Do the Distributional Characteristics of Corporate Bonds Predict Their Future Returns?*

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Abstract

We investigate whether the distributional characteristics of corporate bonds predict the cross-sectional differences in future bond returns. The results indicate a significantly positive (negative) link between volatility (skewness) and expected returns, whereas kurtosis does not make a robust incremental contribution to the predictability of bond returns. These findings remain intact after controlling for transaction costs, liquidity, and bond characteristics. We also propose new risk factors based on the distributional moments of corporate bond returns, and show that the new risk factors represent an important source of common return variation missing from the long-established stock and bond market factors.

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1 Introduction

The distribution of individual security returns plays a central role in optimal asset allocation, derivative pricing, and risk management. Over the past three decades, academics and practitioners have therefore devoted substantial efforts to modeling and estimating the distribution of individual stock returns. However, little attention has been paid to the distribution of corporate bond returns. Trading and the outstanding amount of corporate bonds have increased substantially over time, indicating that, at present, bond positions play a larger role in investors' portfolios than at any time in the past.[1] Institutional investors in particular make extensive use of corporate bonds in constructing their portfolios.[2] Therefore, understanding the distribution of corporate bond returns is crucial to understanding the true risks inherent in institutional investors' portfolios.

We investigate the distributional characteristics of corporate bonds and find that the empirical distribution of bond returns is skewed, peaked around the mode, and has fat-tails, implying that extreme returns occur much more frequently than predicted by the normal distribution. Hence, ignoring non-normality features of the return distribution significantly understates downside risk in bond portfolios, potentially posing a solvency risk for bond investors. This study is motivated by our empirical observation that the distribution of corporate bond returns exhibits significant departures from normality. We argue for a pricing framework for corporate bonds that builds in non-normality up front because beyond its pure statistical merit, there lies a significant, practical benefit for investors: the potential to improve portfolio efficiency and reduce its risk relative to unpredictable, extreme negative events.

The paper is also inspired by the unique market features, the types of investors and investors' attitudes toward risk in the corporate bond market. First and foremost, firms that issue corporate bonds suffer from the potential default risk given the legal requirement on the payments of coupons and principals, whereas firms that issue stocks have only negligible exposure to bankruptcy. This main disparity makes *credit risk* particularly important in determining corporate bond returns. Second, bondholders are more sensitive to *downside risk* than stockholders. Bondholders gain the cash flow of fixed coupon and principal pay-

[1]Corporate bonds constitute one of the largest components of the U.S. bond market, which is considered the largest security market in the world. According to the Federal Reserve database, the total market value of outstanding corporate bonds in the United States was about \$1.74 trillion in 1990 and it increased monotonically to \$11.10 trillion by the end of 2013. This implies an annual growth rate of 8.5% per annum from 1990 to 2013. The corporate bond market is active as well. Over the past 12 years, daily trading volume has been in the range of \$12.6 billion to \$19.7 billion, with an average of \$15.9 billion (source: www.sifma.org).

[2]According to flow of fund data during 1986-2012, about 82% of corporate bonds were held by institutional investors including insurance companies, mutual funds and pension funds. The participation rate of individual investors in the corporate bond market is very low.

ments and, thus hardly benefit from the euphoric news in firm fundamentals. Since the upside payoffs are capped, the bond payoff relation with investor beliefs about the underlying fundamental becomes concave, whereas the equity payoff relation with investor beliefs regarding the underlying fundamental is linear (e.g., Hong and Sraer (2013)). Third, given the relatively low level of *liquidity* in the corporate bond market, care must be taken in determining the appropriate price and model used in the estimation of abnormal returns of bond portfolios (e.g., Bessembinder, Kahle, Maxwell, and Xu (2009)).

The challenge is to come up with an accurate, comprehensive measure of credit risk, downside risk, and liquidity risk of corporate bonds. We conjecture that one way to characterize or proxy for a wide range of risks embedded in bond portfolios is to rely on the high-order moments of the empirical return distribution that capture the magnitude and frequency of large price movements in corporate bonds. Thus, we test if the distributional characteristics of bond returns – volatility, skewness, and kurtosis – provide potential clues as to the reasonable proxies for the common risk factors in corporate bond returns.

In this paper, we assemble a comprehensive dataset of corporate bond returns from January 1973 to December 2012, including close to 1 million monthly bond return observations for a total of 14,796 bonds issued by 4,401 firms. Then, for the first time in the literature, we investigate whether the distributional characteristics of corporate bonds predict the cross-sectional differences in future bond returns. First, we test the significance of a cross-sectional relation between volatility and future returns on corporate bonds using portfolio-level analysis, and find that bonds in the highest volatility quintile generate 6.05% to 7.15% more raw and risk-adjusted returns per annum compared to bonds in the lowest volatility quintile. We examine the source of the significant return spread between high- and low-volatility bonds, and find that the significantly positive return spread is due to outperformance by high-volatility bonds, but not to underperformance by low-volatility bonds. We also test if the positive relation between volatility and future returns holds controlling for bond characteristics, and find that volatility remains a significant predictor after controlling for the credit rating, maturity, size, and liquidity risk of corporate bonds.[3]

Second, we examine the cross-sectional relation between skewness and future bond returns. Bivariate portfolio results show that, after controlling for the volatility of bond returns and well-known stock and bond market factors, bonds in the lowest skewness quintile generate 2.53% to 3.13% more raw and risk-adjusted returns per annum compared to bonds in the

[3] Although the positive relation between volatility and expected returns is stronger for high-yield bonds, bonds with longer maturity, bonds with lower market value, and bonds with higher liquidity risk, a significantly positive link between volatility and returns exists for investment-grade bonds, short- and medium-term bonds, bonds with large market value, as well as bonds with low liquidity risk.

highest skewness quintile, consistent with the three-moment asset pricing models in that risk-averse investors prefer positively skewed assets to negatively skewed assets. We also find that the significantly negative return spread between high- and low-skew bonds is due to outperformance by low-skew (negative skew) bonds but not to underperformance by high-skew (positive skew) bonds.

Third, we investigate the significance of a cross-sectional relation between kurtosis and future returns. Univariate portfolio analyses show that bonds in the highest kurtosis quintile generate 4.21% to 4.40% more raw and risk-adjusted returns per annum compared to bonds in the lowest kurtosis quintile. The significantly positive return spread is due to outperformance by high-kurtosis bonds, but not to underperformance by low-kurtosis bonds. Bivariate portfolio-level analyses indicate that the predictive relation between kurtosis and bond returns remains positive, but economically and statistically weak after controlling for the credit rating, maturity, and size of corporate bonds.

We also test the significance of volatility, skewness, and kurtosis simultaneously using bond-level cross-sectional regressions. The Fama-MacBeth (1973) regression results echo the portfolio analysis, indicating that the volatility and skewness of corporate bonds predict their future returns, whereas kurtosis does not make a robust incremental contribution to such predictability. Our main findings remain intact after running a battery of robustness checks, such as accounting for transaction costs, controlling for bond illiquidity and liquidity risk, using only quoted or transaction data, performing subsample analyses, and testing longer-term predictability.

Finally, we propose new risk factors based on the distributional characteristics of corporate bonds and test whether the long-established stock and bond market factors in the literature can explain our distribution-based risk factors.[4] Since the volatility, skewness, and kurtosis of bond returns are found to be correlated with credit risk, we rely on the conditional bivariate portfolios using credit rating as the first sorting variable and the distributional moments as the second sorting variable when constructing new risk factors, namely the volatility factor (VOL^F), the skewness factor ($SKEW^F$), and the kurtosis factor ($KURT^F$). We also construct a broad, common risk factor, VSK, using the first principal component of these newly proposed VOL^F, $SKEW^F$, and $KURT^F$ factors.

We run time-series factor regressions to assess the predictive power of the new risk factors.

[4]The long-established stock market factors include the five factors of Fama and French (1993), Carhart (1997) and Pastor and Stambaugh (2003): the excess stock market return (MKT), the size factor (SMB), the book-to-market factor (HML), the momentum factor (MOM), and the liquidity factor (LIQ). The standard bond market factors include the excess bond market return (Elton, Gruber, and Blake (1995)), the default spread (DEF) and the term spread (TERM) factors of Fama and French (1993).

The intercepts (alphas) from these time-series regressions represent the abnormal returns not explained by the standard stock and bond market factors. When we use the most general 8-factor model that combines all of the commonly used stock and bond market factors, we find that the alphas for the VOL^F, $SKEW^F$, and $KURT^F$ factors are all economically and statistically significant; 0.42% per month (t-statistic = 3.84), -0.21% per month (t-statistic = -2.95), and 0.25% per month (t-statistic = 2.88), respectively. Finally, the alpha for the common risk factor (VSK) is 0.50% per month with a t-statistic of 4.01. We should also note that the adjusted-R^2 values from these factor regressions are found be small, especially for the $SKEW^F$ and VSK factors. The significant alphas, combined with the small R^2 values, suggest that the new bond market risk factors represent an important source of common return variation missing from the long-established stock and bond market risk factors.

These results suggest that the newly proposed distribution-based risk factors capture some components of downside risk, credit risk, and liquidity risk of corporate bonds, providing a proxy for a comprehensive measure of substantive risk embedded in corporate bonds, which cannot be fully characterized by the existing stock and/or bond market risk factors.

This paper is organized as follows. Section 2 provides a literature review. Section 3 describes the data and variables used in our empirical analyses. Section 4 investigates the predictive power of volatility, skewness, and kurtosis for future bond returns. Section 5 investigates the impact of transaction costs and liquidity on our main findings and conducts a battery of robustness checks. Section 6 introduces new risk factors for corporate bonds using the distributional moments of bond returns, and demonstrates that the long-established stock and bond market risk factors cannot explain the distribution-based risk factors. Section 7 concludes the paper.

2 Literature Review

Our paper is related to the literature on the cross-sectional determinants of corporate bond returns. Among these, Fama and French (1993) first show that default and term premia are important risk factors for corporate bond pricing. Gebhardt, Hvidkjaer, and Swaminathan (2005) test the pricing power of default beta and term beta and find that they are significantly related to the cross-section of bond returns, even after controlling for a large number of bond characteristics. Lin, Wang, and Wu (2011) construct the market liquidity risk factor and show that it is priced in the cross-section of corporate bond returns. Bongaerts, DeJong, and Driessen (2012) study the effect of expected liquidity and liquidity risk on corporate bond returns. Acharya, Amihud, and Bharath (2013) show that corporate bonds are exposed to liquidity shocks in equity and treasury markets. Jostova, Nikolova, Philipov, and Stahel (2013) investigate whether the momentum anomaly exists in the corporate bond market. There are also two recent papers, Chordia, Goyal, Nozawa, Subrahmanyam, and Tong (2015) and Choi and Kim (2015) that examine whether equity market anomalies can be priced in the cross-section of corporate bond returns.

Our paper distinguishes from the aforementioned literature in two important ways. First, we provide novel evidence that the distributional characteristics of bond returns, especially volatility and skewness, are robustly priced in the cross-section of expected bond returns. These findings remain intact after controlling for default and term premia, bond liquidity risk, and bond characteristics such as credit rating, maturity, and size. Second, we propose new risk factors based on these distributional characteristics, and show that the new risk factors represent an important source of common return variation missing from the long-established stock and bond market factors.

As pointed out by Bessembinder, Kahle, Maxwell, and Xu (2009), existing factor models (e.g., Fama and French (1993); Elton, Gruber, and Blake (1995)) are not well specified to test abnormal bond returns, possibly due to insufficient controls for potential omitted risk factors. Yet it is important for institutional investors to use an appropriate risk factor model to price corporate bonds and measure the abnormal returns of corporate bond portfolios. Our newly proposed distribution-based risk factor model provides a sound measure of abnormal return after accounting for substantive risk embedded in corporate bonds, which cannot be fully characterized by the existing risk factors.

This paper contributes to the literature by providing new evidence on the risk-return analysis of corporate bonds. We present new evidence that the distributional moments of corporate bonds are priced in the cross-section of bond expected returns. A large number of articles examine the determinants of credit spreads through either structured or reduced-form models,[5] but only a few studies examine the cross-section of corporate bond returns through a formal asset pricing model.[6] Our paper differs from the above literature by analyzing the cross-section of corporate bond returns (not yield spreads) through factor models.

We also contribute to the asset pricing literature on high-order moments by providing theo-

[5]Over the past decade, a large number of studies contribute to the understanding of explaining the credit spread puzzle, including but not limited to Elton, Gruber, Agrawal, and Mann (2001), Longstaff, Mithal, and Neis (2005), Chen, Lesmond, and Wei (2007), Cremers, Driessen, and Maenhout (2008), Chen, Collin-Dufresne, and Goldstein (2009), Ericsson, Jacobs, and Oviedo (2009), Zhang, Zhou, and Zhu (2009), Huang and Huang (2012), and Bai and Wu (2015).

[6]There are other related papers, but they are either on the time series analyses of bond returns/yields (Blume, Keim, and Patel (1991)) or on the change in bond yields (Collin-Dufresne, Goldstein, and Martin (2001)).

retically consistent evidence in the corporate bond market. The literature has not yet reached an agreement on the positive (negative) risk-return tradeoff between volatility/kurtosis (skewness) and the cross-section of individual stocks or options.[7] Our results, however, demonstrate a theoretically consistent positive (negative) and significant relation between volatility/kurtosis (skewness) and corporate bond returns.

3 Data and Variables

3.1 Corporate Bond Data

The corporate bond data set is compiled from six major sources: Lehman Brothers fixed income database (Lehman), Datastream, National Association of Insurance Commissioners database (NAIC), Bloomberg, the enhanced version of the Trade Reporting and Compliance Engine (TRACE), and Mergent fixed income securities database (FISD). The Lehman data cover the sample period from January 1973 to March 1998; Datastream reports corporate bond information from January 1990 to June 2014. Both Lehman and Datastream provide prices based on dealer quotes. NAIC reports the transaction information by insurance companies for the period January 1994 - July 2013; Bloomberg provides daily bond prices from January 1997 to December 2004; and the Enhanced TRACE records the transactions of the entire corporate bond market from July 2002 to December 2012. The two datasets, NAIC and TRACE, provide prices based on the real transactions.

Our goal is to examine the distributional characteristics of corporate bonds and their linkage to expected bond returns. The cornerstone of our analysis is an accurate measure of corporate bond returns. We highlight the following filtering criteria in order to choose qualified bonds. Throughout all data sources, we first remove bonds that are not listed or traded in the U.S. public market, which include bonds issued through private placement, bonds issued under the 144A rule, bonds that do not trade in US dollars, and bond issuers not in the jurisdiction of the United States. Second, we focus on corporate bonds that are

[7]There is an ongoing debate on the cross-sectional relation between distributional characteristics and future stock returns. For example, Ang, Hodrick, Xing, and Zhang (2006) find a significantly negative link between stock returns and lagged idiosyncratic volatility, whereas Fu (2009) provides evidence of a positive and significant relation between conditional volatility and future stock returns. Empirical studies testing the ability of skewness (or related measures) to predict cross-sectional variation in stock returns have produced mixed results. Xing, Zhang, and Zhao (2010) and Cremers and Weinbaum (2010) find a theoretically contradictory positive relation between skewness and future stock returns, while Bali, Cakici, and Whitelaw (2011) and Conrad, Dittmar, and Ghysels (2013) find a theoretically consistent negative relation. Aside from Dittmar (2002), who finds evidence that kurtosis plays an important role in pricing individual stocks, the literature on kurtosis is sparse.

not structured notes, not mortgage backed or asset backed. We also remove the bonds that are agency-backed or equity-linked.

Third, we exclude convertible bonds since this option feature distorts the return calculation and makes it impossible to compare the returns of convertible and non-convertible bonds.[8] Fourth, corporate bonds trading under five dollars per share usually are considered as default or close to default; their return calculated in the standard way of price and accrued interest cannot reflect the firm fundamental or risk premia required for compensation, so we remove bonds if their quoted or trade-based prices are less than five dollars. We also remove bonds if their prices are larger than one thousand dollars. Fifth, we remove bonds with floating rate; that means the sample comprises only bonds with fixed or zero coupon. This rule is applied based on the consideration of accuracy in bond return calculation, given the challenge in tracking floating-coupon bond's cash flows.

Our last rule excludes any bonds with less than one year to maturity. This rule is applied to all major corporate bond indices such as Barclays Capital corporate bond index, Bank of America Merrill Lynch corporate bond index, and Citigroup corporate bond index. If a bond has less than one year to maturity, it will be delisted from major bond indices hence index-tracking investors will change their holding positions. Such operation will distort bond return calculation, hence we remove them from our sample.

Among all six corporate bond data sets, the Enhanced TRACE provides the most detailed information on bond transactions at the intraday frequency. Beyond the above filtering criteria, we further clean up TRACE transaction records by eliminating when-issued bonds, locked-in bonds, and bonds with commission trading, special prices, or special sales conditions. We remove transaction records that are canceled, and adjust records that are subsequently corrected or reversed. Bond trades with more than 2-day settlement are also removed from our sample. In addition, we exclude transactions below $100,000 following the convention in the corporate bond literature such as Bessembinder et al. (2009) in order to mitigate the impact of retail investors.

To calculate corporate bond return, we need to have the integral input of the accrued interest, which relies on the information on coupon rate, interest payment frequency, and maturity date. After merging bond price data (TRACE, NAIC, Bloomberg, Datastream, Lehman) to bond characteristics data (Mergent FISD), we further eliminate bonds with incomplete

[8]Bonds also contain other option features such as putable, redeemable/callable, exchangeable, and fungible. Except callable bonds, bonds with other option features are relatively a small portion in the sample. However, callable bonds constitute about 67% of the whole sample. Hence, we keep the callable bonds in our final sample, but we also conduct a robustness check for a smaller sample filtering out the bonds with option features.

information in either coupon, interest frequency, or maturity date.

Finally, we adopt the following principle to handle the overlapping observations among different data sets. If two or more data sets have overlapping observations at any point in time, we give priority to the data set that reports the transaction-based bond prices. For example, TRACE will dominate other data sets in the recent decade. If there are no transaction data or the coverage of the data is too small, we give priority to the data set that has a relatively larger coverage on bonds/firms, and can be better matched to the bond characteristic data, FISD. For example, Bloomberg daily quotes data are preferred to those of Datastream for the period 1998 to 2002 for its larger coverage and higher percentage of matching rate to FISD.

After implementing the above filtering criteria, matching with rating data (Section 3.2) and calculating bond returns (Section 3.3), our final sample includes 14,796 bonds issued by 4,401 unique firms, a total of 964,317 bond-month return observations during the sample period of January 1975 to December 2012. This is by far the most complete corporate bond dataset in the literature. Table A.1 of the online appendix shows the data filtering process for TRACE, Lehman, and NAIC; two other datasets Datastream and Bloomberg are pre-filtered in the process of downloading.

3.2 Rating Data

Corporate bond credit ratings capture information on bond default probability, and hence is an important control variable in our analysis. We collect bond-level rating information from Mergent FISD historical ratings. If a bond is rated only by Moody's or by Standard & Poor's, we use that rating. If a bond is rated by both rating agencies, we use the average rating. All ratings are assigned a number to facilitate the analysis, for example, 1 refers to a AAA rating, 2 refers to AA+, 21 refers to CCC, and so forth. Investment-grade bonds have ratings from 1 (AAA) to 10 (BBB-). Non-investment-grade bonds have ratings above 10.

3.3 Bond Return

The monthly corporate bond return at time t is computed as

$$R_{i,t} = \frac{P_{i,t} + AI_{i,t} + Coupon_{i,t}}{P_{i,t-1} + AI_{i,t-1}} - 1, \tag{1}$$

where $P_{i,t}$ is the transaction price, $AI_{i,t}$ is accrued interest, and $Coupon_{i,t}$ is the coupon payment, if any, of bond i in month t.

The quote-based data sets of Lehman and Datastream provide month-end prices and returns. The NAIC and Bloomberg data provide daily prices and the time-stamped TRACE data provide intraday clean prices. For TRACE, we first calculate the daily clean price as the trading volume-weighted average of intraday prices, following Bessembinder et al. (2009), which helps minimize the effect of bid-ask spreads in prices.

As for converting the daily bond data to monthly prices, the literature suggests various ways. Lin, Wang, and Wu (2011) use the last transaction price at the end of each month. If the transaction does not fall in the last trading day of the month, they interpolate the last price of the month and the first price of the following month. Jostova et al. (2013) and Chordia et al. (2015) use the last available daily price from the last five trading days of the month as the month-end price.

In this paper, we adopt a method that gleans all possibilities in calculating a reasonable monthly return. There are three scenarios for a return to be realized at the end of month t: (i) from the end of month $t-1$ to the end of month t, (ii) from the beginning of month t to the end of month t, and (iii) from the beginning of month t to the beginning of month $t+1$. All previously documented methods can be categorized in the first scenario. However, scenarios (ii) and (iii) also happen frequently throughout the sample. We calculate monthly returns for all three scenarios, where the end (beginning) of the month refers to the last (first) five trading days of each month. If there are multiple trading records in the five-day window, the one closest to the last trading day of the month is selected. If a monthly return can be realized in more than one scenario, the realized return in the first scenario (from month-end $t-1$ to month-end t) is selected.

Table A.2 of the online appendix presents the summary statistics for the monthly raw returns of corporate bonds. Panel A presents the distribution of monthly raw returns per annum, as well as the unique number of bonds and issuers for each year from 1975 to 2012. On average, there are about 2,777 bonds and 895 firms per annum over the whole sample. Panel B presents the time-series average of the cross-sectional returns' distribution and bond characteristics. The average monthly bond return is 0.62%, which corresponds to 7.44% per annum for about 1 million bond-month observations. Among these, about 75% are investment-grade bonds with an annual return of 6.72%, and the remaining high-yield bonds have an annual return of 10.32%.

3.4 Volatility, Skewness, and Kurtosis

In probability theory and statistics, the variance (volatility) is used as a measure of how far a set of numbers are spread out from each other. In particular, the variance is the second moment of a distribution, describing how far the numbers lie from the mean (expected value). Skewness is a measure of the asymmetry of a probability distribution. Negative skewness is often viewed as a proxy for left tail risk, to the extent that it is consistent with a long left tail in the distribution of returns, with the bulk of the values (possibly including the median) to the right of the mean. High-kurtosis means that more variance can be attributed to infrequent extreme returns and is consistent with a sharper peak and longer tails than would be implied by a normal distribution.

We use a 60-month rolling-window estimation to generate the monthly time-series measures of volatility, skewness, and kurtosis for each bond in our sample:[9]

$$
\begin{aligned}
VOL_{i,t} &= \frac{1}{n-1}\sum_{t=1}^{n}(R_{i,t}-\overline{R}_i)^2, \\
SKEW_{i,t} &= \frac{1}{n}\sum_{t=1}^{n}\left(\frac{R_{i,t}-\overline{R}_i}{\sigma_{i,t}}\right)^3, \\
KURT_{i,t} &= \frac{1}{n}\sum_{t=1}^{n}\left(\frac{R_{i,t}-\overline{R}_i}{\sigma_{i,t}}\right)^4 - 3,
\end{aligned}
\qquad (2)
$$

where $R_{i,t}$ is the return on bond i in month t; $\bar{R}_i = \frac{\sum_{t=1}^{n} R_{i,t}}{n}$ is the sample mean of returns over the past 60 months ($n = 60$); $VOL_{i,t}$, $SKEW_{i,t}$, and $KURT_{i,t}$ are the sample variance, skewness, and kurtosis of monthly returns over the past 60 months, respectively; and $\sigma_{i,t} = \sqrt{VOL_{i,t}}$ is the sample standard deviation of monthly returns on bond i over the past 60 months, defined as the square root of the variance.[10]

[9] A bond is included in our sample if it has at least 24 monthly return observations in the 60-month rolling window before the test month. Our data start in January 1973 and we report regression results starting from January 1975. Until January 1978, we use the criterion of at least 24 monthly return observations to justify bond qualification. After January 1978, we adopt the rule of a 60-month rolling window.

[10] To reduce the influence of outliers in the second-stage portfolio-level analyses and cross-sectional regressions, we winsorize volatility, skewness, and kurtosis at 1% and 99%. Our results are similar without winsorization, or with winsorization at 0.5% and 99.5%. Our results are also robust to different rolling windows in estimating volatility, skewness, and kurtosis, e.g., a rolling window of 24 and 36 months instead of 60 months. These robust results are available upon request.

3.5 Normality Test for Corporate Bond Returns

In this section, we examine the distributional characteristics of monthly corporate bond returns and report the results in Table 1. Panel A presents the total number of bonds and the percentage of bonds with significant and insignificant return moments, for the time-series distribution of all corporate bond returns. For each bond in our sample from January 1975 to December 2012, we compute the volatility (%), skewness, and excess kurtosis of monthly returns, and then test whether these high-order moments are significantly different from zero. As shown in Panel A, the time-series distribution of corporate bond returns exhibit significant return volatility, skewness, and excess kurtosis. Among the 14,796 bonds, all of them have significant volatility at the 10% level or better. In addition, 6,695 bonds exhibit positive skewness and 8,101 bonds exhibit negative skewness. Among the bonds with positive (negative) skewness, 57.2% (52.5%) are statistically significant at the 10% level or better. Finally, the majority of bonds (13,345) exhibit positive excess kurtosis and among these bonds, 77.9% are statistically significant at the 10% level or better. Table 1 also performs the Jarque-Bera normality test for the time-series distribution of corporate bond returns. The last column of Panel A shows that 70.9% of the bonds in our sample exhibit significant Jarque-Bera (JB) statistics and reject the null hypothesis of normality at the 10% level or better.[11]

Panel B of Table 1 reports the total number of months and the number of months with significant and insignificant return moments for the cross-sectional distribution of monthly corporate bond returns. For each month from January 1975 to December 2012, we compute the volatility (%), skewness, and excess kurtosis of the cross-sectional observations of bond returns, and test whether these distributional moments are significantly different from zero. As shown in Panel B, the cross-sectional distribution of bond returns exhibit significant volatility, skewness, and excess kurtosis in almost all of the 456 months. The last column of Panel B shows that the Jarque-Bera statistics are significant for all of the sample periods, rejecting the null hypothesis of normal distribution of the cross-sectional bond returns.

To understand the asset pricing implications of these significant higher-order moments in corporate bond returns, we examine the relation between volatility, skewness, kurtosis and the cross-section of expected bond returns in the next section.

[11]For 62% of the corporate bonds in our sample, the JB statistics are significant at the 5% level or better, rejecting the null hypothesis of normality.

4 Volatility, Skewness, Kurtosis and the Cross-Section of Expected Bond Returns

4.1 Volatility and Corporate Bond Returns

The mean-variance theory of portfolio choice determines the optimum asset mix by maximizing the expected risk premium per unit of risk in a mean-variance framework or the expected value of a utility function approximated by the portfolio's expected return and variance. In both cases, the market risk of the portfolio is defined in terms of the variance (or standard deviation) of the portfolio's returns. Although a vast literature investigates the cross-sectional relation between volatility and expected returns on individual stocks, our paper is the first to examine the predictive power of volatility in the cross-section of corporate bond returns.

4.1.1 Univariate Portfolio Analysis of Volatility

We first test the significance of a cross-sectional relation between volatility and future returns on corporate bonds using portfolio-level analysis. For each month from January 1975 to December 2012, we form quintile portfolios by sorting corporate bonds based on their volatility (VOL), where quintile 1 contains bonds with the lowest volatility and quintile 5 contains bonds with the highest volatility. Table 2 shows the average volatility of bonds in each quintile, the next month average excess return, and the 5- and 7-factor alphas for each quintile. The last three columns report the average credit rating, average maturity, and average bond amount outstanding for each quintile, respectively. The last row in Table 2 displays the differences in average returns of quintiles 5 and 1, and the differences in the alphas of quintiles 5 and 1 with respect to the 5- and 7-factor models. Average excess returns and alphas are defined in terms of monthly percentage. Newey-West (1987) adjusted t-statistics are reported in parentheses.

Moving from quintile 1 to quintile 5, the average excess return on the volatility portfolios increases monotonically from 0.05% to 0.64% per month. This indicates a monthly average return difference of 0.59% between quintiles 5 and 1 (i.e., High-VOL quintile vs. Low-VOL quintile) with a Newey-West t-statistic of 3.60, showing that this positive return difference is economically and statistically significant. This result indicates that corporate bonds in the highest VOL quintile generate 7.15% per annum higher return than bonds in the lowest VOL quintile do.

In addition to the average excess returns, Table 2 also presents the intercepts (alphas) from the regression of the quintile excess portfolio returns on a constant, the excess market return (MKT), a size factor (SMB), a book-to-market factor (HML), a momentum factor (MOM), and a liquidity factor (LIQ), following Fama and French (1993), Carhart (1997), and Pastor and Stambaugh (2003).[12] The third column of Table 2 shows that, similar to the average excess returns, the 5-factor alpha on the volatility portfolios also increases monotonically from -0.05% to 0.45% per month, moving from the Low-VOL to the High-VOL quintile, indicating a positive and significant alpha difference of 0.50% per month (t-statistic = 3.11).

Beyond well-known stock market factors (size, book-to-market, momentum, and liquidity), we also test whether the significant return difference between High-VOL bonds and Low-VOL bonds can be explained by bond market factors. Following Elton et al. (2001), Bessembinder et al. (2009), and Fung and Hsieh (2004), we use the default and term spread risk factors as well as the long-term interest rate and credit risk factors. The default spread factor (DEF) is defined as the monthly change in the difference between BAA- and AAA-rated corporate bond yields. The term spread factor (TERM) is defined as the monthly change in the difference between 10-year and 3-month constant-maturity Treasury yields. The credit risk factor (CredSpr) is defined as the monthly change in the difference between BAA-rated corporate bond yields and 10-year constant-maturity Treasury yields. The long-term interest rate factor (10Y) is defined as the monthly change in 10-year constant-maturity Treasury yields.

Similar to our earlier findings from the average excess returns and the 5-factor alphas, the fourth and fifth columns of Table 2 show that, the 7-factor alpha also increases monotonically, moving from the Low-VOL to the High-VOL quintile. When DEF and TERM are included in the five equity market factors, the 7-factor alpha difference between quintiles 5 and 1 is 0.51% with a t-statistic of 3.23. When CredSpr and 10Y are included to the five equity market factors, the 7-factor alpha difference between quintiles 5 and 1 is 0.51% with a t-statistic of 3.16.[13]

These results indicate that after controlling for well-known stock and bond market factors, the return difference between high- and low-volatility bonds remains positive and highly significant. Next, we investigate the source of significant return and alpha differences between high- and low-volatility bonds: Is it due to outperformance by High-VOL bonds, underperformance by Low-VOL bonds, or both? For this, we focus on the economic and statistical significance of the risk-adjusted returns of quintile 1 versus those of quintile 5. As reported in

[12] The factors MKT (excess market return), SMB (small minus big), HML (high minus low), MOM (winner minus loser), and LIQ (liquidity risk) are described in and obtained from Kenneth French's and Lubos Pastor's online data libraries: http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/ and http://faculty.chicagobooth.edu/lubos.pastor/research/, respectively.

[13] Tables A.3 and A.4 of the online appendix present results from the univariate portfolios sorted by volatility for investment-grade and non-investment-grade bonds separately. The results indicate that the return and alpha spreads are economically and statistically significant for both investment-grade and non-investment-grade bonds.

Table 2, the 5- and 7-factor alphas of bonds in quintile 1 (low-volatility bonds) are economically and statistically insignificant, whereas the 5- and 7-factor alphas of bonds in quintile 5 (high-volatility bonds) are economically and statistically significant. Hence, we conclude that the significantly positive alpha spread between high- and low-volatility bonds is due to outperformance by High-VOL bonds, but not to underperformance by Low-VOL bonds.

Lastly, we examine the average characteristics of individual bonds in volatility portfolios. As presented in the last three columns of Table 2, high-volatility bonds have lower credit rating, longer maturity, and smaller in size. As we move from the Low-VOL to the High-VOL quintile, credit rating and bond maturity monotonically increase, whereas the bond amount outstanding monotonically decreases. This creates a potential concern about the interaction between volatility and bond characteristics. We provide different ways of handling this interaction. Specifically, we test whether the positive relation between volatility and the cross-section of bond returns still holds once we control for credit rating, maturity, and size using bivariate portfolio sorts and Fama-MacBeth (1973) regressions in later subsections. We will provide in Section 5.2 a comprehensive analysis of bond liquidity and transaction costs as well as their potential impacts on our main findings.

4.1.2 Bivariate Portfolio Analysis of Volatility and Bond Characteristics

Table A.5 of the online appendix presents the results from the bivariate sorts of volatility and bond characteristics. In Panel A of Table A.5, we form quintile portfolios every month from January 1975 to December 2012 by first sorting corporate bonds into five quintiles based on their credit rating. Then, within each rating portfolio, bonds are sorted further into five sub-quintiles based on their volatility. This methodology, under each rating-sorted quintile, produces sub-quintile portfolios of bonds with dispersion in volatility and nearly identical ratings (i.e., these newly generated volatility sub-quintile portfolios control for differences in ratings). VOL,1 represents the lowest volatility-ranked bond quintiles within each of the five rating-ranked quintiles. Similarly, VOL,5 represents the highest volatility-ranked quintiles within each of the five rating-ranked quintiles. Panel A of Table A.5 shows that the 5- and 7-factor alphas increase monotonically from the VOL,1 to the VOL,5 quintile. More importantly, the return and alpha differences between quintiles 5 and 1 are in the range of 0.33% to 0.42% per month and statistically significant. These results indicate that after controlling for credit ratings, the return and alpha spreads between high- and low-volatility bonds remain positive and highly significant. We further investigate the interaction between volatility and credit rating by sorting investment-grade and non-investment-grade bonds separately into bivariate quintile portfolios based on their volatility and credit ratings. After controlling for credits ratings, the return and alpha differences between the VOL,1 and VOL,5 quintiles are in the range of 0.20% to 0.28% per month and statistically significant for investment-grade bonds; the differences are much higher for non-investment-grade bonds, in the range of 0.69% to 0.73% per month, and statistically significant. As expected, the positive relation between volatility and expected returns is stronger for non-investment-grade bonds, but the significantly positive link between volatility and returns exists for investment-grade bonds even after we control for credit ratings.

Panel B of Table A.5 presents the results from the bivariate sorts of volatility and maturity. Quintile portfolios are formed by first sorting corporate bonds into five quintiles based on their maturity. Then, within each maturity portfolio, bonds are sorted further into five sub-quintiles based on their volatility. This methodology, under each maturity-sorted quintiles, produces sub-quintile portfolios of bonds with dispersion in volatility and nearly identical maturities (i.e., these newly generated volatility sub-quintile portfolios control for differences in maturity). Panel B shows that after controlling for bond maturity, the alpha differences between high- and low-volatility bonds remain positive, in the range of 0.35% to 0.43% per month, and they are highly significant. We further examine the interaction between volatility and maturity by sorting short-maturity bonds (1 year $\leq$ maturity $\leq$ 5 years), medium-maturity bonds (5 years $<$ maturity $\leq$ 10 years), and long-maturity bonds (maturity $>$ 10 years) separately into bivariate quintile portfolios based on their volatility and maturity. After controlling for maturity, the return and alpha spreads between the VOL,1 and VOL,5 quintiles are in the range of 0.38% to 0.43% per month for short-maturity bonds, 0.34% to 0.38% per month for medium-maturity bonds, and 0.38% to 0.45% per month for long-maturity bonds. Although the economic significance of these return and alpha spreads is similar across the three maturity groups, the statistical significance of the return and alpha differences between high- and low-volatility bonds is greater for long-maturity bonds. This result makes sense because longer-term bonds usually offer higher interest rates, but may entail additional risks.[14]

Panel C of Table A.5 presents the results from the bivariate sorts of volatility and amount outstanding. Quintile portfolios are formed by first sorting corporate bonds into five quintiles based on their market value (size). Then, within each size portfolio, bonds are sorted further into five sub-quintiles based on their volatility. This methodology, under each size-sorted quintiles, produces sub-quintile portfolios of bonds with dispersion in volatility and nearly

[14]The longer the bond's maturity, the more time there is for rates to change and, hence, affect the price of the bond. Therefore, bonds with longer maturities generally present greater interest rate risk than bonds of similar credit quality that have shorter maturities. To compensate investors for this interest rate risk, long-term bonds generally offer higher yields than short-term bonds of the same credit quality do.

identical size (i.e., these newly generated volatility sub-quintile portfolios control for differences in size). Panel C shows that after controlling for size, the alpha differences between high- and low-volatility bonds remain positive, in the range of 0.40% to 0.50% per month, and are highly significant. We further examine the interaction between volatility and size by sorting small and large bonds separately into bivariate quintile portfolios based on their volatility and size.[15] After controlling for size, the return and alpha differences between the VOL,1 and VOL,5 quintiles range from 0.52% to 0.57% per month for small bonds and from 0.24% to 0.35% per month for large bonds. As expected, the positive relation between volatility and expected returns is stronger for bonds with low market value, but the significantly positive link between volatility and returns exists for bonds with high market value, even after controlling for size.

4.2 Skewness and Corporate Bond Returns

Modeling portfolio risk with the traditional volatility measures implies that investors are concerned only about the average variation (and co-variation) of asset returns and are not allowed to treat the negative and positive tails of the return distribution separately. However, there is a wealth of experimental evidence on loss aversion (Kahneman et al. (1990)). According to the three-moment asset pricing models of Arditti (1967), Kraus and Litzenberger (1976), and Kane (1982), investors have an aversion to variance and a preference for positive skewness, implying that the expected return is a function of both volatility and skewness. To be consistent with the three-moment asset pricing models, we test the significance of a cross-sectional relation between skewness and future bond returns while controlling for volatility.

4.2.1 Bivariate Portfolio Analysis of Skewness and Volatility

To perform this test, we form quintile portfolios every month from January 1975 to December 2012 by first sorting corporate bonds into five quintiles based on their volatility. Then, within each volatility portfolio, bonds are sorted further into five sub-quintiles based on their skewness. This methodology, under each volatility-sorted quintiles, produces sub-quintile portfolios of bonds with dispersion in skewness and nearly identical volatilities (i.e., these newly generated skewness sub-quintile portfolios control for differences in volatilities). In Table 3, SKEW,1 represents the lowest skewness-ranked bond quintiles within each of the five volatility-ranked quintiles. Similarly, SKEW,5 represents the highest skewness-ranked bond quintiles within each of the five volatility-ranked quintiles.

[15] For each month from January 1975 to December 2012, individual bonds are ranked by their market value and then decomposed into two groups (small vs. big) based on the median market value.

Table 3 shows the average skewness of bonds in each quintile, the next month average excess return, and the 5- and 7-factor alpha values for each quintile. The last three columns report the average rating, average maturity, and average bond amount outstanding for each skewness quintile. The last row in Table 3 displays the differences in the average returns of quintiles 5 and 1, and the differences in the alphas of quintiles 5 and 1 with respect to the 5- and 7-factor models.

Moving from quintile 1 to quintile 5, the average excess return on the skewness portfolios decreases almost monotonically from 0.38% to 0.17% per month, indicating a monthly average return difference of -0.21% per month between quintiles 5 and 1 with a Newey-West t-statistic of -3.76. This result implies that after controlling for volatility, corporate bonds in the lowest-SKEW quintile generate 2.5% more annual returns compared to bonds in the highest-SKEW quintile. Table 3 also shows that the 5- and 7-factor alpha differences between the high- and low-skewness quintiles are similar in magnitude at -0.26% per month with t-statistics ranging from -3.77 to -3.84, consistent with the three-moment asset pricing models in that risk-averse investors prefer positively skewed to negatively skewed assets.

These results indicate that after controlling for the volatility of bond returns and well-known stock and bond market factors, the cross-sectional relation between skewness and future bond returns remains negative and highly significant. Next, we investigate the source of significant alpha spreads between high- and low-skewness bonds: Is it due to underperformance by High-SKEW bonds, outperformance by Low-SKEW bonds, or both? As reported in Table 3, the 5- and 7-factor alphas of bonds in quintile 1 (low-skew bonds) are positive and economically and statistically significant, whereas the 5- and 7-factor alphas of bonds in quintile 5 (high-skew bonds) are economically and statistically insignificant. Hence, we conclude that the significantly negative alpha spread between High- and Low-SKEW bonds is due to outperformance by Low-SKEW (negative skew) bonds, but not to underperformance by High-SKEW (positive skew) bonds.

The last three columns of Table 3 present the average characteristics of bonds in the skewness portfolios. There is no significant difference in credit rating, maturity, or market value of bonds between the low- and high-SKEW quintiles because the volatility is controlled for when we form the skewness portfolios. However, we still test whether the negative relation between skewness and the cross-section of bond returns holds once we control for credit rating, maturity, and size using bivariate portfolio sorts and Fama-MacBeth regressions.

4.2.2 Bivariate Portfolio Analysis of Skewness and Bond Characteristics

Table A.6 of the online appendix presents the results from the bivariate sorts of skewness and bond characteristics. In Panel A of Table A.6, quintile portfolios are formed by first sorting corporate bonds into five quintiles based on their credit rating. Then, within each rating portfolio, bonds are sorted further into five sub-quintiles based on their skewness. Panel A shows that after controlling for credit ratings, the 5- and 7-factor alpha differences between high- and low-skewness bonds remain negative, -0.24% per month, and statistically significant. We further investigate the interaction between skewness and credit rating by sorting investment-grade and non-investment-grade bonds separately into bivariate quintile portfolios based on their skewness and credit ratings. After controlling for credit ratings, the alpha differences between the SKEW,1 and SKEW,5 quintiles are about -0.21% per month and statistically significant for investment-grade bonds. For non-investment-grade bonds, the alpha spreads between the SKEW,1 and SKEW,5 quintiles are much higher in absolute magnitude, in the range of -0.50% to -0.52% per month, and highly significant. As expected, the negative relation between skewness and expected returns is stronger for non-investment-grade bonds, but the significantly negative link between skewness and returns exists for investment-grade bonds, even after we control for credit ratings.

In Panel B of Table A.6, we form quintile portfolios by first sorting corporate bonds into five quintiles based on their maturity. Then, within each maturity portfolio, bonds are sorted further into five sub-quintiles based on their skewness. Panel B shows that after controlling for maturity, the 5- and 7-factor alpha differences between high- and low-skewness bonds remain negative, -0.19% per month, and statistically significant. We further investigate the interaction between skewness and maturity by sorting short-, medium-, and long-maturity bonds separately into bivariate quintile portfolios based on their skewness and maturity. After controlling for maturity, the alpha spreads between the SKEW,1 and SKEW,5 quintiles are negative but statistically insignificant for short- and medium-term bonds, whereas the alpha spreads are negative, much higher in absolute magnitude, and highly significant for long-term bonds.

In Panel C of Table A.6, we form quintile portfolios by first sorting bonds into five quintiles based on their market value (size). Then, within each size quintile, bonds are sorted further into five sub-quintiles based on their skewness. Panel C shows that after controlling for size, the 5- and 7-factor alpha differences between the SKEW,1 and SKEW,5 quintiles remain negative, -0.21% per month, and statistically significant. We further investigate the interaction between skewness and bond size by sorting small and large bonds separately into bivariate quintile portfolios based on their skewness and size. After controlling for size, the negative relation between skewness and expected returns is stronger for bonds with low market value, but the significantly negative link between skewness and returns exists for bonds with high market value, even after we control for size.

4.3 Kurtosis and Corporate Bond Returns

Dittmar (2002) extends the three-moment asset-pricing model using the restriction of decreasing absolute prudence. Kimball (1993) proposes this restriction in response to Pratt and Zeckhauser (1987), who find that decreasing absolute risk aversion does not rule out certain counterintuitive risk-taking behaviors. For example, any risk-averse agent should be unwilling to accept a bet with a negative expected payoff. Pratt and Zeckhauser show that, if an agent's preferences are restricted to only exhibiting decreasing absolute risk aversion, the agent could be willing to take this negative mean sequential gamble. Kimball shows that standard risk aversion rules out the aforementioned behavior. Sufficient conditions for standard risk aversion are decreasing absolute risk aversion and decreasing absolute prudence, $-d(U'''/U'')/dW < 0$. Thus, the assumptions of positive marginal utility, risk aversion, decreasing absolute risk aversion, and decreasing absolute prudence imply $U'''' < 0$, that is, a preference for lower kurtosis: Investors are averse to kurtosis, and prefer stocks with lower probability mass in the tails of the distribution to stocks with higher probability mass in the tails of the distribution.

Although Dittmar (2002) examines the significance of kurtosis in predicting future stock returns, the predictive power of kurtosis has not been investigated for alternative asset classes. This paper is the first to investigate whether kurtosis predicts the cross-sectional differences in bond returns.

4.3.1 Univariate Portfolio Analysis of Kurtosis

We test the significance of a cross-sectional relation between kurtosis and future bond returns using univariate quintile portfolios. Table 4 shows that moving from quintile 1 to quintile 5, the average excess return on the kurtosis portfolios increases almost monotonically from 0.15% to 0.50% per month, indicating a monthly average return difference of 0.35% per month between quintiles 5 and 1, with a t-statistic of 3.32. This result implies that corporate bonds in the highest KURT quintile generate 4.2% more annual returns compared to bonds in the lowest KURT quintile. Table 4 also shows that the 5- and 7-factor alpha differences between the highest and lowest kurtosis quintiles are about 0.37% per month and highly significant. These results are consistent with Dittmar's (2002) finding that risk-averse investors prefer high expected return and low kurtosis.

Next, we investigate the source of significant alpha spreads between high- and low-kurtosis bonds: Is it due to outperformance by High-KURT bonds, underperformance by Low-KURT bonds, or both? As reported in Table 4, the 5- and 7-factor alphas of bonds in quintile 1 (low-kurtosis bonds) are positive but they are statistically insignificant, whereas the 5- and 7-factor alphas of bonds in quintile 5 (high-kurtosis bonds) are economically and statistically significant. Hence, we conclude that the significantly positive return spread between High- and Low-KURT bonds is due to outperformance by High-KURT bonds, but not to underperformance by Low-KURT bonds.

The last three columns of Table 4 present the average characteristics of bonds in the kurtosis portfolios. Bonds with high-kurtosis have higher credit ratings, shorter maturity, and lower market value. As we move from the Low- to High-KURT quintile, the average credit rating increases, whereas average maturity and average market value decrease almost monotonically. We provide two different ways of handling the potential interaction of kurtosis with the bond characteristics by testing if the positive relation between kurtosis and future bond returns still holds once we control for credit rating, maturity, and size based on bivariate portfolio sorts and Fama-MacBeth regressions.

4.3.2 Bivariate Portfolio Analysis of Kurtosis and Bond Characteristics

Table A.7 presents the results from the bivariate sorts of kurtosis and bond characteristics. In Panel A of Table A.7, we form quintile portfolios by first sorting corporate bonds into five quintiles based on their credit rating. Then, within each rating portfolio, bonds are sorted further into five sub-quintiles based on their kurtosis. Panel A shows that after controlling for credit ratings, the 5- and 7-factor alpha differences between high- and low-kurtosis bonds remain positive, 0.22% per month, and statistically significant. We further investigate the interaction between kurtosis and credit ratings by sorting investment-grade and non-investment-grade bonds separately into bivariate quintile portfolios based on their kurtosis and credit ratings. After controlling for credit ratings, the alpha differences between the KURT,1 and KURT,5 quintiles are positive but statistically insignificant for investment-grade bonds. For non-investment-grade bonds, the alpha differences between the KURT,1 and KURT,5 quintiles are much higher, in the range of 0.43% to 0.44% per month, and highly significant.

In Panel B of Table A.7, quintile portfolios are formed by first sorting corporate bonds into five quintiles based on their maturity. Then, within each maturity portfolio, bonds are sorted further into five sub-quintiles based on their kurtosis. Panel B shows that after controlling for maturity, the 5- and 7-factor alpha differences between high- and low-kurtosis bonds remain positive, in the range of 0.28% to 0.29% per month, and statistically significant. We further investigate the interaction between kurtosis and maturity by sorting short-, medium-, and long-maturity bonds separately into bivariate quintile portfolios based on their kurtosis and maturity. After controlling for maturity, the alpha spreads between the KURT,1 and KURT,5 quintiles are in the range of 0.31% to 0.33% per month for short-maturity bonds, 0.29% to 0.31% per month for medium-maturity bonds, and about 0.29% per month for long-maturity bonds. Although the economic significance of these return and alpha spreads is similar across the three maturity groups, the statistical significance of the alpha differences between high- and low-kurtosis bonds is somewhat higher for long-maturity bonds.

In Panel C of Table A.7, we form quintile portfolios by first sorting corporate bonds into five quintiles based on their market value (size). Then, within each size quintile, bonds are sorted further into five sub-quintiles based on their kurtosis. Panel C shows that after controlling for size, the 5- and 7-factor alpha differences between high- and low-kurtosis bonds remain positive, 0.31% per month, and statistically significant. We further investigate the interaction between kurtosis and bond size by sorting small and large bonds separately into bivariate quintile portfolios based on their kurtosis and size. After controlling for size, the positive relation between kurtosis and expected returns is stronger for bonds with low market value, but the significantly positive link between kurtosis and returns exists for bonds with high market value as well.

4.4 Fama-MacBeth Regression Results

So far we have tested the significance of volatility, skewness, and kurtosis as a determinant of the cross-section of future bond returns at the portfolio level. This portfolio-level analysis has the advantage of being non-parametric, in the sense that we do not impose a functional form on the relation between distributional characteristics and future bond returns. The portfolio-level analysis also has two potentially disadvantages. First, it throws away a large amount of information in the cross-section via aggregation. Second, it is a difficult setting in which to control for multiple effects or bond characteristics simultaneously. Consequently, we now examine the cross-sectional relation between volatility, skewness, and kurtosis and expected returns at the bond level using Fama and MacBeth (1973) regressions.

We present the time-series averages of the slope coefficients from the regressions of one-month-ahead excess bond returns on volatility (VOL), skewness ($SKEW$), kurtosis ($KURT$), and the control variables. The average slopes provide standard Fama-MacBeth tests for determining which explanatory variables on average have non-zero premium. Monthly cross-sectional regressions are run for the following specification and nested versions thereof:

$$R_{i,t+1} = \lambda_{0,t} + \lambda_{1,t} VOL_{i,t} + \lambda_{2,t} SKEW_{i,t} + \lambda_{3,t} KURT_{i,t} + \sum_{k=1}^{K} \lambda_{k,t} Control_{k,t} + \varepsilon_{i,t+1}, \quad (3)$$

where $R_{i,t+1}$ is the excess return on bond i in month t+1. The predictive cross-sectional regressions are run on the one-month lagged values of distributional moments and control variables.

Table 5 reports the time series average of the intercept and slope coefficients λ's and the average adjusted R^2 values over the 456 months from January 1975 to December 2012. The Newey-West adjusted t-statistics are reported in parentheses. The control variables are bond characteristics such as credit rating ($RATE$), maturity (MAT), amount outstanding ($SIZE$) and lagged bond excess return. The univariate regression results show a positive and statistically significant relation between volatility and the cross-section of future bond returns. The average slope, $\lambda_{1,t}$, from the monthly regressions of excess returns on VOL alone is 0.014 with a t-statistic of 3.58. The economic magnitude of the associated effect is similar to that documented in Table 2 for the univariate quintile portfolios of volatility. The spread in average volatility between quintiles 5 and 1 is approximately 40.62 (=$6.72^2 - 2.13^2$), multiplying this spread by the average slope of 0.014 yields an estimated monthly risk premium of 57 basis points.

The average slope, $\lambda_{2,t}$, from the univariate cross-sectional regressions of excess bond returns on SKEW is negative but statistically insignificant. Consistent with the univariate quintile portfolios of kurtosis in Table 4, the average slope, $\lambda_{3,t}$, from the univariate cross-sectional regressions of excess bond returns on KURT is positive, 0.050, and highly significant with a t-statistic of 3.83. As shown in the first column of Table 4, the spread in average kurtosis between quintiles 5 and 1 is approximately 6.47. Multiplying this spread by the average slope of 0.050 yields an estimated monthly risk premium of 32 basis points.

Regression specifications (4) to (6) in Table 5 show that after controlling for lagged excess return, credit rating, maturity, and size, the average slope on volatility and kurtosis remains positive and statistically significant, and the average slope on skewness is negative but statistically insignificant. In other words, controlling for the lagged return and bond characteristics does not affect the cross-sectional relation between the distributional characteristics and future bond returns.

In general, the coefficients of the individual control variables are also as expected. Similar to the findings of earlier studies on individual stocks (e.g., Jegadeesh (1990); Lehmann (1990)), bonds exhibit significant short-term reversals, since the average slope on the one-month lagged return is negative and highly significant. Depending on the specification, non-investment-grade bonds are expected to generate higher future returns than investment-grade bonds since the average slope on credit ratings is positive and significant in some cases. The average slope on maturity is positive and highly significant, implying that longer-maturity bonds generate higher future returns than shorter-maturity bonds do. As in the findings of earlier studies on individual stocks (e.g., Banz (1981); Fama and French (1992)), bonds exhibit the size effect, albeit statistically insignificant, as the average slope on bond size is negative but insignificant.

Regression (7) presents the bivariate regression results from the cross-sectional regressions of excess bond returns on VOL and SKEW. Consistent with the bivariate quintile portfolios of volatility and skewness in Table 3, the average slope on VOL is significantly positive at 0.016 (t-stat.=3.72), and the average slope on SKEW is significantly negative at -0.180 (t-stat.= -4.28). The economic magnitudes of the associated volatility and skewness effects are also similar to those documented in Table 3: the spread in average skewness between quintiles 5 and 1 is approximately 1.78, implying an estimated skewness premium of 32 basis points per month. Regression (8) replicates the bivariate regressions with volatility and skewness after controlling for the lagged excess return and bond characteristics and the results are robust as in Regression (7).

Regression (9) tests the cross-sectional predictive power of volatility, skewness, and kurtosis simultaneously. Consistent with the mean-variance portfolio theory and the three-moment asset pricing models, the average slope on VOL is significantly positive at 0.010 (t-stat.=2.84), and the average slope on SKEW is significantly negative at -0.170 (t-stat.= -4.30). Although the average slope on KURT is positive, it is not statistically significant, implying that after controlling for volatility and skewness, kurtosis does not predict future returns on corporate bonds. This result confirms the finding from the trivariate sorts of volatility, skewness, and kurtosis in Table A.8 of the online appendix.[16]

The last two specifications, Regressions (10) to (11), present results from the multivariate regressions with all three distributional characteristics (VOL, SKEW, KURT) after controlling

[16]For trivariate sorting, tercile portfolios are first formed by sorting bonds into three portfolios based on their volatility; then within each volatility portfolio, bonds are sorted further into three sub-terciles based on their skewness; lastly, within each skewness portfolio, bonds are sorted further into three sub-terciles based on their kurtosis. Table A.8 shows that the return and alpha differences between high-KURT and low-KURT portfolios are in the range of 0.12% to 0.15% per month but statistically insignificant, indicating that after controlling for volatility and skewness, kurtosis does not make a significant incremental contribution to the predictability of future bond returns.

for the lagged excess return and bond characteristics. Similar to our findings from Regression (9), the cross-sectional relation between volatility (skewness) and future bond returns is positive (negative) and highly significant after controlling for the lagged excess return, credit rating, maturity, and size, whereas the cross-sectional relation between kurtosis and expected bond returns is flat.

5 Bond Liquidity and Other Robustness Check

Liquidity is an important concern in the corporate bond market. All alphas found in previous sections are subject to stringent tests in the real world. In subsection 5.1, we estimate the transaction cost for hedge portfolios and test whether the alphas remain economically and statistically significant after accounting for transaction costs. To address the liquidity concern, we also examine our Fama-MacBeth regression results controlling for bond illiquidity level or bond liquidity risk in subsection 5.2. To address other related concerns, we further provide a battery of robustness checks in subsection 5.3.

5.1 Transaction Costs

In this subsection, we investigate the impact of transaction costs on hedge portfolios sorted by volatility, skewness and kurtosis. We estimate portfolio transaction costs through bond trading illiquidity and portfolio turnover, a method also used by Chordia et al. (2015). Bond illiquidity is based on the measure of Bao, Pan, and Wang (2011), which extracts the transitory component from bond prices. Specifically, let $\Delta p_t = p_t - p_{t-1}$ be the log price change from $t-1$ to t, then bond illiquidity is defined as

$$ILLIQ = -Cov_t(\Delta p_{itd}, \Delta p_{itd+1}), \tag{4}$$

where Δp_{itd} is the log price change for bond i on day d of month t.[17] We compute $ILLIQ$ at the bond level, and compute its cross-sectional average for each portfolio every month. The time-series average of the illiquidity measure, multiplied by the time-series average of the portfolio turnover rate is reported as the transaction costs (denoted as *Trans Costs*).

[17]As discussed by Niederhoffer and Osborne (1966), Roll (1984), and Grossman and Miller (1988), lack of liquidity in an asset leads to transitory components in its price, and thus the magnitude of such transitory price movements reflects the degree of illiquidity in the market. Since transitory price movements lead to negatively autocorrelated price changes, the negative of the autocovariance in relative price changes in eq. (4) provides a meaningful measure of illiquidity.

Table 6 shows the estimated transaction costs for bond portfolios sorted by VOL, SKEW and KURT. The results indicate that the estimated transaction costs are small compared to the return and alpha spreads for the volatility-sorted portfolios. The average transaction cost for the volatility-sorted portfolio is about 0.122% per month for all bonds, 0.083% per month for investment-grade bonds, and 0.185% per month for non-investment-grade bonds. Deducting these transaction cost estimates from the return and alpha spreads, reported in Table 2, Tables A.3 and A.4 of the online appendix, provide clear evidence that after accounting for transaction costs, the return and alpha spreads in the volatility-sorted portfolios remain economically significant; in the range of 4.6% to 5.7% per annum for all bonds, in the range of 3.3% to 3.9% per annum for investment-grade bonds, and more than 10% per annum for non-investment-grade bonds. Similarly, the average transaction cost for the skewness-sorted portfolios (after controlling for volatility) is about 0.089% per month for all bonds, 0.050% per month for investment-grade bonds, and 0.155% per month for non-investment-grade bonds. The average transaction cost for the kurtosis-sorted portfolios is about 0.078% per month for all bonds, 0.057% per month for investment-grade bonds, and 0.127% per month for non-investment-grade bonds.

Overall, these results indicate that the key distributional characteristics of corporate bonds are strong determinants of the cross-sectional dispersion in future returns, even after accounting for transaction costs.

5.2 Controlling for Bond Illiquidity and Liquidity Risk

In addition to estimating transaction costs for hedge portfolios, we test whether the significant relation between volatility, skewness, kurtosis, and future bond returns remains intact after controlling for corporate bond illiquidity or liquidity risk in the Fama-MacBeth regressions.

For corporate bond illiquidity, we consider three proxies. The first proxy is $ILLIQ$ defined in the previous subsection. The second proxy is Amihud (2002) illiquidity measure. We first calculate the daily price impact as the daily absolute return scaled by daily trading volume. Then, the monthly illiquidity measure of Amihud is defined as the daily price impact averaged in a month. The third proxy is Roll's measure, calculated using historical returns from a rolling 60-month window similar to the construction of VOL, SKEW, and KURT: $Roll = 2\sqrt{-\text{cov}(r_t, r_{t-1})}$ if $\text{cov}(r_t, r_{t-1}) < 0$; otherwise, $Roll = 0$ (r_t is the bond excess return in month t). Note that the first two proxies require daily transaction data and hence they are available only for the subsample period of 2002 to 2012. The Roll's measure has a longer period from 1975 to 2012.

For liquidity risk exposure, we use two measures, LIQ1 and LIQ2, constructed by Lin, Wang, and Wu (2011).[18] The measure LIQ1 is the corporate bond liquidity beta using the method of Pastor and Stambaugh (2003) and LIQ2 is the corporate bond beta on Amihud's (2002) illiquidity measure.

Panel A of Table 7 shows that controlling for illiquidity and other bond characteristics (rating, maturity, and size), the significantly positive (negative) relation between volatility (skewness) and future bond returns remains intact. It is worth noting that corporate bond illiquidity alone, under the proxy of $ILLIQ$, is positively related to future bond returns, which is consistent with theoretical predictions.

Panel B of Table 7 shows that controlling for the liquidity risk exposure and other bond characteristics (rating, maturity, and size), the significantly positive (negative) relation between volatility (skewness) and future bond returns also remains intact. However, there is no evidence of a significant link between liquidity beta and future bond returns in our sample.

5.3 Robustness Check

5.3.1 Value-Weighted Portfolios

Bonds with severe liquidity concern are often those with small size. We replicate our main findings using the value-weighted portfolios, which mitigate the impact of illiquid small bond transactions. Panel A of Table 8 presents results from the value-weighted portfolios using bond outstanding dollar value as weights. The results remain economically and statistically significant for the volatility-, skewness-, and kurtosis-sorted portfolios. For the value-weighted portfolios, corporate bonds in the highest volatility quintile generate 0.52% per month higher return than bonds in the lowest volatility quintile. After controlling for volatility, corporate bonds in the lowest skewness quintile generate 0.17% per month higher returns than bonds in the highest skewness quintile. In addition, corporate bonds in the highest kurtosis quintile generate 0.28% per month higher returns than bonds in the lowest kurtosis quintile. These results suggest that after bond size has been taken into account, the distributional moments of corporate bonds predict their future returns.

[18] We thank Junbo Wang for providing us with the data on LIQ1 and LIQ2 used by Lin, Wang, and Wu (2011). The monthly data on LIQ1 and LIQ2 are available from January 1999 to March 2009. In their paper, both proxies of corporate bond market liquidity factor are defined as innovation to the market liquidty series through a fitting ARMA model, and market liquidity is calculated as the average of bond-level liquidity.

5.3.2 Non-Financial Firms

Our empirical analyses have so far been based on the entire bond sample issued by both financial and non-financial firms. After excluding bonds issued by financial firms, Panel B of Table 8 shows that our main results remain intact. Specifically, the average raw and risk-adjusted return spreads between high-volatility and low-volatility quintiles are in the range of 0.47% to 0.58% per month and highly significant. The average raw and risk-adjusted return spreads between high-skewness and low-skewness quintiles are in the range of -0.19% to -0.21%. And the average raw and risk-adjusted return spreads between high-kurtosis and low-kurtosis quintiles are in the range of 0.38% to 0.39%. Overall, these results are very similar to those obtained from the full sample including both financial and non-financial firms.

5.3.3 Lehman Non-Transaction Data

As discussed in Section 3, our bond data are gathered from a range of data sources, which contain a mix of quoted and transaction prices. In this subsection, we focus on a subsample of the Lehman data covering the period from 1973 to 1996. As presented in Panel C of Table 8, the average return spreads in volatility- and skewness-sorted portfolios are, respectively, 0.59% and -0.13% per month and highly significant. The average return spreads in kurtosis-sorted portfolios are in the range of 0.33% to 0.36%. Similarly, the 5- and 7-factor alpha spreads are large in magnitude and highly significant, indicating strong cross-sectional relations between volatility, skewness, kurtosis, and future bond returns.

5.3.4 TRACE Enhanced Transaction Data

Bessembinder, Maxwell, and Venkataraman (2006) highlights the importance of using TRACE daily transaction data. We now focus on the subsample of TRACE enhanced transaction data from July 2002 to December 2012. Panel D of Table 8 reports our key results for VOL-, SKEW-, and KURT-sorted portfolios using the TRACE data. Our main findings remain very similar to those obtained from the full sample, though with the real transaction data from 2002 to 2012, our results are even stronger. Corporate bonds in the highest volatility (lowest skewness) quintile generate 0.75% (0.34%) per month higher return compared to bonds in the lowest volatility (highest skewness) quintile. Corporate bonds in the highest kurtosis quintile generate 0.45% per month higher return compared to bonds in the lowest kurtosis quintile.

5.3.5 Results over the Business Cycle

We also investigate the significance of a cross-sectional relation between volatility, skewness, kurtosis and future bond returns during the periods of high and low economic activity. We determine increases and decreases in economic activity according to the Chicago Fed National Activity Index (CFNAI), which is a monthly index designed to assess overall economic activity and related inflationary pressure (see, e.g., Allen, Bali, and Tang (2012)). The CFNAI is a weighted average of 85 existing monthly indicators of national economic activity. It is constructed to have an average value of zero and a standard deviation of one. Since economic activity tends toward trend growth rate over time, a positive index reading corresponds to growth above trend (good state) and a negative index reading corresponds to growth below trend (bad state).[19] We find that the positive relation between volatility and future bond returns is significant in both good and bad states, although the results are stronger in bad states of the economy; see Panels E and F of Table 8. During periods of high economic activity, corporate bonds in the highest volatility (lowest skewness) quintile generate 0.46% (0.12%) per month higher average return than those in the lowest volatility (highest skewness) quintile. During periods of low economic activity, corporate bonds in the highest volatility (lowest skewness) quintile generate 0.76% (0.32%) per month higher average return than those in the lowest volatility (highest skewness) quintile. Similarly, positive kurtosis premia (as measured by the 5- and 7-factor alphas) are found to be significant in both states, but somewhat higher during bad states of the economy.

5.3.6 Longer-term Predictability

In this subsection, we test the significance of a cross-sectional relation between volatility, skewness, kurtosis and longer horizon future returns on corporate bonds. We present the time-series averages of the slope coefficients from the regressions of up to six-month-ahead excess bond returns on volatility (VOL), skewness ($SKEW$), kurtosis ($KURT$), and the control variables. Monthly cross-sectional regressions are run for the following multivariate specification:

$$R_{i,t+\tau} == \lambda_{0,t} + \lambda_{1,t} VOL_{i,t} + \lambda_{2,t} SKEW_{i,t} + \lambda_{3,t} KURT_{i,t} + \sum_{k=1}^{K} \lambda_{k,t} Control_{k,t} + \varepsilon_{i,t+\tau}, \quad (5)$$

[19]The 85 economic indicators that are included in the CFNAI are drawn from four broad categories of data: production and income; employment, unemployment, and hours; personal consumption and housing; and sales, orders, and inventories. Each of these data series measures some aspect of overall macroeconomic activity. The derived index provides a single, summary measure of a factor common to these national economic data.

where $R_{i,t+\tau}$ is the excess return on bond i in month $t + \tau$ ($\tau = 2, 3, 4, 5, 6$).

Table A.9 of the online appendix reports the time series averages of the intercept, slope coefficients, and adjusted R^2 values over the 456 months from January 1975 to December 2012. The results indicate a positive and significant relation between volatility and corporate bond returns five months into the future. The negative relation between skewness and corporate bond returns remains significant for two- and three-month ahead returns. Similar to our earlier findings, after controlling for volatility and skewness, kurtosis does not predict longer horizon future returns on corporate bonds.

5.3.7 Firm-level Analysis

Throughout the paper, our empirical analyses are based on the bond-level data since we test whether the distributional characteristics of *individual* bonds predict their future returns. However, firms often have multiple bonds outstanding at the same time. To control for bonds issued by the same firm in our cross-sectional regressions, for each month in our sample, we pick one bond with the median size as the representative for the firm and re-run the Fama-MacBeth regressions using this firm-level data. As presented in Table A.10 of the online appendix, our main findings from the firm-level regressions remain qualitatively similar to those obtained from the bond-level regressions. Both the univariate and multivariate regression results present a positive (negative) and statistically significant relation between volatility (skewness) and future firm-level bond returns.

6 Do Existing Stock and Bond Market Factors Explain the VOL, SKEW and KURT Factors?

We have so far shown that the distributional characteristics (VOL, SKEW, and KURT) of corporate bonds are powerful predictors of the cross-sectional variation in future returns, even after controlling for a large number of bond characteristics, bond-level illiquidity, liquidity risk, and transaction costs. These results suggest that the distributional moments, consistent with asset pricing models, are reasonable proxies for common risk factors in bond returns. To investigate this thoroughly, in this section, we propose new risk factors based on the distributional moments of corporate bond returns and then test if these distribution-based risk factors are explained by the long-established stock and bond market factors.

6.1 New Risk Factors Based on the Distributional Characteristics of Corporate Bond Returns

We use double sorts to construct common risk factors for corporate bonds, since volatility, skewness, and kurtosis of bond returns are correlated with credit rating. As expected, corporate bonds with high volatility and negative skewness (a proxy for left-tail risk) have high credit risk. Consistent with these findings, corporate bonds with high kurtosis have high credit risk as well. Thus, it is natural to use credit risk as the first sorting variable in the construction of these new risk factors of corporate bonds. For each month from January 1975 to December 2012, we form portfolios by first sorting corporate bonds into five quintiles based on their credit rating; then within each rating portfolio, bonds are sorted further into five sub-quintiles based on their volatility, skewness, or kurtosis, separately. The VOL^F factor is the average return difference between the highest volatility portfolio and the lowest volatility portfolio within each rating portfolio. This methodology, under each rating-sorted quintile, produces sub-quintile portfolios of bonds with dispersion in volatility and nearly identical ratings. Similarly, the $SKEW^F$ factor is the average return difference between the highest skewness portfolio and the lowest skewness portfolio within each rating portfolio. The $KURT^F$ factor is the average return difference between the highest kurtosis portfolio and the lowest kurtosis portfolio within each rating portfolio. We also construct a broad, common factor of **V**olatility, **S**kewness, and **K**urtosis (denoted by VSK), using the first principal component of VOL^F, $SKEW^F$ and $KURT^F$ factors. The principal component analysis leads to the following factor loadings that define the VSK factor: $VSK = 0.70 \times VOL^F - 0.18 \times SKEW^F + 0.69 \times KURT^F$. Figure 1 plots the time-series of VOL^F, $SKEW^F$ and $KURT^F$ factors and the common risk factor, VSK, from January 1975 to December 2012.

Panel A of Table 9 reports the summary statistics for the new risk factors (VOL^F, $SKEW^F$ and $KURT^F$), and the long-established stock and bond market risk factors in the literature. The traditional stock market factors include the five factors of Fama and French (1993), Carhart (1997) and Pastor and Stambaugh (2003): the excess stock market return (MKT), the size factor (SMB), the book-to-market factor (HML), the momentum factor (MOM), and the liquidity factor (LIQ). The standard bond market factors include the excess bond market return (Elton, Gruber, and Blake (1995)), the default spread (DEF) and the term spread (TERM) factors of Fama and French (1993).

Over the period from January 1975 to December 2012, the VOL^F factor has an economically and statistically significant risk premium: mean of 0.53% per month with a t-statistic of 5.35. The $SKEW^F$ and $KURT^F$ factors also have significant risk premia: mean of -0.16%

per month (t-stat.= -2.65) and 0.18% per month (t-stat.=2.39), respectively. Consistent with these findings, the VSK factor has an economically and statistically significant risk premium: 0.52% per month with a t-statistic of 4.91. For comparison, Panel A of Table 9 also shows the summary statistics for the commonly used stock market factors. The stock market risk premium, MKT^{Stock} is 0.63% per month with a t-statistic of 2.93. SMB, HML, UMD, and LIQ factors have an average monthly return of 0.29% (t-stat.=2.03), 0.36% (t-stat.=2.52), 0.64% (t-stat.=3.02), and 0.01% (t-stat.=0.35), respectively. The corporate bond market risk premium, MKT^{Bond}, is 0.25% per month with a t-statistic of 3.25. Since risk premia are expected to be higher during financial and economic downturns, we examine the average risk premia for the newly proposed VSK factor during good and bad states of the economy. As expected, we find that the average risk premium on the VSK factor is higher during bad states of the economy: 0.69% per month (t-stat.=3.23) during periods of low economic activity (CFNAI $<$ 0) and 0.39% per month (t-stat.=4.27) during periods of high economic activity (CFNAI $>$ 0). We looked into this further for recessionary vs. non-recessionary periods, and find that the average risk premium on the VSK factor is much higher at 1.05% per month (t-stat.=2.06) during recessionary periods (CFNAI $<$ -0.7), whereas 0.41% per month (t-stat.=5.72) during non-recessionary periods (CFNAI $>$ -0.7). Finally, we examine the bond risk premia during the recent financial crisis and find that the average risk premium on the VSK factor is extremely large at 1.60% per month for the period July 2007-June 2009. These magnitudes provide clear evidence that the distribution-based common factor of corporate bonds generates economically large risk premia during downturns of the economy.

Panel B of Table 9 shows that all of these new risk factors have low correlations with the existing stock and bond market factors. Specifically, the correlations between the VOL^F factor and the standard stock market factors (MKT^{Stock}, SMB, HML, UMD, and LIQ) are in the range of 0.01 and 0.28 in absolute magnitude. The correlations between the VOL^F factor and the standard bond market factors (MKT^{Bond}, DEF, and TERM) are in the range of 0.01 and 0.28 in absolute magnitude. The corresponding correlations are even lower for the $SKEW^F$ factor; in the range 0.02 and 0.08 for the stock market factors and range from 0.04 to 0.06 for the bond market factors in absolute magnitude. Similarly, the corresponding correlations are low for the $KURT^F$ factor; in the range 0.01 and 0.27 for the stock market factors and range from 0.05 to 0.20 for the bond market factors in absolute magnitude. Consistent with these findings, the correlations between the common VSK factor and the traditional stock and bond market factors are very low; in the range of 0.01 and 0.31 for the stock market factors and range from 0.01 to 0.10 for the bond market factors in absolute magnitude. These results suggest that the newly proposed risk factors represent an important source of common return variation missing from the long-established stock and bond market risk factors.

6.2 Time-Series Analysis

To examine whether the conventional stock and bond market risk factors can explain the newly proposed distribution-based risk factors of corporate bonds, we conduct a formal test using the following time-series regression:

$$VSK_t = \alpha + \sum_{k=1}^{K} \beta_k Factor_{k,t}^{Stock} + \sum_{l=1}^{L} \beta_l Factor_{l,t}^{Bond} + \varepsilon_t, \tag{6}$$

where VSK is the common risk factor obtained from the first principal component of the VOL^F, $SKEW^F$ and $KURT^F$ factors. $Factor_{k,t}^{Stock}$ denotes a vector of stock market factors; MKT^{Stock}, SMB, HML, UMD, and LIQ and $Factor_{k,t}^{Bond}$ denotes a vector of bond market factors; MKT^{Bond}, DEF, and TERM.

Equation (6) is re-estimated separately for each of the newly proposed risk factors by replacing the VSK factor on the left hand side with the VOL^F, $SKEW^F$ and $KURT^F$ factors. These factor regression results are presented in Table 10. The intercepts (alphas) from these time-series regressions represent the abnormal returns not explained by the standard stock nd bond market factors. The alphas are defined in terms of monthly percentage. Newey-West (1987) adjusted t-statistics are reported in parentheses.

Panel A of Table 10 reports the regression results using the stock market factors as explanatory variables. In Model 1 (i.e., the market model) where the only explanatory variable is the excess return on stock market, all of the intercepts are economically and statistically significant. The alphas for the VOL^F, $SKEW^F$ and $KURT^F$ factors are 0.45% per month (t-stat.=4.49), -0.17% per month (t-stat.= -2.51), and 0.16% (t-stat.=2.01), respectively. Consistent with these findings, the CAPM alpha for the VSK factor is positive and highly significant; 0.45% per month (t-stat.=4.43). In Model 2 where the explanatory variables include five commonly used stock market factors of Fama and French (1993), Carhart (1997), and Pastor and Stambaugh (2003), all of the alphas remain economically large and statistically significant. The adjusted-R^2 values from these regressions are in the range of -0.19% to 14.74%, suggesting that the commonly used stock market factors have low explanatory power for the distribution-based risk factors of corporate bonds. In particular, the adjusted-R^2 values are close to zero for the $SKEW^F$ factor. Overall, these results suggest that the newly proposed bond market factors capture important source of common return variation in corporate bonds missing from the traditional stock market factors.

Panel B of Table 10 shows the regression results using the standard bond market risk factors as explanatory variables. In Model 3 where the only explanatory variable is the excess bond market return, all of the intercepts are economically and statistically significant. The alphas for the VOL^F, $SKEW^F$ and $KURT^F$ factors are 0.41% per month (t-stat.=4.29), -0.19% per month (t-stat.= -3.23), and 0.23% (t-stat.=3.02), respectively. Consistent with these findings, the CAPM alpha for the VSK factor is positive and highly significant; 0.48% per month (t-stat.=4.45). In Model 4 where the explanatory variables include the default spread (DEF) and term spread (TERM) factors of Fama and French (1993), all of the intercepts remain both economically strong and statistically significant. The adjusted-R^2 values from these regressions are in the range of 0.10% to 9.62%. In particular, the adjusted-R^2 values are close to zero for the $SKEW^F$ and VSK factors, implying that the commonly used bond market risk factors have low explanatory power for the distribution-based risk factors of corporate bonds.

Panel C of Table 10 presents the regression results from the extended 8-factor model, combining all of the stock and bond market factors. The results are consistent with our earlier findings. First, the alphas of all distribution-based bond risk factors are economically and statistically significant, indicating that the existing stock and bond market factors are not sufficient to capture the information content in these new bond risk factors. Second, the explanatory power of the existing factors is considerably low for the new bond market factors. Combining all factors together, they explain about 22.20% of the VOL^F factor, 1.59% of the $SKEW^F$ factor, 12.71% of the $KURT^F$ factor, and 14.14% of the VSK factor. These findings suggest that our new bond market risk factors represent an important source of common return variation missing from the long-established stock and bond market risk factors.

7 Conclusion

In spite of the dominance of mean-variance portfolio theory, there has been longstanding interest in whether high-order moments (skewness, kurtosis, and tail risk) play a special role in determining expected returns. An extensive literature examines the significance of distributional moments in predicting future stock and option returns, but almost no work has been done on the predictive power of volatility and higher order moments of bond returns. This paper is the first to investigate if the distributional characteristics of corporate bonds predict the cross-sectional differences in future bond returns.

We test the significance of a cross-sectional relation between volatility and future returns on corporate bonds using portfolio level analysis, and find that bonds in the highest volatility quintile generate 6.05% to 7.15% more annual raw and risk-adjusted returns compared to bonds in the lowest volatility quintile. After controlling for the volatility of bond returns and well-known stock and bond market factors, bivariate portfolio results show that bonds in the lowest skewness quintile generate 2.53% to 3.13% more annual raw and risk-adjusted returns compared to bonds in the highest skewness quintile, consistent with investors' preference for positively skewed assets. Bonds in the highest kurtosis quintile generate 4.21% to 4.40% more annual raw and risk-adjusted returns compared to bonds in the lowest kurtosis quintile. These results are consistent with theoretical models with high-order moments, which is in contrast to the mixed findings for the cross-section of stock and option returns.

Based on the cross-sectional asset pricing results from portfolio-level analyses, we generate new risk factors of corporate bonds using bivariate sorts of credit rating and distributional characteristics, VOL^F, $SKEW^F$, $KURT^F$ and their first principal component VSK. We show that the existing risk factors in the stock and bond literature do not have significant explanatory power for our newly proposed risk factors. That means, the distribution-based risk factors of corporate bonds contain additional predictive power beyond current predictors. One possible explanation for the additional power, as suggested by our analysis, is that the distribution-based risk factors capture the downside risk of corporate bonds reflected in higher credit risk, longer time-to-maturity, lower market value, and higher liquidity risk, which cannot be fully captured by the existing stock and/or bond market factors.

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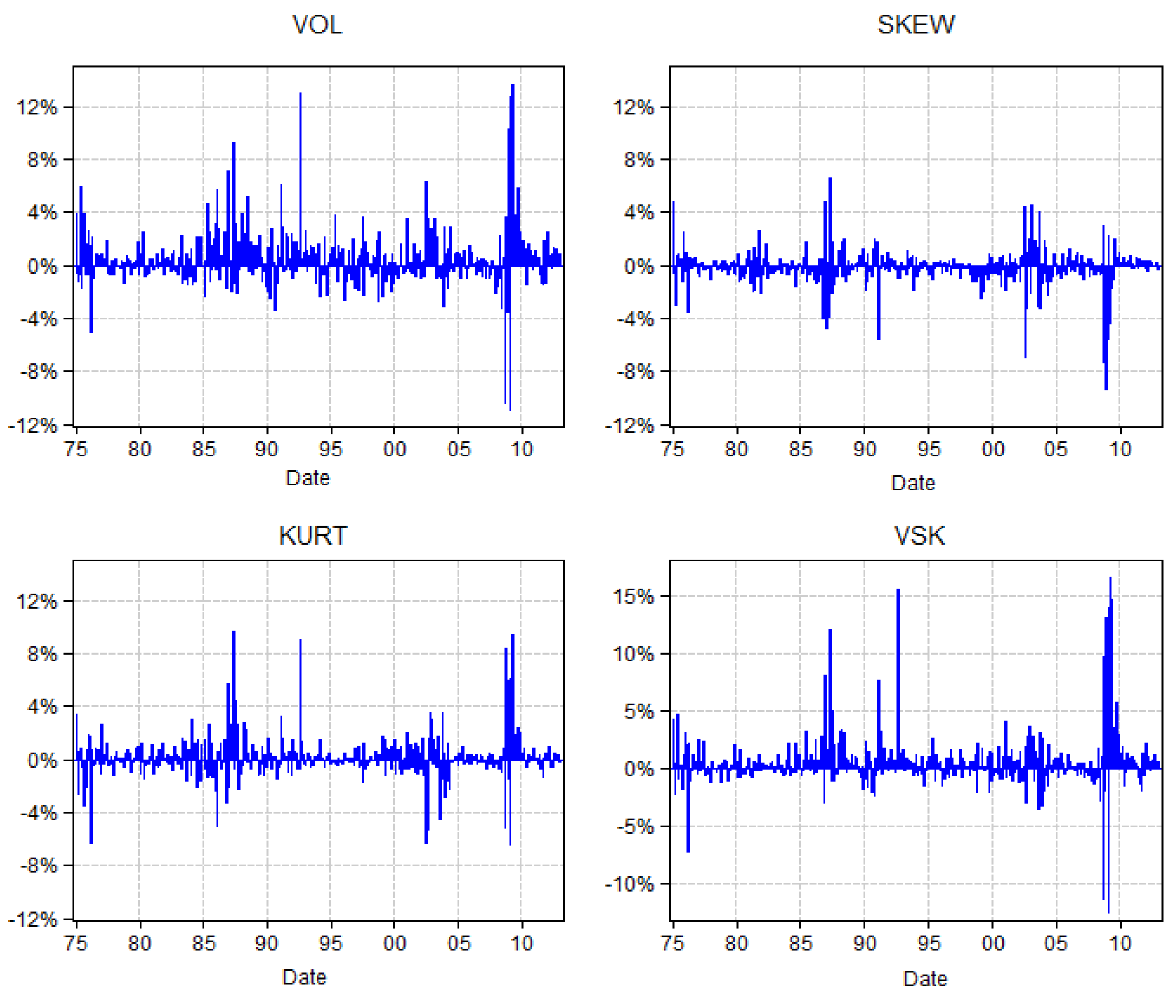
Figure 1: VOL^F, $SKEW^F$, $KURT^F$ **and the** VSK **Factors: 1975 – 2012**



This figure plots the monthly time-series of the distribution-based risk factors VOL^F, $SKEW^F$ and $KURT^F$ and the common risk factor, VSK, from January 1975 to December 2012. The volatility factor (VOL^F) is constructed by first sorting corporate bonds on credit rating into quintiles, then within each rating portfolio, corporate bonds are sorted into sub-quintiles based on the volatility. VOL^F is the average return difference between the highest VOL portfolio and the lowest VOL portfolio within each rating portfolio. The skewness factor ($SKEW^F$) is constructed by first sorting corporate bonds on credit rating into quintiles, then within each rating portfolio, corporate bonds are sorted into sub-quintiles based on the skewness. $SKEW^F$ is the average return difference between the highest SKEW portfolio and the lowest SKEW portfolio within each rating portfolio. The kurtosis factor ($KURT^F$) is constructed by first sorting corporate bonds on credit rating into quintiles, then within each rating portfolio, corporate bonds are sorted into sub-quintiles based on the kurtosis. $KURT^F$ is the average return difference between the highest KURT portfolio and the lowest KURT portfolio within each rating portfolio. The common risk factor, VSK, is constructed using the first principal component of VOL^F, $SKEW^F$ and $KURT^F$ factors, $VSK = 0.70 \times VOL^F - 0.18 \times SKEW^F + 0.69 \times KURT^F$.

Table 1: **Normality Test for Corporate Bond Returns**

Panel A reports the total number of bonds and the percentage of bonds with significant and insignificant return moments, for the time-series distribution of all corporate bond returns. For each bond in our sample from January 1975 to December 2012, we compute the volatility (%), skewness, and excess kurtosis of monthly returns, and then test whether these high-order moments are significantly different from zero. Panel B reports the total number of months and the number of months with significant and insignificant return moments for the cross-sectional distribution of monthly corporate bond returns. For each month from January 1975 to December 2012, we compute the the return moments including volatility (%), skewness, and excess kurtosis using the cross-section of bond returns, and test whether these distributional moments are significantly different from zero. Table also reports the Jarque-Bera (JB) statistics for the normality test of the distribution of corporate bond returns. The median p-value is reported to test the statistical significance of the return moments and the significance of the JB statistics. The sample period starts from January 1975 to December 2012.

Panel A: the time-series distribution of all corporate bond returns

		Skewness		Kurtosis		Normality
	Volatility	Positive	Negative	Positive	Negative	JB-stat
Total # of bonds	14,796	6,695	8,101	13,345	1,451	14,796
% of bonds significant	100.00	57.18	52.49	77.93	1.03	70.90
Median p-value	0.00	0.00	0.00	0.00	0.00	0.00
% of bonds insignificant	0.00	42.82	47.51	22.07	98.97	29.10

Panel B: the cross-sectional distribution of monthly corporate bond returns

		Skewness		Kurtosis		Normality
	Volatility	Positive	Negative	Positive	Negative	JB-stat
Total # of months	456	228	228	454	2	456
# of months significant	455	222	224	453	2	456
Median p-value	0.00	0.00	0.00	0.00	0.00	0.00
# of months insignificant	1	6	4	1	0	0

Table 2: **Univariate Portfolios of Corporate Bonds Sorted by Volatility (VOL)**

Quintile portfolios are formed every month from January 1975 to December 2012 by sorting corporate bonds based on their 60-month rolling total variance (VOL). Quintile 1 is the portfolio with the lowest volatility, and Quintile 5 is the portfolio with the highest volatility. Table reports the average volatility, the next-month average excess return, the 5- and 7-factor alpha for each quintile. The last three columns report average portfolio characteristics including bond rating, time-to-maturity (years), and amount outstanding (size, in billions of dollars) for each quintile. The last row shows the differences in monthly average returns, the differences in alphas with respect to the 5- and 7-factor models. The 5-factor model includes the excess market return (MKT), a size factor (SMB), a book-to-market factor (HML), a momentum factor (MOM), and a liquidity factor (LIQ). The 7-factor model includes the five factors plus two bond market factors: the default spread factor (DEF) and the term spread factor (TERM), or the credit risk factor (CredSpr) and the long-term interest rate factor (10Yr). Average excess returns and alphas are defined in monthly percentage terms. Newey-West adjusted t-statistics are given in parentheses. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

Quintiles	Average	Average	5-factor	7-factor alpha	7-factor alpha	Average Portfolio Characteristics		
	volatility	excess return	alpha	with DEF and TERM	with CredSpr and 10Yr	Rating	Maturity	Size
Low VOL	2.130	0.046	-0.052	-0.056	-0.056	6.600	9.996	0.261
		(0.49)	(-0.59)	(-0.59)	(-0.98)			
2	2.740	0.123	0.007	0.002	0.001	6.623	12.770	0.236
		(1.11)	(0.07)	(0.02)	(0.02)			
3	3.209	0.146	-0.001	-0.005	-0.005	6.631	15.348	0.240
		(1.20)	(-0.01)	(-0.04)	(-0.08)			
4	3.796	0.233	0.062	0.057	0.056	7.019	17.881	0.231
		(1.71)	(0.50)	(0.43)	(0.70)			
High VOL	6.720	0.642	0.452	0.450	0.450	10.221	17.482	0.219
		(3.01)	(2.30)	(2.21)	(2.50)			
High − Low		0.596***	0.504***	0.505***	0.505***			
Return/Alpha diff.		(3.60)	(3.11)	(3.23)	(3.16)			

Table 3: **Quintile Portfolios of Corporate Bonds Sorted by SKEW Controlling for VOL**

Quintile portfolios are formed every month from January 1975 to December 2012 by first sorting corporate bonds based on their 60-month rolling total variance (VOL). Then, within each volatility portfolio, corporate bonds are sorted into sub-quintiles based on their 60-month rolling skewness ($SKEW$). "Quintile SKEW,1" is the portfolio of corporate bonds with the lowest $SKEW$ within each volatility portfolio and "Quintile SKEW, 5" is the portfolio of corporate bonds with the highest $SKEW$ within each volatility portfolio. Table also reports the average $SKEW$ within each volatility portfolio, the next-month average excess return, the 5- and 7-factor alpha for each quintile. The last three columns report average portfolio characteristics including bond rating, time-to-maturity (years), and amount outstanding (size, in billions of dollars) for each quintile. The last row shows the differences in monthly average returns, the differences in alphas with respect to the 5- and 7-factor models. The 5-factor model includes the excess market return (MKT), a size factor (SMB), a book-to-market factor (HML), a momentum factor (MOM), and a liquidity factor (LIQ). The 7-factor model includes the five factors plus two bond market factors: the default spread factor (DEF) and the term spread factor (TERM), or the credit risk factor (CredSpr) and the long-term interest rate factor (10Yr). Average excess returns and alphas are defined in monthly percentage terms. Newey-West adjusted t-statistics are given in parentheses. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

$SKEW$ Quintiles after controlling for VOL	Average skew	Average excess return	5-factor alpha	7-factor alpha with DEF and TERM	7-factor alpha with CredSpr and 10Yr	Average Portfolio Characteristics: Rating	Maturity	Size
SKEW,1	-0.874	0.383	0.306	0.300	0.304	8.615	13.183	0.248
		(3.35)	(2.64)	(2.60)	(3.11)			
SKEW,2	-0.221	0.219	0.066	0.062	0.061	7.362	14.974	0.248
		(1.94)	(0.62)	(0.59)	(0.82)			
SKEW,3	0.040	0.183	0.030	0.025	0.021	6.807	15.484	0.237
		(1.60)	(0.26)	(0.22)	(0.28)			
SKEW,4	0.325	0.182	0.018	0.014	0.012	6.834	15.312	0.232
		(1.64)	(0.17)	(0.13)	(0.19)			
SKEW,5	0.904	0.172	0.046	0.039	0.043	7.575	13.806	0.239
		(1.63)	(0.46)	(0.39)	(0.62)			
SKEW,5 − SKEW,1 Return/Alpha diff.		-0.211***	-0.260***	-0.260***	-0.261***			
		(-3.76)	(-3.77)	(-3.84)	(-3.84)			

Table 4: **Univariate Portfolios of Corporate Bonds Sorted by Kurtosis (KURT)**

Quintile portfolios are formed every month from January 1975 to December 2012 by sorting corporate bonds based on their 60-month rolling kurtosis ($KURT$). Quintile 1 is the portfolio with the lowest kurtosis, and Quintile 5 is the portfolio with the highest kurtosis. Table also reports the average kurtosis, the next-month average excess return, the 5- and 7-factor alpha for each quintile. The last three columns report average portfolio characteristics including bond rating, time-to-maturity (years), and amount outstanding (size, in billions of dollars) for each quintile. The last row shows the differences in monthly average returns, the differences in alphas with respect to the 5- and 7-factor models. The 5-factor model includes the excess market return (MKT), a size factor (SMB), a book-to-market factor (HML), a momentum factor (MOM), and a liquidity factor (LIQ). The 7-factor model includes the five factors plus two bond market factors: the default spread factor (DEF) and the term spread factor (TERM), or the credit risk factor (CredSpr) and the long-term interest rate factor (10Yr). Average excess returns and alphas are defined in monthly percentage terms. Newey-West adjusted t-statistics are given in parentheses. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

Quintiles	Average	Average	5-factor	7-factor alpha	7-factor alpha	Average Portfolio Characteristics		
	kurtosis	excess return	alpha	with DEF and TERM	with CredSpr and 10Yr	Rating	Maturity	Size
Low KURT	-0.075	0.151	0.009	0.005	0.003	6.639	15.535	0.242
		(1.25)	(0.08)	(0.04)	(0.05)			
2	0.636	0.153	0.012	0.008	0.006	6.639	15.744	0.239
		(1.24)	(0.10)	(0.06)	(0.09)			
3	1.294	0.177	0.015	0.011	0.010	6.875	15.216	0.242
		(1.40)	(0.13)	(0.09)	(0.14)			
4	2.276	0.205	0.055	0.051	0.051	7.299	14.370	0.245
		(1.57)	(0.47)	(0.40)	(0.61)			
High KURT	6.396	0.502	0.373	0.370	0.371	9.635	12.483	0.219
		(3.14)	(2.54)	(2.37)	(2.82)			
High − Low		0.351***	0.365***	0.365***	0.367***			
Return/Alpha diff.		(3.32)	(3.38)	(3.44)	(3.57)			

Table 5: **Fama-MacBeth Cross-Sectional Regressions with VOL, SKEW, and KURT**

This table reports the average intercept and slope coefficients from the Fama and MacBeth (1973) cross-sectional regressions of one-month-ahead corporate bond excess returns on total variance (VOL), skewness (SKEW), and kurtosis (KURT) with and without the control variables. Bond characteristics are credit rating, time-to-maturity (years), amount outstanding (size, in billions of dollars), and past month excess return. Ratings are in conventional numerical scores, where 1 represents a AAA rating and 21 reflects a C rating. Higher numerical score means lower ratings. The Fama and MacBeth cross-sectional regressions are run each month for the period January 1975 to December 2012. Each row represents a cross-sectional regression. Newey-West (1987) t-statistics are reported in parentheses to determine the statistical significance of the average intercept and slope coefficients. The last column reports the average adjusted R^2 values. Numbers in bold denote statistical significance of the average slope coefficients.

	Intercept	VOL	SKEW	KURT	Rating	Maturity	Size	Lagged Return	R^2_{adj}
(1)	0.008	**0.014**							0.044
	(0.07)	(3.58)							
(2)	0.208		-0.041						0.012
	(1.60)		(-1.08)						
(3)	0.111			**0.050**					0.020
	(0.91)			(3.83)					
(4)	-0.045	**0.009**			0.009	**0.005**	-0.338	**-0.170**	0.174
	(-0.37)	(2.65)			(0.81)	(1.65)	(-1.10)	(-9.94)	
(5)	-0.122		-0.038		**0.034**	**0.007**	-0.336	**-0.156**	0.157
	(-0.95)		(-1.39)		(2.22)	(2.26)	(-1.07)	(-9.36)	
(6)	-0.167			**0.020**	**0.030**	**0.008**	-0.368	**-0.157**	0.159
	(-1.26)			(2.29)	(2.11)	(2.42)	(-1.01)	(-9.30)	
(7)	-0.023	**0.016**	**-0.180**						0.057
	(-0.20)	(3.72)	(-4.28)						
(8)	-0.051	**0.009**	**-0.120**		0.007	**0.006**	-0.359	**-0.166**	0.178
	(-0.40)	(2.50)	(-3.59)		(0.65)	(1.85)	(-0.96)	(-9.74)	
(9)	-0.030	**0.017**	**-0.168**	-0.003					0.071
	(-0.26)	(3.84)	(-3.68)	(-0.26)					
(10)	-0.114	**0.010**	**-0.170**	-0.012	0.009	**0.004**	-0.096		0.121
	(-1.02)	(2.84)	(-4.30)	(-1.56)	(0.88)	(1.71)	(-0.55)		
(11)	-0.056	**0.008**	**-0.101**	-0.005	0.009	**0.006**	-0.267	**-0.169**	0.181
	(-0.43)	(2.42)	(-2.98)	(-0.49)	(0.76)	(1.64)	(-0.81)	(-9.68)	

Table 6: **Transaction Costs for Bond Portfolios Sorted by VOL, SKEW, and KURT**

This table reports the estimated transaction costs for bond portfolios sorted by volatility (VOL), skewness (SKEW) and kurtosis (KURT). We estimate the portfolio transaction costs, *Trans Cost*, following Chordia et al. (2015). *Trans Cost* is the product of the time-series average of the illiquidity measure, as in Bao, Pan, and Wang (2011), multiplied by the time-series average of the portfolio turnover rate. The transaction costs are in percentage per month, from January 2003 to December 2012 using TRACE Enhanced data.

	Low	2	3	4	High	High-Low
Panel A: All Bonds						
VOL	0.016	0.012	0.016	0.028	0.106	0.122
SKEW	0.057	0.033	0.019	0.019	0.032	0.089
KURT	0.016	0.022	0.026	0.029	0.062	0.078
Panel B: Investment-grade bonds						
VOL	0.018	0.011	0.015	0.020	0.064	0.083
SKEW	0.029	0.022	0.014	0.013	0.021	0.050
KURT	0.016	0.013	0.015	0.017	0.041	0.057
Panel C: Non-investment-grade bonds						
VOL	0.014	0.014	0.058	0.062	0.170	0.185
SKEW	0.098	0.080	0.035	0.049	0.057	0.155
KURT	0.024	0.069	0.051	0.061	0.103	0.127

Table 7: **Controlling for Bond Liquidity and Liquidity Risk**

This table reports the average intercept and slope coefficients from the Fama and MacBeth (1973) cross-sectional regressions of one-month-ahead corporate bond excess returns on the corporate bonds total variance or volatility (VOL), skewness (SKEW), and kurtosis (KURT) controlling for bond illiquidity level (Panel A) as well as liquidity risk (Panel B). Bond illiquidity levels include the illiquidity measure ILLIQ in Bao, Pan, and Wang (2011), the Amihud (2002) illiquidity measure, and the Roll's measure calculated using historical returns from a rolling 60-month window similar to the construction of VOL, SKEW, and KURT. Bond liquidity risk include LIQ1 and LIQ2. LIQ1 is the Pastor-Stambaugh liquidity beta in Lin, Wang, and Wu (2011). LIQ2 is the Amihud illiquidity beta in Lin, Wang, and Wu (2011). Other control variables are credit rating, time-to-maturity (years), amount outstanding (size, in billions of dollars), and past month excess return. Ratings are in conventional numerical scores, where 1 represents a AAA rating and 21 reflects a C rating. Higher numerical score means lower ratings. Average slope coefficients are reported in separate columns for each variable. Each row represents a cross-sectional regression. Newey-West (1987) t-statistics are reported in parentheses to determine the statistical significance of the average intercept and slope coefficients. The last column reports the average adjusted R^2 values. Numbers in bold denote statistical significance of the average slope coefficients.

Panel A: Controlling for bond illiquidity level

	Intercept	VOL	SKEW	KURT	Roll	ILLIQ	Amihud	Rating	Maturity	Size	R^2_{adj}
(1)	-0.104	**0.019**	**-0.170**	-0.001	0.015			0.007	0.002	-0.026	0.179
	(-0.90)	(3.41)	(-4.50)	(-0.13)	(0.62)			(0.67)	(0.66)	(-0.13)	
(2)	-0.047	**0.009**	**-0.093**	-0.010		**0.012**		0.009	0.005	-0.282	0.170
	(-0.36)	(2.28)	(-2.97)	(-1.06)		(4.28)		(0.81)	(1.46)	(-0.86)	
(3)	-0.033	**0.008**	**-0.085**	-0.008			0.043	0.005	0.002	-0.121	0.140
	(-0.29)	(2.45)	(-2.29)	(-0.84)			(1.04)	(-0.43)	(0.46)	(-0.32)	

Panel B: Controlling for liquidity risk

	Intercept	VOL	SKEW	KURT	LIQ1	LIQ2	Rating	Maturity	Size	R^2_{adj}
(1)	-0.064	**0.010**	**-0.100**	-0.006	-0.007		0.010	0.005	-0.257	0.186
	(-0.50)	(2.57)	(-2.97)	(-0.60)	(-0.46)		(1.00)	(1.57)	(-0.78)	
(2)	-0.051	**0.009**	**-0.087**	-0.004	-0.008		0.011	0.005	-0.261	0.186
	(-0.40)	(2.51)	(-2.44)	(-0.42)		(-0.32)	(1.06)	(1.59)	(-0.79)	

Table 8: **Robustness Check**

This table reports a battery of robustness checks on corporate bond portfolios sorted by volatility (VOL), skewness (SKEW), and kurtosis (KURT). Panel A reports the value-weighted portfolio results, using bond outstanding dollar value as weights. Panel B presents the results for bonds issued by non-financial firms only. Panels C uses the Lehman data only. Panel D uses the TRACE transaction data only. Panels E reports the results during periods of high economic activity, based on the Chicago Fed National Activity Index (CFNAI > 0). Panels F reports the results during periods of low economic activity (CFNAI < 0). *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

High − Low	Average excess return	5-factor alpha	7-factor alpha with DEF and TERM	7-factor alpha with CredSpr and 10Yr
Panel A: Value-weighting				
VOL	0.520***	0.370**	0.379**	0.378**
SKEW	-0.176***	-0.217***	-0.218***	-0.219***
KURT	0.278***	0.284***	0.285***	0.287***
Panel B: Non-financial firms				
VOL	0.580***	0.473***	0.476***	0.476***
SKEW	-0.186***	-0.203***	-0.204***	-0.205***
KURT	0.385***	0.383***	0.385***	0.388***
Panel C: Lehman Non-Transaction Data Only				
VOL	0.586***	0.451***	0.448***	0.475***
SKEW	-0.130**	-0.129*	-0.126*	-0.123*
KURT	0.340***	0.356**	0.354**	0.325**
Panel D: TRACE Transaction Data Only				
VOL	0.745***	0.557**	0.575**	0.621**
SKEW	-0.338**	-0.335**	-0.333**	-0.349**
KURT	0.451**	0.349**	0.376**	0.403**
Panel E: Low Economic Activity				
VOL	0.760**	0.671**	0.651**	0.734***
SKEW	-0.317***	-0.361***	-0.349***	-0.387***
KURT	0.346**	0.373**	0.375**	0.437**
Panel F: High Economic Activity				
VOL	0.460***	0.298**	0.273**	0.341***
SKEW	-0.123**	-0.126**	-0.136**	-0.113**
KURT	0.356***	0.319**	0.372***	0.203*

Table 9: **Summary Statistics for VOL^F, $SKEW^F$, $KURT^F$, and the VSK Factors**

Panel A reports the summary statistics for the distribution-based risk factors (VOL^F, $SKEW^F$ and $KURT^F$), and the long-established stock and bond market risk factors in the literature. The volatility factor (VOL^F) is constructed by first sorting corporate bonds on credit rating into quintiles, then within each rating portfolio, corporate bonds are sorted into sub-quintiles based on the volatility. VOL^F is the average return difference between the highest VOL portfolio and the lowest VOL portfolio within each rating portfolio. The skewness factor ($SKEW^F$) is constructed by first sorting corporate bonds on credit rating into quintiles, then within each rating portfolio, corporate bonds are sorted into sub-quintiles based on the skewness. $SKEW^F$ is the average return difference between the highest SKEW portfolio and the lowest SKEW portfolio within each rating portfolio. The kurtosis factor ($KURT^F$) is constructed by first sorting corporate bonds on credit rating into quintiles, then within each rating portfolio, corporate bonds are sorted into sub-quintiles based on the kurtosis. $KURT^F$ is the average return difference between the highest KURT portfolio and the lowest KURT portfolio within each rating portfolio. The VSK factor is constructed using the first principal component of VOL^F, $SKEW^F$ and $KURT^F$ factors, $VSK = 0.70 \times VOL^F - 0.18 \times SKEW^F + 0.69 \times KURT^F$. The stock market factors include the excess stock market return (MKT^{Stock}), the size factor (SMB), the book-to-market factor (HML), the momentum factor (UMD), and the Pastor-Stambaugh stock liquidity factor (LIQ). The bond market factors include the excess bond market returns constructed using the U.S. Barclay Aggregate Bond Index (MKT^{Bond}), the default spread factor (DEF) and the term spread factor (TERM). Panel B reports the correlations among the factors. The sample period starts from January 1975 to December 2012.

Panel A: Summary statistics

	Distribution-based bond risk factors				Stock market factors					Bond market factors		
	VOL^F	$SKEW^F$	$KURT^F$	VSK	MKT^{Stock}	SMB	HML	UMD	LIQ	MKT^{Bond}	DEF	TERM
Mean	0.53	-0.16	0.18	0.52	0.63	0.29	0.36	0.64	0.00	0.25	0.00	0.00
t-stat	(5.35)	(-2.65)	(2.39)	(4.91)	(2.93)	(2.03)	(2.52)	(3.02)	(0.35)	(3.25)	(-0.27)	(0.14)

Panel B: Correlations

	VOL^F	$SKEW^F$	$KURT^F$	VSK	MKT^{Stock}	SMB	HML	UMD	LIQ	MKT^{Bond}	DEF	TERM
VOL^F	1	-0.09	0.51	0.91	0.28	0.06	0.06	-0.27	0.01	0.31	0.01	-0.12
$SKEW^F$		1	-0.05	-0.19	0.02	0.03	0.06	0.06	0.08	0.06	-0.04	-0.05
$KURT^F$			1	0.82	0.08	0.12	0.06	-0.27	0.00	-0.20	0.05	0.15
VSK				1	0.22	0.10	0.06	-0.31	0.00	0.10	0.04	0.00
MKT^{Stock}					1	0.27	-0.30	-0.11	0.30	0.22	-0.07	0.04
SMB						1	-0.25	0.06	0.09	-0.08	-0.07	0.13
HML							1	-0.18	-0.05	0.01	0.02	0.10
UMD								1	-0.04	0.01	-0.01	-0.16
LIQ									1	0.01	-0.01	0.03
MKT^{Bond}										1	0.24	-0.30
DEF											1	0.05
TERM												1

Table 10: **Time-series Regressions of VOL^F, $SKEW^F$, $KURT^F$ and VSK Factors on the Stock and Bond Market Factors**

This table reports the intercept (α) and slope coefficients from time-series regressions of VOL^F, $SKEW^F$, $KURT^F$ and the common risk factor, VSK, on the stock and bond market factors. The VSK factor is constructed using the first principal component of VOL^F, $SKEW^F$ and $KURT^F$ factors, and $VSK = 0.70 \times VOL^F - 0.18 \times SKEW^F + 0.69 \times KURT^F$. The stock market factors include the excess stock market return (MKT^{Stock}), the size factor (SMB), the book-to-market factor (HML), the momentum factor (UMD), and the Pastor-Stambaugh stock liquidity factor (LIQ). The bond market factors include the excess bond market returns constructed using the U.S. Barclay Aggregate Bond Index (MKT^{Bond}), the default spread factor (DEF), and the term spread factor (TERM). Newey-West adjusted t-statistics are given in parentheses. Numbers in bold denote statistical significance of the average slope coefficients. The sample period starts from January 1975 to December 2012.

Panel A: Regressions with stock market factors

Dep. Var	α	MKT^{Stock}	SMB	HML	UMD	LIQ	R^2_{adj}
		Model 1: CAPM with excess stock market return					
VOL^F	**0.45**	**0.13**					7.86%
	(4.49)	(3.21)					
$SKEW^F$	**-0.17**	0.00					-0.19%
	(-2.51)	(0.23)					
$KURT^F$	**0.16**	0.03					0.46%
	(2.01)	(0.92)					
VSK	**0.45**	**0.11**					4.74%
	(4.43)	(2.82)					
		Model 2: Fama-French (1993), Carhart (1997), Pastor-Stambaugh (2003)					
VOL^F	**0.47**	**0.14**	0.02	**0.08**	**-0.10**	-3.11	14.74%
	(4.18)	(4.13)	(0.58)	(1.96)	(-2.32)	(-1.19)	
$SKEW^F$	**-0.21**	0.01	0.02	0.04	0.02	1.70	0.72%
	(-2.76)	(0.23)	(0.83)	(1.33)	(1.13)	(0.88)	
$KURT^F$	**0.20**	0.01	**0.07**	0.03	**-0.09**	-0.75	8.65%
	(2.14)	(0.46)	(3.46)	(0.90)	(-2.98)	(-0.48)	
VSK	**0.50**	**0.11**	**0.06**	0.07	**-0.14**	-3.00	14.11%
	(4.00)	(2.56)	(2.14)	(1.42)	(-2.62)	(-1.05)	

Table 10. (Continued)

Panel B: Regressions with bond market factors

Dep. Var	α	MKT^{Bond}	DEF	TERM	R^2_{adj}
		Model 3: CAPM with excess bond market return			
VOL^F	**0.41**	**0.41**			9.27%
	(4.29)	(6.04)			
$SKEW^F$	**-0.19**	0.05			0.10%
	(-3.23)	(0.91)			
$KURT^F$	**0.23**	**-0.19**			3.60%
	(3.02)	(-3.66)			
VSK	**0.48**	**0.14**			0.77%
	(4.45)	(2.43)			
		Model 4: Elton-Gruber-Blake (1995), Bessembinder et al. (2009)			
VOL^F	**0.41**	**0.42**	-1.25	-0.16	9.62%
	(4.42)	(5.56)	(-1.03)	(-0.88)	
$SKEW^F$	**-0.19**	0.05	-0.79	-0.14	0.61%
	(-3.16)	(0.87)	(-0.71)	(-1.32)	
$KURT^F$	**0.23**	**-0.19**	0.96	0.28	4.64%
	(3.11)	(-3.08)	(0.76)	(1.58)	
VSK	**0.48**	**0.15**	-0.07	0.11	0.37%
	(4.57)	(1.92)	(-0.04)	(0.50)	

Panel C: Regressions with stock and bond market factors

Dep. Var	α	MKT^{Stock}	MKT^{Bond}	SMB	HML	UMD	LIQ	DEF	TERM	R^2_{adj}
					Model 5					
VOL^F	**0.42**	**0.12**	**0.30**	0.05	0.08	**-0.12**	-2.39	-0.40	**-0.52**	22.20%
	(3.84)	(2.88)	(3.89)	(1.50)	(1.73)	(-2.60)	(-0.92)	(-0.28)	(-3.21)	
$SKEW^F$	**-0.21**	-0.01	0.06	0.01	0.02	0.03	2.51	-0.85	-0.12	1.59%
	(-2.95)	(-0.51)	(1.04)	(0.32)	(0.73)	(1.31)	(1.32)	(-0.79)	(-1.08)	
$KURT^F$	**0.25**	0.04	**-0.23**	**0.06**	0.04	**-0.09**	-1.19	1.35	0.06	12.71%
	(2.88)	(1.24)	(-3.85)	(2.52)	(1.04)	(-2.76)	(-0.73)	(0.98)	(0.40)	
VSK	**0.50**	**0.11**	**0.08**	0.08	**-0.15**	-2.95	0.80	-0.30	0.05	14.14%
	(4.01)	(2.37)	(2.20)	(1.45)	(-2.69)	(-0.98)	(0.40)	(-1.73)	(0.59)	

Do the Distributional Characteristics of Corporate Bonds Predict Their Future Returns?

Online Appendix

To save space in the paper, we present some of our findings in the Online Appendix. Table A.1 shows the data filtering process for TRACE, Lehman, and NAIC. Table A.2 presents additional summary statistics for corporate bonds in our sample. Tables A.3 and A.4 present results from the quintile portfolios of corporate bonds sorted by VOL for investment-grade and non-investment-grade bonds, respectively. Table A.5 presents results from the quintile portfolios of corporate bonds sorted by VOL controlling for credit rating, maturity, and size. Table A.6 presents results from the quintile portfolios of corporate bonds sorted by SKEW controlling for credit rating, maturity, and size. Table A.7 presents results from the quintile portfolios of corporate bonds sorted by KURT controlling for credit rating, maturity, and size. Table A.8 presents results on the trivariate portfolios of corporate bonds sorted by VOL, SKEW, and KURT. Table A.9 presents results from the Fama-MacBeth regressions of longer term bond returns on VOL, SKEW, and KURT. Table A.10 presents results for the firm-level Fama-MacBeth cross-sectional regressions.

Table A.1: **Corporate Bond Data Filtering Process**

Panel A: TRACE_Enhanced (Jul2002 - Dec2012)

	Bonds	Issuers	Obs
Original (Intraday)			114.2 mil
Cleaning Transactions (remove cancellation, revise correction, reversed trades, and trades with more than 2-day settlement)			
remove locked-in bonds	97,048	6,827	109.2 mil
Converting to Daily Data	88,205	6,814	13.2 mil
Merging with TRACE Master data			
keep only corporate bonds (remove asset-backed, agency-backed, index-linked securities)	27,417	3,935	6.11 mil
removing private bonds	25,757	3,821	6.10 mil
Merging with Mergent FISD Data	21,374	2,453	
keep only corporate bonds	17,520	2,149	
remove private bonds	17,491	2,144	5.27 mil
Further cleaning before calculating bond return			
remove bonds with floating-rate coupon	14,589	2,062	4.88 mil
remove convertible bonds	13,971	1,917	4.63 mil
remove bonds with prices outside [$5,$1000]	13,902	1,866	4.62 mil
Calculate monthly bond return	12,835	1,954	408,466

Panel B: Lehman (Jan1973 - Mar1998)

	Bonds	Issuers	Obs
Original (Monthly)			1.71 mil
Merge with Mergent FISD	32,844	6,781	1,305,739
remove non-us bonds	17,189	3,361	772,956
remove asset-backed, canadian, yankee bonds	17,132	3,338	771,069
keep only corporate bonds	12,899	3,130	617,274
remove bonds with floating coupon	12,361	3,009	600,177
remove convertible bonds	12,358	3,007	600,068
remove private bonds	11,937	2,780	595,227
remove bonds with prices beyond [$5,$1000]	11,937	2,780	594,560
Calculate monthly bond return	11,937	2,780	594,560

Table A.1: **(Continued)**

Panel C: NAIC (Jan1994 - Jul2013)

	Bonds	Issuers	Obs
Original (Daily)			
Merge with Mergent FISD	103,580	10,469	3.78 mil
remove non-US bonds	95,727	8,174	3.38 mil
remove asset-backed, canadian, yankee bonds	94,883	8,080	3.33 mil
keep only corporate bonds	44,452	6,930	2.46 mil
remove bonds with floating coupon	39,871	6,592	2.39 mil
remove convertible bonds	37,418	5,878	2.29 mil
remove private bonds	31,944	5,096	2.06 mil
remove bonds with prices beyond [$5,$1000]	31,853	5,088	2.05 mil
Compress multiple daily transactions	31,853	5,088	1.03 mil
remove bonds with missing information to calculate AI	29,347	5,005	1.00 mil
Calculate monthly bond return	16,485	3,820	166,017

Panel D: Final Sample for Corporate Bond Monthly Returns

			Unique	Unique	Bond-Month	Monthly Average	
Start	End	Data Source	Issuers	Bonds	Obs	Issuers	Bonds
Jan1973	Mar1998	Lehman	2,782	11,939	594,753	630	1968
Apr1998	Jun2002	Bloomberg,NAIC	2,496	8,653	96,318	742	1889
Jul2002	Dec2012	TRACE_Enhance	1,954	12,835	408,466	1074	3242
	Total		4,401	14,796	964,317	895	2777

Table A.2: **Descriptive Statistics**

For each year from 1975 to 2012, Panel A reports the number of unique bonds, the number of unique issuers, the mean, median, standard deviation and monthly return percentiles of corporate bonds in our sample. Panel B reports the time-series average of the cross-sectional statistics on the number of bond-month observations, the cross-sectional mean, median, standard deviation and monthly return percentiles of corporate bonds, as well as bond characteristics including bond price ($), amount outstanding ($ million), credit rating, and time-to-maturity (year). Ratings are in conventional numerical scores, where 1 represents a AAA rating and 21 reflects a C rating. Higher numerical score means lower ratings. Numerical ratings of 10 or below (BBB- or better) are considered investment grade, and ratings of 11 or higher (BB+ or worse) are labeled high yield.

Panel A: Summary statistics by year (1975-2012)

	# of	# of	Bond monthly returns and percentiles (%)								
Year	bonds	issuers	Mean	Median	SD	1st	5th	25th	75th	95th	99th
1975	786	317	1.55	0.75	4.19	-6.85	-3.97	-0.91	3.72	7.59	14.56
1976	385	182	1.77	1.66	3.10	-3.61	-1.38	0.67	2.71	4.93	10.72
1977	716	288	0.20	0.38	2.62	-4.91	-2.75	-0.76	1.20	2.44	4.76
1978	836	335	0.04	0.10	1.74	-4.09	-2.48	-0.93	0.96	2.59	4.15
1979	903	347	-0.29	0.15	3.38	-11.02	-8.53	-1.32	1.87	3.42	5.01
1980	1293	453	-0.25	-0.81	5.90	-10.81	-8.02	-3.98	2.39	13.03	16.56
1981	1405	442	0.21	-0.85	5.31	-8.67	-7.01	-3.46	3.07	11.14	14.07
1982	1568	470	3.02	2.63	3.95	-4.79	-2.99	1.00	5.18	9.24	11.59
1983	1718	490	0.77	0.70	3.29	-6.12	-4.39	-0.88	2.59	5.70	7.75
1984	1867	524	1.36	1.59	6.30	-9.00	-5.09	-1.25	3.39	7.63	10.89
1985	2355	688	1.85	1.63	4.79	-5.87	-3.32	0.00	3.28	8.06	11.70
1986	2974	865	1.68	1.14	9.10	-9.30	-2.70	0.31	2.32	6.97	16.79
1987	3233	941	0.41	0.58	9.68	-13.11	-5.16	-1.02	1.72	5.01	11.95
1988	3298	968	1.05	0.69	9.21	-6.49	-2.17	-0.42	1.90	4.93	8.83
1989	3228	972	0.99	0.92	3.47	-4.74	-1.54	0.11	1.96	3.81	5.43
1990	2376	751	0.47	0.74	4.18	-11.36	-3.40	-0.32	1.66	4.07	7.20
1991	2980	794	1.71	1.26	4.37	-3.93	-0.35	0.72	2.20	5.31	12.00
1992	4070	1139	0.95	0.84	8.62	-5.24	-2.50	-0.02	1.71	3.43	7.49
1993	4315	1283	0.99	0.66	3.08	-3.11	-1.39	0.26	1.60	3.84	5.88
1994	3585	1140	-0.24	-0.08	2.45	-5.63	-3.79	-1.08	0.80	2.79	4.65
1995	3768	1175	1.58	1.39	2.21	-2.58	-0.57	0.77	2.27	4.69	7.27
1996	3888	1239	0.40	0.28	2.37	-4.85	-2.36	-0.62	1.46	3.29	4.75
1997	3903	1233	0.87	0.89	2.06	-3.21	-2.01	0.22	1.59	3.40	6.32
1998	3888	1703	0.38	0.43	2.09	-6.65	-3.03	0.00	1.11	3.03	5.82
1999	2001	697	-0.53	0.05	3.01	-8.41	-5.04	-1.45	0.65	2.20	4.94
2000	2101	708	0.28	0.75	2.76	-7.60	-4.59	-0.34	1.43	3.60	5.68
2001	1919	652	0.42	0.74	2.69	-6.66	-4.17	-0.33	1.50	3.58	6.45
2002	2314	889	0.51	0.68	6.20	-17.22	-7.03	-1.32	2.09	7.60	20.15
2003	1568	696	0.84	0.66	8.31	-13.28	-7.72	-1.99	3.40	8.98	18.11
2004	2029	823	0.35	0.61	4.05	-9.46	-5.45	-1.56	2.28	5.49	10.28
2005	2374	940	-0.26	-0.14	3.65	-10.55	-6.02	-2.05	1.74	4.88	8.88
2006	2846	1067	0.13	0.15	3.36	-8.24	-4.81	-1.48	1.79	4.89	9.02
2007	3485	1208	-0.22	0.05	3.49	-10.22	-5.75	-1.82	1.63	4.59	7.96
2008	4015	1254	-1.14	-0.54	10.18	-33.56	-15.88	-3.93	2.09	11.28	25.42
2009	4914	1425	2.29	1.24	10.81	-24.49	-8.03	-1.11	4.10	16.20	41.41
2010	5827	1668	0.44	0.45	3.58	-8.02	-4.39	-1.11	1.84	5.26	10.19
2011	5699	1613	0.22	0.29	3.44	-9.27	-4.68	-1.03	1.61	4.87	8.95
2012	5105	1636	0.47	0.34	3.32	-6.86	-3.65	-0.67	1.51	4.80	9.32

Table A.2: **(Continued)**

Panel B: Cross-sectional statistics (Overall sample period: 1975-2012)

					Percentiles					
	N	Mean	Median	SD	1st	5th	25th	75th	95th	99th
Investment Grade Bonds										
Return (%)	964,271	0.62	0.61	3.61	-7.21	-3.06	-0.45	1.64	4.14	8.81
Price ($)	964,317	93.95	94.52	12.59	51.53	73.79	88.75	101.21	110.76	118.17
Size ($mil)	962,925	231	173	230	28	39	101	280	625	1166
Rating	959,713	7.54	6.76	3.98	1.55	2.43	4.93	9.11	15.62	19.64
TTM (yr)	964,317	15.64	13.26	15.04	5.23	6.17	9.41	20.04	29.11	38.45
Investment Grade Bonds										
Return (%)	761,724	0.56	0.60	2.18	-4.87	-2.51	-0.36	1.51	3.47	6.03
Price ($)	761,728	95.28	95.05	10.89	63.24	79.25	89.79	101.68	111.20	118.14
Size ($mil)	760,378	235	175	232	30	42	94	290	648	1187
Rating	757,124	6.02	6.01	2.23	1.49	2.25	4.59	7.60	9.66	9.88
TTM (yr)	761,728	16.21	13.79	15.97	5.63	6.28	9.48	21.31	29.32	38.28
High Yield Bonds										
Return (%)	202,547	0.86	0.79	6.46	-14.48	-5.96	-0.94	2.47	7.40	18.22
Price ($)	202,589	87.03	89.98	16.39	35.25	57.79	79.56	97.14	106.13	113.33
Size ($mil)	202,547	213	159	205	30	50	105	250	550	1082
Rating	202,589	14.62	14.36	2.85	11.03	11.07	12.39	16.17	20.08	21.54
TTM (yr)	202,589	13.32	11.56	7.55	5.07	6.03	9.08	15.11	27.99	36.71

Table A.3: **Univariate Portfolios of Corporate Bonds Sorted by Volatility (VOL) for Investment-Grade Bonds**

Quintile portfolios are formed every month from January 1975 to December 2012 by sorting corporate bonds based on their 60-month rolling total variance (VOL), within investment-grade bonds. Quintile 1 is the portfolio with the lowest volatility, and Quintile 5 is the portfolio with the highest volatility. Table also reports the average volatility, the next-month average excess return, the 5- and 7-factor alpha for each quintile. The last three columns report average portfolio characteristics including bond rating, time-to-maturity (years), and amount outstanding (size, in billions of dollars) for each quintile. The last row shows the differences in monthly average returns, the differences in alphas with respect to the 5- and 7-factor models. The 5-factor model includes the excess market return (MKT), a size factor (SMB), a book-to-market factor (HML), a momentum factor (MOM), and a liquidity factor (LIQ). The 7-factor model includes the five factors plus two bond market factors: the default spread factor (DEF) and the term spread factor (TERM), or the credit risk factor (CredSpr) and the long-term interest rate factor (10Yr). Average excess returns and alphas are defined in monthly percentage terms. Newey-West adjusted t-statistics are given in parentheses. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

Quintiles	Average volatility	Average excess return	5-factor alpha	7-factor alpha with DEF and TERM	7-factor alpha with CredSpr and 10Yr	Average Portfolio Characteristics		
						Rating	Maturity	Size
Low VOL	2.107	0.031	-0.063	-0.067	-0.067	5.888	9.837	0.272
		(0.33)	(-0.71)	(-0.70)	(-1.20)			
2	2.677	0.124	0.015	0.010	0.008	5.902	12.450	0.242
		(1.15)	(0.14)	(0.09)	(0.14)			
3	3.092	0.139	0.004	-0.002	-0.002	5.862	15.250	0.242
		(1.16)	(0.03)	(-0.01)	(-0.04)			
4	3.561	0.204	0.048	0.042	0.040	5.888	17.980	0.233
		(1.56)	(0.39)	(0.33)	(0.62)			
High VOL	5.253	0.439	0.295	0.289	0.287	6.472	20.240	0.229
		(2.77)	(1.89)	(1.75)	(2.54)			
High − Low Return/Alpha diff.		0.408***	0.358***	0.356***	0.354***			
		(4.06)	(3.30)	(3.28)	(3.47)			

Table A.4: **Univariate Portfolios of Corporate Bonds Sorted by Volatility (VOL) for Non-Investment-Grade Bonds**

Quintile portfolios are formed every month from January 1975 to December 2012 by sorting corporate bonds based on their 60-month rolling total variance (VOL), within non-investment-grade bonds. Quintile 1 is the portfolio with the lowest volatility, and Quintile 5 is the portfolio with the highest volatility. Table also reports the average volatility, the next-month average excess return, the 5- and 7-factor alpha for each quintile. The last three columns report average portfolio characteristics including bond rating, time-to-maturity (years), and amount outstanding (size, in billions of dollars) for each quintile. The last row shows the differences in monthly average returns, the differences in alphas with respect to the 5- and 7-factor models. The 5-factor model includes the excess market return (MKT), a size factor (SMB), a book-to-market factor (HML), a momentum factor (MOM), and a liquidity factor (LIQ). The 7-factor model includes the five factors plus two bond market factors: the default spread factor (DEF) and the term spread factor (TERM), or the credit risk factor (CredSpr) and the long-term interest rate factor (10Yr). Average excess returns and alphas are defined in monthly percentage terms. Newey-West adjusted t-statistics are given in parentheses. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

Quintiles	Average volatility	Average excess return	5-factor alpha	7-factor alpha with DEF and TERM	7-factor alpha with CredSpr and 10Yr	Average Portfolio Characteristics		
						Rating	Maturity	Size
Low VOL	2.526	0.086	-0.021	-0.023	-0.006	13.359	9.164	0.204
		(0.75)	(-0.19)	(-0.21)	(-0.07)			
2	3.480	0.191	0.028	0.028	0.039	13.560	13.338	0.222
		(1.48)	(0.23)	(0.23)	(0.43)			
3	4.476	0.396	0.225	0.223	0.239	13.894	14.108	0.213
		(2.26)	(1.29)	(1.27)	(1.53)			
4	5.968	0.378	0.133	0.142	0.147	14.757	13.730	0.225
		(1.61)	(0.66)	(0.77)	(0.81)			
High VOL	10.222	1.210	1.038	1.043	1.042	16.286	12.953	0.211
		(3.29)	(3.24)	(3.32)	(3.32)			
High − Low		1.124***	1.059***	1.066***	1.048***			
Return/Alpha diff.		(3.73)	(3.96)	(4.11)	(3.94)			

Table A.5: **Quintile Portfolios of Corporate Bonds Sorted by VOL Controlling for Credit Rating, Maturity, and Size**

Quintile portfolios are formed every month from January 1975 to December 2012 by first sorting corporate bonds based on credit rating (Panel A), maturity (Panel B) or size (Panel C). Then, within each quintile portfolio, corporate bonds are sorted into sub-quintiles based on their 60-month rolling total variance (VOL). "Quintile VOL,1" is the portfolio of corporate bonds with the lowest VOL within each quintile portfolio and "Quintile VOL, 5" is the portfolio of corporate bonds with the highest VOL within each quintile portfolio. Table shows the 5- and 7-factor alpha for each quintile. The last row shows the differences in alphas with respect to the 5- and 7-factor models. The 5-factor model (**M1**) includes the excess market return (MKT), a size factor (SMB), a book-to-market factor (HML), a momentum factor (MOM), and a liquidity factor (LIQ). The 7 factor model (**M2**) includes the default spread factor (DEF) and the term spread factor (TERM) in addition to the 5-factor. The 7-factor model (**M3**) includes the credit risk factor (CredSpr) and the long-term interest rate factor (10Yr) in addition to the 5-factor. Average excess returns and alphas are defined in monthly percentage terms. Newey-West adjusted t-statistics are given in parentheses. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

Panel A: Quintile portfolios of corporate bonds sorted by VOL controlling for credit rating

	All Bonds			Investment Grade			High Yield		
	M1	M2	M3	M1	M2	M3	M1	M2	M3
VOL,1	-0.040	-0.043	-0.039	-0.048	-0.052	-0.048	-0.018	-0.023	0.011
	(-0.43)	(-0.43)	(-0.63)	(-0.52)	(-0.52)	(-0.83)	(-0.15)	(-0.18)	(0.11)
VOL,2	0.011	0.007	0.005	0.016	0.010	0.008	0.112	0.113	0.116
	(0.11)	(0.06)	(0.08)	(0.15)	(0.09)	(0.13)	(0.77)	(0.80)	(0.93)
VOL,3	0.052	0.048	0.048	0.014	0.009	0.009	0.181	0.182	0.198
	(0.43)	(0.37)	(0.62)	(0.12)	(0.08)	(0.15)	(1.03)	(1.06)	(1.29)
VOL,4	0.090	0.085	0.082	(0.55)	(0.48)	(0.89)	0.379	0.380	0.381
	(0.67)	(0.59)	(0.83)	(0.55)	(0.48)	(0.89)	(2.05)	(2.10)	(2.19)
VOL,5	0.293	0.288	0.291	0.154	0.148	0.150	0.683	0.691	0.705
	(1.94)	(1.77)	(2.32)	(1.08)	(0.98)	(1.59)	(2.65)	(2.71)	(2.89)
VOL,5 − VOL,1	0.333***	0.331***	0.330***	0.202**	0.200**	0.198**	0.701***	0.714***	0.694***
Return/Alpha diff.	(3.41)	(3.33)	(3.39)	(2.31)	(2.30)	(2.49)	(3.92)	(4.14)	(3.96)

Panel B: Quintile portfolios of corporate bonds sorted by VOL controlling for maturity

	All Bonds			Short Maturity Bonds			Medium Maturity Bonds			Long Maturity Bonds		
	M1	M2	M3	M1	M2	M3	M1	M2	M3	M1	M2	M3
VOL,1	-0.016	-0.023	-0.007	0.040	0.072	-0.003	0.059	0.088	-0.011	0.015	0.001	-0.005
	(-0.16)	(-0.22)	(-0.13)	(0.63)	(1.24)	(-0.05)	(0.64)	(1.01)	(-0.18)	(0.12)	(0.01)	(-0.08)
VOL,2	-0.005	-0.010	-0.013	0.008	0.028	-0.031	-0.011	-0.010	-0.036	0.025	0.019	0.016
	(-0.04)	(-0.09)	(-0.22)	(0.08)	(0.30)	(-0.35)	(-0.11)	(-0.09)	(-0.57)	(0.20)	(0.15)	(0.25)
VOL,3	0.012	0.008	0.012	-0.351	-0.336	-0.387	0.150	0.147	0.118	-0.007	-0.011	0.001
	(0.11)	(0.06)	(0.19)	(-1.24)	(-1.19)	(-1.40)	(1.22)	(1.17)	(1.29)	(-0.06)	(-0.09)	(0.01)
VOL,4	0.068	0.063	0.061	-0.145	-0.121	-0.184	0.035	0.037	0.011	0.049	0.043	0.039
	(0.55)	(0.47)	(0.73)	(-0.67)	(-0.56)	(-0.88)	(0.27)	(0.27)	(0.11)	(0.37)	(0.31)	(0.50)
VOL,5	0.333	0.328	0.342	0.417	0.457	0.385	0.395	0.440	0.349	0.399	0.391	0.397
	(1.79)	(1.70)	(1.99)	(1.61)	(2.02)	(1.58)	(1.76)	(2.04)	(1.62)	(2.23)	(2.09)	(2.54)
VOL,5 − VOL,1	0.349**	0.351**	0.349**	0.377*	0.385**	0.388*	0.336*	0.352**	0.360*	0.384***	0.390***	0.402***
Return/Alpha diff.	(2.38)	(2.52)	(2.41)	(1.71)	(1.97)	(1.86)	(1.86)	(1.97)	(1.95)	(3.24)	(3.41)	(3.27)

Panel C: Quintile portfolios of corporate bonds sorted by VOL controlling for size

	All Bonds			Small Bonds			Large Bonds		
	M1	M2	M3	M1	M2	M3	M1	M2	M3
VOL,1	-0.067	-0.074	-0.059	-0.057	-0.064	-0.046	-0.064	-0.073	-0.055
	(-0.81)	(-0.88)	(-1.12)	(-0.66)	(-0.76)	(-0.78)	(-0.69)	(-0.79)	(-0.98)
VOL,2	0.022	0.017	0.015	0.004	-0.001	0.001	0.006	-0.004	0.007
	(0.23)	(0.18)	(0.26)	(0.04)	(-0.02)	(0.01)	(0.06)	(-0.04)	(0.12)
VOL,3	0.041	0.037	0.041	0.036	0.031	0.024	0.023	0.014	0.018
	(0.38)	(0.35)	(0.67)	(0.32)	(0.29)	(0.33)	(0.20)	(0.13)	(0.27)
VOL,4	0.077	0.071	0.069	0.030	0.025	0.028	0.053	0.043	0.055
	(0.66)	(0.62)	(0.89)	(0.21)	(0.18)	(0.24)	(0.43)	(0.36)	(0.73)
VOL,5	0.327	0.321	0.337	0.462	0.452	0.476	0.180	0.172	0.191
	(2.09)	(2.07)	(2.36)	(1.92)	(1.89)	(2.02)	(1.24)	(1.21)	(1.55)
VOL,5 − VOL,1	0.395***	0.395***	0.396***	0.519**	0.516**	0.522**	0.244**	0.245**	0.245**
Return/Alpha diff.	(3.23)	(3.27)	(3.23)	(2.46)	(2.47)	(2.46)	(2.38)	(2.43)	(2.38)

Table A.6: **Quintile Portfolios Sorted by SKEW Controlling for Credit Rating, Maturity, and Size**

Quintile portfolios are formed every month from January 1975 to December 2012 by first sorting corporate bonds based on credit rating (Panel A), maturity (Panel B) or size (Panel C). Then, within each quintile portfolio, corporate bonds are sorted into sub-quintiles based on their 60-month rolling total skewness ($SKEW$). "Quintile SKEW,1" is the portfolio of corporate bonds with the lowest $SKEW$ within each quintile portfolio and "Quintile SKEW, 5" is the portfolio of corporate bonds with the highest $SKEW$ within each quintile portfolio. Table shows the 5- and 7-factor alpha for each quintile. The last row shows the differences in alphas with respect to the 5- and 7-factor models. The 5-factor model (**M1**) includes the excess market return (MKT), a size factor (SMB), a book-to-market factor (HML), a momentum factor (MOM), and a liquidity factor (LIQ). The 7 factor model (**M2**) includes the default spread factor (DEF) and the term spread factor (TERM) in addition to the 5-factor. The 7-factor model (**M3**) includes the credit risk factor (CredSpr) and the long-term interest rate factor (10Yr) in addition to the 5-factor. Average excess returns and alphas are defined in monthly percentage terms. Newey-West adjusted t-statistics are given in parentheses. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

Panel A: Quintile portfolios of corporate bonds sorted by SKEW controlling for credit rating

	All Bonds			Investment Grade			High Yield		
	M1	M2	M3	M1	M2	M3	M1	M2	M3
SKEW,1	0.260	0.256	0.260	0.162	0.157	0.160	0.576	0.575	0.608
	(2.22)	(2.21)	(2.56)	(1.42)	(1.43)	(1.85)	(3.18)	(3.15)	(3.46)
SKEW,2	0.053	0.048	0.046	0.045	0.038	0.035	0.236	0.237	0.239
	(0.50)	(0.46)	(0.65)	(0.42)	(0.37)	(0.59)	(1.55)	(1.57)	(1.63)
SKEW,3	0.046	0.042	0.042	0.003	-0.002	-0.003	0.277	0.278	0.292
	(0.42)	(0.39)	(0.62)	(0.03)	(-0.02)	(-0.05)	(1.91)	(1.93)	(2.23)
SKEW,4	0.029	0.024	0.021	0.050	0.043	0.039	0.186	0.190	0.192
	(0.26)	(0.22)	(0.30)	(0.44)	(0.39)	(0.64)	(1.30)	(1.35)	(1.48)
SKEW,5	0.024	0.020	0.024	-0.043	-0.048	-0.045	0.074	0.072	0.093
	(0.22)	(0.19)	(0.31)	(-0.42)	(-0.48)	(-0.78)	(0.43)	(0.41)	(0.56)
SKEW,5 − SKEW,1	-0.236***	-0.235***	-0.235***	-0.206***	-0.205***	-0.205***	-0.502***	-0.503***	-0.515***
Return/Alpha diff.	(-3.07)	(-3.15)	(-3.12)	(-2.90)	(-2.98)	(-2.95)	(-3.03)	(-2.99)	(-3.04)

Panel B: Quintile portfolios of corporate bonds sorted by SKEW controlling for maturity

	All Bonds			Short Maturity Bonds			Medium Maturity Bonds			Long Maturity Bonds		
	M1	M2	M3	M1	M2	M3	M1	M2	M3	M1	M2	M3
SKEW,1	0.256	0.249	0.265	0.287	0.323	0.255	0.386	0.418	0.323	0.341	0.326	0.320
	(2.12)	(2.08)	(2.54)	(1.86)	(2.09)	(1.67)	(2.57)	(2.89)	(2.23)	(2.62)	(2.57)	(3.13)
SKEW,2	0.041	0.036	0.034	-0.074	-0.043	-0.118	0.052	0.054	0.032	0.047	0.041	0.039
	(0.39)	(0.34)	(0.47)	(-0.52)	(-0.31)	(-0.88)	(0.48)	(0.51)	(0.36)	(0.39)	(0.36)	(0.51)
SKEW,3	-0.010	-0.015	-0.011	-0.335	-0.319	-0.373	0.083	0.080	0.049	-0.007	-0.010	0.002
	(-0.10)	(-0.14)	(-0.16)	(-1.87)	(-1.81)	(-2.12)	(0.69)	(0.67)	(0.50)	(-0.06)	(-0.09)	(0.03)
SKEW,4	0.036	0.030	0.027	-0.079	-0.059	-0.113	0.003	0.008	-0.021	0.044	0.038	0.034
	(0.33)	(0.29)	(0.43)	(-0.59)	(-0.43)	(-0.87)	(0.04)	(0.08)	(-0.29)	(0.35)	(0.32)	(0.48)
SKEW,5	0.070	0.064	0.079	0.160	0.190	0.121	0.142	0.188	0.084	0.070	0.061	0.067
	(0.64)	(0.60)	(0.97)	(1.50)	(1.83)	(1.17)	(1.20)	(1.74)	(0.81)	(0.57)	(0.51)	(0.77)
SKEW,5 − SKEW,1	-0.186**	-0.185**	-0.185**	-0.127	-0.133	-0.134	-0.244*	-0.23*	-0.239*	-0.271***	-0.265***	-0.253***
Return/Alpha diff.	(-2.50)	(-2.55)	(-2.51)	(-0.86)	(-0.86)	(-0.96)	(-1.75)	(-1.79)	(-1.76)	(-2.75)	(-2.81)	(-2.77)

Panel C: Quintile portfolios of corporate bonds sorted by SKEW controlling for size

	All Bonds			Small Bonds			Large Bonds		
	M1	M2	M3	M1	M2	M3	M1	M2	M3
SKEW,1	0.285	0.278	0.293	0.321	0.312	0.334	0.193	0.187	0.203
	(2.35)	(2.31)	(2.76)	(2.11)	(2.09)	(2.37)	(1.64)	(1.58)	(2.01)
SKEW,2	0.010	0.005	0.004	-0.015	-0.019	-0.015	-0.010	-0.019	-0.009
	(0.10)	(0.05)	(0.05)	(-0.13)	(-0.16)	(-0.16)	(-0.09)	(-0.18)	(-0.12)
SKEW,3	0.028	0.023	0.027	0.020	0.015	0.019	-0.003	-0.011	-0.008
	(0.25)	(0.22)	(0.41)	(0.17)	(0.13)	(0.24)	(-0.03)	(-0.10)	(-0.11)
SKEW,4	0.029	0.024	0.021	0.002	-0.003	0.000	-0.005	-0.015	-0.004
	(0.28)	(0.23)	(0.33)	(0.02)	(-0.03)	(0.00)	(-0.05)	(-0.13)	(-0.06)
SKEW,5	0.077	0.071	0.087	0.071	0.064	0.085	0.033	0.026	0.044
	(0.70)	(0.66)	(1.10)	(0.56)	(0.51)	(0.81)	(0.30)	(0.24)	(0.60)
SKEW,5 − SKEW,1	-0.208***	-0.207***	-0.207***	-0.250***	-0.248***	-0.249**	-0.160**	-0.160**	-0.159**
Return/Alpha diff.	(-2.64)	(-2.69)	(-2.67)	(-2.59)	(-2.64)	(-2.58)	(-2.07)	(-2.11)	(-2.13)

Table A.7: **Quintile Portfolios Sorted by KURT Controlling for Credit Rating, Maturity, and Size**

Quintile portfolios are formed every month from January 1975 to December 2012 by first sorting corporate bonds based on credit rating (Panel A), maturity (Panel B) or size (Panel C). Then, within each quintile portfolio, corporate bonds are sorted into sub-quintiles based on their 60-month rolling kurtosis ($KURT$). "Quintile KURT,1" is the portfolio of corporate bonds with the lowest $KURT$ within each quintile portfolio and "Quintile KURT, 5" is the portfolio of corporate bonds with the highest $KURT$ within each quintile portfolio. Table shows the 5- and 7-factor alpha for each quintile. The last row shows the differences in alphas with respect to the 5- and 7-factor models. The 5-factor model (**M1**) includes the excess market return (MKT), a size factor (SMB), a book-to-market factor (HML), a momentum factor (MOM), and a liquidity factor (LIQ). The 7 factor model (**M2**) includes the default spread factor (DEF) and the term spread factor (TERM) in addition to the 5-factor. The 7-factor model (**M3**) includes the credit risk factor (CredSpr) and the long-term interest rate factor (10Yr) in addition to the 5-factor. Alphas are defined in monthly percentage terms. Newey-West adjusted t-statistics are given in parentheses. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

Panel A: Quintile portfolios of corporate bonds sorted by KURT controlling for credit rating

	All Bonds			Investment Grade			High Yield		
	M1	M2	M3	M1	M2	M3	M1	M2	M3
KURT, 1	0.008	0.003	0.008	0.020	0.015	0.019	0.044	0.039	0.075
	(0.07)	(0.03)	(0.11)	(0.18)	(0.14)	(0.31)	(0.35)	(0.31)	(0.67)
KURT, 2	0.022	0.017	0.014	0.017	0.011	0.007	0.113	0.116	0.116
	(0.21)	(0.16)	(0.22)	(0.15)	(0.10)	(0.12)	(0.80)	(0.84)	(0.91)
KURT, 3	0.056	0.052	0.052	-0.001	-0.006	-0.007	0.301	0.302	0.316
	(0.52)	(0.49)	(0.71)	(-0.01)	(-0.06)	(-0.12)	(1.97)	(2.00)	(2.22)
KURT, 4	0.093	0.088	0.086	0.063	0.057	0.053	0.423	0.426	0.429
	(0.86)	(0.83)	(1.07)	(0.58)	(0.54)	(0.81)	(2.46)	(2.48)	(2.58)
KURT, 5	0.227	0.223	0.227	0.111	0.105	0.108	0.481	0.480	0.504
	(1.95)	(1.95)	(2.30)	(1.03)	(1.03)	(1.40)	(2.52)	(2.53)	(2.72)
KURT, 5 − KURT,1	0.220***	0.220***	0.219***	0.091	0.090	0.089	0.437***	0.441***	0.429***
Return/Alpha diff.	(2.70)	(2.74)	(2.84)	(1.32)	(1.38)	(1.40)	(2.66)	(2.69)	(2.66)

Panel B: Quintile portfolios of corporate bonds sorted by KURT controlling for maturity

	All Bonds			Short Maturity Bonds			Medium Maturity Bonds			Long Maturity Bonds		
	M1	M2	M3	M1	M2	M3	M1	M2	M3	M1	M2	M3
KURT, 1	0.002	-0.005	0.013	0.064	0.104	0.016	0.050	0.080	-0.035	0.084	0.069	0.061
	(0.02)	(-0.05)	(0.22)	(0.94)	(1.85)	(0.28)	(0.50)	(0.90)	(-0.52)	(0.67)	(0.56)	(0.89)
KURT, 2	-0.005	-0.010	-0.012	-0.132	-0.111	-0.166	0.009	0.015	-0.013	-0.008	-0.013	-0.016
	(-0.04)	(-0.09)	(-0.19)	(-0.96)	(-0.80)	(-1.26)	(0.09)	(0.16)	(-0.17)	(-0.06)	(-0.11)	(-0.22)
KURT, 3	0.032	0.028	0.032	-0.288	-0.271	-0.325	0.130	0.128	0.097	0.010	0.007	0.018
	(0.29)	(0.26)	(0.44)	(-1.58)	(-1.51)	(-1.81)	(1.07)	(1.06)	(0.96)	(0.08)	(0.06)	(0.22)
KURT, 4	0.089	0.083	0.081	-0.043	-0.017	-0.080	0.077	0.078	0.056	0.050	0.044	0.041
	(0.80)	(0.76)	(0.97)	(-0.26)	(-0.10)	(-0.49)	(0.66)	(0.68)	(0.56)	(0.43)	(0.39)	(0.54)
KURT, 5	0.288	0.282	0.297	0.379	0.413	0.346	0.343	0.391	0.295	0.364	0.354	0.361
	(2.29)	(2.26)	(2.67)	(2.52)	(2.78)	(2.36)	(2.27)	(2.71)	(1.98)	(2.80)	(2.82)	(3.38)
KURT, 5 − KURT,1	0.286***	0.287***	0.284***	0.315**	0.308**	0.330***	0.293***	0.311***	0.330***	0.280***	0.285***	0.300***
Return/Alpha diff.	(3.04)	(3.06)	(3.18)	(2.38)	(2.35)	(2.60)	(2.64)	(2.70)	(2.93)	(2.91)	(2.98)	(3.12)

Panel C: Quintile portfolios of corporate bonds sorted by KURT controlling for size

	All Bonds			Small Bonds			Large Bonds		
	M1	M2	M3	M1	M2	M3	M1	M2	M3
KURT, 1	-0.023	-0.031	-0.013	-0.030	-0.038	-0.009	-0.022	-0.033	-0.012
	(-0.21)	(-0.29)	(-0.21)	(-0.27)	(-0.35)	(-0.14)	(-0.19)	(-0.29)	(-0.18)
KURT, 2	0.024	0.018	0.015	0.008	0.003	0.006	0.008	-0.002	0.009
	(0.22)	(0.17)	(0.24)	(0.07)	(0.03)	(0.08)	(0.07)	(-0.02)	(0.13)
KURT, 3	0.047	0.043	0.047	0.131	0.126	0.120	0.014	0.006	0.009
	(0.44)	(0.41)	(0.67)	(1.08)	(1.07)	(1.27)	(0.12)	(0.05)	(0.13)
KURT, 4	0.083	0.078	0.076	0.053	0.049	0.053	0.025	0.016	0.027
	(0.75)	(0.72)	(0.91)	(0.39)	(0.36)	(0.43)	(0.22)	(0.15)	(0.34)
KURT, 5	0.283	0.277	0.292	0.280	0.271	0.289	0.206	0.198	0.217
	(2.36)	(2.32)	(2.76)	(1.54)	(1.52)	(1.66)	(1.77)	(1.71)	(2.31)
KURT, 5 − KURT,1	0.306***	0.308***	0.305***	0.310**	0.309**	0.298**	0.229***	0.231***	0.228***
Return/Alpha diff.	(3.37)	(3.40)	(3.59)	(2.28)	(2.31)	(2.34)	(2.93)	(2.97)	(3.08)

Table A.8: **Trivariate Portfolios of Corporate Bonds Sorted by VOL, SKEW, and KURT**

Every month from January 1975 to December 2012, all corporate bonds in the sample are grouped into 27 portfolios based on trivariate dependent sorts of volatility (VOL), skewness ($SKEW$), and kurtosis ($KURT$). All bonds in the sample are first sorted into three portfolios based on their 60-month rolling total variance (VOL). Then, within each volatility portfolio, corporate bonds are sorted into three portfolios based on their 60-month rolling skewness ($SKEW$). Finally, all bonds in each of the nine resulting portfolios are sorted into three portfolios based on their 60-month rolling kurtosis ($KURT$). "KURT,1" is the portfolio of corporate bonds with the lowest $KURT$ within each VOL and SKEW portfolio and "KURT, 3" is the portfolio of corporate bonds with the highest $KURT$ within each VOL and SKEW portfolio. Table also reports the average $KURT$ within each VOL and SKEW portfolio, the next-month average excess return, the 5- and 7-factor alpha for each quintile. The last three columns report average portfolio characteristics including bond rating, time-to-maturity (years), and amount outstanding (size, in billions of dollars) for each quintile. The last row shows the differences in monthly average returns, the differences in alphas with respect to the 5- and 7-factor models. The 5-factor model includes the excess market return (MKT), a size factor (SMB), a book-to-market factor (HML), a momentum factor (MOM), and a liquidity factor (LIQ). The 7-factor model includes the five factors plus two bond market factors: the default spread factor (DEF) and the term spread factor (TERM), or the credit risk factor (CredSpr) and the long-term interest rate factor (10Yr). Average excess returns and alphas are defined in monthly percentage terms. Newey-West adjusted t-statistics are given in parentheses. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

$KURT$ Terciles after controlling for VOL and $SKEW$	Average excess return	5-factor alpha	7-factor alpha with DEF and TERM	7-factor alpha with CredSpr and and 10Yr	Average Portfolio Characteristics			
					Kurtosis	Rating	Maturity	Size
KURT,1	0.161	0.029	0.021	0.025	0.429	6.905	15.884	0.249
	(1.15)	(0.24)	(0.15)	(0.31)				
KURT,2	0.219	0.068	0.064	0.065	1.559	7.173	14.801	0.235
	(1.54)	(0.54)	(0.46)	(0.75)				
KURT,3	0.291	0.174	0.167	0.168	4.307	8.140	13.061	0.235
	(2.01)	(1.33)	(1.15)	(1.66)				
KURT,3 − KURT,1	0.129	0.149	0.147	0.143				
Return/Alpha diff.	(1.33)	(1.48)	(1.50)	(1.50)				

Table A.9: **Fama-MacBeth Regressions of Longer Term Bond Returns on VOL, SKEW, and KURT**

This table reports the average intercept and slope coefficients from the Fama and MacBeth (1973) cross-sectional regressions of longer term corporate bond excess returns on the corporate bonds total variance (VOL), skewness (SKEW), and kurtosis (KURT), with and without the control variables. The control variables are credit rating, time-to-maturity (years), amount outstanding (size, in billions of dollars), and past month excess return. Ratings are in conventional numerical scores, where 1 represents a AAA rating and 21 reflects a C rating. Higher numerical score means lower ratings. The Fama and MacBeth cross-sectional regressions are run each month for the period January 1975 to December 2012. Average slope coefficients are reported in separate columns for each variable. Each row represents a cross-sectional regression. Newey-West (1987) t-statistics are reported in parentheses to determine the statistical significance of the average intercept and slope coefficients. The last column reports the average adjusted R^2 values. Numbers in bold denote statistical significance of the average slope coefficients.

Intercept	VOL	SKEW	KURT	Rating	Maturity	Size	Lagged Return	Adj. R^2
				Panel A: Dependent variable=R_{t+2}				
-0.031	**0.013**	**-0.141**	-0.004	0.011	-0.001	-0.203	**-0.033**	0.143
(-0.25)	(2.63)	(-2.29)	(-0.28)	(1.05)	(-0.25)	(-0.90)	(-1.88)	
				Panel B: Dependent variable=R_{t+3}				
-0.124	**0.080**	**-0.141**	0.030	0.001	-0.003	0.700	0.007	0.140
(-1.02)	(2.58)	(-1.99)	(1.19)	(0.06)	(-0.53)	(1.17)	(0.22)	
				Panel C: Dependent variable=R_{t+4}				
-0.060	**0.011**	0.055	-0.027	0.010	0.011	-1.276	**-0.052**	0.132
(-0.52)	(2.34)	(0.50)	(-1.07)	(0.87)	(1.35)	(-1.04)	(-1.84)	
				Panel D: Dependent variable=R_{t+5}				
-0.115	**0.008**	-0.060	-0.018	0.024	**0.004**	-0.091	**0.057**	0.155
(-0.90)	(1.71)	(-1.51)	(-0.74)	(1.56)	(1.73)	(-0.51)	(2.60)	
				Panel E: Dependent variable=R_{t+6}				
-0.203	0.005	-0.073	0.010	0.019	0.001	0.867	-0.008	0.127
(-1.64)	(1.00)	(-1.42)	(0.82)	(1.58)	(0.18)	(1.27)	(-0.50)	

Table A.10: **Firm-Level Fama-MacBeth Cross-Sectional Regressions**

This table reports the average intercept and slope coefficients from the firm-level Fama and MacBeth (1973) cross-sectional regressions of one-month-ahead corporate bond excess returns on the corporate bonds total variance (VOL), skewness (SKEW), and kurtosis (KURT) with and without the control variables (Panel A); and on three VaR measures, with and without the control variables (Panel B). The control variables are credit rating, time-to-maturity (years), amount outstanding (size, in billions of dollars), and past month excess return. Ratings are in conventional numerical scores, where 1 represents a AAA rating and 21 reflects a C rating. Higher numerical score means lower ratings. The Fama and MacBeth cross-sectional regressions are run each month for the median-size bond issued by the same firm from the period January 1975 to December 2012. Average slope coefficients are reported in separate columns for each variable. Each row represents a cross-sectional regression. Newey-West (1987) t-statistics are reported in parentheses to determine the statistical significance of the average intercept and slope coefficients. The last column reports the average adjusted R^2 values. Numbers in bold denote statistical significance of the average slope coefficients.

	Intercept	VOL	SKEW	KURT	Rating	Maturity	Size	Lagged Return	Adj. R^2
(1)	-0.009	**0.015**							0.050
	(-0.08)	(3.14)							
(2)	0.237		-0.055						0.012
	(1.83)		(-1.27)						
(3)	0.084			**0.062**					0.020
	(0.71)			(3.78)					
(4)	-0.057	**0.014**			0.007	0.002	0.244	**-0.118**	0.141
	(-0.35)	(2.15)			(0.53)	(0.23)	(0.39)	(-3.60)	
(5)	-0.039	**0.017**	**-0.225**						0.064
	(-0.35)	(3.37)	(-4.36)						
(6)	-0.032	**0.020**	**-0.192**		0.002	-0.002	0.955	**-0.125**	0.142
	(-0.20)	(2.60)	(-3.82)		(0.18)	(-0.20)	(1.17)	(-4.98)	
(7)	-0.053	**0.021**	**-0.207**	-0.007					0.071
	(-0.47)	(3.26)	(-3.59)	(-0.40)					
(8)	-0.131	**0.019**	**-0.177**	-0.002	0.010	0.005	-0.103	**-0.146**	0.150
	(-1.00)	(2.87)	(-3.82)	(-1.04)	(0.80)	(1.32)	(-0.47)	(-9.43)	