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

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Abstract

This paper investigates the significance of volatility, skewness, kurtosis, and downside risk in predicting the cross-sectional variation in future returns on corporate bonds. 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. Bonds in the highest volatility quintile generate 6% to 7% more annual raw and risk-adjusted returns compared to bonds in the lowest volatility quintile. After volatility is controlled for, bonds with low skewness generate 2.5% to 3% more annual raw and risk-adjusted returns compared to bonds with high skewness. The cross-sectional relation between downside risk and bond returns is even stronger than for volatility and skewness. These findings remain intact after controlling for transaction costs, liquidity and a large set of bond characteristics and risk factors. Hence, the distributional characteristics of corporate bonds are powerful determinants of the cross-sectional differences in future returns.

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1 Introduction

The mean-variance portfolio theory developed by Markowitz (1952) critically relies on two assumptions: Either investors have quadratic utility or asset returns are jointly normally distributed. If an investor has a quadratic preference, she cares only about the mean and variance of returns, and the skewness and kurtosis of returns have no effect on expected utility. A mean-variance framework can be justified if the asset returns are jointly normally distributed, since the mean and variance sufficiently describe the distribution. However, the empirical distribution of asset returns is typically skewed, peaked around the mode, and has fat-tails, implying that extreme returns occur much more frequently than predicted by the normal distribution. Therefore, the traditional measures of market risk (e.g., volatility) may not be sufficient to approximate the true risk faced by individual firms, especially during extraordinary periods (e.g., market downturns, economic recessions).

Although the mean-variance criterion has been the basis for a large body of research and has had significant impact on the academic and non-academic financial communities, it has been subject to theoretical and empirical criticism. Arditti (1967), Kraus and Litzenberger (1976), and Kane (1982) extend the mean-variance portfolio theory of Markowitz (1952) to incorporate the effect of skewness on valuation. They present a three-moment asset pricing model in which investors hold concave preferences and like positive skewness. Their results indicate that assets that decrease a portfolio's skewness (i.e., that make the portfolio returns more left-skewed) are less desirable and should command higher expected returns. Similarly, Harvey and Siddique (2000) propose an asset pricing model with conditional co-skewness, where risk-averse investors prefer positively skewed assets to negatively skewed assets. Following Pratt and Zeckhauser (1987) and Kimball (1993), Dittmar (2002) extends the three-moment asset pricing model and finds preference for lower kurtosis; that is, investors are averse to kurtosis, and prefer stocks with lower probability mass to stocks with higher probability mass in the tails of the distribution. According to Dittmar (2002), assets that increase a portfolio's kurtosis (i.e., that make the portfolio returns more leptokurtic) are less desirable and should command higher expected returns.

The distribution of individual security returns plays a central role in optimal portfolio selection, derivative pricing, and financial risk management. Over the past three decades, academics and practitioners have therefore devoted substantial effort to modelling and estimating the distributions of individual stock returns. Almost no work, however, has been conducted on 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. Institutional investors in particular have been shown to make extensive use of corporate bonds in constructing their portfolios. Understanding the distribution of corporate bond returns and their predictive power is therefore crucial to understanding the risks inherent in investors' portfolios. Although a large number of studies examine the significance of volatility, skewness, and kurtosis in predicting future stock returns, no work has been conducted on the predictive power of volatility and higher order moments of bond returns. This paper is the first to investigate whether the distributional characteristics of corporate bonds predict the cross-section of expected bond returns.

Corporate bonds are debt obligations issued by private and public corporations.[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 U.S. was about $1.74 trillion in 1990 and it increased monotonically to $11.10 trillion by the end of 2013.[2] 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 to $19.7 billion, with an average of $15.9 billion (source: www.sifma.org).

Investors in corporate bonds include large financial institutions, such as pension funds, mutual funds, hedge funds, insurance companies and banks. Individuals, from the very wealthy to people of modest means, also invest in corporate bonds because of the many benefits these securities offer. Specifically, corporate bonds usually offer higher yields than government bonds or certificate of deposits of comparable maturity. This high-yield potential is, however, generally accompanied by higher risks. People who want steady income from their investments, while preserving their principal, may include corporate bonds in their portfolios. Corporate bonds also provide an opportunity to choose from a variety of sectors, structures, and credit-quality characteristics to meet investment objectives.[3]

Due to the aforementioned benefits of investing in corporate bonds, we think that the size and liquidity of the U.S. corporate bond market will continue to grow over time. Despite the importance

[1] Companies use the proceeds from bond sales for a variety of purposes, such as expanding their business, purchasing new equipment, investing in research and development, buying back their own stock, paying shareholder dividends, refinancing debt, and financing mergers and acquisitions.

[2] Source: Financial Accounts of the United States, Release Z1, Table L212, Line 1 (Total Liabilities).

[3] Investors can reduce their risks by diversifying their assets. Bonds are one type of asset, along with shares of equity, cash, and other investments. Investors can also diversify the types of bonds they hold. For example, investors could buy bonds of different maturities—balancing short-, intermediate-, and long-term bonds—or diversify the mix of their bond holdings by combining corporate, Treasury, and municipal bonds. Investors with greater risk tolerance could decide to buy bonds of lower credit quality, accepting higher risks in pursuit of higher yields. More conservative investors, however, may prefer to limit their bond holdings solely to high-quality bonds, avoiding riskier or more speculative bonds.

of the corporate bond market, little is known about the distributional properties of corporate bond returns. This paper makes an innovative contribution to the literature by examining the cross-sectional predictive power of the volatility, skewness, kurtosis, and downside risk of corporate bonds.

First, we test the significance of a cross-sectional relation between volatility and future returns on corporate bonds using portfolio 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. The return spread between high- and low-volatility bonds remains positive and highly significant after controlling for well-known stock and bond market factors. We investigate the source of significant return and alpha differences 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 bond returns holds controlling for bond characteristics. Our results indicate that the predictive power of volatility remains intact after controlling for the credit rating, maturity, size, and liquidity risk of corporate bonds. 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 high market value as well as bonds with low liquidity risk.

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 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 investigate the source of significant return and alpha spreads in the skewness portfolios and find that the significantly negative return spread between high- and low-skew bonds is due to outperformance by low-skew bonds, but not to underperformance by high-skew bonds. When we investigate the interaction between skewness and bond characteristics, we find that the negative relation between skewness and expected returns is stronger for high-yield bonds, bonds with longer maturity, and bonds with lower market value. However, a significantly negative link between skewness and returns exists for investment-grade bonds and bonds with high market value as well.

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. The positive relation between kurtosis and expected returns is significantly positive for non-investment-grade bonds, long-maturity bonds, and bonds with lower market value, but the cross-sectional link between kurtosis and returns is not significant for investment-grade bonds. After controlling for volatility and skewness, kurtosis has no predictive power for future bond returns.

We also investigate 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.

Finally, we test the significance of a cross-sectional relation between Value-at-Risk (VaR) and future bond returns. Univariate portfolio-level analyses show that bonds in the highest VaR quintile generate 7.93% to 9.66% more annual raw and risk-adjusted returns compared to bonds in the lowest VaR quintile. The return spread between high- and low-VaR bonds remains positive and highly significant after controlling for well-known stock and bond market factors. The significantly positive return and alpha spreads are due to outperformance by high-VaR bonds, but not to underperformance by low-VaR bonds. Bivariate portfolio analyses indicate that the predictive relation between VaR and bond returns remains significantly positive after controlling for the credit rating, maturity, size, and liquidity risk of corporate bonds. Although the positive relation between VaR 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 VaR and future returns exists for investment-grade bonds, short- and medium-term bonds, bonds with high market value as well as bonds with low liquidity risk. The Fama-MacBeth regressions, controlling for lagged return, credit rating, maturity, size, and liquidity risk simultaneously, also indicate a significantly positive link between VaR and bond returns.

We also investigate the impact of transaction costs on hedge portfolios sorted by volatility and VaR. The results indicate that the estimated transaction costs are low compared to the return and alpha spreads for the volatility- and VaR-sorted portfolios. Specifically, the average transaction cost for the volatility-sorted portfolio is about 0.12% per month for all bonds, 0.08% per month for investment-grade bonds, and 0.18% per month for non-investment-grade bonds. After accounting for these relatively low 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. Similar economically significant results are obtained for VaR-sorted portfolios, implying that the key distributional characteristics of corporate bonds remain powerful determinants of the cross-sectional differences in future returns even after accounting for liquidity and transaction costs.

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 presents a framework describing the relation between distributional characteristics and expected returns. Section 5 investigates the predictive power of volatility, skewness, and kurtosis for future bond returns. Section 6 examines the significance of a cross-sectional relation between VaR and future bond returns. Section 7 provides a set of robustness checks. Section 8 concludes the paper.

2 Literature Review

The capital asset pricing model of Sharpe (1964), Lintner (1965), and Black (1972) predicts a positive relation between expected returns on securities and their market betas, and variables other than beta do not capture cross-sectional variation in expected returns. However, the theoretical evidence suggests that idiosyncratic volatility is positively linked to the cross-section of expected returns if investors demand compensation for not being able to diversify firm-specific risk. Levy (1978) theoretically shows that idiosyncratic risk affects equilibrium asset prices if investors do not hold many assets in their portfolio. Merton (1987) indicates that if investors do not hold the market portfolio, they care about total risk, not just market risk. Therefore, firms with higher total variance require higher returns to compensate for imperfect diversification.

Despite the importance of the risk-return tradeoff and the theoretical appeal of Levy's (1978) and Merton's (1987) results, the empirical asset pricing literature has not yet reached an agreement on the existence of such a positive risk-return tradeoff in the cross-section of individual stocks. Because the volatility of individuals stocks is not observable, different approaches and specifications used by previous studies in estimating volatility are largely responsible for the conflicting empirical evidence. There is ongoing debate on the cross-sectional relation between volatility and future stock returns.

Ang et al. (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. Bali and Cakici (2008) show that the cross-sectional relation is sensitive to the data frequency used to estimate idiosyncratic volatility, methods of portfolio formation, and the inclusion/exclusion of small and illiquid stocks. Follow-up studies (e.g., Huang et al. (2010); Han and Lesmond (2011)) show that the significantly negative link between idiosyncratic volatility and future stock returns is driven by short-term return reversals or reversals of liquidity shocks. Bali, Cakici, and Whitelaw (2011) find that the negative effect of idiosyncratic volatility is driven by its close association with a preference for lottery-like stocks.[4]

As summarized above, a large number of studies examine the significance of volatility in predicting future stock and option returns. However, no work has been conducted yet on the risk-return tradeoff in the corporate bond market. This paper is the first to investigate the significance of a cross-sectional relation between volatility and future returns on corporate bonds. Unlike the aforementioned works on individual stocks and options, our results demonstrate a theoretically consistent positive and significant relation between volatility and bond returns.

Arditti (1967), Kraus and Litzenberger (1976), and Harvey and Siddique (2000) extend the mean-variance portfolio theory to incorporate the effect of skewness on asset returns. Mitton and Vorkink (2007) and Barberis and Huang (2008) develop models in which investors have preferences for lottery-like assets with high idiosyncratic skewness. Empirical studies testing the ability of skewness (or related measures) to predict cross-sectional variation in stock returns have produced mixed results. Cremers and Weinbaum (2010) and Xing, Zhang, and Zhao (2010) find a theoretically contradictory positive relation between skewness and future stock returns, while Bali, Cakici, and Whitelaw (2011), Bali and Murray (2013), and Conrad, Dittmar, and Ghysels (2013) find a theoretically consistent negative relation. The aforementioned studies test the significance of the physical and option implied measures of skewness in predicting future stock and option returns. However, there is no work yet on the significance of skewness preference in the corporate bond market. This paper provides the first evidence on the theoretically consistent negative and significant relation between skewness and future bond returns.

Pratt and Zeckhauser (1987), Kimball (1993), and Dittmar (2002) extend the three-moment asset pricing model to incorporate the effect of kurtosis on asset returns. Their results provide theoretical

[4] Bali and Hovakimian (2009), Goyal and Saretto (2009), Cao and Han (2013), and An, Ang, Bali, and Cakici (2014) investigate the cross-sectional relation between option implied volatility and future stock and option returns.

and empirical evidence of investors' aversion to kurtosis (or preference for lower kurtosis). Aside from the work of Dittmar (2002), who finds evidence that kurtosis plays an important role in pricing individual stocks, the literature on kurtosis is sparse. This paper is the first to investigate the significance of a cross-sectional relation between kurtosis and future returns on corporate bonds. Our portfolio-level analyses and cross-sectional regressions indicate that after controlling for volatility and skewness, kurtosis does not make a significant incremental contribution to the prediction of cross-sectional variation in bond returns.

There is an extensive literature on financial risk management and Value-at-Risk (VaR) per se; however, only a few studies investigate the cross-sectional or time-series relation between VaR and expected returns on individual stocks or equity portfolios (e.g., Bali, Demirtas, and Levy (2009); Huang et al. (2012)). The predictive power of VaR has not been investigated for alternative asset classes. This paper provides the first evidence on the theoretically consistent positive and significant relation between VaR and future bond returns.

Our paper also contributes to the literature by providing new evidence in the risk-return analysis of corporate bonds. A large number of papers study the determinants of credit spread 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. Among these few, that of Fama and French (1993) proposes two common risk factors, default premium and term premium, for corporate bonds. Gebhardt, Hvidkjaer, and Swaminathan (2005) test the pricing power of betas on the default spread and term spread by comparing with bond characteristics. Lin, Wang, and Wu (2011) construct a market liquidity risk factor and show that it is priced in the cross-section of corporate bond returns. Bongaerts, De Jong, and Driessen (2012) study the effect of liquidity risk on corporate bond returns. Jostova et al. (2013) investigate whether the momentum anomaly exists in the corporate bond market. Two recent papers by Chordia et al. (2014) and Choi and Kim (2014) examine whether equity market anomalies can be priced in the cross-section of corporate bond returns. Our paper distinguishes from the above literature by providing new evidence that the distributional features of corporate bonds, especially volatility, skewness, and VaR, are robustly priced in the cross-section of future bond returns. These risk factors are generated solely from the distribution of corporate bond returns.

[5]The seminal papers in the 'credit spread puzzle' literature are those of Collin-Dufresne, Goldstein, and Martin (2001), Elton et al. (2001), and Huang and Huang (2012). Over the past decade, a large number of studies have contributed to the understanding of risk factors for corporate bond premiums, including but not limited to those by 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), and Bai and Wu (2015).

3 Data and Variables

3.1 Corporate Bond Data

The corporate bond data set is compiled from six major sources: the Lehman Brothers fixed income database (Lehman), Datastream, the National Association of Insurance Commissioners database (NAIC), Bloomberg, the enhanced version of the Trade Reporting and Compliance Engine (TRACE), and the Mergent fixed income securities database (FISD). The Lehman data are from January 1973 to March 1998, and Datastream reports corporate bond information from January 1990 to June 2014. Both Lehman and Datastream data provide prices based on dealer quotes. The NAIC database reports the transaction information by insurance companies from January 1994 to July 2013, the Bloomberg database provides daily bond prices from January 1997 to December 2004, and the enhanced TRACE records the transaction of the entire corporate bond market from July 2002 to December 2012.[6] The datasets of the NAIC and TRACE provide prices based on 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 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 not structured notes, mortgage backed, or asset backed. We also remove 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.[7] Fourth, corporate bonds trading under $5 dollars per share are usually considered in default or close to default; their return, calculated in the standard way, with price and accrued interest, cannot reflect the firm fundamental or risk premium required for compensation, so we remove such bonds if their quoted or trade-based prices are less than $5.00.[8] We also remove bonds if their prices are above $1,000. Fifth, we remove bonds with a floating rate, which means the sample comprises only bonds with a fixed or

[6] The TRACE data start in July 2002, but in earlier periods TRACE only collected the records of select firms, – often large and liquid firms. The data expand to the whole corporate bond market after October 2004.

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

[8] This rule is in the same spirit of equity studies removing stocks with prices trading under five dollars per share.

zero coupon. This rule is applied based on considering the accuracy of the bond return calculations, given the challenge in tracking floating-coupon bond cash flows.

Our last rule excludes any bonds with less than one year to maturity. This rule is applied to all major corporate bond indexes, such as the Barclays Capital Corporate Bond Index, the Bank of America Merrill Lynch Corporate Bond Index, and the Citigroup Corporate Bond Index.[9] If a bond has less than one year to maturity, it will be delisted from major bond indexes; hence, index-tracking investors will change their holding positions. Such an operation will distort bond return calculations; hence, we remove these bonds 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 were cancelled and adjust records that were subsequently corrected or reversed. Bond trades with more than a two-day settlement are also removed from our sample.

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

Finally, we adopt the following principle to handle overlapping observations between different data sets. If two or more data sets have overlapping observations at any time, we give priority to the data set that reports transaction-based bond prices. For example, TRACE will dominate other data sets in the recent decade. If there are no transaction data or too little data coverage, we give priority to the data set that has relatively greater coverage of bonds/firms, and which can better matched to the FISD bond characteristic data. For example, Bloomberg daily quote data are preferred to those of Datastream from 1998 to 2002 due to greater coverage and a higher matching rate percentage with the FISD data.

After implementing the above filtering criteria, matching with rating data (Section 3.2) and calculating bond returns (Section 3.3), we obtain a final sample of 14,796 bonds issued by 4,401 unique firms, for a total of 964,317 bond-month return observations during the sample period from January

[9] The Dow Jones Bond Index requires a bond to have at least one and a half years to maturity in order to qualify for inclusion in the index. The Dow Jones Bond Index is relatively small, comprising 96 bonds.

1975 to December 2012. This is by far the most complete corporate bond dataset in the literature. Table A.1 in the online appendix shows the data filtering process for the TRACE, Lehman, and NAIC data; the two other datasets, Datastream and Bloomberg, were pre-filtered when they were originally downloaded. Panel A of Table 1 reports the number of unique bonds and the number of unique 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.

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-rated 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. Bao and Pan (2013) take all trades from the 21st of the month and later and calculate the month-end price as the transaction size-weighted average of these trades. 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, Nikolova, Philipov, and Stahel (2013), and Chordia et.al. (2014) 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: 1) from the end of month $t-1$ to the end of month t, 2) from the beginning of month t to the end of month t, and 3) 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 2) and 3) 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 1 presents the summary statistics for the monthly raw returns of corporate bonds. Panel A of Table 1 presents the distribution of monthly raw returns per annum, as well as the unique number of bonds and issuers per annum. Panel B of Table 1 presents the cross-sectional bond returns' distribution and characteristics. The average monthly bond return is 0.68%, which is 8.16% per annum for about 1 million bond-month observations. Among these, about 75% are investment-grade bonds with an annual return of 7.32%, and the remaining high-yield bonds have an annual return of 11.76%.

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 measure of 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:

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

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 (volatility).[10,11]

4 Distributional Characteristics and Expected Returns

We consider an investor allocating a portfolio to maximize the expected utility of the end-of-period wealth $U(W)$. We assume that the distribution of returns on the investor's portfolio of risky assets is asymmetrical and fat-tailed. The expected value of the end-of-period wealth can be written as $\bar{W} = \sum_{i=1}^{n} w_i \bar{R}_i + w_f r_f$, where $\bar{R}_i$ is unity plus the expected rate of the return on the ith risky asset, r_f is unity plus the rate of return on the riskless asset, w_i is the fraction of wealth allocated to the ith risky asset, and w_f is the fraction of wealth allocated to the riskless asset. Since our objective is to measure the effect of higher moments on the standard asset pricing models, we now approximate the expected utility by a Taylor series expansion around the expected wealth. For this purpose, the utility function is expressed in terms of the wealth distribution, so that

$$
E[U(W)] = \int U(W)f(W)dW, \tag{3}
$$

[10] 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 since 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.

[11] 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 36-months instead of 60 months).

where $f(W)$ is the probability density function of the end-of-period wealth that depends on the multivariate distribution of returns and on the vector of weights w. Hence, the infinite-order Taylor series expansion of the utility function is

$$U(W) = \sum_{k=0}^{\infty} \frac{U^{(k)}(\bar{W})(W - \bar{W})^k}{k!}, \tag{4}$$

where $\bar{W} = E(W)$ denotes the expected end-of-period wealth. Under rather mild conditions (Loistl (1976)), the expected utility is given by:

$$E[U(W)] = E\left[\sum_{k=0}^{\infty} \frac{U^{(k)}(\bar{W})(W - \bar{W})^k}{k!}\right] = \sum_{k=0}^{\infty} \frac{U^{(k)}(\bar{W})}{k!} E\left[(W - \bar{W})^k\right]. \tag{5}$$

Therefore, the expected utility depends on all the central moments of the distribution of the end-of-period wealth.

It should be noted that the approximation of the expected utility by a Taylor series expansion is related to investors' preference (or aversion) toward all moments of the distribution, which are directly given by derivatives of the utility function. Scott and Horvath (1980) indicate that, under the assumptions of positive marginal utility and decreasing absolute risk aversion at all wealth levels together with strict consistency in moment preferences, one obtains[12]

$$\begin{aligned} U^{(k)}(W) &> 0 \quad \forall W \quad \text{if } k \text{ is odd,} \\ U^{(k)}(W) &< 0 \quad \forall W \quad \text{if } k \text{ is even.} \end{aligned}$$

Focusing on terms up to the fourth one, we obtain

$$\begin{aligned} E[U(W)] = U(\bar{W}) + U^{(1)}(\bar{W})E\left[(W - \bar{W})\right] + \tfrac{1}{2}U^{(2)}(\bar{W})E\left[(W - \bar{W})^2\right] + \\ \tfrac{1}{3!}U^{(3)}(\bar{W})E\left[(W - \bar{W})^3\right] + \tfrac{1}{4!}U^{(4)}(\bar{W})E\left[(W - \bar{W})^4\right] + O(W^4), \end{aligned} \tag{6}$$

where $O(W^4)$ is the Taylor remainder. We define the expected return, variance, skewness, and kurtosis of the end-of-period return, R_p, as[13]

$$\mu_p = E[R_p] = \bar{W},$$

[12] Pratt and Zeckhauser (1987), Kimball (1993), and Dittmar (2002) discuss further the conditions that yield such moment preferences or aversion.

[13] These definitions of skewness and kurtosis, as central higher moments, differ from the statistical definitions as standardized central higher moments $E[((r_p - \mu_p)/\sigma_p)^j]$ for $j = 3, 4$.

$$\sigma_p^2 = E[(R_p - \mu_p)^2] = E[(W - \bar{W})^2],$$

$$s_p^3 = E[(R_p - \mu_p)^3] = E[(W - \bar{W})^3],$$

$$\kappa_p^4 = E[(R_p - \mu_p)^4] = E[(W - \bar{W})^4].$$

Hence, the expected utility is simply approximated by the following preference function:

$$E[U(W)] \approx U(\bar{W}) + \frac{1}{2}U^{(2)}(\bar{W})\sigma_p^2 + \frac{1}{3!}U^{(3)}(\bar{W})s_p^3 + \frac{1}{4!}U^{(4)}(\bar{W})\kappa_p^4. \quad (7)$$

Under the conditions established by Scott and Horvath (1980), the expected utility depends positively on the mean and skewness of R_p, and negatively on the variance and kurtosis of R_p, that is, $\frac{\partial E[U(W)]}{\partial \mu_p} > 0$, $\frac{\partial E[U(W)]}{\partial \sigma_p^2} < 0$, $\frac{\partial E[U(W)]}{\partial s_p^3} > 0$, and $\frac{\partial E[U(W)]}{\partial \kappa_p^4} < 0$. This indicates aversion to variance and kurtosis and preference for (positive) skewness.

Under the assumptions of positive marginal utility, risk aversion, decreasing absolute risk aversion, and decreasing absolute prudence, equation (7) shows that the expected return on a risky asset is a function of the asset's distributional characteristics (volatility, skewness, and kurtosis). Using portfolio-level analyses and cross-sectional regressions, this study is the first to investigate whether the distributional characteristics of corporate bonds predict their future returns.

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

5.1 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-sectional pricing of corporate bonds.

5.1.1 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 alpha values 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 percentages. Newey-West (1987) adjusted t-statistics are given 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 statistically and economically significant. This result indicates that corporate bonds in the highest VOL quintile generate 7.15% per annum higher returns than bonds in the lowest VOL quintile do.

In addition to the average excess returns, Table 2 also presents the intercepts (5-factor 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).[14] 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).

In addition to well-known stock market factors (size, book-to-market, momentum, and liquidity), we 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), Fung and Hsieh (2004), and

[14]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.

Avramov et al. (2013), and Jostova et al. (2013), 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 (ΔDEF) is defined as the monthly change in the difference between BAA- and AAA-rated corporate bond yields. The term spread factor (ΔTERM) is defined as the monthly change in the difference between 10-year and 3-month constant-maturity Treasury yields. The credit risk factor (ΔCredSpr) 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 (Δ10Y) 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 ΔDEF and ΔTERM 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 3.23. When ΔCredSpr and Δ10Y 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.[15]

These results indicate that after controlling for the well-known stock and bond market factors, the return difference between high-volatility and low-volatility bonds remains positive and highly significant. Next, we investigate the source of significant return and alpha differences between High-VOL and Low-VOL 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 average raw and risk-adjusted returns of quintile 1 versus those of quintile 5. As reported in Table 2, the average excess return and the 5- and 7-factor alphas of bonds in quintile 1 (low-volatility bonds) are economically and statistically insignificant, whereas the average raw return and 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 return/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 lower market value. As we move from the Low-VOL to the High-VOL quintile, the average credit rating and average maturity monotonically increase, whereas the average market value

[15]Tables A.2 and A.3 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.

monotonically decreases. This creates 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.

5.1.2 Bivariate Portfolio Analysis of Volatility

Table 3 presents the results from the bivariate sorts of volatility and credit rating.[16] 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 quintiles, 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). In Panel A of Table 3, 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 bond quintiles within each of the five rating-ranked quintiles. Panel A of Table 3 shows that the average excess returns and the 5- and 7-factor alphas increase monotonically, moving 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 ratings by sorting investment-grade bonds (with rating from 1 to 10) and high-yield bonds (with rating above 10) separately into bivariate quintile portfolios based on their volatility and credit ratings.[17] Panel B of Table 3 shows that after controlling for credits ratings, the return and alpha differences between the VOL,1 to the VOL,5 quintiles are in the range of 0.20% to 0.28% per month and statistically significant for investment-grade bonds. For non-investment-grade bonds, the return and alpha spreads between the VOL,1 to the VOL,5 quintiles are much higher, in the range of 0.69% to 0.73% per month, and

[16] Ratings are in conventional numerical scores, where 1 represents a AAA rating and 21 reflects a C rating. Higher numerical scores correspond to lower ratings.

[17] 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 or non-investment-grade. Investment-grade bonds are considered more likely than non-investment-grade bonds to be paid on time. Non-investment-grade bonds, which are also called high-yield or speculative bonds, generally offer higher interest rates to compensate investors for greater risk.

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.

Table 4 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 A of Table 4 shows that after controlling for bond maturity, the return and 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. Panel B of Table 4 shows that after controlling for maturity, the return and alpha spreads between the VOL,1 and the 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.[18] This result makes sense because longer-term bonds usually offer higher interest rates, but may entail additional risks.[19]

Table 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 identical size (i.e., these newly generated volatility sub-quintile portfolios control for differences in size). Panel A of Table 5 shows that after controlling

[18]Table A.4 of the online appendix presents detailed results from the univariate quintile portfolios of short-maturity, medium-maturity, and long-maturity bonds.

[19]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 interest rates than short-term bonds of the same credit quality do.

for size, the return and 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.[20] Panel B of Table 5 shows that after controlling for size, the return and alpha differences between the VOL,1 and the 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.[21]

5.2 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, Knetsch, and Thaler (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.[22] 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.

5.2.1 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 6, SKEW,1 represents the lowest skewness-ranked

[20] 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. large) based on the median market value.

[21] Table A.5 of the online appendix presents detailed results from the univariate quintile portfolios of small and big bonds.

[22] For option implied volatility, skewness and stock return characteristics, see Bakshi and Kapadia (2003) and Bakshi, Kapadia, and Madan (2003).

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.

Table 6 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 6 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 6 also shows that the 5- and 7-factor alpha differences between the highest- and lowest-skewness quintiles are similar in magnitude at -0.26% per month with t-statistics in the range of -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.[23]

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-SKEW and Low-SKEW bonds: Is it due to underperformance by High-SKEW bonds, outperformance by Low-SKEW bonds, or both? As reported in Table 6, the 5- and 7-factor alphas of bonds in quintile 1 (low-skew bonds) are positive and are 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 bonds, but not due to underperformance by High-SKEW bonds.

The last three columns of Table 6 present the average characteristics of bonds in the skewness portfolios. There is no significant difference between the credit rating, maturity, and market value of

[23]In Table A.6 of the online appendix, we form quintile portfolios by first sorting bonds into five quintiles based on their skewness. Then, within each skewness quintile, bonds are sorted further into five sub-quintiles based on their volatility. As shown in Table A.6 from the bivariate sorts of volatility and skewness, the return and alpha spreads between the highest and lowest volatility quintiles are in the range of 0.44% to 0.54% and significant, implying that after controlling for skewness, the cross-sectional relation between volatility and future bond returns remains positive and highly significant.

bonds in 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.

5.2.2 Bivariate Portfolio Analysis of Skewness and Bond Characteristics

Table 7 presents the results from the bivariate sorts of skewness and bond characteristics. In Panel A of Table 7, 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 of Table 7 shows that after controlling for credit ratings, the 5- and 7-factor alpha differences between high- and low-skew bonds remain negative, -0.24% per month, and statistically significant. In Panel A of Table 7, 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. Panel A of Table 7 shows that after controlling for credit ratings, the alpha differences between the SKEW,1 to the 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 to the 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 controlling for credit ratings.

In Panel B of Table 7, 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 of Table 7 shows that after controlling for maturity, the 5- and 7-factor alpha differences between high- and low-skew bonds remain negative, -0.19% per month, and statistically significant. In Panel B of Table 7, 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. Panel B of Table 7 shows that after controlling for maturity, the alpha spreads between the SKEW,1 to the 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 7, 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 subquintiles based on their skewness. Panel C of Table 7 shows that after controlling for size, the 5- and 7-factor alpha differences between the SKEW,1 to the SKEW,5 quintiles remain negative, -0.21% per month, and statistically significant. In Panel C of Table 7, 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. Panel C of Table 7 shows that 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.

5.3 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 explains the cross-sectional differences in bond returns.

5.3.1 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 8 shows the average kurtosis of bonds in each quintile, the next month's average excess return, and the 5- and 7-factor alphas for each quintile. The last three columns report the average bond characteristics for each quintile. The last row in Table 8 displays the differences in average returns of quintiles 5 and 1, and the differences in 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 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 8 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) that risk-averse investors prefer high expected return and low kurtosis.

Next, we investigate the source of significant alpha spreads between High- and Low-KURT bonds: Is it due to outperformance by High-KURT bonds, underperformance by Low-KURT bonds, or both? As reported in Table 8, the 5- and 7-factor alphas of bonds in quintile 1 (low-kurtosis bonds) are positive but 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-kurtosis bonds is due to outperformance by High-KURT bonds, but not to underperformance by Low-KURT bonds.

The last three columns of Table 8 present the average characteristics of bonds in the kurtosis portfolios. Bonds with high-kurtosis have lower 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.

5.3.2 Bivariate Portfolio Analysis of Kurtosis and Bond Characteristics

Table 9 presents the results from the bivariate sorts of kurtosis and bond characteristics. In Panel A of Table 9, 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 of Table 9 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. In Panel A of Table 9, 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. Panel A of Table 9 shows that 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 9, 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 of Table 9 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. In Panel B of Table 9, 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. Panel B of Table 9 shows that 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 9, 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 of Table 9 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. In Panel C of Table 9, 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. Panel C of Table 9 shows that 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.[24]

[24]Table A.7 of the online appendix presents the results from the trivariate sorts of volatility, skewness, and kurtosis.

5.4 Fama-MacBeth Regression Results

So far we have tested the significance of the 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 significant 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; credit rating (*RATE*), maturity (*MAT*), amount outstanding (*SIZE*), and lagged excess return. The average slopes provide standard Fama-MacBeth tests for determining which explanatory variables on average have non-zero premiums. Monthly cross-sectional regressions are run for the following econometric specification and nested versions thereof:

$$\begin{aligned} R_{i,t+1} = \lambda_{0,t} + \lambda_{1,t} VOL_{i,t} + \lambda_{2,t} SKEW_{i,t} + \lambda_{3,t} KURT_{i,t} + \\ \lambda_{4,t} RATE_{i,t} + \lambda_{5,t} MAT_{i,t} + \lambda_{6,t} SIZE_{i,t} + \lambda_{7,t} R_{i,t} + \varepsilon_{i,t+1} \end{aligned}, \qquad (8)$$

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 *VOL, SKEW, KURT, RATE, MAT*, *SIZE*, and excess return.

Table 10 reports the time series averages of the intercept and slope coefficients $\lambda_{i,t}$ (i = 0, 1, . . . , 7) and the average adjusted R^2 values over the 456 months from January 1975 to December 2012. The Newey-West adjusted t-statistics are given in parentheses. 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

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. Then within each skewness portfolio, bonds are sorted further into three sub-terciles based on their kurtosis. Table A.7 shows that the return and alpha differences between high- 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.

volatility between quintiles 5 and 1 is approximately 40.62. 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 8, 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 8, 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.

The next three regressions in Table 10 (regressions (4) to (6)) 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 distributional characteristics and 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 rating 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 6, 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 6. As reported in Table A.6 of the online appendix, the spread in average volatility between quintiles 5 and 1 is approximately 38.80, implying an estimated monthly risk premium of 62 basis points for volatility. As shown in Table 6, the spread in average skewness between quintiles 5 and 1 is approximately 1.78, implying an estimated monthly risk premium of 32 basis points for skewness.

Regression (8) replicates the bivariate regressions with volatility and skewness after controlling for the lagged excess return and bond characteristics. Similar to our results from Regression (7), the cross-sectional relation between volatility (skewness) and future bond returns is positive (negative) and highly significant after controlling for lagged return, credit rating, maturity, and size.

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.

The last two specifications in Table 10 (regressions (10) to (11)) present results from the multivariate regressions with all three distributional characteristics (VOL, SKEW, KURT) after controlling for 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. Consistent with our findings from the trivariate portfolios of VOL, SKEW, and KURT reported in Table A.7 of the online appendix, the cross-sectional relation between kurtosis and expected returns is flat, after controlling for volatility and skewness.

Overall, the Fama-MacBeth regression results echo the portfolio-level analyses, indicating that the volatility and skewness of corporate bonds predict their future returns, whereas the leptokurtic behavior of the distribution does not contribute significantly to the prediction of cross-sectional variation in bond returns.

6 Value-at-Risk and the Cross-Section of Expected Bond Returns

Value-at-Risk (VaR) determines how much the value of an asset could decline over a given period of time with a given probability as a result of changes in market rates or prices. For example, if the given period of time is one day and the given probability is 1%, the VaR measure would be an estimate of the decline in the asset's value that could occur with 1% probability over the next trading day. In other words, if the VaR measure is accurate, losses greater than the VaR measure should occur less than 1% of the time. There is substantial empirical evidence showing that the distribution of financial returns is typically skewed to the left, peaked around the mean (leptokurtic) and has fat tails. The fat tails and negative skewness suggest that extreme outcomes happen much more frequently than predicted by the normal distribution, and the negative returns of a given magnitude have higher probabilities of occurring than positive returns of the same magnitude. This also suggests that the normality assumption and the traditional measure of risk (volatility) can produce measures of downside risk that are inappropriate estimates of the true risk faced by individual firms. Downside risk measures accounting for higher-order moments of the return distribution provide more accurate estimates of actual losses and produce good predictions of market risk during extraordinary periods such as stock market crashes, bond market collapses, and foreign exchange crises.

Bali, Demirtas, and Levy (2009) provide an economic framework that indicates a positive relation between VaR and expected returns. Based on the standard utility functions (such as constant absolute risk aversion and constant relative risk aversion), Bali et al. (2009) show that an increase in VaR reduces the expected utility of wealth because VaR for long positions (defined by the left tail of the return distribution) increases with variance and kurtosis and decreases with positive skewness (see Cornish and Fisher (1937)). Hence, investors have aversion to VaR, which implies a positive relation between VaR and expected returns.

In this section, we use different confidence levels to check the robustness of VaR as a cross-sectional predictor of future bond returns. The estimation is based on the lower tail of the empirical return distribution. For each month from January 1975 to December 2012, three VaR measures are calculated: 1% VaR is defined as the lowest monthly return observation over the past 60 months, 5% VaR is defined as the third lowest monthly return observation over the past 60 months, and 10% VaR is defined as the sixth lowest monthly return observation over the past 60 months.[25] Note that the original maximum likely loss values are negative since they are obtained from the left tail of the return distribution. However, the original VaR measures (1%, 5%, 10% VaR) are multiplied by -1 before running our portfolio-level analyses and cross-sectional regressions. Hence, as will be discussed later in this section, the slope coefficients from cross-sectional regressions are estimated to be positive, which gives the central result of this section that there is a positive and significant relation between VaR and future bond returns.

Only a few studies investigate the significance of VaR in predicting future stock returns (e.g., Bali et al. (2009); Huang et al. (2012)), the predictive power of VaR has not been investigated

[25] Although the lowest return observation over the past 60 months is about 1.67% VaR, it is referred to as the 1% VaR measure in this paper.

for alternative asset classes. This paper is the first to test whether VaR predicts the cross-sectional differences in bond returns.

6.1 Univariate Portfolio Analysis of Value-at-Risk

We examine the significance of a cross-sectional relation between VaR and future bond returns using univariate quintile portfolios. Panels A to C of Table 11 present the results for 1% VaR, 5% VaR, and 10% VaR, respectively. The panels in Table 11 show the average VaR values of bonds in each quintile, the next month average excess return, and the 5- and 7-factor alpha for each quintile. The last three columns report the average bond characteristics for each quintile. The last row in Table 11 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.

Panel A of Table 11 shows that the average return difference between the High 1%VaR and Low 1%VaR quintiles is positive and highly significant; 0.81% per month with a t-statistic of 3.17. Panel A also shows that the 5- and 7-factor alpha differences between the highest and lowest 1%VaR quintiles are about 0.66% per month and statistically significant. Similar results are obtained from the univariate quintile portfolios of 5% VaR and 10% VaR. Specifically, Panel B of Table 11 shows that the average return and alpha differences between the High 5%VaR and Low 5%VaR quintiles are positive, in the range of 0.83% to 0.89% per month, and significant with t-statistics ranging from 2.34 to 2.76. Similarly, Panel C of Table 11 shows that the average return and alpha differences between the High 10%VaR and Low 10%VaR quintiles are positive, in the range of 0.90% and 0.91% per month, and significant with t-statistics ranging from 2.71 to 3.05. These results are consistent with Bali et al. (2009) that loss-averse investors prefer high expected return and low VaR.[26]

Next, we investigate the source of significant alpha spreads between High- and Low-VaR bonds: Is it due to outperformance by High-VaR bonds, underperformance by Low-VaR bonds, or both? As reported in Panels A to C of Table 11, the 5- and 7-factor alphas of bonds in quintile 1 (Low-VaR bonds) are economically and statistically insignificant, whereas the 5- and 7-factor alphas of bonds in quintile 5 (High-VaR bonds) are positive and economically and statistically significant. This result holds for all three measures of VaR. Hence, we conclude that the significantly positive alpha spread between High- and Low-VaR bonds is due to outperformance by High-VaR bonds, but not to

[26]Tables A.8 and A.9 of the online appendix present the results from the univariate portfolios sorted by 5%VaR for investment-grade and non-investment-grade bonds separately. The results indicate that the return and alpha spreads from the VaR-sorted portfolios are economically and statistically significant for both investment-grade and non-investment-grade bonds.

underperformance by Low-VaR bonds.

The last three columns of Table 11 present the average characteristics of bonds in the VaR portfolios. As presented in the last three columns of Table 11, bonds with high VaR have lower credit ratings, longer maturity, and lower market value. We provide different ways of handling the potential interaction of VaR with the bond characteristics. Specifically, we test whether the positive relation between VaR and the cross-section of bond returns holds once we control for credit rating, maturity, and size based on bivariate portfolio sorts and Fama-MacBeth regressions.

6.2 Bivariate Portfolio Analysis of VaR and Bond Characteristics

Table 12 presents the results from the bivariate sorts of 5% VaR and bond characteristics.[27] In Panel A of Table 12, quintile portfolios are formed by first sorting corporate bonds into five quintiles based on their credit ratings. Then, within each rating portfolio, bonds are sorted further into five sub-quintiles based on their 5%VaR. Panel A of Table 12 shows that after controlling for credit rating, the 5- and 7-factor alpha differences between high- and low-VaR bonds remain positive, about 0.43% per month, and highly significant with t-statistics ranging from 3.18 to 3.31. In Panel A of Table 12, we further investigate the interaction between VaR and credit ratings by sorting investment-grade and non-investment-grade bonds separately into bivariate quintile portfolios based on their 5%VaR and credit ratings. Panel A of Table 12 shows that for investment-grade bonds, after controlling for credit ratings, the alpha spreads between the VaR,1 and VaR,5 quintiles are positive, in the range of 0.33% to 0.34% per month, and significant with t-statistics ranging from 2.81 to 2.99. For non-investment-grade bonds, the alpha spreads between the VaR,1 and VaR,5 quintiles are much higher, in the range of 0.93% to 0.94% per month, and highly significant with t-statistics ranging from 4.54 to 4.62.

In Panel B of Table 12, quintile portfolios are formed by first sorting bonds into five quintiles based on their maturity. Then, within each maturity portfolio, bonds are sorted further into five sub-quintiles based on their 5%VaR. Panel B of Table 12 shows that after controlling for maturity, the 5- and 7-factor alpha differences between high- and low-VaR bonds remain positive, in the range of 0.66% to 0.67% per month, and highly significant with t-statistics ranging from 2.95 to 3.00. In Panel B of Table 12, we further investigate the interaction between VaR and maturity by sorting short-, medium-, and long-maturity bonds separately into bivariate quintile portfolios based on their 5%VaR and maturity. Panel B of Table 12 shows that after controlling for maturity, the alpha

[27] As shown in Table A.10 and A.11 of the online appendix, results from the bivariate sorts of bond characteristics by 1% VaR and 10% VaR are very similar to those reported in Table 12.

spreads between VaR,1 and VaR,5 quintiles are in the range of 0.34% to 0.35% per month and marginally significant for short-maturity bonds, 0.69% to 0.73% per month and statistically significant for medium-maturity bonds, and about 0.59% per month and significant for long-maturity bonds. Although the economic significance of these alpha spreads is similar across the three maturity groups, the statistical significance of the alpha differences between high- and low-VaR bonds is somewhat higher for medium- and long-maturity bonds.

In Panel C of Table 12, quintile portfolios are formed 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 5%VaR. Panel C of Table 12 shows that after controlling for size, the 5- and 7-factor alpha differences between high- and low-VaR bonds remain positive, about 0.76% per month, and statistically significant. In Panel C of Table 12, we further investigate the interaction between VaR and bond size by sorting small and large bonds separately into bivariate quintile portfolios based on their 5%VaR and size. Panel C of Table 12 shows that after controlling for size, the positive relation between VaR and expected returns is stronger for bonds with low market value, but the significantly positive link between VaR and returns exists for bonds with high market value too.

6.3 Fama-MacBeth Regressions with VaR

In this section, we present the time-series averages of the slope coefficients from the regressions of one-month-ahead excess bond returns on the 1% VaR, 5% VaR, 10% VaR, and the control variables; credit rating ($RATE$), maturity (MAT), amount outstanding ($SIZE$), and lagged excess return. Monthly cross-sectional regressions are run for the following econometric specification and nested versions thereof:

$$R_{i,t+1} = \lambda_{0,t} + \lambda_{1,t} VaR_{i,t} + \lambda_{2,t} RATE_{i,t} + \lambda_{3,t} MAT_{i,t} + \lambda_{4,t} SIZE_{i,t} + \lambda_{5,t} R_{i,t} + \varepsilon_{i,t+1}, \tag{9}$$

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 1% *VaR,* 5% *VaR,* 10% *VaR, RATE, MAT*, *SIZE*, and excess return.

Table 13 reports the time series averages of the intercept and slope coefficients, and the average adjusted R^2 values for the sample period from January 1975 to December 2012. The Newey-West adjusted t-statistics are given in parentheses. The univariate regression results show a positive and statistically significant relation between VaR and the cross-section of future bond returns. The average slope from the monthly regressions of excess returns on 1%VaR is 0.049 with a t-statistic of 4.92. The economic magnitude of the associated effect is similar to that documented in Table 11, Panel A for the univariate quintile portfolios of 1% VaR. The spread in average 1%VaR between quintiles 5 and 1 is approximately 13.56. Multiplying this spread by the average slope of 0.046 yields an estimated monthly risk premium of 62 basis points. Similarly, the average slope coefficients from the monthly regressions of excess returns on 5%VaR and 10%VaR are positive and highly significant; 0.096 (t-stat. = 4.82) for 5% VaR and 0.156 (t-stat. = 4.63) for 10% VaR. These average slope coefficients generate economic magnitudes similar to those presented in Panels B and C of Table 11 for the univariate quintile portfolios of 5% VaR and 10% VaR; the monthly risk premium of 63 basis points for 5% VaR and 10% VaR.

Table 13 also shows that controlling for the lagged excess return, credit rating, maturity, and size simultaneously does not affect the significantly positive link between VaR and bond returns. The average slope coefficients on 1%VaR, 5%VaR, and 10%VaR are positive and highly significant in multivariate regressions. However, after controlling for VaR, the predictive power of bond characteristics (credit rating, maturity, and size) either disappears or becomes very weak.

7 Robustness Check

7.1 Longer-term Predictability

In this section, 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:

$$\begin{aligned} R_{i,t+\tau} = \lambda_{0,t} + \lambda_{1,t} VOL_{i,t} + \lambda_{2,t} SKEW_{i,t} + \lambda_{3,t} KURT_{i,t} + \\ \lambda_{4,t} RATE_{i,t} + \lambda_{5,t} MAT_{i,t} + \lambda_{6,t} SIZE_{i,t} + \lambda_{7,t} R_{i,t} + \varepsilon_{i,t+\tau}, \end{aligned} \tag{10}$$

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

Table A.12 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.

We also test the significance of a cross-sectional relation between 1% VaR, 5% VaR, 10% VaR and longer horizon future returns on corporate bonds. Table A.13 of the online appendix presents the time-series averages of the slope coefficients from the regressions of up to six-month-ahead excess bond returns on the 1% VaR, 5% VaR, 10% VaR, and the control variables:

$$R_{i,t+\tau} = \lambda_{0,t} + \lambda_{1,t} VaR_{i,t} + \lambda_{2,t} RATE_{i,t} + \lambda_{3,t} MAT_{i,t} + \lambda_{4,t} SIZE_{i,t} + \lambda_{5,t} R_{i,t} + \varepsilon_{i,t+\tau}, \tag{11}$$

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

Table A.13 shows that VaR predicts cross-sectional variations in bond returns five months into the future and this result holds for all three measures of VaR. However, the predictive power of the control variables becomes weak or completely disappears for longer horizon return predictability.

7.2 Transaction Costs

In this section, we check the impact of transaction costs on hedge portfolios sorted by VOL and VaR. We estimate the portfolio transaction costs using Bao, Pan, and Wang's (2011) measure (L^{BPW}), which is aimed at extracting the transitory component from bond price. Specifically, let $\Delta p_t = p_t - p_{t-1}$ be the log price change from $t-1$ to t. Then, L^{BPW} is defined as

$$L_{it}^{BPW} = -Cov_t(\Delta p_{itd}, \Delta p_{itd+1}), \tag{12}$$

where Δp_{itd} is the log price change in bond i on day d of month t.[28] We compute L^{BPW} 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 (TransCosts). The TransCosts are in percentage per month, from January 2003 to December 2012, using TRACE data.

Table A.14 of the online appendix shows the estimated transaction costs for the bond portfolios sorted by volatility and 5% VaR. The results indicate that the estimated transaction costs are small

[28] 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 serially correlated price changes, the negative of the autocovariance in relative price changes in equation (12) provides a meaningful measure of illiquidity.

compared to the return and alpha spreads for the volatility- and VaR-sorted portfolios. Panel A of Table A.16 shows that the average transaction cost for the volatility-sorted portfolio is about 0.12% per month for all bonds, 0.08% per month for investment-grade bonds, and 0.18% per month for non-investment-grade bonds. Deducting these transaction cost estimates from the return and alpha spreads reported in Table 2, and Tables A.2 and A.3 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.

Panel B of Table A.14 presents the estimated transaction costs for bond portfolios sorted by 5% VaR. Panel B shows that the average transaction cost for the VaR-sorted portfolio is about 0.16% per month for all bonds, 0.05% per month for investment-grade bonds, and 0.33% per month for non-investment-grade bonds. Subtracting these transaction cost estimates from the return and alpha spreads reported in Table 11, and Tables A.8 and A.9 of the online appendix show that the transaction cost adjusted return and alpha spreads in the VaR-sorted portfolios are in the range of 8.0% and 8.7% per annum for all bonds, in the range of 3.6% and 3.7% per annum for investment-grade bonds, and more than 10% per annum 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 liquidity and transaction costs.

7.3 Controlling for Bond Illiquidity

In this section, we test whether the significant relation between volatility, skewness, downside risk and future bond returns remains intact after controlling for corporate bond illiquidity. Since the data on bond level illiquidity have much shorter sample coverage compared to our original sample from 1975 to 2012, we did not use illiquidity as a control variable in our previous analyses. Our illiquidity measure, L^{BPW}, is constructed following Bao, Pan, and Wang (2011) as in the previous section.

After estimating the illiquidity measure for each bond in our sample, we use it as an additional control variable in multivariate Fama-MacBeth regressions:

$$\begin{aligned} R_{i,t+1} = \lambda_{0,t} + \lambda_{1,t} VOL_{i,t} + \lambda_{2,t} SKEW_{i,t} + \lambda_{3,t} KURT_{i,t} + \\ \lambda_{4,t} RATE_{i,t} + \lambda_{5,t} MAT_{i,t} + \lambda_{6,t} SIZE_{i,t} + \lambda_{7,t} R_{i,t} + \lambda_{8,t} L^{BPW}_{i,t} + \varepsilon_{i,t+1}, \end{aligned} \quad (13)$$

where L^{BPW} is to control for the illiquidity of corporate bonds.

Consistent with theoretical predictions, Table A.15 of the online appendix shows that corporate bond illiquidity is positively related to future bond returns. Table A.15 also provides evidence 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.

Finally, we examine if the cross-sectional relation between VaR and future bond returns remains strong after controlling for the illiquidity of corporate bonds. Table A.16 of the online appendix presents the time-series averages of the slope coefficients from the regressions of one-month-ahead excess bond returns on the 1% VaR, 5% VaR, 10% VaR, bond characteristics (rating, maturity, and size), lagged return, and the additional control variable L^{BPW}. Table A.16 shows that controlling for illiquidity and other bond characteristics, the positive relation between VaR and future bond returns remains highly significant.

7.4 Controlling for Liquidity Risk Exposure

In this section, we test whether the significant relation between volatility, skewness, downside risk and future bond returns remains intact after controlling for the liquidity risk exposure of corporate bonds. Since the data on liquidity factors have much shorter sample coverage compared to our original sample from 1975 to 2012, we did not use liquidity risk as a control variable in our previous analyses.

We use two different measures of liquidity risk exposure, LIQ1 and LIQ2, constructed by Lin, Wang, and Wu (2011).[29] The measure LIQ1 is the corporate bond liquidity beta using the method of Pastor-Stambaugh (2003) and LIQ2 is the corporate bond beta on Amihud's (2002) illiquidity measure.

After estimating the exposure of corporate bonds to liquidity factors, we use it as an additional control variable in multivariate Fama-MacBeth regressions:

$$\begin{aligned} R_{i,t+1} = \lambda_{0,t} + \lambda_{1,t}VOL_{i,t} + \lambda_{2,t}SKEW_{i,t} + \lambda_{3,t}KURT_{i,t} + \\ \lambda_{4,t}RATE_{i,t} + \lambda_{5,t}MAT_{i,t} + \lambda_{6,t}SIZE_{i,t} + \lambda_{7,t}R_{i,t} + \lambda_{8,t}LIQ_{i,t} + \varepsilon_{i,t+1}, \end{aligned} \tag{14}$$

[29] We thank Junbo Wang for providing us with the data on LIQ1 and LIQ2 by their paper 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. To obtain bond-level liquidity, LIQ1 estimates $\pi_{i,t}$ in the regression $r^e_{i,j+1,t} = \rho_0 + \rho_1 r_{i,j,t} + \pi_{i,t} sign(r^e_{i,j,t}) Vol_{i,j,t} + \epsilon_{i,j+1,t}$ where $r^e_{i,j,t}$ is the bond i return on day j in month t, and sign$(\cdot)$ is an indicator function whose value is equal to 1 if $r^e_{i,j,t}$ is positive and -1 if it is negative. LIQ2 constructs the bond-level Amihud illiquidity measure using bond daily return and volume, $ILLIQ_{it} = \frac{1}{Days_{it}} \sum_{j=1}^{Days_{it}} \frac{|r_{i,j,t}|}{Vol_{i,j,t}}$.

where LIQ1 and LIQ2 are used to control for the liquidity risk exposure of corporate bonds.

Table A.17 of the online appendix shows that controlling for liquidity risk exposure and other bond characteristics (rating, maturity, and size), the significantly positive (negative) relation between volatility (skewness) and future bond returns remains intact. Table A.17 provides no evidence of a significant link between liquidity risk and future bond returns in our sample. Finally, we examine if the cross-sectional relation between VaR and future bond returns remains strong after controlling for liquidity risk exposure of corporate bonds. Table A.18 of the online appendix presents the time-series averages of the slope coefficients from the regressions of one-month-ahead excess bond returns on the 1% VaR, 5% VaR, 10% VaR, bond characteristics (rating, maturity, and size), lagged return, and the additional control variables LIQ1 and LIQ2. Table A.18 shows that controlling for the liquidity risk exposure and other bond characteristics, the positive relation between VaR and future bond returns remains highly significant.

8 Conclusion

In spite of the dominance of the mean-variance portfolio theory, there has been longstanding interest in the literature on the question of whether skewness, kurtosis, and/or downside risk play a special role in determining expected returns. Such a role could emerge, for example, due to preferences that treat losses and gains asymmetrically, return distributions that are asymmetric, or some combination of the two. An extensive literature examines the significance of distributional parameters in predicting future stock and option returns, but 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% to 7% more annual raw and risk-adjusted returns compared to bonds in the lowest volatility quintile. The predictive power of volatility remains intact after controlling for credit ratings, maturity, size, and liquidity of corporate bonds. The significantly positive link remains intact for investment-grade bonds, short- and medium-term bonds, liquid bonds, and bonds with high market value. 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 2.5% to 3.1% more annual raw and risk-adjusted returns compared to bonds in the highest skewness quintile, consistent with investors' preference for positively skewed assets. The significantly negative link also remains after controlling for bond characteristics. When testing volatility, skewness, and kurtosis simultaneously in the Fama-MacBeth cross-sectional regressions, the results emulate the portfolio level analyses, indicating that the volatility and skewness of corporate bonds predict their future returns, whereas kurtosis does not have a significant predictive power for future bond returns.

The cross-sectional relation between downside risk and bond returns is even stronger than volatility and skewness. Univariate portfolio-level analyses show that bonds in the highest VaR quintile generate 7.9% to 11.0% more annual raw and risk-adjusted returns compared to bonds in the lowest VaR quintile. Bivariate portfolio level analyses indicate that the predictive relation between VaR and bond returns remains significantly positive after controlling for the credit rating, maturity, liquidity, and size of corporate bonds. Although the positive relation between VaR and expected returns is stronger for non-investment-grade bonds, long-maturity bonds, less liquid bonds, and bonds with lower market value, the significantly positive link between VaR and future returns exists for investment-grade-bonds, short- and medium-term bonds, liquid bonds, and bonds with high market value. The Fama-MacBeth regressions, controlling for lagged return, credit rating, maturity, liquidity and size simultaneously, also indicate a significantly positive link between VaR and bond returns. Hence, we conclude that the distributional characteristics of corporate bonds are powerful determinants of the cross-sectional differences in future returns.

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Table 1. 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 number of bond-month observations, the cross-sectional mean, median, standard deviation and monthly return percentiles of corporate bonds, and 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 scores correspond to 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 unique	# of unique	Bond monthly returns and percentiles (%)								
Year	bonds	issuer	Mean	Median	Std. dev	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

Panel A (Continued)

Year	# of unique bonds	# of unique issuer	Bond monthly returns and percentiles (%)								
			Mean	Median	Std. dev	1st	5th	25th	75th	95th	99th
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 1. (Continued)

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

					Percentiles					
	N	Mean	Median	Std. dev	1st	5th	25th	75th	95th	99th
All Bonds										
Bond Return (%)	964,271	0.68	0.68	5.64	-10.42	-4.49	-0.65	1.93	5.62	12.50
Price ($)	964,317	97.04	100.24	16.94	38.43	62.79	92.50	106.00	117.30	129.85
Amount Out ($ million)	962,925	266	150	368	5	16	100	300	800	2000
Rating	959,713	8.02	7.00	4.13	1.00	2.00	5.50	10.00	16.00	20.50
Time-to-maturity (year)	964,317	13.84	9.42	39.11	1.29	2.29	5.70	20.00	29.17	37.50
Investment Grade Bonds										
Bond Return (%)	761,724	0.61	0.63	3.75	-8.43	-4.11	-0.66	1.86	5.16	10.30
Price ($)	761,728	98.33	100.57	15.79	47.94	66.37	93.84	106.52	118.27	130.98
Amount Out ($ million)	760,378	272	150	382	4	15	100	300	900	2000
Rating	757,124	6.30	6.50	2.29	1.00	2.00	5.00	8.00	10.00	10.00
Time-to-maturity (year)	761,728	14.72	9.90	43.78	1.25	2.21	5.75	21.83	29.50	38.00
High Yield Bonds										
Bond Return (%)	202,547	0.98	0.85	9.91	-20.15	-6.41	-0.60	2.25	7.68	22.79
Price ($)	202,589	92.19	98.66	19.97	22.00	50.00	85.50	104.13	113.00	123.56
Amount Out ($ million)	202,547	242	150	311	9	20	100	300	700	1500
Rating	202,589	14.43	14.50	3.04	10.50	10.50	12.00	16.00	20.50	24.00
Time-to-maturity (year)	202,589	10.51	8.17	7.82	1.42	2.67	5.58	13.92	25.50	29.58

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 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 two bond market factors in addition to the five factors; the default spread factor (ΔDEF) is defined as the monthly change in the difference between the BAA-rated and AAA-rated corporate bond yields, and the term spread factor (ΔTERM) is defined as the monthly change in the difference between 10-year and 3-month constant-maturity Treasury yields. The credit risk factor (ΔCredSpr) 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 (Δ10Yr) is defined as the monthly change in 10-year constant-maturity Treasury yields. 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 ΔDEF and ΔTERM	7-factor alpha with ΔCredSpr and Δ10Yr	Average Portfolio Characteristics		
						Rating	Maturity	Size
Low VOL	4.536	0.046	-0.052	-0.056	-0.056	6.600	9.996	0.261
		(0.49)	(-0.59)	(-0.59)	(-0.98)			
2	7.508	0.123	0.007	0.002	0.001	6.623	12.770	0.236
		(1.11)	(0.07)	(0.02)	(0.02)			
3	10.297	0.146	-0.001	-0.005	-0.005	6.631	15.348	0.240
		(1.20)	(-0.01)	(-0.04)	(-0.08)			
4	14.407	0.233	0.062	0.057	0.056	7.019	17.881	0.231
		(1.71)	(0.50)	(0.43)	(0.70)			
High VOL	45.160	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 VOL Controlling for Credit Rating

Quintile portfolios are formed every month from January 1975 to December 2012 by first sorting corporate bonds based on credit ratings. Then, within each rating portfolio, corporate bonds are sorted into sub-quintiles based on their 60-month rolling total variance (VOL). Panel A reports the results for all bonds, and Panel B reports the results separately for investment-grade and high-yield bonds. "Quintile VOL,1" is the portfolio of corporate bonds with the lowest VOL within each rating portfolio and "Quintile VOL, 5" is the portfolio of corporate bonds with the highest VOL within each rating portfolio. Table also report the average VOL within each rating 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 two bond market factors in addition to the five factors; the default spread factor (ΔDEF) is defined as the monthly change in the difference between the BAA-rated and AAA-rated corporate bond yields, and the term spread factor (ΔTERM) is defined as the monthly change in the difference between 10-year and 3-month constant-maturity Treasury yields. The credit risk factor (ΔCredSpr) 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 (Δ10Yr) is defined as the monthly change in 10-year constant-maturity Treasury yields. 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)

VOL Quintiles after controlling for credit rating	Average excess return	5-factor alpha	7-factor alpha with ΔDEF and ΔTERM	7-factor alpha with ΔCredSpr and and Δ10Yr	Average Portfolio Characteristics			
					Volatility	Rating	Maturity	Size
VOL,1	0.063	-0.040	-0.043	-0.039	4.873	7.258	10.273	0.259
	(0.65)	(-0.43)	(-0.43)	(-0.63)				
VOL,2	0.138	0.011	0.007	0.005	8.115	7.236	12.381	0.238
	(1.24)	(0.11)	(0.06)	(0.08)				
VOL,3	0.200	0.052	0.048	0.048	11.755	7.398	14.758	0.235
	(1.55)	(0.43)	(0.37)	(0.62)				
VOL,4	0.267	0.090	0.085	0.082	17.439	7.471	17.064	0.236
	(1.81)	(0.67)	(0.59)	(0.83)				
VOL,5	0.486	0.293	0.288	0.291	39.538	7.823	18.218	0.214
	(2.85)	(1.94)	(1.77)	(2.32)				
VOL,5 − VOL,1	0.423***	0.333***	0.331***	0.330***				
Return/Alpha diff.	(3.97)	(3.41)	(3.33)	(3.39)				

Table 3. (Continued)

Panel B: Quintile portfolios of corporate bonds sorted by VOL controlling for credit rating within subgroups

Investment Grade Bonds

VOL Quintiles after controlling for credit rating	Average excess return	5-factor alpha	7-factor alpha with ΔDEF and ΔTERM	7-factor alpha with ΔCredSpr and Δ10Yr
VOL,5 − VOL,1	0.284***	0.202**	0.200**	0.198**
Return/Alpha diff.	(3.32)	(2.31)	(2.30)	(2.49)

High Yield Bonds

VOL Quintiles after controlling for credit rating	Average excess return	5-factor alpha	7-factor alpha with ΔDEF and ΔTERM	7-factor alpha with ΔCredSpr and Δ10Yr
VOL,5 − VOL,1	0.732***	0.701***	0.714***	0.694***
Return/Alpha diff.	(3.84)	(3.92)	(4.14)	(3.96)

Table 4. Quintile Portfolios of Corporate Bonds Sorted by VOL Controlling for Time-to-Maturity

Quintile portfolios are formed every month from January 1975 to December 2012 by first sorting corporate bonds based on time-to-maturity. Then, within each maturity 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 maturity portfolio and "Quintile VOL, 5" is the portfolio of corporate bonds with the highest VOL within each maturity portfolio. Panel A reports the results for all bonds, and Panel B reports the results separately for 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). Table also reports the average VOL within each maturity 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 two bond market factors in addition to the five factors; the default spread factor (ΔDEF) is defined as the monthly change in the difference between the BAA-rated and AAA-rated corporate bond yields, and the term spread factor (ΔTERM) is defined as the monthly change in the difference between 10-year and 3-month constant-maturity Treasury yields. The credit risk factor (ΔCredSpr) 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 (Δ10Yr) is defined as the monthly change in 10-year constant-maturity Treasury yields. 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 maturity (all bonds)

VOL Quintiles after controlling for maturity	Average excess return	5-factor alpha	7-factor alpha with ΔDEF and ΔTERM	7-factor alpha with ΔCredSpr and and Δ10Yr	Average Portfolio Characteristics			
					Volatility	Rating	Maturity	Size
VOL,1	0.073	-0.016	-0.023	-0.007	5.484	6.673	13.884	0.259
	(0.69)	(-0.16)	(-0.22)	(-0.13)				
VOL,2	0.115	-0.005	-0.010	-0.013	7.981	6.324	14.360	0.254
	(1.02)	(-0.04)	(-0.09)	(-0.22)				
VOL,3	0.134	0.012	0.008	0.012	10.127	6.646	14.374	0.237
	(1.13)	(0.11)	(0.06)	(0.19)				
VOL,4	0.227	0.068	0.063	0.061	14.239	7.249	14.949	0.228
	(1.72)	(0.55)	(0.47)	(0.73)				
VOL,5	0.508	0.333	0.328	0.342	44.619	10.382	15.141	0.224
	(2.40)	(1.79)	(1.70)	(1.99)				
VOL,5 − VOL,1 Return/Alpha diff.	0.435***	0.349**	0.351**	0.349**				
	(2.75)	(2.38)	(2.52)	(2.41)				

Table 4. (Continued)

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

Short Maturity Bonds

VOL Quintiles after controlling for maturity	Average excess return	5-factor alpha	7-factor alpha with ΔDEF and ΔTERM	7-factor alpha with ΔCredSpr and Δ10Yr
VOL,5 − VOL,1	0.429*	0.377*	0.385**	0.388*
Return/Alpha diff.	(1.73)	(1.71)	(1.97)	(1.86)

Medium Maturity Bonds

VOL Quintiles after controlling for maturity	Average excess return	5-factor alpha	7-factor alpha with ΔDEF and ΔTERM	7-factor alpha with ΔCredSpr and Δ10Yr
VOL,5 − VOL,1	0.380*	0.336*	0.352**	0.360*
Return/Alpha diff.	(1.83)	(1.86)	(1.97)	(1.95)

Long Maturity Bonds

VOL Quintiles after controlling for maturity	Average excess return	5-factor alpha	7-factor alpha with ΔDEF and ΔTERM	7-factor alpha with ΔCredSpr and Δ10Yr
VOL,5 − VOL,1	0.451***	0.384***	0.390***	0.402***
Return/Alpha diff.	(3.60)	(3.24)	(3.41)	(3.27)

Table 5. Quintile Portfolios of Corporate Bonds Sorted by VOL Controlling for Size

Quintile portfolios are formed every month from January 1975 to December 2012 by first sorting corporate bonds based on amount outstanding (size, in billions of dollars). Then, within each size 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 size portfolio and "Quintile VOL, 5" is the portfolio of corporate bonds with the highest VOL within each size portfolio. Panel A reports the results for all bonds, and Panel B reports the results separately for small and large bonds. Size breakpoints are based on the median amount outstanding. Table also reports the average VOL within each size 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 two bond market factors in addition to the five factors; the default spread factor (ΔDEF) is defined as the monthly change in the difference between the BAA-rated and AAA-rated corporate bond yields, and the term spread factor (ΔTERM) is defined as the monthly change in the difference between 10-year and 3-month constant-maturity Treasury yields. The credit risk factor (ΔCredSpr) 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 (Δ10Yr) is defined as the monthly change in 10-year constant-maturity Treasury yields. 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 size (all bonds)

VOL Quintiles after controlling for size	Average excess return	5-factor alpha	7-factor alpha with ΔDEF and ΔTERM	7-factor alpha with ΔCredSpr and and Δ10Yr	Average Portfolio Characteristics: Volatility	Rating	Maturity	Size
VOL,1	0.007	-0.067	-0.074	-0.059	4.552	6.652	9.865	0.243
	(0.09)	(-0.81)	(-0.88)	(-1.12)				
VOL,2	0.141	0.022	0.017	0.015	7.571	6.682	12.738	0.236
	(1.42)	(0.23)	(0.18)	(0.26)				
VOL,3	0.172	0.041	0.037	0.041	10.383	6.803	15.065	0.250
	(1.55)	(0.38)	(0.35)	(0.67)				
VOL,4	0.238	0.077	0.071	0.069	15.362	7.263	17.464	0.238
	(1.98)	(0.66)	(0.62)	(0.89)				
VOL,5	0.511	0.327	0.321	0.337	44.789	9.957	16.986	0.246
	(3.15)	(2.09)	(2.07)	(2.36)				
VOL,5 − VOL,1	0.504***	0.395***	0.395***	0.396***				
Return/Alpha diff.	(4.21)	(3.23)	(3.27)	(3.23)				

Table 5. (Continued)

Panel B: Quintile portfolios of corporate bonds sorted by VOL controlling for size within subgroups

Small Bonds

VOL Quintiles after controlling for size	Average excess return	5-factor alpha	7-factor alpha with ΔDEF and ΔTERM	7-factor alpha with ΔCredSpr and Δ10Yr
VOL,5 − VOL,1	0.566***	0.519**	0.516**	0.522**
Return/Alpha diff.	(3.18)	(2.46)	(2.47)	(2.46)

Large Bonds

VOL Quintiles after controlling for size	Average excess return	5-factor alpha	7-factor alpha with ΔDEF and ΔTERM	7-factor alpha with ΔCredSpr and Δ10Yr
VOL,5 − VOL,1	0.346***	0.244**	0.245**	0.245**
Return/Alpha diff.	(3.24)	(2.38)	(2.43)	(2.38)

Table 6. 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 report 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 two bond market factors in addition to the five factors; the default spread factor (ΔDEF) is defined as the monthly change in the difference between the BAA-rated and AAA-rated corporate bond yields, and the term spread factor (ΔTERM) is defined as the monthly change in the difference between 10-year and 3-month constant-maturity Treasury yields. The credit risk factor (ΔCredSpr) 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 (Δ10Yr) is defined as the monthly change in 10-year constant-maturity Treasury yields. 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 excess return	5-factor alpha	7-factor alpha with ΔDEF and ΔTERM	7-factor alpha with ΔCredSpr and and Δ10Yr	Average Portfolio Characteristics			
					Skewness	Rating	Maturity	Size
SKEW,1	0.383	0.306	0.300	0.304	-0.874	8.615	13.183	0.248
	(3.35)	(2.64)	(2.60)	(3.11)				
SKEW,2	0.219	0.066	0.062	0.061	-0.221	7.362	14.974	0.248
	(1.94)	(0.62)	(0.59)	(0.82)				
SKEW,3	0.183	0.030	0.025	0.021	0.040	6.807	15.484	0.237
	(1.60)	(0.26)	(0.22)	(0.28)				
SKEW,4	0.182	0.018	0.014	0.012	0.325	6.834	15.312	0.232
	(1.64)	(0.17)	(0.13)	(0.19)				
SKEW,5	0.172	0.046	0.039	0.043	0.904	7.575	13.806	0.239
	(1.63)	(0.46)	(0.39)	(0.62)				
SKEW,5 − SKEW,1	-0.211***	-0.260***	-0.260***	-0.261***				
Return/Alpha diff.	(-3.76)	(-3.77)	(-3.84)	(-3.84)				

Table 7. Quintile Portfolios of Corporate Bonds 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 (ΔDEF) and the term spread factor (ΔTERM) in addition to the 5-factor. The 7-factor model (**M3**) includes the credit risk factor (ΔCredSpr) and the long-term interest rate factor (Δ10Yr) in addition to the 5-factor. The default spread factor (ΔDEF) is defined as the monthly change in the difference between the BAA-rated and AAA-rated corporate bond yields. The term spread factor (ΔTERM) is defined as the monthly change in the difference between 10-year and 3-month constant-maturity Treasury yields. The credit risk factor (ΔCredSpr) 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 (Δ10Yr) is defined as the monthly change in 10-year constant-maturity Treasury yields. 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)

Table 7. (Continued)

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 8. 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 two bond market factors in addition to the five factors; the default spread factor (ΔDEF) is defined as the monthly change in the difference between the BAA-rated and AAA-rated corporate bond yields, and the term spread factor (ΔTERM) is defined as the monthly change in the difference between 10-year and 3-month constant-maturity Treasury yields. The credit risk factor (ΔCredSpr) 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 (Δ10Yr) is defined as the monthly change in 10-year constant-maturity Treasury yields. 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 kurtosis	Average excess return	5-factor alpha	7-factor alpha with ΔDEF and ΔTERM	7-factor alpha with ΔCredSpr and Δ10Yr	Average Portfolio Characteristics: 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 9. Quintile Portfolios of Corporate Bonds 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 (ΔDEF) and the term spread factor (ΔTERM) in addition to the 5-factor. The 7-factor model (**M3**) includes the credit risk factor (ΔCredSpr) and the long-term interest rate factor (Δ10Yr) in addition to the 5-factor. The default spread factor (ΔDEF) is defined as the monthly change in the difference between the BAA-rated and AAA-rated corporate bond yields. The term spread factor (ΔTERM) is defined as the monthly change in the difference between 10-year and 3-month constant-maturity Treasury yields. The credit risk factor (ΔCredSpr) 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 (Δ10Yr) is defined as the monthly change in 10-year constant-maturity Treasury yields. 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)

Table 9. (Continued)

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 10. 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 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 scores correspond to 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 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)	0.008	**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 11. Univariate Portfolios of Corporate Bonds Sorted by Value-at-Risk (VaR)

Quintile portfolios are formed every month by sorting corporate bonds based on three Value-at-Risk (VaR) measures. 1% VaR (Panel A) is defined as the lowest monthly return observation over the past 60 months. 5% VaR (Panel B) is defined as the third lowest monthly return observation over the past 60 months. 10% VaR (Panel C) is defined as the sixth lowest monthly return observation over the past 60 months. The original VaR measures (1%, 5%, 10% VaR) are multiplied by -1. Quintile 1 is the portfolio with the lowest VaR, and Quintile 5 is the portfolio with the highest VaR. Table also reports the average VaR, 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 two bond market factors in addition to the five factors; the default spread factor (ΔDEF) is defined as the monthly change in the difference between the BAA-rated and AAA-rated corporate bond yields, and the term spread factor (ΔTERM) is defined as the monthly change in the difference between 10-year and 3-month constant-maturity Treasury yields. The credit risk factor (ΔCredSpr) 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 (Δ10Yr) is defined as the monthly change in 10-year constant-maturity Treasury yields. 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 1% VaR

Quintiles	Average VaR	Average excess return	5-factor alpha	7-factor alpha with ΔDEF and ΔTERM	7-factor alpha with ΔCredSpr and Δ10Yr	Average Portfolio Characteristics: Rating	Maturity	Size
Low VaR	3.711	0.030	-0.073	-0.077	-0.078	6.937	11.673	0.173
		(0.30)	(-0.74)	(-0.82)	(-1.06)			
2	5.354	0.235	0.109	0.104	0.101	6.751	14.021	0.188
		(1.57)	(0.77)	(0.75)	(0.91)			
3	6.596	0.267	0.197	0.192	0.189	6.724	15.977	0.187
		(1.70)	(1.16)	(1.11)	(1.26)			
4	8.220	0.218	0.096	0.094	0.093	7.286	17.557	0.175
		(1.51)	(0.64)	(0.64)	(0.74)			
High VaR	17.275	0.835	0.590	0.586	0.582	10.758	16.345	0.162
		(3.10)	(2.16)	(2.15)	(2.13)			
High − Low Return/Alpha diff.		0.805***	0.663**	0.663**	0.661**			
		(3.17)	(2.42)	(2.41)	(2.40)			

Table 11. (Continued)

Panel B: Quintile portfolios of corporate bonds sorted by 5% VaR

Quintiles	Average VaR	Average excess return	5-factor alpha	7-factor alpha with ΔDEF and ΔTERM	7-factor alpha with ΔCredSpr and Δ10Yr	Average Portfolio Characteristics		
						Rating	Maturity	Size
Low VaR	2.111	0.061	-0.059	-0.064	-0.063	7.550	11.472	0.178
		(0.59)	(-0.59)	(-0.66)	(-0.82)			
2	3.196	0.266	0.151	0.147	0.141	7.175	13.486	0.170
		(1.87)	(1.12)	(1.11)	(1.32)			
3	4.008	0.238	0.117	0.111	0.110	7.117	15.491	0.179
		(1.93)	(0.94)	(0.93)	(1.15)			
4	4.859	0.259	0.195	0.192	0.189	7.230	18.081	0.183
		(1.35)	(1.02)	(1.01)	(1.12)			
High VaR	8.670	0.955	0.767	0.764	0.764	10.118	17.827	0.179
		(2.83)	(2.15)	(2.13)	(2.14)			
High − Low Return/Alpha diff.		0.894***	0.826**	0.828**	0.826**			
		(2.76)	(2.34)	(2.36)	(2.34)			

Panel C: Quintile portfolios of corporate bonds sorted by 10% VaR

Quintiles	Average VaR	Average excess return	5-factor alpha	7-factor alpha with ΔDEF and ΔTERM	7-factor alpha with ΔCredSpr and Δ10Yr	Average Portfolio Characteristics		
						Rating	Maturity	Size
Low VaR	0.981	0.153	0.070	0.066	0.067	7.889	11.946	0.178
		(1.49)	(0.68)	(0.67)	(0.83)			
2	1.764	-0.138	-0.273	-0.279	-0.282	7.371	13.785	0.165
		(-0.86)	(-1.73)	(-1.81)	(-1.98)			
3	2.356	0.470	0.367	0.362	0.356	7.258	14.865	0.174
		(2.24)	(1.76)	(1.75)	(1.85)			
4	2.971	0.557	0.473	0.469	0.472	7.483	17.469	0.186
		(2.69)	(1.97)	(1.95)	(2.10)			
High VaR	4.782	1.067	0.969	0.965	0.967	9.395	18.543	0.187
		(3.37)	(2.86)	(2.83)	(2.89)			
High − Low Return/Alpha diff.		0.914***	0.899***	0.899***	0.900***			
		(3.05)	(2.73)	(2.72)	(2.71)			

Table 12. Quintile Portfolios of Corporate Bonds Sorted by 5% (VaR) Controlling for Credit Rating, Maturity, and Size

Quintile portfolios are formed every month 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 5% VaR, defined as the third lowest monthly return observation over the past 60 months multiplied by -1. "VaR,1" is the portfolio of corporate bonds with the lowest VaR within each quintile portfolio and "VaR, 5" is the portfolio of corporate bonds with the highest VaR 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 (ΔDEF) and the term spread factor (ΔTERM) in addition to the 5-factor. The 7-factor model (**M3**) includes the credit risk factor (ΔCredSpr) and the long-term interest rate factor (Δ10Yr) in addition to the 5-factor. The default spread factor (ΔDEF) is defined as the monthly change in the difference between the BAA-rated and AAA-rated corporate bond yields. The term spread factor (ΔTERM) is defined as the monthly change in the difference between 10-year and 3-month constant-maturity Treasury yields. The credit risk factor (ΔCredSpr) 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 (Δ10Yr) is defined as the monthly change in 10-year constant-maturity Treasury yields. 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 5% VaR controlling for credit rating

	All Bonds			Investment Grade			High Yield		
	M1	M2	M3	M1	M2	M3	M1	M2	M3
VaR, 1	-0.029	-0.033	-0.034	-0.092	-0.096	-0.098	0.026	0.021	0.044
	(-0.27)	(-0.29)	(-0.42)	(-0.95)	(-0.92)	(-1.49)	(0.18)	(0.14)	(0.35)
VaR, 2	0.037	0.033	0.033	0.056	0.052	0.050	0.003	0.004	0.001
	(0.34)	(0.28)	(0.44)	(0.52)	(0.45)	(0.79)	(0.02)	(0.03)	(0.01)
VaR, 3	0.144	0.140	0.139	0.073	0.068	0.065	0.241	0.241	0.255
	(1.10)	(1.00)	(1.42)	(0.61)	(0.53)	(0.92)	(1.23)	(1.24)	(1.47)
VaR, 4	0.205	0.200	0.199	0.134	0.126	0.124	0.473	0.470	0.472
	(1.46)	(1.34)	(1.92)	(1.06)	(0.97)	(1.84)	(2.29)	(2.29)	(2.43)
VaR, 5	0.404	0.399	0.400	0.243	0.238	0.239	0.956	0.961	0.973
	(2.21)	(2.10)	(2.63)	(1.50)	(1.41)	(2.01)	(3.73)	(3.82)	(3.99)
VaR, 5 − VaR,1	0.433***	0.432***	0.433***	0.335***	0.334***	0.337***	0.930***	0.940***	0.929***
Return/Alpha diff.	(3.18)	(3.19)	(3.31)	(2.81)	(2.85)	(2.99)	(4.54)	(4.65)	(4.62)

Table 12. (Continued)

Panel B: Quintile portfolios of corporate bonds sorted by 5% VaR 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
VaR, 1	0.019	0.012	0.013	0.023	0.050	-0.015	0.113	0.136	0.045	-0.025	-0.038	-0.047
	(0.16)	(0.09)	(0.15)	(0.35)	(0.85)	(-0.26)	(1.16)	(1.39)	(0.62)	(-0.17)	(-0.26)	(-0.43)
VaR, 2	0.038	0.033	0.032	-0.058	-0.038	-0.097	0.020	0.019	-0.012	0.049	0.044	0.043
	(0.35)	(0.29)	(0.57)	(-0.71)	(-0.48)	(-1.31)	(0.21)	(0.18)	(-0.19)	(0.38)	(0.33)	(0.68)
VaR, 3	0.118	0.114	0.110	-0.326	-0.309	-0.354	0.192	0.189	0.155	0.124	0.120	0.115
	(0.92)	(0.83)	(1.22)	(-0.97)	(-0.92)	(-1.08)	(1.34)	(1.25)	(1.25)	(0.91)	(0.85)	(1.39)
VaR, 4	0.117	0.112	0.112	0.100	0.123	0.059	0.036	0.054	0.003	0.103	0.098	0.099
	(0.87)	(0.78)	(1.09)	(0.45)	(0.55)	(0.27)	(0.26)	(0.36)	(0.03)	(0.73)	(0.68)	(1.00)
VaR, 5	0.680	0.673	0.679	0.358	0.397	0.323	0.799	0.863	0.732	0.549	0.539	0.539
	(2.68)	(2.63)	(2.84)	(1.42)	(1.74)	(1.30)	(2.32)	(2.56)	(2.21)	(2.20)	(2.12)	(2.33)
VaR, 5 − VaR,1	0.661***	0.660***	0.666***	0.336	0.347*	0.337	0.686**	0.727**	0.687**	0.574***	0.577***	0.586***
Return/Alpha diff.	(2.95)	(3.03)	(3.00)	(1.53)	(1.73)	(1.57)	(2.26)	(2.40)	(2.27)	(2.73)	(2.83)	(2.80)

Panel C: Quintile portfolios of corporate bonds sorted by 5% VaR controlling for size

	All Bonds			Small Bonds			Large Bonds		
	M1	M2	M3	M1	M2	M3	M1	M2	M3
VaR, 1	-0.072	-0.079	-0.076	-0.028	-0.034	-0.015	-0.029	-0.037	-0.032
	(-0.75)	(-0.76)	(-1.16)	(-0.28)	(-0.32)	(-0.22)	(-0.28)	(-0.34)	(-0.51)
VaR, 2	0.077	0.072	0.071	0.014	0.009	0.007	-0.002	-0.010	-0.007
	(0.69)	(0.60)	(1.05)	(0.12)	(0.07)	(0.09)	(-0.02)	(-0.09)	(-0.10)
VaR, 3	0.016	0.012	0.008	0.068	0.062	0.054	0.043	0.033	0.038
	(0.13)	(0.09)	(0.10)	(0.54)	(0.47)	(0.62)	(0.34)	(0.25)	(0.53)
VaR, 4	0.153	0.148	0.147	0.168	0.164	0.162	0.072	0.063	0.069
	(1.16)	(1.07)	(1.65)	(1.08)	(0.99)	(1.21)	(0.51)	(0.42)	(0.72)
VaR, 5	0.687	0.681	0.685	0.673	0.662	0.671	0.481	0.472	0.478
	(2.49)	(2.44)	(2.65)	(2.21)	(2.15)	(2.31)	(1.82)	(1.74)	(1.93)
VaR, 5 − VaR,1	0.758***	0.760***	0.760***	0.701**	0.696**	0.686**	0.510**	0.509**	0.510**
Return/Alpha diff.	(3.03)	(3.07)	(3.05)	(2.48)	(2.54)	(2.51)	(2.21)	(2.22)	(2.19)

Table 13. Fama-MacBeth Cross-Sectional Regressions with VaR

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 three VaR measures, with and without the control variables. 1% VaR is defined as the lowest monthly return observation over the past 60 months. 5% VaR is defined as the third lowest monthly return observation over the past 60 months. 10% VaR is defined as the sixth lowest monthly return observation over the past 60 months. The original VaR measures (1%, 5%, 10% VaR) are multiplied by -1. 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 scores correspond to 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. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

	Intercept	1% VaR	5% VaR	10% VaR	Rating	Maturity	Size	Lagged Return	Adj. R^2
(1)	-0.194	0.049***							0.046
	(-1.63)	(4.92)							
(2)	-0.212		0.096***						0.035
	(-2.00)		(4.82)						
(3)	-0.186			0.156***					0.033
	(-1.78)			(4.63)					
(4)	-0.214	0.038***			0.010	0.003	-0.285	-0.147***	0.159
	(-1.57)	(4.09)			(0.82)	(1.16)	(-0.84)	(-8.78)	
(5)	-0.211		0.082***		0.014	0.000	-0.359	-0.146***	0.163
	(-1.53)		(4.73)		(1.22)	(0.11)	(-1.00)	(-7.70)	
(6)	-0.204			0.109***	0.023*	0.001	-0.446	-0.148***	0.162
	(-1.48)			(3.94)	(1.89)	(0.29)	(-1.22)	(-7.52)	

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 the results on the quintile portfolios of corporate bonds sorted by VOL within investment-grade bonds. Table A.3 presents the results on the quintile portfolios of corporate bonds sorted by VOL within non-investment-grade bonds. Table A.4 presents the results on the quintile portfolios of corporate bonds sorted by VOL within short-, medium-, and long-maturity bonds. Table A.5 presents the results on the quintile portfolios of corporate bonds sorted by VOL within small and large bonds. Table A.6 presents the results on the quintile portfolios of corporate bonds sorted by VOL controlling for SKEW. Table A.7 presents the results on the trivariate portfolios of corporate bons sorted by VOL, SKEW, and KURT. Table A.8 presents the results on the quintile portfolios of corporate bonds sorted by 5%VaR within investment-grade bonds. Table A.9 presents the results on the quintile portfolios of corporate bonds sorted by 5%VaR within non-investment-grade bonds. Table A.10 presents the results on the quintile portfolios of corporate bonds sorted by 1%VaR controlling for credit rating, maturity, and size. Table A.11 presents the results on the quintile portfolios of corporate bonds sorted by 10%VaR controlling for credit rating, maturity, and size. Table A.12 presents the results from the Fama-MacBeth regressions of longer term bond returns on VOL, SKEW, and KURT. Table A.13 presents the results from the Fama-MacBeth regressions of longer term bond returns on 1%VaR, 5%VaR, and 10%VaR. Table A.14 presents transaction cost estimates for bond portfolios sorted by VOL and VAR. Table A.15 presents the results from the Fama-MacBeth regressions of one-month-ahead corporate bond excess returns on the corporate bonds total variance or volatility (VOL), skewness (SKEW), kurtosis (KURT), and the illiquidity measure (L^{BPW}) in Bao, Pan, and Wang (2011). Table A.16 presents the results from the Fama-MacBeth regressions of one-month-ahead corporate bond excess returns on three VaR measures, and the illiquidity measure (L^{BPW}) in Bao, Pan, and Wang (2011). Table A.17 presents the results from the Fama-MacBeth regressions with VOL, SKEW, KURT, and liquidity beta. Table A.18 presents the results from the Fama-MacBeth regressions with VaR and liquidity beta.

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

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

Start	End	Data Source	Unique Issuers	Unique Bonds	Bond-Month Obs	Monthly Average Issuers	Monthly Average 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. Univariate Portfolios of Corporate Bonds Sorted by Volatility (VOL) Within 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 two bond market factors in addition to the five factors; the default spread factor (ΔDEF) is defined as the monthly change in the difference between the BAA-rated and AAA-rated corporate bond yields, and the term spread factor (ΔTERM) is defined as the monthly change in the difference between 10-year and 3-month constant-maturity Treasury yields. The credit risk factor (ΔCredSpr) 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 (Δ10Yr) is defined as the monthly change in 10-year constant-maturity Treasury yields. 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 ΔDEF and ΔTERM	7-factor alpha with ΔCredSpr and Δ10Yr	Average Portfolio Characteristics		
						Rating	Maturity	Size
Low VOL	4.440	0.031	-0.063	-0.067	-0.067	5.888	9.837	0.272
		(0.33)	(-0.71)	(-0.70)	(-1.20)			
2	7.169	0.124	0.015	0.010	0.008	5.902	12.450	0.242
		(1.15)	(0.14)	(0.09)	(0.14)			
3	9.561	0.139	0.004	-0.002	-0.002	5.862	15.250	0.242
		(1.16)	(0.03)	(-0.01)	(-0.04)			
4	12.678	0.204	0.048	0.042	0.040	5.888	17.980	0.233
		(1.56)	(0.39)	(0.33)	(0.62)			
High VOL	27.592	0.439	0.295	0.289	0.287	6.472	20.240	0.229
		(2.77)	(1.89)	(1.75)	(2.54)			
High − Low		0.408***	0.358***	0.356***	0.354***			
Return/Alpha diff.		(4.06)	(3.30)	(3.28)	(3.47)			

Table A.3. Univariate Portfolios of Corporate Bonds Sorted by Volatility (VOL) Within 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 two bond market factors in addition to the five factors; the default spread factor (ΔDEF) is defined as the monthly change in the difference between the BAA-rated and AAA-rated corporate bond yields, and the term spread factor (ΔTERM) is defined as the monthly change in the difference between 10-year and 3-month constant-maturity Treasury yields. The credit risk factor (ΔCredSpr) 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 (Δ10Yr) is defined as the monthly change in 10-year constant-maturity Treasury yields. 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 ΔDEF and ΔTERM	7-factor alpha with ΔCredSpr and Δ10Yr	Average Portfolio Characteristics		
						Rating	Maturity	Size
Low VOL	6.379	0.086	-0.021	-0.023	-0.006	13.359	9.164	0.204
		(0.75)	(-0.19)	(-0.21)	(-0.07)			
2	12.108	0.191	0.028	0.028	0.039	13.560	13.338	0.222
		(1.48)	(0.23)	(0.23)	(0.43)			
3	20.037	0.396	0.225	0.223	0.239	13.894	14.108	0.213
		(2.26)	(1.29)	(1.27)	(1.53)			
4	35.619	0.378	0.133	0.142	0.147	14.757	13.730	0.225
		(1.61)	(0.66)	(0.77)	(0.81)			
High VOL	104.489	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.4. Quintile Portfolios of Corporate Bonds Sorted by VOL Controlling for Time-to-Maturity

Quintile portfolios are formed every month from January 1975 to December 2012 by first sorting corporate bonds based on time-to-maturity. Then, within each maturity 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 maturity portfolio and "Quintile VOL, 5" is the portfolio of corporate bonds with the highest VOL within each maturity portfolio. Panel A reports the results for all bonds, and Panel B reports the results separately for 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). Table also reports the average VOL within each maturity 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 two bond market factors in addition to the five factors; the default spread factor (ΔDEF) is defined as the monthly change in the difference between the BAA-rated and AAA-rated corporate bond yields, and the term spread factor (ΔTERM) is defined as the monthly change in the difference between 10-year and 3-month constant-maturity Treasury yields. The credit risk factor (ΔCredSpr) 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 (Δ10Yr) is defined as the monthly change in 10-year constant-maturity Treasury yields. 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.

VOL Quintiles after controlling for maturity	Average excess return	5-factor alpha	7-factor alpha with ΔDEF and ΔTERM	7-factor alpha with ΔCredSpr and and Δ10Yr	Average Portfolio Characteristics: Volatility	Rating	Maturity	Size
Panel A: Short Maturity Bonds								
VOL,1	0.070	0.040	0.072	-0.003	2.196	6.695	3.362	0.301
	(1.09)	(0.63)	(1.24)	(-0.05)				
VOL,2	0.047	0.008	0.028	-0.031	6.882	7.292	3.376	0.314
	(0.50)	(0.08)	(0.30)	(-0.35)				
VOL,3	-0.276	-0.351	-0.336	-0.387	16.006	8.033	3.371	0.299
	(-1.02)	(-1.24)	(-1.19)	(-1.40)				
VOL,4	-0.102	-0.145	-0.121	-0.184	19.298	8.636	3.404	0.250
	(-0.49)	(-0.67)	(-0.56)	(-0.88)				
VOL,5	0.499	0.417	0.457	0.385	44.237	11.491	3.406	0.231
	(1.68)	(1.61)	(2.02)	(1.58)				
VOL,5 − VOL,1	0.429*	0.377*	0.385**	0.388*				
Return/Alpha diff.	(1.73)	(1.71)	(1.97)	(1.86)				

Table A.4. (Continued)

VOL Quintiles after controlling for maturity	Average excess return	5-factor alpha	7-factor alpha with ΔDEF and ΔTERM	7-factor alpha with ΔCredSpr and and Δ10Yr	Average Portfolio Characteristics			
					Volatility	Rating	Maturity	Size
			Panel B: Medium Maturity Bonds					
VOL,1	0.145	0.059	0.088	-0.011	4.218	7.671	7.163	0.295
	(1.56)	(0.64)	(1.01)	(-0.18)				
VOL,2	0.073	-0.011	-0.010	-0.036	6.050	7.069	7.367	0.292
	(0.70)	(-0.11)	(-0.09)	(-0.57)				
VOL,3	0.258	0.150	0.147	0.118	8.367	7.256	7.449	0.288
	(2.01)	(1.22)	(1.17)	(1.29)				
VOL,4	0.153	0.035	0.037	0.011	12.639	7.965	7.406	0.252
	(1.11)	(0.27)	(0.27)	(0.11)				
VOL,5	0.525	0.395	0.440	0.349	45.701	11.566	7.291	0.234
	(2.08)	(1.76)	(2.04)	(1.62)				
VOL,5 − VOL,1	0.380*	0.336*	0.352**	0.360*				
Return/Alpha diff.	(1.83)	(1.86)	(1.97)	(1.95)				
			Panel C: Long Maturity Bonds					
VOL,1	0.112	0.015	0.001	-0.005	7.243	6.332	20.912	0.212
	(0.92)	(0.12)	(0.01)	(-0.08)				
VOL,2	0.156	0.025	0.019	0.016	10.036	6.074	20.769	0.221
	(1.23)	(0.20)	(0.15)	(0.25)				
VOL,3	0.138	-0.007	-0.011	0.001	12.667	6.443	21.047	0.222
	(1.03)	(-0.06)	(-0.09)	(0.01)				
VOL,4	0.229	0.049	0.043	0.039	16.850	6.863	21.279	0.231
	(1.61)	(0.37)	(0.31)	(0.50)				
VOL,5	0.563	0.399	0.391	0.397	44.881	9.296	23.104	0.225
	(2.81)	(2.23)	(2.09)	(2.54)				
VOL,5 − VOL,1	0.451***	0.384***	0.390***	0.402***				
Return/Alpha diff.	(3.60)	(3.24)	(3.41)	(3.27)				

Table A.5. Quintile Portfolios of Corporate Bonds Sorted by VOL Controlling for Size

Quintile portfolios are formed every month from January 1975 to December 2012 by first sorting corporate bonds based on amount outstanding (size, in billions of dollars). Then, within each size 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 size portfolio and "Quintile VOL, 5" is the portfolio of corporate bonds with the highest VOL within each size portfolio. Panel A reports the results for all bonds, and Panel B reports the results separately for small and large bonds. Size breakpoints are based on the median amount outstanding. Table also reports the average VOL within each size 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 two bond market factors in addition to the five factors; the default spread factor (ΔDEF) is defined as the monthly change in the difference between the BAA-rated and AAA-rated corporate bond yields, and the term spread factor (ΔTERM) is defined as the monthly change in the difference between 10-year and 3-month constant-maturity Treasury yields. The credit risk factor (ΔCredSpr) 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 (Δ10Yr) is defined as the monthly change in 10-year constant-maturity Treasury yields. 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.

VOL Quintiles after controlling for size	Average excess return	5-factor alpha	7-factor alpha with ΔDEF and ΔTERM	7-factor alpha with ΔCredSpr and and Δ10Yr	Average Portfolio Characteristics			
					Volatility	Rating	Maturity	Size
Panel A: Small Bonds								
VOL,1	0.027	-0.057	-0.064	-0.046	4.962	6.579	9.670	0.091
	(0.32)	(-0.66)	(-0.76)	(-0.78)				
VOL,2	0.149	0.004	-0.001	0.001	8.151	6.648	12.820	0.090
	(1.51)	(0.04)	(-0.02)	(0.01)				
VOL,3	0.161	0.036	0.031	0.024	11.613	6.723	14.576	0.091
	(1.42)	(0.32)	(0.29)	(0.33)				
VOL,4	0.234	0.030	0.025	0.028	19.093	7.428	16.062	0.091
	(1.65)	(0.21)	(0.18)	(0.24)				
VOL,5	0.593	0.462	0.452	0.476	55.921	10.318	15.445	0.091
	(2.75)	(1.92)	(1.89)	(2.02)				
VOL,5 − VOL,1	0.566***	0.519**	0.516**	0.522**				
Return/Alpha diff.	(3.18)	(2.46)	(2.47)	(2.46)				

Table A.5. (Continued)

VOL Quintiles after controlling for size	Average excess return	5-factor alpha	7-factor alpha with ΔDEF and ΔTERM	7-factor alpha with ΔCredSpr and and Δ10Yr	Average Portfolio Characteristics			
					Volatility	Rating	Maturity	Size
Panel B: Large Bonds								
VOL,1	0.023	-0.064	-0.073	-0.055	4.831	6.074	10.729	0.354
	(0.25)	(-0.69)	(-0.79)	(-0.98)				
VOL,2	0.100	0.006	-0.004	0.007	7.461	6.259	13.415	0.351
	(0.94)	(0.06)	(-0.04)	(0.12)				
VOL,3	0.137	0.023	0.014	0.018	10.143	6.132	16.203	0.361
	(1.17)	(0.20)	(0.13)	(0.27)				
VOL,4	0.182	0.053	0.043	0.055	14.230	6.540	18.892	0.352
	(1.43)	(0.43)	(0.36)	(0.73)				
VOL,5	0.370	0.180	0.172	0.191	36.835	8.820	18.441	0.353
	(2.37)	(1.24)	(1.21)	(1.55)				
VOL,5 − VOL,1 Return/Alpha diff.	0.346***	0.244**	0.245**	0.245**				
	(3.24)	(2.38)	(2.43)	(2.38)				

Table A.6. Quintile Portfolios of Corporate Bonds Sorted by VOL Controlling for SKEW

Quintile portfolios are formed every month from January 1975 to December 2012 by first sorting corporate bonds based on their 60-month rolling skewness ($SKEW$). Then, within each skewness portfolio, corporate bonds are sorted into sub-quintiles based on their 60-month total variance (VOL). "Quintile VOL,1" is the portfolio of corporate bonds with the lowest VOL within each skewness portfolio and "Quintile VOL, 5" is the portfolio of corporate bonds with the highest VOL within each skewness portfolio. Table also reports the average VOL within each skewness 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 two bond market factors in addition to the five factors; the default spread factor (ΔDEF) is defined as the monthly change in the difference between the BAA-rated and AAA-rated corporate bond yields, and the term spread factor (ΔTERM) is defined as the monthly change in the difference between 10-year and 3-month constant-maturity Treasury yields. The credit risk factor (ΔCredSpr) 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 (Δ10Yr) is defined as the monthly change in 10-year constant-maturity Treasury yields. 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.

VOL Quintiles after	Average	5-factor	7-factor alpha	7-factor alpha	Average Portfolio Characteristics			
controlling for $SKEW$	excess return	alpha	with ΔDEF and ΔTERM	with ΔCredSpr and and Δ10Yr	Volatility	Rating	Maturity	Size
VOL,1	0.042	-0.030	-0.037	-0.033	4.763	6.584	9.984	0.267
	(0.43)	(-0.33)	(-0.37)	(-0.58)				
VOL,2	0.105	-0.020	-0.025	-0.026	7.822	6.597	12.627	0.240
	(0.96)	(-0.19)	(-0.22)	(-0.43)				
VOL,3	0.170	0.042	0.037	0.032	10.726	6.771	15.113	0.236
	(1.39)	(0.37)	(0.30)	(0.50)				
VOL,4	0.237	0.075	0.071	0.070	16.085	7.493	17.400	0.232
	(1.73)	(0.59)	(0.52)	(0.82)				
VOL,5	0.584	0.405	0.398	0.403	43.571	9.778	17.740	0.225
	(2.79)	(2.17)	(2.08)	(2.41)				
VOL,5 − VOL,1	0.542***	0.435***	0.435***	0.436***				
Return/Alpha diff.	(3.52)	(3.07)	(3.25)	(3.12)				

Table A.7. 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 two bond market factors in addition to the five factors; the default spread factor (ΔDEF) is defined as the monthly change in the difference between the BAA-rated and AAA-rated corporate bond yields, and the term spread factor (ΔTERM) is defined as the monthly change in the difference between 10-year and 3-month constant-maturity Treasury yields. The credit risk factor (ΔCredSpr) 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 (Δ10Yr) is defined as the monthly change in 10-year constant-maturity Treasury yields. 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 ΔDEF and ΔTERM	7-factor alpha with ΔCredSpr and and Δ10Yr	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 Return/Alpha diff.	0.117	0.149	0.150	0.150				
	(1.33)	(1.48)	(1.50)	(1.50)				

Table A.8. Univariate Portfolios of Corporate Bonds Sorted by 5% Value-at-Risk (VaR) Within Investment-Grade Bonds

Quintile portfolios are formed every month by sorting corporate bonds based on 5% VaR, defined as the third lowest monthly return observation over the past 60 months, within investment-grade bonds. The original 5% VaR measure is multiplied by -1. Quintile 1 is the portfolio with the lowest VaR, and Quintile 5 is the portfolio with the highest VaR. Table also reports the average VaR, 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 two bond market factors in addition to the five factors; the default spread factor (ΔDEF) is defined as the monthly change in the difference between the BAA-rated and AAA-rated corporate bond yields, and the term spread factor (ΔTERM) is defined as the monthly change in the difference between 10-year and 3-month constant-maturity Treasury yields. The credit risk factor (ΔCredSpr) 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 (Δ10Yr) is defined as the monthly change in 10-year constant-maturity Treasury yields. 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 5% VaR

Quintiles	Average VaR	Average excess return	5-factor alpha	7-factor alpha with ΔDEF and ΔTERM	7-factor alpha with ΔCredSpr and Δ10Yr	Average Portfolio Characteristics		
						Rating	Maturity	Size
Low VaR	2.121	0.060	-0.059	-0.063	-0.065	6.109	11.319	0.187
		(0.61)	(-0.62)	(-0.68)	(-0.97)			
2	3.142	0.191	0.072	0.068	0.066	6.080	13.460	0.169
		(1.79)	(0.69)	(0.66)	(1.02)			
3	3.876	0.316	0.182	0.175	0.169	5.938	15.670	0.182
		(2.19)	(1.25)	(1.26)	(1.58)			
4	4.610	0.130	0.006	-0.002	-0.006	5.858	17.847	0.186
		(0.87)	(0.04)	(-0.01)	(-0.05)			
High VaR	6.156	0.410	0.297	0.293	0.297	6.369	21.089	0.190
		(2.95)	(1.85)	(1.82)	(2.23)			
High VaR − Low VaR Return/Alpha diff.		0.349***	0.356***	0.356***	0.362***			
		(3.48)	(2.63)	(2.73)	(2.79)			

Table A.9. Univariate Portfolios of Corporate Bonds Sorted by 5% Value-at-Risk (VaR) Within Non-Investment-Grade Bonds

Quintile portfolios are formed every month by sorting corporate bonds based on 5% VaR, defined as the third lowest monthly return observation over the past 60 months, within non-investment-grade bonds. The original 5% VaR measure is multiplied by -1. Quintile 1 is the portfolio with the lowest VaR, and Quintile 5 is the portfolio with the highest VaR. Table also reports the average VaR, 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 two bond market factors in addition to the five factors; the default spread factor (ΔDEF) is defined as the monthly change in the difference between the BAA-rated and AAA-rated corporate bond yields, and the term spread factor (ΔTERM) is defined as the monthly change in the difference between 10-year and 3-month constant-maturity Treasury yields. The credit risk factor (ΔCredSpr) 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 (Δ10Yr) is defined as the monthly change in 10-year constant-maturity Treasury yields. 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 5% VaR

Quintiles	Average VaR	Average excess return	5-factor alpha	7-factor alpha with ΔDEF and ΔTERM	7-factor alpha with ΔCredSpr and Δ10Yr	Average Portfolio Characteristics		
						Rating	Maturity	Size
Low VaR	2.253	0.137	0.074	0.071	0.088	13.821	10.071	0.175
		(1.22)	(0.62)	(0.59)	(0.81)			
2	3.754	0.258	0.006	0.003	0.007	13.730	12.759	0.194
		(1.30)	(0.03)	(0.02)	(0.04)			
3	5.106	0.313	0.204	0.203	0.217	13.989	13.551	0.177
		(1.50)	(0.96)	(0.96)	(1.07)			
4	6.937	0.952	0.642	0.647	0.659	14.249	15.568	0.195
		(2.78)	(1.89)	(1.92)	(1.96)			
High VaR	13.624	1.602	1.235	1.231	1.234	15.986	13.471	0.191
		(3.41)	(2.54)	(2.52)	(2.52)			
High VaR − Low VaR Return/Alpha diff.		1.465***	1.161**	1.160**	1.146**			
		(3.27)	(2.47)	(2.46)	(2.44)			

Table A.10. Portfolios of Corporate Bonds Sorted by 1% VaR Controlling for Bond Characteristics

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 1% VaR, defined as the lowest monthly return observation over the past 60 months multiplied by -1. "VaR,1" is the portfolio of corporate bonds with the lowest VaR within each quintile portfolio and "VaR, 5" is the portfolio of corporate bonds with the highest VaR 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 (ΔDEF) and the term spread factor (ΔTERM) in addition to the 5-factor. The 7-factor model (**M3**) includes the credit risk factor (ΔCredSpr) and the long-term interest rate factor (Δ10Yr) in addition to the 5-factor. The default spread factor (ΔDEF) is defined as the monthly change in the difference between the BAA-rated and AAA-rated corporate bond yields. The term spread factor (ΔTERM) is defined as the monthly change in the difference between 10-year and 3-month constant-maturity Treasury yields. The credit risk factor (ΔCredSpr) 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 (Δ10Yr) is defined as the monthly change in 10-year constant-maturity Treasury yields. 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 1% VaR controlling for credit rating

	All Bonds			Investment Grade			High Yield		
	M1	M2	M3	M1	M2	M3	M1	M2	M3
VaR, 1	-0.028	-0.032	-0.033	-0.054	-0.058	-0.054	0.029	0.031	0.054
	(-0.26)	(-0.27)	(-0.40)	(-0.56)	(-0.55)	(-0.85)	(0.18)	(0.20)	(0.39)
VaR, 2	0.050	0.046	0.045	0.045	0.040	0.037	0.035	0.034	0.033
	(0.45)	(0.39)	(0.63)	(0.42)	(0.35)	(0.69)	(0.25)	(0.24)	(0.26)
VaR, 3	0.071	0.067	0.067	0.092	0.087	0.084	0.119	0.120	0.126
	(0.60)	(0.53)	(0.86)	(0.69)	(0.62)	(0.97)	(0.69)	(0.70)	(0.81)
VaR, 4	0.174	0.169	0.166	0.121	0.116	0.113	0.427	0.427	0.431
	(1.08)	(0.98)	(1.24)	(0.99)	(0.89)	(1.57)	(2.02)	(2.06)	(2.21)
VaR, 5	0.465	0.461	0.460	0.260	0.255	0.254	1.066	1.062	1.073
	(2.75)	(2.61)	(3.30)	(1.68)	(1.58)	(2.29)	(3.62)	(3.58)	(3.74)
VaR, 5 − VaR,1	0.493***	0.492***	0.493***	0.314***	0.313***	0.308***	1.037***	1.031***	1.019***
Return/Alpha diff.	(4.40)	(4.40)	(4.51)	(3.28)	(3.30)	(3.53)	(4.65)	(4.65)	(4.65)

Table A.10. (Continued)

Panel B: Quintile portfolios of corporate bonds sorted by 1% VaR 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
VaR, 1	0.014	0.006	0.009	0.063	0.096	0.023	0.063	0.089	-0.013	0.065	0.052	0.054
	(0.13)	(0.05)	(0.14)	(0.85)	(1.44)	(0.34)	(0.66)	(0.94)	(-0.21)	(0.51)	(0.40)	(0.74)
VaR, 2	0.123	0.118	0.116	-0.038	-0.021	-0.084	-0.002	-0.000	-0.032	0.117	0.113	0.111
	(0.87)	(0.80)	(1.09)	(-0.39)	(-0.22)	(-0.92)	(-0.01)	(-0.00)	(-0.28)	(0.82)	(0.76)	(1.20)
VaR, 3	0.001	-0.002	-0.006	-0.393	-0.372	-0.426	0.133	0.128	0.094	0.060	0.057	0.052
	(0.01)	(-0.01)	(-0.08)	(-1.18)	(-1.12)	(-1.31)	(1.12)	(1.02)	(1.01)	(0.46)	(0.41)	(0.66)
VaR, 4	0.127	0.123	0.123	-0.002	0.021	-0.035	0.099	0.117	0.066	0.010	0.006	0.006
	(1.01)	(0.91)	(1.46)	(-0.01)	(0.09)	(-0.15)	(0.69)	(0.78)	(0.55)	(0.07)	(0.04)	(0.06)
VaR, 5	0.660	0.653	0.657	0.473	0.500	0.447	0.895	0.952	0.826	0.603	0.592	0.592
	(2.74)	(2.64)	(2.88)	(2.09)	(2.40)	(2.03)	(2.57)	(2.77)	(2.44)	(2.65)	(2.51)	(2.87)
VaR, 5 − VaR,1	0.646***	0.646***	0.648***	0.410**	0.404**	0.424**	0.832***	0.863***	0.839***	0.538***	0.540***	0.538***
Return/Alpha diff.	(3.16)	(3.21)	(3.19)	(2.28)	(2.40)	(2.42)	(2.62)	(2.74)	(2.68)	(3.07)	(3.10)	(3.09)

Panel C: Quintile portfolios of corporate bonds sorted by 1% VaR controlling for size

	All Bonds			Small Bonds			Large Bonds		
	M1	M2	M3	M1	M2	M3	M1	M2	M3
VaR, 1	-0.066	-0.072	-0.069	-0.066	-0.072	-0.069	-0.042	-0.051	-0.046
	(-0.67)	(-0.69)	(-1.09)	(-0.67)	(-0.69)	(-1.09)	(-0.40)	(-0.45)	(-0.68)
VaR, 2	0.028	0.024	0.022	0.028	0.024	0.022	-0.012	-0.020	-0.017
	(0.25)	(0.20)	(0.31)	(0.25)	(0.20)	(0.31)	(-0.10)	(-0.16)	(-0.27)
VaR, 3	0.069	0.066	0.062	0.069	0.066	0.062	0.026	0.015	0.020
	(0.59)	(0.53)	(0.85)	(0.59)	(0.53)	(0.85)	(0.21)	(0.12)	(0.29)
VaR, 4	0.121	0.117	0.116	0.121	0.117	0.116	0.099	0.089	0.095
	(0.88)	(0.80)	(1.17)	(0.88)	(0.80)	(1.17)	(0.73)	(0.62)	(1.13)
VaR, 5	0.662	0.654	0.656	0.662	0.654	0.656	0.508	0.500	0.506
	(2.73)	(2.64)	(2.91)	(2.73)	(2.64)	(2.91)	(2.10)	(2.01)	(2.26)
VaR, 5 − VaR,1	0.727***	0.727***	0.726***	0.727***	0.727***	0.726***	0.550***	0.551***	0.552***
Return/Alpha diff.	(3.41)	(3.41)	(3.39)	(3.41)	(3.41)	(3.39)	(2.70)	(2.71)	(2.68)

Table A.11. Portfolios of Corporate Bonds Sorted by 10% VaR Controlling for Bond Characteristics

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 10% VaR, defined as the sixth lowest monthly return observation over the past 60 months multiplied by -1. "VaR,1" is the portfolio of corporate bonds with the lowest VaR within each quintile portfolio and "VaR, 5" is the portfolio of corporate bonds with the highest VaR 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 (ΔDEF) and the term spread factor (ΔTERM) in addition to the 5-factor. The 7-factor model (**M3**) includes the credit risk factor (ΔCredSpr) and the long-term interest rate factor (Δ10Yr) in addition to the 5-factor. The default spread factor (ΔDEF) is defined as the monthly change in the difference between the BAA-rated and AAA-rated corporate bond yields. The term spread factor (ΔTERM) is defined as the monthly change in the difference between 10-year and 3-month constant-maturity Treasury yields. The credit risk factor (ΔCredSpr) 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 (Δ10Yr) is defined as the monthly change in 10-year constant-maturity Treasury yields. 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 10% VaR controlling for credit rating

	All Bonds			Investment Grade			High Yield		
	M1	M2	M3	M1	M2	M3	M1	M2	M3
VaR, 1	0.013	0.009	0.008	-0.037	-0.041	-0.042	-0.026	-0.027	-0.004
	(0.12)	(0.08)	(0.11)	(-0.37)	(-0.38)	(-0.66)	(-0.20)	(-0.20)	(-0.04)
VaR, 2	-0.065	-0.070	-0.070	-0.028	-0.033	-0.035	0.172	0.171	0.171
	(-0.58)	(-0.59)	(-0.91)	(-0.27)	(-0.31)	(-0.63)	(0.83)	(0.85)	(0.89)
VaR, 3	0.154	0.150	0.149	0.097	0.091	0.091	0.284	0.284	0.291
	(1.20)	(1.10)	(1.56)	(0.83)	(0.74)	(1.34)	(1.66)	(1.65)	(1.84)
VaR, 4	0.245	0.239	0.237	0.135	0.128	0.125	0.354	0.353	0.357
	(1.62)	(1.49)	(2.02)	(1.04)	(0.92)	(1.50)	(1.92)	(1.96)	(2.19)
VaR, 5	0.510	0.504	0.504	0.246	0.240	0.240	0.907	0.910	0.922
	(2.76)	(2.61)	(3.33)	(1.61)	(1.50)	(2.33)	(3.13)	(3.18)	(3.34)
VaR, 5 − VaR,1	0.496***	0.494***	0.495***	0.283***	0.280***	0.282***	0.933***	0.937***	0.926***
Return/Alpha diff.	(3.79)	(3.79)	(3.91)	(3.06)	(3.06)	(3.29)	(3.75)	(3.81)	(3.82)

Table A.11. (Continued)

Panel B: Quintile portfolios of corporate bonds sorted by 10% VaR 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
VaR, 1	0.003	-0.004	-0.002	0.038	0.066	-0.003	0.067	0.095	0.003	0.018	0.008	-0.001
	(0.03)	(-0.03)	(-0.02)	(0.52)	(1.03)	(-0.04)	(0.69)	(0.98)	(0.05)	(0.15)	(0.06)	(-0.02)
VaR, 2	0.038	0.033	0.031	-0.058	-0.040	-0.099	0.042	0.040	0.013	0.087	0.081	0.079
	(0.32)	(0.26)	(0.42)	(-0.53)	(-0.36)	(-0.93)	(0.37)	(0.33)	(0.15)	(0.64)	(0.59)	(1.00)
VaR, 3	0.080	0.077	0.073	-0.356	-0.335	-0.379	0.066	0.068	0.029	0.132	0.129	0.124
	(0.59)	(0.54)	(0.73)	(-1.07)	(-1.02)	(-1.16)	(0.51)	(0.51)	(0.27)	(0.89)	(0.84)	(1.22)
VaR, 4	0.255	0.250	0.251	0.268	0.286	0.233	0.196	0.200	0.174	0.125	0.120	0.121
	(1.66)	(1.54)	(2.02)	(1.48)	(1.57)	(1.32)	(1.12)	(1.14)	(1.13)	(0.91)	(0.83)	(1.31)
VaR, 5	0.638	0.630	0.636	0.326	0.368	0.281	0.799	0.861	0.729	0.528	0.518	0.518
	(2.51)	(2.43)	(2.68)	(1.36)	(1.70)	(1.19)	(2.43)	(2.64)	(2.31)	(2.07)	(2.00)	(2.25)
VaR, 5 − VaR,1	0.635***	0.633***	0.638***	0.288	0.302*	0.285	0.732**	0.766**	0.726**	0.510**	0.510**	0.518**
Return/Alpha diff.	(2.84)	(2.89)	(2.89)	(1.48)	(1.67)	(1.44)	(2.50)	(2.57)	(2.50)	(2.38)	(2.45)	(2.42)

Panel C: Quintile portfolios of corporate bonds sorted by 10% VaR controlling for size

	All Bonds			Small Bonds			Large Bonds		
	M1	M2	M3	M1	M2	M3	M1	M2	M3
VaR, 1	-0.034	-0.042	-0.038	0.012	0.005	0.026	-0.035	-0.044	-0.039
	(-0.34)	(-0.38)	(-0.57)	(0.11)	(0.05)	(0.34)	(-0.33)	(-0.39)	(-0.59)
VaR, 2	-0.072	-0.076	-0.076	-0.064	-0.068	-0.070	0.005	-0.003	0.001
	(-0.67)	(-0.67)	(-1.14)	(-0.58)	(-0.59)	(-0.90)	(0.04)	(-0.02)	(0.01)
VaR, 3	0.158	0.154	0.149	0.216	0.211	0.202	0.033	0.024	0.028
	(1.17)	(1.08)	(1.50)	(1.44)	(1.32)	(1.65)	(0.28)	(0.19)	(0.41)
VaR, 4	0.284	0.280	0.279	0.150	0.143	0.144	0.182	0.173	0.178
	(1.73)	(1.65)	(2.19)	(1.02)	(0.92)	(1.18)	(1.23)	(1.11)	(1.78)
VaR, 5	0.656	0.649	0.654	0.696	0.689	0.708	0.420	0.411	0.417
	(2.25)	(2.21)	(2.39)	(2.23)	(2.19)	(2.40)	(1.57)	(1.50)	(1.67)
VaR, 5 − VaR,1	0.691***	0.691***	0.692***	0.684**	0.684**	0.682**	0.454*	0.455**	0.456*
Return/Alpha diff.	(2.61)	(2.65)	(2.63)	(2.51)	(2.58)	(2.55)	(1.96)	(1.99)	(1.97)

Table A.12. 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 scores correspond to 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 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.13. Fama-MacBeth Regressions of Longer Term Bond Returns on Value-at-Risk (VaR)

This table reports the average intercept and slope coefficients from the Fama and Macbeth (1973) cross-sectional regressions of corporate bond excess returns on three VaR measures. 1% VaR is defined as the lowest monthly return observation over the past 60 months. 5% VaR is defined as the third lowest monthly return observation over the past 60 months. 10% VaR is defined as the sixth lowest monthly return observation over the past 60 months. The original VaR measures (1%, 5%, 10% VaR) are multiplied by -1. 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 scores correspond to 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 coefficients. The last column reports the average adjusted R^2 values. Numbers in bold denote statistical significance of the average slope coefficients.

Intercept	1% VaR	5% VaR	10% VaR	Rating	Maturity	Size	Lagged Return	Adj. R^2
Panel A: Dependent variable=R_{t+2}								
-0.277	**0.038**			0.014	0.003	-0.012	**-0.031**	0.120
(-2.38)	(3.98)			(1.34)	(0.98)	(-0.06)	(-2.38)	
-0.270		**0.066**		**0.020**	0.000	-0.007	**-0.035**	0.123
(-2.43)		(4.47)		(1.99)	(0.02)	(-0.03)	(-2.51)	
-0.263			**0.089**	**0.027**	0.000	-0.167	**-0.031**	0.120
(-2.29)			(3.39)	(2.51)	(0.12)	(-0.69)	(-2.38)	
Panel B: Dependent variable=R_{t+3}								
-0.288	**0.034**			0.013	0.004	-0.061	-0.007	0.115
(-2.53)	(4.15)			(1.37)	(1.50)	(-0.29)	(-0.54)	
-0.272		**0.062**		0.016	0.003	-0.260	-0.005	0.117
(-2.58)		(4.04)		(1.68)	(0.83)	(-0.99)	(-0.37)	
-0.291			**0.072**	**0.024**	0.002	-0.153	-0.004	0.115
(-2.60)			(2.83)	(2.32)	(0.76)	(-0.70)	(-0.24)	
Panel C: Dependent variable=R_{t+4}								
-0.215	**0.029**			0.013	0.003	0.188	**-0.030**	0.116
(-1.89)	(3.66)			(1.26)	(0.99)	(1.05)	(-2.36)	
-0.209		**0.058**		0.017	-0.000	0.259	**-0.025**	0.119
(-1.94)		(3.60)		(1.65)	(-0.11)	(1.50)	(-2.03)	
-0.214			**0.081**	**0.022**	0.002	-0.071	**-0.031**	0.116
(-1.94)			(3.05)	(1.98)	(0.76)	(-0.39)	(-2.26)	
Panel D: Dependent variable=R_{t+5}								
-0.253	**0.017**			0.014	**0.005**	-0.007	-0.001	0.111
(-2.05)	(2.03)			(1.41)	(1.83)	(-0.05)	(-0.06)	
-0.205		**0.027**		0.015	0.004	-0.006	-0.004	0.115
(-1.85)		(2.29)		(1.59)	(1.40)	(-0.05)	(-0.42)	
-0.247			**0.034**	**0.018**	0.004	0.076	-0.008	0.114
(-2.09)			(2.13)	(1.77)	(1.62)	(0.40)	(-0.74)	
Panel E: Dependent variable=R_{t+6}								
-0.080	0.011			0.006	0.002	0.095	**0.059**	0.121
(-0.73)	(1.41)			(0.57)	(0.71)	(0.65)	(4.76)	
-0.069		0.016		0.010	0.002	0.059	**0.063**	0.124
(-0.65)		(0.95)		(1.09)	(0.80)	(0.49)	(5.03)	
-0.059			0.018	0.008	0.003	-0.022	**0.062**	0.126
(-0.55)			(0.91)	(0.83)	(1.13)	(-0.13)	(4.90)	

Table A.14. Transaction Costs for Bond Portfolios Sorted by VOL and VaR

This table reports the estimated transaction costs for the bond portfolios sorted by volatility (Panel A) and 5% VaR (Panel B). We estimate the portfolio transaction costs using Bao, Pan, and Wang (2011)'s measure (L^{BPW}). This is calculated as the autocovariance of excess bond returns:

$$L_{it}^{BPW} = -Cov_t(\Delta p_{itd}, \Delta p_{itd+1}),$$

where Δp_{itd} is the log price change in bond i on day d of month t. We compute L^{BPW} 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 (TransCosts). The TransCosts are in percentage per month, from January 2003 to December 2012 using TRACE data.

Panel A: Quintile portfolios of corporate bonds sorted by VOL

	Low	2	3	4	High	High-Low
			Panel A1: All Bonds			
L^{BPW}	0.360	0.276	0.378	0.635	2.207	
Turnover	0.043	0.043	0.042	0.044	0.048	
TransCosts	0.016	0.012	0.016	0.028	0.106	0.122
			Panel A2: Invstment Grade bonds			
L^{BPW}	0.426	0.253	0.373	0.481	1.376	
Turnover	0.043	0.042	0.040	0.042	0.047	
TransCosts	0.018	0.011	0.015	0.020	0.064	0.083
			Panel A3: Non-Invstment Grade bonds			
L^{BPW}	0.266	0.264	1.153	1.333	3.767	
Turnover	0.054	0.054	0.050	0.047	0.045	
TransCosts	0.014	0.014	0.058	0.062	0.170	0.185

Panel B: Quintile portfolios of corporate bonds sorted by 5% VaR

	Low	2	3	4	High	High-Low
			Panel B1: All Bonds			
L^{BPW}	0.556	0.653	2.036	1.223	5.586	
Turnover	0.028	0.027	0.024	0.053	0.026	
TransCosts	0.015	0.017	0.049	0.065	0.146	0.162
			Panel B2: Invstment Grade bonds			
L^{BPW}	0.548	0.582	2.082	0.817	1.316	
Turnover	0.028	0.028	0.024	1.747	0.027	
TransCosts	0.015	0.016	0.049	1.427	0.036	0.051
			Panel B3: Non-Invstment Grade bonds			
L^{BPW}	0.728	1.021	5.119	3.821	11.805	
Turnover	0.028	0.027	0.024	0.053	0.026	
TransCosts	0.020	0.027	0.122	0.203	0.309	0.330

Table A.15. Fama-MacBeth Cross-Sectional Regressions with VOL, SKEW, KURT, Illiquidity, and Bond Characteristics

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), kurtosis (KURT), and the illiquidity measure (L^{BPW}) in Bao, Pan, and Wang (2011), with and without 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 scores correspond to 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 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	L^{BPW}	Rating	Maturity	Size	Lagged Return	Adj. R^2
(1)	-0.012				**0.815**					0.014
	(-0.07)				(2.86)					
(2)	-0.239				**0.706**	0.029	0.006	0.069	**-0.304**	0.151
	(-1.48)				(2.28)	(1.05)	(1.08)	(1.21)	(-18.72)	
(3)	-0.033	**0.018**	**-0.155**	-0.008	**0.013**					0.076
	(-0.29)	(3.95)	(-3.59)	(-0.84)	(4.77)					
(4)	-0.047	**0.009**	**-0.093**	-0.010	**0.012**	0.009	0.005	-0.282	**-0.169**	0.188
	(-0.36)	(2.28)	(-2.97)	(-1.06)	(4.28)	(0.81)	(1.46)	(-0.86)	(-9.74)	

Table A.16. Fama-MacBeth Cross-Sectional Regressions with VaR, Illiquidity, and Bond Characteristics

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 three VaR measures and the illiquidity measure (L^{BPW}) in Bao, Pan, and Wang (2011), with and without control variables. 1% VaR is defined as the lowest monthly return observation over the past 60 months. 5% VaR is defined as the third lowest monthly return observation over the past 60 months. 10% VaR is defined as the sixth lowest monthly return observation over the past 60 months. The original VaR measures (1%, 5%, 10% VaR) are multiplied by -1. 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 scores correspond to 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 coefficients. The last column reports the average adjusted R^2 values. Numbers in bold denote statistical significance of the average slope coefficients.

	Intercept	1% VaR	5% VaR	10% VaR	L^{BPW}	Rating	Maturity	Size	Lagged Return	Adj. R^2
(1)	-0.001				**0.724**					0.013
	(-0.01)				(2.66)					
(2)	-0.210				**0.575**	0.026	0.007	0.045	**-0.284**	0.137
	(-1.31)				(2.13)	(1.02)	(1.30)	(0.73)	(-16.31)	
(3)	-0.085	**0.024**			**0.027**	0.006	0.003	-0.465	**-0.155**	0.208
	(-0.79)	(2.84)			(4.73)	(0.85)	(0.82)	(-1.11)	(-8.10)	
(4)	-0.094		**0.052**		**0.027**	0.006	0.002	-0.535	**-0.161**	0.217
	(-0.86)		(3.56)		(4.75)	(0.88)	(0.54)	(-1.26)	(-8.09)	
(5)	-0.077			**0.064**	**0.027**	0.011	0.003	-0.630	**-0.156**	0.218
	(-0.71)			(3.18)	(4.78)	(1.38)	(0.84)	(-1.39)	(-7.50)	

Table A.17. Fama-MacBeth Cross-Sectional Regressions with VOL, SKEW, KURT, Liquidity Beta, and Bond Characteristics

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), kurtosis (KURT), and liquidity beta (LIQ), with and without control variables. 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). 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 scores correspond to 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 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	LIQ1	LIQ2	Rating	Maturity	Size	Lagged Return	Adj. R^2
(1)	-0.117	**0.011**	**-0.164**	-0.011	0.002			0.010	0.003	-0.080	0.125
	(-1.06)	(3.18)	(-4.35)	(-1.49)	(0.11)			(0.99)	(1.47)	(-0.45)	
(2)	-0.114	**0.009**	**-0.149**	-0.005		-0.002		0.010	**0.004**	-0.086	0.127
	(-1.02)	(2.89)	(-3.86)	(-0.71)		(-0.07)		(1.03)	(1.70)	(-0.49)	
(3)	-0.064	**0.010**	**-0.100**	-0.006	-0.007		0.010	0.005	-0.257	**-0.172**	0.186
	(-0.50)	(2.57)	(-2.97)	(-0.60)	(-0.46)		(1.00)	(1.57)	(-0.78)	(-9.67)	
(4)	-0.051	**0.009**	**-0.087**	-0.004	-0.008		0.011	0.005	-0.261	**-0.172**	0.186
	(-0.40)	(2.51)	(-2.44)	(-0.42)		(-0.32)	(1.06)	(1.59)	(-0.79)	(-9.80)	

Table A.18. Fama-MacBeth Cross-Sectional Regressions with VaR, Liquidity Beta, and Bond Characteristics

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 three VaR measures, with and without control variables. 1% VaR is defined as the lowest monthly return observation over the past 60 months. 5% VaR is defined as the third lowest monthly return observation over the past 60 months. 10% VaR is defined as the sixth lowest monthly return observation over the past 60 months. The original VaR measures (1%, 5%, 10% VaR) are multiplied by -1. 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). 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 scores correspond to 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 coefficients. The last column reports the average adjusted R^2 values. Numbers in bold denote statistical significance of the average slope coefficients.

	Intercept	1% VaR	5% VaR	10% VaR	LIQ1	LIQ2	Rating	Maturity	Size	Lagged Return	Adj. R^2
(1)	-0.219	**0.038**			-0.004		**-0.150**	0.010	0.003	-0.277	0.163
	(-1.63)	(4.25)			(-0.26)		(-8.73)	(0.96)	(1.13)	(-0.81)	
(2)	-0.497	**0.034**				-0.010	**-0.202**	0.004	0.001	0.320	0.134
	(-2.54)	(2.58)				(-0.16)	(-14.28)	(0.14)	(0.17)	(1.29)	
(3)	-0.224		**0.083**		-0.000		**-0.148**	0.014	0.000	-0.343	0.166
	(-1.64)		(5.19)		(-0.02)		(-7.71)	(1.32)	(0.10)	(-0.95)	
(4)	-0.441		**0.046**			0.002	**-0.207**	0.006	0.001	0.316	0.129
	(-2.18)		(2.67)			(0.03)	(-14.05)	(0.23)	(0.27)	(1.27)	
(5)	-0.207			**0.107**	0.003		**-0.150**	**0.023**	0.001	-0.432	0.165
	(-1.53)			(4.28)	(0.18)		(-7.51)	(1.97)	(0.31)	(-1.18)	
(6)	-0.394			**0.053**		0.033	**-0.204**	0.006	0.000	0.382	0.128
	(-1.90)			(2.65)		(0.53)	(-13.60)	(0.23)	(0.01)	(1.19)	