indicators in the leading index),[4] we believe that the leading index - an average of 10 leading indicators - should be a better barometer of future economic conditions. Over our sample period, the correlation coefficient of $\Delta lead_t$ and $\Delta slope_t$ is indeed -0.32, even though the weight of yield curve slope is 0.3274 in the leading index.

Table 2 summarizes the explanatory variables under consideration and the predicted sign of the correlation between these variables and credit spread changes.

3 Empirical Results

To compare the explanatory power of the different driving factors under consideration, we run OLS regressions with each set of explanatory variables separately, and then examine the interaction of these variables in explaining credit spread changes. To check the robustness of results from such exercises, we run regressions first using the whole sample period and then using the sub-period of January 1997 to December 2001 to check the stability of the results. The choice of the relatively long sub-sample is intended to retain enough observations for the regression.

Regression models with economic time series often encounter errors that have serial correlation or heteroskedasticity of unknown form. Since the underlying portfolio itself of each index changes from month to month, the heteroskedasticity in the errors would likely be severe in OLS regressions. To correct for this bias in our hypothesis testing on the OLS parameter estimates, we use the test statistics recently proposed by Kiefer, Volgelsang, and Bunzel [2000] (KVB hereafter) that is robust to general forms of serial correlation/heteroskedasticity in the errors.[5] Unlike the widely used Newey-West heteroskedasticity and autocorrelation consistent (HAC) estimators, the KVB test does not explicitly require estimates of the variance-covariance matrix to construct the test.

Consider a linear regression model as follows:[6]

$$y_t = X_t'\beta + \epsilon_t, \quad t = 1, 2, ..., T \tag{1}$$

[4] The yield curve slope is defined as the difference between the 10-year Treasury bond rate and the federal fund rate in the leading index.

[5] We thank Herman Bierens for pointing out this method to us. The KVB test statistics reported here are estimated using the software package from *EasyReg International*.

[6] Notation here largely follows Kiefer, Vogelsang, and Bunzel [2000].

where $E[\epsilon_t|X_t] = 0$, ϵ is stationary, and may be serially correlated and have conditional heteroskedasticity, β is a $k \times 1$ vector of regression parameter, and X_t is a $k \times 1$ vector of regressors. Consider further a general linear hypotheses of the form

$$H_0 : R\beta = c, \quad H_1 : R\beta \neq c, \tag{2}$$

where R is a $m \times k$ matrix of rank m and c is a $m \times 1$ vector of restriction. The KVB test statistics is then given by

$$F^* = T \left(R\hat{\beta} - c\right)' \left[R\hat{B}R'\right]^{-1} \left(R\hat{\beta} - c\right) m^{-1} \tag{3}$$

where $\hat{\beta}$ is the OLS regression estimates of β, and

$$\begin{aligned} \hat{B} &= \left(T^{-1}\sum_{t=1}^{T} X_t X_t'\right)^{-1} \hat{C} \left(T^{-1}\sum_{t=1}^{T} X_t X_t'\right)^{-1} \\ \hat{C} &= T^{-2}\sum_{t=1}^{T} \hat{S}_t \hat{S}_t', \quad \hat{S}_t = \sum_{j=1}^{t} X_j \hat{\epsilon}_j \end{aligned}$$

The limiting distribution of F^* is a function of independent standard Wiener processes that is invariant to nuisance parameter and only depends on m. The KVB robust test statistics have two major advantages over the HAC estimators. First, they avoid the selection problem of a truncation lag in the nonparametric estimation of variance-covariance matrix of the OLS estimates. Second, the KVB tests have better finite sample size properties than HAC estimator tests. This is particularly important given our relatively small sample size.

3.1 Group Level Regressions

3.1.1 Realized Default Rates

For each investment-grade index, we regress the credit spread changes ΔCS_t on changes in Moody's trailing 12-month default rates of all U.S. corporate issuers, $\Delta df_{a,t}$. For high-yield indices, the changes in default rates of U.S. speculative grade issuers $\Delta df_{s,t}$ is used. The estimation results for the full sample and the sub-sample are reported in Panel A and Panel B of Table 3 respectively.

The sign of estimated coefficients on realized default rate changes turns out to be different from expected, albeit insignificant in most cases. In both samples, the sign of estimated coefficients is uniformly negative and the adjusted R^2 is below 5%. This reinforces the common understanding that realized default rates are, by construction, lagging variables. Our results here indicate that realized default rates contain little information on the future prospect of default risk.

3.1.2 Interest Rate Variables

We use interest rate changes, yield curve slope changes, and interest rate volatility changes to capture the impact of interest rate dynamics on credit spreads. The following equation is estimated for both the full sample and the sub-sample:

$$\Delta CS_t = \alpha + \beta_1 \Delta level_t + \beta_2 \Delta slope_t + \beta_3 \Delta \sigma^r_{hv,t} + \epsilon_t. \tag{4}$$

The results are presented in Panels A and B of Table 4.

As can be seen from the table, interest rate variables can only account for a small portion of the credit spread changes of investment-grade indices. For the full sample, the adjusted R^2 ranges from 1.29% for BBB-A 10-15 years index to 15.81% for AA-AAA 10-15 years index. The sub-sample results exhibit similar picture. The signs of the coefficients on interest rate variables are consistent with common understanding. High interest rates and steep yield curve are usually associated with expanding economy and narrow credit spreads. Increasing interest rate volatility is usually associated with widen credit spreads. However, the KVB test statistics show that these relations are mostly insignificant. The only exception is for AA-AAA 10-15 years index where slope changes are significantly negative in both full sample and sub-sample.

These interest rate variables, however, perform better with credit spread changes of high-yield indices. The adjusted R^2 is respectively 32.84% for BB rated index, 34.08% for B rated index, and 25.21% for C rated index. The overall fit is slightly lower in the sub-period. In both samples, the KVB test statistics on coefficients of these two variables are slightly below the 90% critical value for BB rated and C rated indices, and are significant at the 90% level for B rated index. Yield curve slope changes have positive coefficients for high-yield indices, but with very small KVB test statistics.

Given the forward-looking nature of credit spreads, we would expect option implied interest rate volatility to have a higher correlation with credit spreads. Panel C of Table 4 contains the estimation results of regression using changes in implied volatility of 30-year Treasury bond futures options traded on CBOT over the period January 1997 through August 2001:

$$\Delta CS_t = \alpha + \beta_1 \Delta level_t + \beta_2 \Delta slope_t + \beta_3 \Delta \sigma^r_{iv,t} + \epsilon_t. \tag{5}$$

The results actually show that implied interest rate volatility changes have weaker effect than historical yield volatility. Given the strong relationship of interest rate volatility (as measured by the three-month option on a 10-year yield) documented in Kao [2000] for the period March 1991 to December 1998, our findings here are surprising. This could be a result of time-varying relationship between interest rate volatility and credit spreads. However, it is also likely to be the problem with our implied interest rate volatility data. The implied interest rate volatility series used here is based on the price of the nearby interest rate future options traded on the Chicago Board of Trade. When one contract expires, the new nearby contract is selected to derive the implied interest rate volatility series. The changing nearby contract may have brought significant noise into the derived implied volatility series.

In an analysis not reported here, we consider using Treasury index yields versus constant maturity Treasury (CMT) yields as proxies of interest rate changes and yield curve slope changes. Specifically, we run regression using changes in the CMT 10-year yield and changes in the CMT 10-year yield minus the CMT 2-year yield. The results (not reported) show that the relationship between Treasury term structure changes and credit spread changes is much weaker when CMT yields are used, and the adjusted R^2 is below 11% for all three high-yield indices over the sample period.

Overall, the interest rate variables considered here can only explain a small portion of investment-grade index credit spread changes, but do a much better job with high-yield credit spread changes. For high-yield indices, the interest rate volatility change is an as important factor as interest rate changes.

3.1.3 Equity Market Variables

We first compare the explanatory power of the $S\&P$ 500 index variables and Russell 2000 index variables on index credit spread changes. The return on the index and changes in historical return volatility are used in regression. Using implied volatility from options on the index would yield similar results. We use the historical return volatility due to concern of the high correlation between the index return and the implied volatility.

Results from both the S&P and Russell indices deliver the same message. Namely, a higher equity market index return will lower credit spreads, and a higher equity volatility will significantly widen credit spreads. Because the adjusted R^2 for most indices is at least 10% higher when the Russell 2000 index variables are used than when the $S\&P$ 500 index variables are used, only results with the Russell 2000 index variables are reported in Panels A and B of Table 5.

A significant portion of credit spread variations in both investment-grade and high-yield indices is associated with returns and volatility in the U.S. equity market over the sample period. The adjusted R^2 reaches respectively 41.12% for BB rated index, 47.09% for B rated index, and 39.66% for C rated index. These two variables could explain over 30% of variations in credit spreads of BBB-A rated 1-10 years and BBB-A rated 15+ years indices. The Russell 2000 index returns and volatility have the lowest explanatory power for movements in credit spreads of AA-AAA 10-15 years index, with an adjusted R^2 of 9.27%. This is also the only case where the coefficient on equity volatility changes is slightly negative. Similar results are obtained from regression using the sub-sample.

Given the close correlation between Russell index variables and corporate credit spread changes, one would expect that other market risk premiums, as measured by returns on the Fama and French [1996] small-minus-big (*smb*) and high-minus-low (*hml*) factors, would also closely co-vary with credit spreads. In an analysis not reported here, we find that the Fama-French 3 factor returns have roughly the same magnitude of explanatory power on credit spread changes as Russell index return and volatility changes. The correlation of the Fama-French market return and *smb* factor return with the Russell index return is over 0.68 during the sample period. This indicates that the small-cap index returns have largely captured both the market wide equity risk premium and the size risk premium. The correlation of Russell 2000 index return with the *hml* factor return is -0.42 over the period. We thus add only the *hml* factor return in regression using the Russell 2000 index variables. The estimated results are reported in Panel A and Panel B of Table 6 for the full sample and sub-sample.

The *hml* factor return is more closely related with credit spread changes of high-yield indices, and contributes only marginally in explaining investment-grade credit spread changes. When the *hml* factor return is added in the regression, these three equity market variables explain 47.93%, 54.94%, and 49.45% of variations in BB rated, B rated, and C rated index credit spreads respectively. The total explanatory power for high-yield index credit spread changes is even higher in the sub-sample.

On balance, the results here indicate that, about 30% of the variations in investment-grade credit spreads and about 50% of the variations in high-yield credit spreads over the past 6 years are associated with returns, volatility and leverage risk premium in the equity market.

3.1.4 Supply/Demand from Corporate Bond Mutual Funds

For each rating/maturity index, we estimate the following regression to examine the impact of buying and selling pressure from corporate bond mutual funds on index credit spreads:

$$\Delta CS_t = \alpha + \beta_1 \Delta liquid_t + \beta_2 \Delta NCF_t + \epsilon_t. \tag{6}$$

The estimation results are reported in Panels A and B of Table 7.

We do not find evidence that mutual fund liquid asset ratio and net cash flow ratio, as proxies of market liquidity, have significant relationship with index credit spread changes over the sample period. The sign of both coefficients of the two mutual fund variables are the opposite of what expected and insignificant in most cases. Also, the adjusted R^2 is below 2% for all investment-grade indices.

3.1.5 Macroeconomic Indicators

To study the relation between macroeconomic indicators and index credit spreads, we run the following regression:

$$\Delta CS_t = \alpha + \beta_1 \Delta lead_t + \beta_2 \Delta ci_t + \beta_3 \Delta \lg_t + \epsilon_t, \tag{7}$$

Estimation results are reported in Panels A and B of Table 8. Measures of the macro-state of the economy clearly are significantly associated with index credit spread movements. As expected, increases in leading index lead to narrowing credit spreads. But surprisingly, the coincident index, which measures the current health of the economy, has positive coefficients that are significant on 5 indices. The sign on the lagged index is mixed and is insignificant in all cases. The adjusted R^2 is over 20% for 3 index credit spread series. And in the best case, the macroeconomic indicators could explain 27% of credit spread variations in BBB-A rated

15+ year index.

Given the significance of indicator indices in explaining credit spreads, it is interesting to find out whether individual macroeconomic indicator could do the same job. In an analysis not reported here, we examine the relation between index credit spread changes and the following individual macroeconomic indicator: growth rate of money supply (M2), inflation expectation from the University of Michigan's Survey Research Center, industrial production index growth rate and unemployment rate. M2 has a standardized factor of 0.3034 in the leading index and industrial production has a standardized factor of 0.1292 in the coincident index. The explanatory power of these macroeconomic indicators alone is generally very weak. This validates the purpose of constructing the indicator indices which effectively smooth out part of the volatility in the individual series and serve a better gauge of the whole economy. Notice that the coefficient on industrial production growth rate is all positive, albeit mostly insignificant. Thus one plausible explanation for the positive sign on coincident index changes is that the real productivity of the economy has been growing over the past few years, but so is the volatility in the market.[7]

3.2 Combined Regressions

From the above group level analysis, we see that index credit spread movements could largely be explained by the interest rate dynamics, equity market returns and volatility, and the general state of the economy. Realized default rates and supply/demand pressures from corporate bond mutual funds do not show any close relation with index credit spread changes. Interest rate and equity market variables are explicitly in the structural models. Recent development in credit risk pricing has been trying to incorporate the economic state variables in the pricing model. We now examine how much of the index credit spread changes could be explained by these three set of variables together:

$$\begin{aligned} \Delta CS_t &= \alpha + \beta_1 \Delta level_t + \beta_2 \Delta slope_t + \beta_3 \Delta \sigma^r_{hv,t} + \beta_4 rus_t \\ &\quad + \beta_5 \sigma^{rus}_{hv,t} + \beta_6 hml_t + \beta_7 \Delta lead_t + \beta_8 \Delta ci_t + \epsilon_t. \end{aligned} \tag{8}$$

The overall explanatory power of these variables is quite striking, as shown in Panel A

[7] The correlation between industrial growth rate and changes in CBOE VIX index has been 0.26 over the sample period.

and Panel B of Table 9. The adjusted R^2 is as high as 67.68% for the B rated index and 60.82% for the BB rated index. It reaches 55.54% for C rated index, 51.4% for the BBB-A rated 15+ years index, and 41.58% for the BBB-A rated 1-10 years index. The explanatory power of these variables is around 30% for all other 4 indices. Similar results are found in the sub-sample estimation. The overall explanatory power on credit spread changes reached here is a notable improvement over most previous studies using either individual corporate bonds or option-adjusted index spreads. More importantly, our findings confirm that credit spread changes of high yield indices are closely related to equity market factors. These findings provide some support of the structural corporate bond models. In summary, the Russell 2000 index return and changes in the Russell historical volatility, and changes in leading index are the most significant explanatory variables in the combined regression.

3.3 Robustness Tests

We now address the robustness of our findings. Since the interest rate variables and Russell index variables are also available at weekly frequency, our first robustness check is to examine the explanatory power of these variables for credit spread changes at weekly frequency. To avoid any possible weekend effect, we select the Tuesday observation of each week. When a Tuesday observation is missing, we use the Wednesday observation.[8] This ensures a valid observations for all weeks over the full December 31 1996 to August 30 2002 sample, and results in a total of 295 data points. Because of the index re-balancing effect, for weeks that span re-balancing days, some of the observed weekly spread changes may be due to index re-balancing. Both the interest rate historical volatility and the Russell 2000 historical return volatility are estimated daily using the data over the past 20 days. The following regression is estimated for the whole weekly sample, and two sub-samples of equal sizes:

$$\begin{aligned}\Delta CS_t &= \alpha + \beta_1 \Delta level_t + \beta_2 \Delta slope_t + \beta_3 \Delta \sigma^r_{hv,t} + \beta_4 rus_t \\ &\quad + \beta_5 \sigma^{rus}_{hv,t} + \epsilon_t. \end{aligned} \tag{9}$$

Table 10 shows that, at weekly frequency, between investment-grade and high-yield index credit spread changes, there is still a large discrepancy in the proportion of credit spread changes that could be associated with changes in interest rate dynamics and equity market index

[8]There is only one Monday observation in the week of the September 11 event.

factors. The adjusted R-squared almost monotonically increases as credit quality gets lower. The significant reduction in the overall adjusted R-squared is not particularly surprising, since the potential problems associated with market microstructure effects and index re-balancing effects would be more severe when the data frequency gets higher. In the case of the whole sample, while the adjusted R-squared is below 20% for all investment-grade indices, it is still 28.91%, 42.19%, and 23.22% for the three high-yield indices respectively. Changes in interest rates, returns on the Russell 2000 index, and changes in the Russell 2000 historical volatility are significant in most of the regressions. The results from the two equally sized sub-samples basically confirm these conclusions. The last row of Panel B of Table 10 reports the adjusted R-squared of the out-of-sample forecasting performance using the estimated coefficients with the first-half of the data. Changes in interest rate factors and equity market factors perform much better in forecasting low credit grade index changes than high grade index changes.

As a final robustness test, we consider the explanatory power of our variables for another source of index credit spreads: the S&P Credit Indices. Standard & Poor's S&P Credit Indices contains daily option-adjusted spreads for two rating spectrum within the U.S. industrial sector: the S&P U.S. industrial investment-grade credit index, and the S&P U.S. industrial speculative-grade credit index. The composite market price used to calculate the option-adjusted spread is based on the average bid and ask prices from a number of sources including brokers and dealers. The level of the indices is adjusted by a divisor whenever there is a change in the index issue. This mitigates the problem due to index re-balancing.[9] The inception date of the indices is December 31 of 1998. We look at changes in those two indices at both weekly and monthly frequency. Eqs. (8) and (9) are estimated respectively using the two S&P credit indices.

Table 11 shows that our results are robust with respect to the specific measures of the general credit spread level over this time period. In the weekly sample, 31.2% of variations in investment-grade index spread changes and 62.41% of variations in high-yield index spread changes are explained by interest rate factors and equity market factors. At monthly frequency, with the eight variables in Eq. (8), the adjusted R-squared is 63.37% for investment-grade spread changes, and 72.95% for high-yield spread changes.

To summarize, our robustness analysis provides evidence that interest rate factors and equity market factors are important determinants of high-yield index credit spread changes

[9]Detailed description of the S&P Credit Indices could be found in *S&P Credit Indices: Overview and Methodology*, 1999, the McGraw-Hill companies, Inc.

even at weekly frequency. This relationship is stronger when the high-yield market is measured as a whole instead of by rating categories. At monthly frequency, we find that interest rate factors, equity market factors, and economic state factors could also explain the majority of the variations of S&P investment-grade and high-yield credit indices in the recent four years.

4 Conclusions

This paper revisits the question of the determinants of corporate bond credit spreads using some new explanatory variables and new credit spread data, the Merrill Lynch corporate bond index option-adjusted credit spreads from January 1997 through July 2002. The new variables we consider include Moody's realized default rates, the historical volatility of interest rates, the Russell 2000 index return volatility, and the Conference Board indices of leading, coincident and lagged indicators. These variables are significantly correlated with the contemporaneous changes in credit spreads, especially for high yield bonds indices.

One finding of our analysis is that the above four new variables plus the interest rate level, the yield curve slope, the Russell 2000 index return, and the Fama-French [1996] high-minus-low factor return can explain more than 40% of credit spread changes in 5 out of 9 rating/maturity indices. In particular, these variables could explain 67.68% of the variation in B rated index credit spreads and 60.82% of the variation in BB rated index credit spreads. The overall explanatory power on credit spread changes achieved here is a notable improvement over most previous studies using either individual corporate bonds or option-adjusted index spreads. Robustness tests using various S&P credit indices confirm the high explanatory power of these variables. Analysis at weekly frequency provides more evidence that high-yield credit spread changes are more closely related with changes in interest rates and equity market factors.

Our findings are important for both pricing and managing credit risk. First, from a pricing perspective, we provide evidence that credit risk models may take into account the impact of the variation in the state of the economy on credit spreads. From a risk management perspective, small-cap equity indices such as the Russell 2000 index may be considered in hedging the equity component of corporate bonds credit spreads. These considerations may call for a hedging strategy based on interest rate variables, equity market return and volatility, and macroeconomic variables.

References

Barnhill, T.M.Jr., F.L. Joutz, and W.F. Maxell. "Factors Affecting the Yields on Noninvestment Grade Bond Indices: A Cointegration Analysis," *Journal of Empirical Finance*, 7 (2000), pp. 57-86.

Black, F. and M. Scholes. "The Pricing of Options and Corporate Liabilities," *Journal of Political Economy*, 81 (1973), pp. 637-654.

Brown, D. "An Empirical Analysis of Credit Spread Innovation," *Journal of Fixed Income*, September (2001), pp. 9-27.

Caouette, J., E. Altman, and P. Narayanan. *Managing Credit Risk : The Next Great Financial Challenge*, (1998), Wiley, John & Sons.

Collin-Dufresne, P., R. Goldstein, and S. Martin. "The Determinants of Credit Spread Changes," *Journal of Finance*, 56 (2001), pp. 2177-2207.

Das, S., and P. Tufano. "Pricing Credit Sensitive Debt When Interest Rates, Credit Ratings and Credit Spreads are Stochastic," *Journal of Financial Engineering*, 5 (1996), pp. 161-198.

Duffee, G.. "The Relation Between Treasury Yields and Corporate Bond Yield Spreads," *Journal of Finance*, 54 (1998), pp. 2225-2241.

Duffie, D., and K. Singleton. "Modeling the Term Structure of Defaultable Bonds," *Review of Financial Studies*, 12 (1999), pp. 687-720.

Elton, E., M. Gruber, D. Agrawal, and C. Mann. "Explaining the Rate Spread on Corporate Bonds," *Journal of Finance*, 56 (2001), pp. 247-277.

Fama, E. F., and K. R. French. "Multifactor Explanations of Asset Pricing Anomalies," *Journal of Finance*, 51 (1996), pp. 55-84.

Fridson, M.S., and J.G. Jonsson. "Spread versus Treasuries and the Riskiness of High-yield Bonds," *Journal of Fixed Income*, 5 (1995), pp. 79-88.

Helwege, J., and P. Kleiman. "Understanding High Yield Bond Default Rates," *Journal of Fixed Income*, 5 (1997), pp. 79-88.

Jarrow, R., and S. Turnbull. "Pricing Derivatives on Financial Securities Subject to Default Risk," *Journal of Finance*, 50 (1995), pp. 53-86.

Kao, D.L. "Estimating and Pricing Credit Risk: An Overview," *Financial Analysts Journal*, July/August (2000), pp. 50-66.

Kiefer, N.M., T.J. Vogelsang, and H. Bunzel. "Simple Robust Testing of Regression Hypotheses," *Econometrica*, 68 (2000), pp. 695-714.

Longstaff, F., and E. Schwartz. "A Simple Approach to Valuing Risky Fixed and Floating Rate Debt," *Journal of Finance*, 50 (1995), pp. 789-820.

Merton, R.C.. "On the Pricing of Corporate Debt: The Risk Structure of Interest Rates," *Journal of Finance*, 29 (1974), pp. 449-470.

Saunders, A.. *Credit Risk Measurement*, (1999), John Wiley & Sons, Inc., New York.

Van Horne, J.. *Financial Market Rates and Flows*, 6th edition (2001), Prentice-Hall.

Table 1

Summary Statistics for Monthly Changes of Merrill Lynch Option Adjusted Credit Spread (OAS) Indexes

This table reports the indicated summary statistics for monthly changes of various Merrill Lynch option-adjusted credit spread (OAS) indexes. Parameter ρ represents the first-order serial correlation coefficients. ΔCS denotes the monthly changes of a credit spread index in basis points. The average number of issues included in each index over the sample period is reported in the last row. The data consists of 67 monthly observations from January 1997 to July 2002.

ΔCS (bp)	AA-AAA 1-10 Yrs	AA-AAA 10-15 Yrs	AA-AAA 15+ Yrs	BBB-A 1-10 Yrs	BBB-A 10-15 Yrs	BBB-A 15+ Yrs	BB	B	C
Mean	-0.08	-1.13	-0.00	2.62	1.11	0.81	6.66	11.99	19.87
Std Dev.	5.07	10.46	6.57	11.47	12.09	12.21	44.82	63.29	105.91
Skewness	0.47	-1.26	-0.77	1.38	1.21	-0.25	1.82	0.59	0.56
Kurtosis	2.29	5.05	3.27	5.41	5.14	2.69	6.9	3.27	2.43
Max	16.62	23.35	15.85	48.98	53.77	37.03	195.26	229.2	384.47
90%	7.16	12.46	8.25	15.37	16.91	16.02	30.61	88.73	137.6
10%	-6.10	-12.87	-6.64	-7.89	-10.83	-12.28	-30.8	-37.58	-110.2
Min	-14.84	-47.54	-25.73	-30.77	-30.28	-41.24	-96.77	-169.76	-236.7
ρ	0.24	0.12	0.23	0.12	0.15	0.08	0.2	0.12	0.13
Issues	82	5	45	813	75	494	419	552	175

Table 2

Description of Explanatory Variables

Variable	Description	Sign
$\Delta df_{a,t}$	changes in Moody's trailing 12-month default rates of all U.S. corporate issuers	+
$\Delta df_{s,t}$	changes in Moody's trailing 12-month default rates of U.S. corporate speculative grade issuers	+
$\Delta level_t$	changes in yield of Merrill Lynch Treasury Master Index	-
$\Delta slope_t$	changes in yield of Merrill Lynch 15+ years Treasury Index minus yield of Merrill Lynch 1-3 year Treasury Index	-
$\Delta\sigma^{r}_{hv,t}$	changes in historical volatility of Merrill Lynch Treasury Master Index yields	+
$\Delta\sigma^{r}_{iv,t}$	changes in implied volatility of 30-year Treasury bond futures options traded on Chicago Board of Trade (CBOT)	+
rus_t	Russell 2000 index return	-
$\Delta\sigma^{rus}_{hv,t}$	changes in historical volatility of Russell 2000 index return	+
$\Delta\sigma^{rus}_{iv,t}$	changes in implied volatility of Russell 2000 index options	+
sp_t	S&P 500 index return	-
$\Delta\sigma^{sp}_{hv,t}$	changes in historical volatility of S&P 500 index return	+
ΔVIX_t	changes in CBOE VIX index	+
smb_t	Fama-French small-minus-big factor returns	-
hml_t	Fama-French high-minus-low factor returns	-
$\Delta liquid_t$	changes in corporate bond mutual funds liquid asset as percentage of total net assets	+
ΔNCF_t	changes in corporate bond mutual funds net new cash flow as percentage of total net assets	-
$\Delta lead_t$	changes in Conference Board leading index	-
Δci_t	changes in Conference Board coincident index	-
Δlg_t	changes in Conference Board lagged index	+

Table 3

Relation between Changes in Credit Spreads and Changes in Realized Default Rates

For each maturity/rating index, we estimate the following regression: $\Delta CS_t = \alpha+\beta_1 default_t+\varepsilon_t$, where $default_t = \Delta df_{a,t}$ for investment-grade indexes and $default_t = \Delta df_{s,t}$ for high-yield indexes. Panel A presents the OLS estimation results over the period January 1997 to July 2002 and Panel B presents the OLS estimation results over the sub-period January 1997 to December 2001. The KVB parameter test statistic is reported in the parenthesis. For m = 1 where m is the number of parameter under test, the 90% critical value of the KVB test statistic is 28.88 and the 95% critical value is 46.39.

Panel A: January 1997 through July 2002 (N = 67)

	AA-AAA 1-10 Yrs	AA-AAA 10-15 Yrs	AA-AAA 15+ Yrs	BBB-A 1-10 Yrs	BBB-A 10-15 Yrs	BBB-A 15+ Yrs	BB	B	C
α	0.36	-0.44	0.57	3.12	2.35	1.49	8.97	16.72	27.21
$default_t$	-7.71	-12.26	-10.12	-8.7	-21.8	-12.01	-18.09	-36.95	-57.42
	(12.84)	(18.19)	(44.81)	(6.43)	(12.05)	(20.38)	(6.24)	(30.72)	(26.5)
Adj R^2	2.83%	1.05%	2.93%	-0.46%	4.58%	0.28%	-0.7%	1.53%	1.11%

Panel B: January 1997 through December 2001 (N = 60)

	AA-AAA 1-10 Yrs	AA-AAA 10-15 Yrs	AA-AAA 15+ Yrs	BBB-A 1-10 Yrs	BBB-A 10-15 Yrs	BBB-A 15+ Yrs	BB	B	C
α	-0.004	-0.21	0.59	1.83	0.55	0.79	2.77	12.84	22.93
$default_t$	-5.41	-14.92	-12.12	-3.02	-12.45	-9.88	-4.27	-29.57	-48.08
	(13.39)	(11.74)	(27.57)	(4.01)	(12.05)	(24.24)	(1.6)	(20.95)	(20.55)
Adj R^2	0.58%	1.63%	3.93%	-1.56%	0.99%	-0.46%	-1.6%	0.28%	0.25%

Table 4

Relation between Changes in Credit Spreads and Interest Rate Variables

For each maturity/rating index, we estimate equation (1): $\Delta CS_t = \alpha+\beta_1\Delta level_t+\beta_2\Delta slope_t+\beta_3\Delta\sigma^r_{hv,t}+ \varepsilon_t$, and equation (2): $CS_t = \alpha+\beta_1\Delta level_t+\beta_2\Delta slope_t+\beta_3\Delta\sigma^r_{iv,t}+ \varepsilon_t$. Panel A presents the OLS estimation results of equation (1) over the period January 1997 to July 2002, Panel B presents the OLS estimation results of equation (1) over the sub-period January 1997 to December 2001, and Panel C presents the OLS estimation results of equation (2) over the period January 1997 to August 2001. The KVB parameter test statistic is reported in the parenthesis. For m = 1 where m is the number of parameter under test, the 90% critical value of the KVB test statistic is 28.88 and the 95% critical value is 46.39.

Panel A: January 1997 through July 2002 (N = 67)

	AA-AAA 1-10 Yrs	AA-AAA 10-15 Yrs	AA-AAA 15+ Yrs	BBB-A 1-10 Yrs	BBB-A 10-15 Yrs	BBB-A 15+ Yrs	BB	B	C
α	-0.01	-0.01	0.02	2.03	1.14	0.62	2.37	5.98	9.95
$\Delta level_t$	-7.14	-0.19	-9.83	-21.92	-14.18	-22.4	-112.6	-157.3	-204.6
	(9.99)	(0)	(5.55)	(8.92)	(3.17)	(5.99)	(21.47)	(34.75)	(24.69)
$\Delta slope_t$	-6.37	-24.47	-6.77	-2.42	-10.05	-11.53	16.41	22.49	72.84
	(7.62)	(44.31)	(3.78)	(0.21)	(4.34)	(2.8)	(1.25)	(0.98)	(4.27)
$\Delta\sigma^r_{hv,t}$	1.24	-0.27	-0.01	3.09	0.9	3.25	11.79	20.02	31.91
	(22.86)	(0.21)	(0)	(10.7)	(1.47)	(17.91)	(27.3)	(47.25)	(28.27)
Adj R^2	7.16%	15.81%	4.99%	15.47%	1.29%	12.13%	32.84%	34.08%	25.21%

Panel B: January 1997 through December 2001 (N = 60)

	AA-AAA 1-10 Yrs	AA-AAA 10-15 Yrs	AA-AAA 15+ Yrs	BBB-A 1-10 Yrs	BBB-A 10-15 Yrs	BBB-A 15+ Yrs	BB	B	C
α	-0.16	-0.02	-0.09	1.58	0.23	0.34	0.38	5.16	10.03
$\Delta level_t$	-4.64	8.08	-7.47	-14.41	-5.01	-16.72	-86.19	-140.79	-168.6
	(11.09)	(4.58)	(3.56)	(8.13)	(0.99)	(4.18)	(27.92)	(31.65)	(25.24)
$\Delta slope_t$	-8.28	-28.39	-7.9	-6.41	-16.71	-14.87	1.33	12.28	60.25
	(13)	(66.42)	(4.85)	(1.7)	(17.69)	(4.72)	(0.01)	(0.29)	(2.83)
$\Delta\sigma^r_{hv,t}$	0.93	0.35	-0.02	2.83	0.19	2.76	10.27	19.5	35.28
	(7.98)	(0.27)	(0)	(9.56)	(0.09)	(12.36)	(27.15)	(31.32)	(26.51)
Adj R^2	7.6%	28.55%	2.12%	8.5%	4.49%	8.21%	27.5%	27.27%	21.26%

Panel C: January 1997 through August 2001 (N=56)

	AA-AAA 1-10 Yrs	AA-AAA 10-15 Yrs	AA-AAA 15+ Yrs	BBB-A 1-10 Yrs	BBB-A 10-15 Yrs	BBB-A 15+ Yrs	BB	B	C
α	-0.09	-0.2	0.33	1.49	0.26	0.72	1.19	6.86	12.58
$\Delta level_t$	-2.85	13.34	-0.73	-8.9	3.48	-6.69	-65.12	-116.17	-123.05
	(12.8)	(52.83)	(0.42)	(11.79)	(4.4)	(3.43)	(70.76)	(50.19)	(46.55)
$\Delta slope_t$	-9.84	-35.53	-7.6	-16.27	-27.28	-22.96	-39.12	-24.59	-4.15
	(7.67)	(274.1)	(2.24)	(5.14)	(25.26)	(5.04)	(3.86)	(0.57)	(0.01)
$\Delta\sigma^r_{iv,t}$	0.5	-1.30	0.24	0.47	0.45	0.96	3.32	8.45	19.34
	(3.21)	(20.55)	(0.36)	(1.58)	(0.79)	(3.14)	(3.31)	(2.91)	(7.99)
Adj R^2	6.5%	38.57%	-1.3%	4.26%	19.21%	7.5%	20.77%	14.3%	6.1%

Table 5

Relation between Credit Spread Changes and Russell 2000 Index Variables

For each maturity/rating index, we estimate the following regression: $\Delta CS_t = \alpha+\beta_1 rus_t+\beta_2\Delta\sigma^{rus}_{hv,t}+ \varepsilon_t$. Panel A presents the OLS estimation results over the period January 1997 to July 2002, and Panel B presents the OLS estimation results over the sub-period January 1997 to December 2001. The KVB parameter test statistic is reported in the parenthesis. For m = 1 where m is the number of parameter under test, the 90% critical value of the KVB test statistic is 28.88 and the 95% critical value is 46.39.

Panel A: January 1997 through July 2002 (N = 67)

	AA-AAA 1-10 Yrs	AA-AAA 10-15 Yrs	AA-AAA 15+ Yrs	BBB-A 1-10 Yrs	BBB-A 10-15 Yrs	BBB-A 15+ Yrs	BB	B	C
α	-0.06	-0.85	0.03	2.69	1.24	0.99	7.04	12.61	20.2
rus_t	-0.26	-0.65	-0.32	-0.72	-0.79	-0.98	-3.25	-4.92	-6.61
	(24)	(120.8)	(35.99)	(22.39)	(28.49)	(34.46)	(17.18)	(29.59)	(36.82)
$\Delta\sigma^{rus}_{hv,t}$	0.17	-0.18	0.18	0.43	0.32	0.34	1.71	2.55	4.69
	(39.56)	(5.18)	(50.16)	(26.27)	(22.3)	(76.38)	(53.69)	(64.18)	(57.45)
Adj R^2	23.76%	9.27%	17.98%	33.67%	26.9%	38.25%	41.12%	47.09%	39.66%

Panel B: January 1997 through December 2001 (N = 60)

	AA-AAA 1-10 Yrs	AA-AAA 10-15 Yrs	AA-AAA 15+ Yrs	BBB-A 1-10 Yrs	BBB-A 10-15 Yrs	BBB-A 15+ Yrs	BB	B	C
α	-0.27	-0.82	-0.1	1.91	0.03	0.63	3.38	10.86	18.45
rus_t	-0.2	-0.59	-0.28	-0.53	-0.59	-0.88	-2.34	-4.41	-5.4
	(25.53)	(62.11)	(46.38)	(27.17)	(39.44)	(34.51)	(22.28)	(26.85)	(49.75)
$\Delta\sigma^{rus}_{hv,t}$	0.15	-0.21	0.17	0.36	0.23	0.3	1.70	2.58	4.95
	(39.98)	(7.9)	(38)	(31.32)	(24.83)	(63.74)	(39.84)	(49.66)	(40.26)
Adj R^2	17.96%	7%	14.14%	27.7%	20.93%	33.95%	46.9%	44.96%	39.54%

Table 6

Regression Analysis with Russell 2000 Index Variables and the Fama-French (1996) *hml* Factor Returns

For each maturity/rating index, we estimate the following regression: $\Delta CS_t = \alpha+\beta_1 rus_t+\beta_2\Delta\sigma^{rus}_{hv,t}+\beta_3 hml_t+\varepsilon_t$. Panel A presents the OLS estimation results over the period January 1997 to July 2002, and Panel B presents the OLS estimation results over the sub-period January 1997 to December 2001. The KVB parameter test statistic is reported in the parenthesis. For m = 1 where m is the number of parameter under test, the 90% critical value of the KVB test statistic is 28.88 and the 95% critical value is 46.39.

Panel A: January 1997 through July 2002 (N = 67)

	AA-AAA 1-10 Yrs	AA-AAA 10-15 Yrs	AA-AAA 15+ Yrs	BBB-A 1-10 Yrs	BBB-A 10-15 Yrs	BBB-A 15+ Yrs	BB	B	C
α	-0.03	-0.83	0.09	2.77	1.28	1.08	7.46	13.23	21.36
rus_t	-0.34	-0.69	-0.45	-0.89	-0.88	-1.18	-4.17	-6.31	-9.19
	(27.13)	(140.8)	(38.74)	(21.65)	(17.54)	(31.07)	(21)	(38.11)	(66.09)
$\Delta\sigma^{rus}_{hv,t}$	0.17	-0.17	0.18	0.43	0.33	0.35	1.73	2.57	4.72
	(48.91)	(5.28)	(34.14)	(32.74)	(24.35)	(82.93)	(86.09)	(72.54)	(80.5)
hml_t	-0.21	-0.09	-0.32	-0.43	-0.22	-0.51	-2.37	-3.55	-6.6
	(10.81)	(1.74)	(11.19)	(7.88)	(1.29)	(9.04)	(16.99)	(35.34)	(87.2)
Adj R^2	27.13%	8.06%	23.18%	36.54%	26.67%	42.14%	47.93%	54.94%	49.45%

Panel B: January 1997 through December 2001 (N = 60)

	AA-AAA 1-10 Yrs	AA-AAA 10-15 Yrs	AA-AAA 15+ Yrs	BBB-A 1-10 Yrs	BBB-A 10-15 Yrs	BBB-A 15+ Yrs	BB	B	C
α	-0.23	-0.82	0.00	1.99	0.03	0.76	3.93	11.96	20.44
rus_t	-0.27	-0.6	-0.42	-0.64	-0.58	-1.06	-3.11	-5.94	-8.16
	(24.01)	(69.01)	(33.78)	(20.41)	(17.48)	(24.71)	(21.48)	(27.81)	(62.28)
$\Delta\sigma^{rus}_{hv,t}$	0.15	-0.21	0.18	0.37	0.23	0.31	1.74	2.66	5.09
	(42.84)	(7.76)	(32.97)	(33.67)	(24.09)	(62.87)	(50.99)	(62.79)	(55.13)
hml_t	-0.14	-0.01	-0.31	-0.24	0.01	-0.41	-1.73	-3.42	-6.18
	(7.66)	(0.04)	(9.04)	(4.54)	(0.01)	(6.06)	(14.96)	(23.61)	(71.21)
Adj R^2	19.09%	5.35%	18.8%	28.13%	19.52%	36.5%	53.03%	53.18%	49.63%

Table 7

Relation between Credit Spread Changes and Supply/Demand from Corporate Bond Mutual Funds

For each maturity/rating index, we estimate the following regression: $\Delta CS_t = \alpha + \beta_1 \Delta liquid_t + \beta_2 \Delta NCF_t + \varepsilon_t$. Panel A presents the OLS estimation results over the period July 1997 to July 2002, and Panel B presents the OLS estimation results over the sub-period July 1997 to December 2001. The KVB parameter test statistic is reported in the parenthesis. For m = 1 where m is the number of parameter under test, the 90% critical value of the KVB test statistic is 28.88 and the 95% critical value is 46.39.

Panel A: July 1997 through July 2002 (N = 61)

	AA-AAA 1-10 Yrs	AA-AAA 10-15 Yrs	AA-AAA 15+ Yrs	BBB-A 1-10 Yrs	BBB-A 10-15 Yrs	BBB-A 15+ Yrs	BB	B	C
α	0.06	-1.12	0.03	3.01	1.42	0.96	7.5	13.56	21.82
$\Delta liquid_t$	-2.4	1.2	-1.31	-4.31	-3.51	-3.82	-11.27	-21.17	-37.09
	(28.35)	(5.01)	(8.01)	(3.33)	(2.51)	(2.8)	(45.88)	(59.94)	(101.3)
ΔNCF_t	0.52	2.96	0.65	1.7	2.08	2.87	6.59	9.53	15.8
	(1.1)	(8.76)	(1.41)	(3.39)	(4.32)	(7.62)	(29.39)	(23.29)	(11.85)
Adj R^2	1.85%	-1.6%	-2.28%	0.35%	-0.71%	0.29%	4.47%	10.15%	11.31%

Panel B: July 1997 through December 2001 (N = 54)

	AA-AAA 1-10 Yrs	AA-AAA 10-15 Yrs	AA-AAA 15+ Yrs	BBB-A 1-10 Yrs	BBB-A 10-15 Yrs	BBB-A 15+ Yrs	BB	B	C
α	-0.27	-1.3	-0.26	1.91	-0.16	0.15	3.29	11.16	19.89
$\Delta liquid_t$	-2.03	1.28	-1.09	-3.67	-1.99	-2.93	-8.04	-21.34	-37.68
	(27.03)	(3.45)	(6.93)	(2.25)	(1.25)	(1.76)	(20.17)	(36.89)	(62.49)
ΔNCF_t	-0.4	2.06	0.1	-0.08	-0.1	1.02	7.03	12.24	20.86
	(1.69)	(2)	(0.03)	(0.03)	(0.02)	(2.14)	(86.17)	(72.26)	(43.02)
Adj R^2	0.8%	-2.86%	-3.36%	-1%	-3.09%	-2.3%	3.26%	10.85%	13.04%

Table 8

Relation between Credit Spread Changes and Macroeconomic Indicators

For each maturity/rating index, we estimate the following regression: $\Delta CS_t = \alpha + \beta_1 \Delta lead_t + \beta_2 \Delta ci_t + \beta_3 \Delta lg_t + \varepsilon_t$. Panel A presents the OLS estimation results over the period January 1997 to July 2002, and Panel B presents the OLS estimation results over the sub-period January 1997 to December 2001. The KVB parameter test statistic is reported in the parenthesis. For m = 1 where m is the number of parameter under test, the 90% critical value of the KVB test statistic is 28.88 and the 95% critical value is 46.39.

Panel A: January 1997 through July 2002 (N = 67)

	AA-AAA 1-10 Yrs	AA-AAA 10-15 Yrs	AA-AAA 15+ Yrs	BBB-A 1-10 Yrs	BBB-A 10-15 Yrs	BBB-A 15+ Yrs	BB	B	C
α	-0.72	-2.24	-1.21	3.59	0.2	0.08	7.38	16.82	26.75
$\Delta lead_t$	-4.64	0.93	-7.08	-14.43	-13.36	-18.99	-65.22	-93.99	-121.3
	(46.51)	(0.83)	(81.79)	(51.03)	(29.05)	(96.95)	(53.72)	(264.2)	(354.7)
Δci_t	6.88	4.83	11.77	6.36	15.28	18.7	47.79	49.29	59.32
	(34.65)	(4.84)	(117.2)	(14.83)	(40.25)	(143.8)	(52.09)	(10.23)	(3.56)
Δlg_t	0.49	2.44	0.41	0.06	-3.43	-0.97	-6.63	-2.55	23.12
	(1.09)	(4.34)	(0.49)	(0)	(8.24)	(1.71)	(2.64)	(0.08)	(1.31)
Adj R^2	11.48%	-1.9%	19.34%	15.08%	10.37%	27%	20.32%	22.24%	14.48%

Panel B: January 1997 through December 2001 (N = 60)

	AA-AAA 1-10 Yrs	AA-AAA 10-15 Yrs	AA-AAA 15+ Yrs	BBB-A 1-10 Yrs	BBB-A 10-15 Yrs	BBB-A 15+ Yrs	BB	B	C
α	-1.08	-2.6	-1.56	2.43	-1.41	-0.61	3.89	14.37	24.69
$\Delta lead_t$	-3.03	2.80	-6.54	-11.18	-7.61	-16.77	-52.38	-88.76	-128.2
	(47.72)	(12.09)	(55.87)	(99.58)	(128.1)	(122.8)	(85.58)	(256.1)	(303.5)
Δci_t	5.71	3.57	11.58	5.02	11.8	17.56	34.2	44.08	57.31
	(34.53)	(2.93)	(122.08)	(5.9)	(45.16)	(117.52)	(14.24)	(5.12)	(2.29)
Δlg_t	1.09	3.17	1.01	1.04	-0.32	-0.48	2.11	0.57	19.43
	(4.14)	(5.2)	(2.28)	(0.62)	(0.09)	(0.27)	(0.22)	(0)	(0.82)
Adj R^2	8.41%	-1.85%	18.94%	12.45%	5.54%	24.17%	23.72%	21.36%	18.35%

Table 9

Regression Analysis with Interest Rate, Equity Market, and Macroeconomic Variables

For each maturity/rating index, we estimate the following regression: $\Delta CS_t = \alpha + \beta_1 \Delta level_t + \beta_2 \Delta slope_t + \beta_3 \Delta\sigma^r_{hv,t} + \beta_4 rus_t + \beta_5 \Delta\sigma^{rus}_{hv,t} + \beta_6 hml_t + \beta_7 \Delta lead_t + \beta_8 \Delta ci_t + \varepsilon_t$. Panel A presents the OLS estimation results over the period January 1997 to July 2002, and Panel B presents the OLS estimation results over the sub-period January 1997 to December 2001. The KVB parameter test statistic is reported in the parenthesis. For m = 1 where m is the number of parameter under test, the 90% critical value of the KVB test statistic is 28.88 and the 95% critical value is 46.39.

Panel A: January 1997 through July 2002 (N = 67)

	AA-AAA 1-10 Yrs	AA-AAA 10-15 Yrs	AA-AAA 15+ Yrs	BBB-A 1-10 Yrs	BBB-A 10-15 Yrs	BBB-A 15+ Yrs	BB	B	C
α	0.18	2.51	-0.54	4.72	2.68	2.15	3.83	14.71	16.96
$\Delta level_t$	-1.69	4.86	-1.03	-9.46	0.03	-3.89	-60.57	-79.82	-83.05
	(17.98)	(2.93)	(0.52)	(33.67)	(0)	(5.34)	(413.6)	(102.7)	(72.53)
$\Delta slope_t$	-6.03	-30.09	-2.91	-8.15	-12.04	-10.93	25.08	15.68	79.62
	(13.47)	(41.92)	(1.17)	(3.31)	(10.73)	(4.62)	(4.67)	(1.14)	(8.72)
$\Delta\sigma^r_{hv,t}$	-0.00	-1.33	-1.79	0.29	-2.3	-0.42	0.79	3.6	5.53
	(0)	(2.34)	(18.2)	(0.41)	(45.07)	(0.87)	(0.72)	(1.84)	(1.33)
rus_t	-0.27	-0.8	-0.34	-0.74	-0.78	-0.95	-3.23	-5.15	-7.79
	(20.39)	(161.7)	(38.46)	(33.3)	(19.51)	(38.63)	(37.34)	(44.4)	(78.76)
$\Delta\sigma^{rus}_{hv,t}$	0.18	0.03	0.21	0.41	0.4	0.34	1.27	1.99	3.73
	(26.01)	(0.19)	(101)	(18.89)	(39.64)	(74.17)	(51.83)	(87.87)	(46.28)
hml_t	-0.16	-0.18	-0.23	-0.37	-0.17	-0.38	-1.74	-2.88	-5.79
	(7.31)	(6.94)	(8.35)	(7.12)	(0.94)	(7.07)	(18.48)	(22.82)	(59.4)
$\Delta lead_t$	-2.42	-0.1	-5.22	-6.4	-7.98	-11.98	-20.83	-31.58	-37.64
	(16.83)	(0.01)	(50.65)	(174.3)	(79.31)	(393.7)	(181.7)	(145.5)	(13.42)
Δci_t	1.85	-9.33	7.71	-4.71	1.83	5.54	18.96	0.21	19.73
	(6.52)	(24.59)	(25.56)	(4.46)	(2.12)	(4.66)	(11.11)	(0)	(0.67)
Adj R^2	28.96%	28.89%	32.94%	41.58%	29.47%	51.4%	60.82%	67.68%	55.54%

Panel B: January 1997 through December 2001 (N = 60)

	AA-AAA 1-10 Yrs	AA-AAA 10-15 Yrs	AA-AAA 15+ Yrs	BBB-A 1-10 Yrs	BBB-A 10-15 Yrs	BBB-A 15+ Yrs	BB	B	C
α	0.22	3.15	-0.61	4.3	1.9	2.11	4.4	16.52	22.99
$\Delta level_t$	-1.37	9.75	-0.06	-6.21	2.93	-2.57	-49.95	-80.81	-62.99
	(5.89)	(18.94)	(0)	(22.27)	(1.9)	(1.37)	(245.3)	(145)	(12.89)
$\Delta slope_t$	-8.48	-35.81	-3.29	-11.99	-19.59	-13.8	3.82	7.19	67.13
	(15.18)	(98.63)	(1.18)	(5.33)	(35.89)	(5.32)	(0.24)	(0.16)	(4.24)
$\Delta\sigma^r_{hv,t}$	-0.15	-0.53	-1.73	0.46	-2.36	-0.56	-0.38	1.99	6.55
	(0.21)	(0.26)	(9.52)	(0.66)	(21.84)	(0.69)	(0.05)	(0.26)	(1.03)
rus_t	-0.21	-0.65	-0.31	-0.52	-0.51	-0.84	-2.55	-5.18	-7.01
	(13.47)	(107)	(21.59)	(30.43)	(11.79)	(26.51)	(29.32)	(30.14)	(76.4)
$\Delta\sigma^{rus}_{hv,t}$	0.18	0.01	0.21	0.37	0.36	0.33	1.51	2.24	4.22
	(20.91)	(0)	(86.97)	(16.31)	(36.76)	(52.23)	(25.21)	(44.04)	(27.57)
hml_t	-0.1	-0.07	-0.22	-0.19	0.05	-0.28	-1.37	-29.69	-5.67
	(3.93)	(1.23)	(6.12)	(3.28)	(0.13)	(3.99)	(11.33)	(16.04)	(45.36)
$\Delta lead_t$	-1.72	0.04	-5.24	-5.98	-5.78	-10.98	-19.91	-8.89	-57.58
	(4.38)	(0)	(30.12)	(147)	(23.27)	(236)	(189.4)	(47.12)	(140.7)
Δci_t	0.5	-11.98	7.63	-5.19	-0.72	4.05	7.18	-3.01	13.48
	(0.16)	(83.57)	(15.09)	(2.7)	(0.06)	(1.19)	(0.84)	(0.21)	(0.2)
Adj R^2	24.39%	38.3%	27.9%	32.94%	32.34%	46%	66.8%	66.01%	57.85%

Table 10

Regression Analysis with Weekly Credit Spread Changes

For each maturity/rating index, we estimate the following regression: $\Delta CS_t = \alpha + \beta_1 \Delta level_t + \beta_2 \Delta slope_t + \beta_3 \Delta\sigma^r_{hv,t} + \beta_4 rus_t + \beta_5 \Delta\sigma^{rus}_{hv,t} + \varepsilon_t$. Panel A presents the OLS estimation results over the whole sample period, and Panel B presents the OLS estimation results over the first half sample, and Panel C presents the OLS estimation results over the second half sample. In Panel B, R^2_f is the adjusted R-squared of the out-of sample forecast using the estimated coefficients based on the first-half sample. The KVB parameter test statistic is reported in the parenthesis. For m = 1 where m is the number of parameter under test, the 90% critical value of the KVB test statistic is 28.88 and the 95% critical value is 46.39.

Panel A: Whole Sample Period (N =295)

	AA-AAA 1-10 Yrs	AA-AAA 10-15 Yrs	AA-AAA 15+ Yrs	BBB-A 1-10 Yrs	BBB-A 10-15 Yrs	BBB-A 15+ Yrs	BB	B	C
α	0.12	0.21	0.16	0.44	0.57	0.36	0.9	0.7	1.68
$\Delta level_t$	-0.76	7.3	-1.74	-7.52	-4.56	-7.77	-55.03	-113.57	-165.21
	(2.96)	(15.13)	(1.58)	(38.71)	(2.3)	(16.05)	(239.6)	(268.4)	(122.7)
$\Delta slope_t$	0.29	-8.8	-0.61	1.29	-5.97	-1.91	5.77	26.03	59.31
	(0.07)	(64.44)	(1.05)	(1.19)	(21.37)	(1.43)	(1.24)	(27.73)	(45.59)
$\Delta\sigma^r_{hv,t}$	0.68	0.27	0.72	1.26	0.56	1.22	2.33	5.89	-1.74
	(12.7)	(0.12)	(5.26)	(75.07)	(10.89)	(26.53)	(7.13)	(43.11)	(0.47)
rus_t	-0.17	-0.51	-0.21	-0.3	-0.46	-0.39	-1.1	-1.81	-0.31
	(58.59)	(20.5)	(32.88)	(158.7)	(86.09)	(110.2)	(46.49)	(437.4)	(0.69)
$\Delta\sigma^{rus}_{hv,t}$	0.17	0.2	0.12	0.35	0.38	0.42	0.97	2.27	5.11
	(118.9)	(19.95)	(16.45)	(18.93)	(11.67)	(79.57)	(38.19)	(41.37)	(25)
Adj R^2	7.1%	6.37%	4.47%	15.92%	9.85%	17.19%	28.91%	42.19%	23.22%

Panel B: First-half Sample (N = 147)

	AA-AAA 1-10 Yrs	AA-AAA 10-15 Yrs	AA-AAA 15+ Yrs	BBB-A 1-10 Yrs	BBB-A 10-15 Yrs	BBB-A 15+ Yrs	BB	B	C
α	0.24	0.37	0.38	0.59	0.37	0.47	0.75	1.26	1.15
$\Delta level_t$	0.04	9.63	1.06	-3.94	4.06	-2.7	-47.03	-93.92	-140.77
	(0)	(30.75)	(1.64)	(18.24)	(9.13)	(6.21)	(343.4)	(601.7)	(26.89)
$\Delta slope_t$	0.68	-2.44	-1.57	-1.94	-7.45	1.02	20.35	39.96	94.59
	(0.48)	(0.28)	(0.92)	(4.74)	(52.45)	(0.4)	(36.07)	(18.29)	(47.7)
$\Delta\sigma^r_{hv,t}$	1.17	2.55	1.35	0.89	-0.05	1.51	0.42	3.84	-16.79
	(27.38)	(12.25)	(18.82)	(17.89)	(0.05)	(19.95)	(1.16)	(3.71)	(12.59)
rus_t	-0.25	-0.92	-0.3	-0.38	-0.67	-0.46	-0.47	-1.96	-2.86
	(32.64)	(185.9)	(28.45)	(33.68)	(65.07)	(21.58)	(21.57)	(122.04)	(47.51)
$\Delta\sigma^{rus}_{hv,t}$	0.18	0.21	0.21	0.19	0.21	0.41	0.7	1.76	1.9
	(15.05)	(3.36)	(49.93)	(15.53)	(6.26)	(33.78)	(42.76)	(45.81)	(16.91)
Adj R^2	7.39%	17.52%	8.85%	9.36%	13.74%	15.99%	49.16%	56.68%	18.22%
Adj R^2_f	1.89	-36.8%	-6.27%	16.26%	2.85%	16.21%	23.42%	37.56%	16.57%

Table 10 (Cont.)

Regression Analysis with Weekly Credit Spread Changes

Panel C: Second-half Sample (N = 148)

	AA-AAA 1-10 Yrs	AA-AAA 10-15 Yrs	AA-AAA 15+ Yrs	BBB-A 1-10 Yrs	BBB-A 10-15 Yrs	BBB-A 15+ Yrs	BB	B	C
α	-0.03	-0.02	-0.11	0.21	0.62	0.18	1.05	-0.12	1.95
$\Delta level_t$	-2.43	0.63	-5.47	-11.04	-13.26	-13.47	-58.53	-133.72	-199.36
	(27.54)	(0.07)	(7.94)	(147.4)	(62.13)	(98.84)	(132.2)	(283.5)	(161.4)
$\Delta slope_t$	0.72	-8.29	0.24	1.59	-7.24	-3.29	-4.31	17.07	38.63
	(0.11)	(21.37)	(0.05)	(0.67)	(13.65)	(1.2)	(0.25)	(3.9)	(19.06)
$\Delta\sigma^{r}_{hv,t}$	0.29	-1.52	0.19	1.24	0.49	0.91	4.14	6.56	3.4
	(4.72)	(20.99)	(0.27)	(19.62)	(3.29)	(6.95)	(14.68)	(45.58)	(5.3)
rus_t	-0.09	-0.09	-0.08	-0.23	-0.27	-0.28	-1.6	-1.64	1.04
	(7.98)	(2.79)	(3.13)	(26.97)	(13.8)	(80.1)	(151.5)	(96.11)	(1.29)
$\Delta\sigma^{rus}_{hv,t}$	0.15	0.14	0.04	0.49	0.52	0.42	1.23	2.69	7.48
	(70.91)	(4.07)	(0.4)	(19.28)	(6.72)	(16.86)	(20.12)	(18.05)	(39.07)
Adj R^2	5.3%	1.64%	1.51%	19.98%	10.46%	17.95%	26.69%	38.11%	28.99%

Table 11

Regression Analysis with Changes of S&P Credit Indices

For S&P investment-grade and speculative-grade credit indices, we estimate the following regression: (1) $\Delta CS_t = \alpha+\beta_1\Delta level_t+\beta_2\Delta slope_t+\beta_3\Delta\sigma^r_{hv,t}+\beta_4 rus_t+\beta_5\Delta\sigma^{rus}_{hv,t}+\varepsilon_t$ using weekly credit spread changes and (2) $\Delta CS_t = \alpha+\beta_1\Delta level_t+\beta_2\Delta slope_t+\beta_3\Delta\sigma^r_{hv,t}+\beta_4 rus_t+\beta_5\Delta\sigma^{rus}_{hv,t}+\beta_6 hml_t+\beta_7\Delta lead_t+\beta_8\Delta ci_t+\varepsilon_t$ using monthly credit spread changes. The S&P credit indices are from December 31 1998 through July 31 2002. Panel A presents the OLS estimation results for weekly regression (1), and Panel B presents the OLS estimation results for monthly regression (2). The KVB parameter test statistic is reported in the parenthesis. For m=1 where m is the number of parameter under test, the 90% critical value of the KVB test statistic is 28.88 and the 95% critical value is 46.39.

Panel A: Weekly Changes of S&P Credit Indices (N=189)

	Investment-grade	High-yield
α	0.37	3.08
$\Delta level_t$	-16.89	-154.19
	(102.3)	(165.8)
$\Delta slope_t$	-0.15	-20.45
	(0)	(16.57)
$\Delta\sigma^r_{hv,t}$	0.92	3.43
	(21.15)	(17.5)
rus_t	-0.48	-1.55
	(36.25)	(113.6)
$\Delta\sigma^{rus}_{hv,t}$	0.28	3.02
	(5.83)	(21.22)
Adj R^2	31.2%	62.41%

Panel B: Monthly Changes of S&P Credit Indices (N=43)

	Investment-grade	High-yield
α	4.46	20.94
$\Delta level_t$	-16.55	-94.38
	(14.97)	(40.73)
$\Delta slope_t$	-15.2	6.82
	(18.25)	(0.18)
$\Delta\sigma^r_{hv,t}$	0.41	-4.53
	(0.1)	(0.67)
rus_t	-1.18	-6.3
	(74.05)	(226.2)
$\Delta\sigma^{rus}_{hv,t}$	0.2	2.44
	(6.66)	(30.97)
hml_t	-0.5	-3.83
	(10.82)	(38.04)
$\Delta lead_t$	-12.62	-46.3
	(204.8)	(59.04)
Δci_t	-0.29	-3.83
	(0.01)	(0.22)
Adj R^2	63.37%	72.95%