Return-Based Factors for Corporate Bonds*

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Abstract

The cross-section of corporate bond returns strongly depends on past bond returns. Comprehensive transaction-based bond data yield evidence of significant return reversals and momentum. Return-based factors for corporate bonds carry sizable premia and provide strong explanatory power for returns of industry- and size/rating/maturity-sorted bond portfolios. We also provide an illiquidity-based explanation of short-term reversal and show that momentum and long-term reversals are prevalent mainly in the high credit risk sector. Further, long-term reversals occur mainly in downgraded bonds (with low returns), indicating that downgrading increases the risk of holding the bonds, thus increasing the required return.

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1 Introduction

Numerous studies have shown that previous stock returns have the ability to predict future stock returns in the cross-section. DeBondt and Thaler (1985) show that stocks with poor performance over the previous three to five years produce higher returns over the next three- to five-year holding periods than stocks with superior performance over the same period. Jegadeesh (1990) shows that contrarian strategies based on stock returns in the previous month generate an abnormal return of 2% per month. In contrast to the short-term and long-term return reversals, Jegadeesh and Titman (1993, 2001) provide evidence of stock price momentum over the medium-term of six to 12 months; stocks that have performed well in the medium-term past (six to 12 months) are more likely to outperform in the future.

Since corporate bond financing forms a significant portion of a firm's capital structure,[1] it is important to conduct an exploration of whether the cross-section of corporate bond returns also depends on past bond returns. We analyze this issue by assembling a comprehensive dataset of corporate bond returns using Trade Reporting and Compliance Engine (TRACE) transaction data from July 2002 to December 2015, yielding more than 1.2 million bond-month observations. Then, we investigate whether bond returns at various horizons can predict cross-sectional differences in future bond returns, and also consider rationales for the predictability.

A vast literature considers explanations for equity return reversals in the cross-section. For example, in rationalizing long-term reversals DeBondt and Thaler (1985, 1987) characterize investors as poor Bayesian decision-makers who tend to overweight recent information and drive security prices away from fundamental values. As investors and analysts extrapolate past information too far into the future, some assets which experience recent bad news become undervalued (long-term losers) and some other assets for which there were recent good news become overvalued (long-term winners). The short-term reversal phenomenon is most often attributed to liquidity effects. Thus, Nagel (2012) presents evidence that the returns of short-term reversal strategies can be used as proxies for the returns associated with liquidity provision, and Avramov, Chordia, and Goyal (2006) document a strong relation

[1] Graham et al. (2015) indicate that the average debt-to-assets ratio for public companies was as high as 35% in 2010.

between short-term return reversals and stock illiquidity.[2]

With regard to momentum, several papers, such as Fama and French (2012), Asness, Moskowitz, and Pedersen (2013), and Jostova, Nikolova, Philipov, and Stahel (2013) find evidence of the momentum phenomenon in international equity markets as well as in different asset classes.[3] Using corporate bonds of private and public firms, Jostova et al. (2013) present evidence of momentum in the cross-section of corporate bond returns. They also show that momentum profits are driven by non-investment-grade (NIG) bonds with an average momentum strategy return of 1.21% per month, whereas the strategy is not profitable among investment-grade (IG) bonds.[4]

In our work, we first test the significance of short-term reversal in corporate bond returns using portfolio-level analysis. We sort corporate bonds into quintile portfolios based on the past one-month return (STR) and find that bonds in the lowest STR quintile (short-term losers) generate 9.36% more raw returns per annum than bonds in the highest STR quintile (short-term winners), indicating strong evidence of short-term reversal in corporate bond returns. We also find that the short-term reversal in bond returns is not a manifestation of the short-term reversal in equity returns. After we control for 11 well-known stock and bond market factors including the stock short-term reversal factor, the risk-adjusted return difference between the lowest and highest STR quintiles is economically large and highly significant: 9% per annum with a t-statistic of 4.61. Regardless of which risk model is used, the first STR quintile generates statistically significant abnormal returns, whereas the fifth STR quintile generates statistically insignificant abnormal returns. Therefore, as in Avramov et al. (2006), we conclude that the short-term reversal phenomenon is driven by bonds with

[2]Roll (1984) proposes a model in which the bid-ask spread generates negative serial correlation in time-series of stock returns. Lo and MacKinlay (1990), Conrad, Gultekin, and Kaul (1997), Keim (1989), Hasbrouck (1991), Admati and Pfleiderer (1989) and Mech (1993) show that microstructure issues such as the bid-ask bounce and transaction costs can generate autocorrelation in security returns. Boudoukh, Richardson, and Whitelaw (1994) demonstrate that a large portion of documented serial correlation is attributable to institutional factors such as trading and non-trading periods, market frictions such as the bid-ask spread, or other microstructure effects.

[3]Barberis, Shleifer, and Vishny (1998), Daniel, Hirshleifer, and Subrahmanyam (1998), and Hong and Stein (1999) develop behavioral models in which the momentum phenomenon arises as a result of investors' delayed reaction and overreaction to information. The predictions of these models are consistent with not only medium-term momentum, but also long-term reversal, as in the long run, the inefficient prices generated by investors' behavioral biases are corrected.

[4]Gebhardt et al. (2005) find no evidence of momentum using a sample of investment-grade bonds. Jostova et al. (2013) find weak evidence of momentum in corporate bonds of publicly traded firms.

low returns in the previous month (short-term losers).

We also document a strong relation between short-term return reversals and bond illiquidity. The largest short-run reversals and the corresponding STR-based trading strategy profits occur in the sample of illiquid bonds. However, the STR-based trading strategy profits are economically and statistically insignificant in the sample of very liquid bonds. More importantly, the return spreads between STR-losers and STR-winners completely disappear in the sample of liquid, investment-grade bonds. Thus, our results indicate an illiquidity-based explanation of short-term reversal in the corporate bond market, consistent with the illiquidity-based explanation of STR in the equity market (e.g., Avramov, Chordia, and Goyal (2006), Nagel (2012)).

Second, we examine the significance of momentum in corporate bond returns. We sort bonds into quintile portfolios based on the past 12-month return (MOM), skipping the short-term reversal month, and find that bonds in the highest MOM quintile (medium-term winners) generate 9.60% more risk-adjusted return per annum than bonds in the lowest MOM quintile (medium-term losers), implying significant momentum in the bond market. Consistent with the findings of Jostova et al. (2013) and Gebhardt et al. (2005), we find a stronger momentum effect in the sample of non-investment-grade bonds, but there is no evidence of momentum in the sample of investment-grade bonds of publicly traded firms. The results also show that the momentum effect is driven by momentum-winners with higher market risk, higher credit risk, and higher interest rate risk, indicating that bond momentum is only prevalent in the bond market segment with high cash flow uncertainty. We also find that the momentum effect is much stronger during economic downturns and periods of high aggregate default risk. In fact, the return spreads between MOM-winners and MOM-losers completely disappear when we exclude the recent financial crisis period. Hence, our results indicate that bond market momentum is restricted in the time series to the crisis period, and in the cross-section to default-prone bonds.

Third, we investigate the significance of long-term reversal in corporate bond returns. In the spirit of DeBondt and Thaler (1985), we use portfolio-level analysis and sort bonds based on their past 36-month cumulative returns (LTR), skipping the 12-month momentum (i.e., from month $t-12$ to $t-2$) and the short-term reversal month (i.e., month $t-1$). We find that bonds in the lowest LTR quintile (long-term losers) generate 7.92% to 8.16% more raw and risk-adjusted returns per annum than bonds in the highest LTR quintile (long-term winners). The cross-sectional predictability holds for one-month-ahead returns as well as for the 12-, 24-, and 36-month ahead returns. Thus, bonds with poor performance over the previous three years generate higher returns over the next three-year holding periods than those with superior performance over the same period. We also find that long-term reversals are strongest in bonds that experience an increase in credit risk (and thus have low returns). The fact that long-term reversals are stronger for poorly-performing bonds with increases in credit risk is at odds with the overreaction story, since one would expect that under short-selling constraints which preclude arbitrage (particularly acute for bonds), the overreaction would be prolonged for well-performing bonds. Instead, our results accord with the idea that long-term reversal captures an increase in required returns owing to the increased risk of holding recently-downgraded bonds.

We also test the significance of STR, MOM, and LTR simultaneously using bond-level cross-sectional regressions. The Fama-MacBeth (1973) regression results echo the portfolio-level analysis, indicating that the STR, MOM, and LTR of corporate bonds predict their future returns. After simultaneously accounting for different bond characteristics in cross-sectional regressions, the predictive power of STR, MOM, and LTR remains economically and statistically significant.

Finally, we introduce return-based factors based on the past return characteristics and test if long-established stock and bond market factors in the literature explain the newly proposed return-based factors of corporate bonds.[5] As will be discussed later in the paper, the STR, MOM, and LTR of bonds are found to be correlated with credit risk and maturity. Thus, we rely on conditional trivariate portfolios using credit rating as the first sorting variable, time-to-maturity as the second sorting variable, and the past return characteristics

[5]The long-established stock market factors include the five factors of Fama and French (1993), Carhart (1997) and Pastor and Stambaugh (2003): the excess stock market return (MKT), the size factor (SMB), the book-to-market factor (HML), the momentum factor (MOM), and the liquidity factor (LIQ). We also consider a short-term stock reversal factor (STR^{Stock}) and a long-term stock return reversal factor (LTR^{Stock}) as well as the profitability and investment factors of Hou, Xue, and Zhang (2015) and Fama and French (2015). The standard bond market factors include the excess bond market return (Elton, Gruber, and Blake (1995)), the default spread (DEF) and the term spread (TERM) factors of Fama and French (1993), plus the corporate bond liquidity factor.

as the third sorting variable when constructing the new factors, namely, the short-term reversal factor (STR^{Bond}), the momentum factor (MOM^{Bond}), and the long-term reversal factor (LTR^{Bond}). We find that all three factors generate significantly positive return premia, with particularly higher magnitudes during economic downturns and volatile periods. The STR^{Bond}, MOM^{Bond}, and LTR^{Bond} factors generate high Sharpe ratios (annualized) of 0.95, 0.32, and 0.73, respectively, even after transaction costs are taken into account.

We run time-series factor regressions to assess the explanatory power of the new return-based factors. The intercepts (alphas) from these time-series regressions represent the abnormal returns, which are not explained by standard stock and bond market factors. When we use the most general 11-factor model that combines all the commonly used stock and bond market factors, we find that the alphas for the STR^{Bond}, MOM^{Bond}, and LTR^{Bond} factors are all economically and statistically significant; 0.69% per month (t-stat. = 8.54), 0.47% (t-stat. = 3.29), and 0.73% (t-stat. = 3.00), respectively. These significant alphas indicate that the existing risk factors are not sufficient to capture the information content in these newly proposed return-based bond factors.

We further examine the explanatory power of the return-based bond factors for alternative test portfolios. We consider three sets of test portfolios based on (i) 5×5 bivariate portfolios independently sorted by bond size and maturity, (ii) 5×5 bivariate portfolios independently sorted by bond size and rating, and (iii) 12 industry-sorted portfolios of corporate bonds. Then, we examine the relative performance of the factor models in explaining the time-series and cross-sectional variations in these test portfolios. We find that the newly proposed 4-factor model with the bond market, short-term reversal, momentum, and long-term reversal factors substantially outperforms a number of factor models considered in the literature in predicting the returns of the industry- and size/rating/maturity-sorted portfolios of corporate bonds.

This paper proceeds as follows. Section 2 describes the data and variables used in our empirical analyses. Section 3 examines the cross-sectional relation between bond return characteristics and the future returns of corporate bonds. Section 4 introduces new return-based factors of corporate bonds, and compares their relative performance with long-established s-tock and bond market factors. Section 5 examines the explanatory power of the return-based bond factors for different sets of test portfolios. Section 6 investigates a liquidity-based explanation for monthly return reversals, while Section 7 and 8 further investigate the source of momentum and long-term reversals in the corporate bond market. Section 9 concludes the paper.

2 Data and Variable Definitions

2.1 Corporate Bond Data

Following Bessembinder, Maxwell, and Venkataraman (2006), who highlight the importance of using TRACE transaction data, we rely on the transaction records reported in the enhanced version of TRACE for the sample period from July 2002 to December 2015. The TRACE dataset offers the best-quality corporate bond transactions, with intraday observations on price, trading volume, and buy and sell indicators. We then merge corporate bond pricing data with the Mergent fixed income securities database to obtain bond characteristics such as offering amount, offering date, maturity date, coupon rate, coupon type, interest payment frequency, bond type, bond rating, bond option features, and issuer information.

For TRACE data, we adopt the filtering criteria proposed by Bai, Bali, and Wen (2016). Specifically, we remove bonds that (i) are not listed or traded in the U.S. public market; (ii) are structured notes, mortgage-backed, asset- backed, agency-backed, or equity-linked; (iii) are convertible; (iv) trade under \$5 or above \$1,000; (v) have floating coupon rates; and (vi) have less than one year to maturity. For intraday data, we also eliminate bond transactions that (vii) are labeled as when-issued, locked-in, or have special sales conditions; (viii) are canceled, (ix) have more than a two-day settlement, and (x) have a trading volume smaller than \$10,000.

2.2 Corporate Bond Return

The monthly corporate bond return at time t is computed as

$$r_{i,t} = \frac{P_{i,t} + AI_{i,t} + C_{i,t}}{P_{i,t-1} + AI_{i,t-1}} - 1 \quad (1)$$

where $P_{i,t}$ is the transaction price, $AI_{i,t}$ is accrued interest, and $C_{i,t}$ is the coupon payment, if any, of bond i in month t. We denote $R_{i,t}$ as bond i's excess return, $R_{i,t} = r_{i,t} - r_{f,t}$, where $r_{f,t}$ is the risk-free rate proxied by the one-month Treasury bill rate.

Using TRACE intraday data, we first calculate the daily clean price as the trading volume-weighted average of intraday prices to minimize the effect of bid-ask spreads in prices, following Bessembinder, Kahle, Maxwell, and Xu (2009). We then convert the bond prices from daily to monthly frequency. Specifically, our method identifies two scenarios for a return to be realized at the end of month t: (i) from the end of month $t-1$ to the end of month t, and (ii) from the beginning of month t to the end of month t. We calculate monthly returns for both scenarios, where the end (beginning) of month refers to the last (first) five trading days within 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 both scenarios, the realized return in scenario one (from month-end $t-1$ to month-end t) is selected.

Our final sample includes 61,871 bonds issued by 4,222 unique firms, yielding a total of 1,261,667 bond-month return observations during the sample period from July 2002 to December 2015. On average, there are about 7,788 bonds per month over the whole sample. Panel A of Table 1 reports the time-series average of the cross-sectional bond returns' distribution and bond characteristics. The sample contains bonds with an average rating of 8.29 (i.e., BBB+), an average issue size of $336 million, and an average of time-to-maturity of 9.26 years. Among the full sample of bonds, about 78% are investment-grade and the remaining 22% are high-yield bonds.

2.3 Cross-Sectional Bond Return Characteristics

2.3.1 Short-term reversal, momentum, and long-term reversal

Similar to Jegadeesh (1990), we measure short-term reversal (STR) of bond i for month t using its previous month return, that is, R_{t-1}. Following Jegadeesh and Titman (1993), we define bond momentum as the past 11-month cumulative returns from months $t-12$ to $t-2$, skipping the short-term reversal month $t-1$. Following DeBondt and Thaler (1985), we quantify long-term reversal (LTR) with the past 36-month cumulative returns from month $t-48$ to $t-13$, skipping the 12-month momentum and the short-term reversal month.[6]

2.3.2 Summary Statistics

Table 1 presents the correlation matrix for the bond-level return characteristics and other bond characteristics such as rating, maturity, and size. As shown in Panel B, credit rating is positively associated with short-term reversal, momentum, and long-term reversal measures, with correlation coefficients ranging from 0.084 to 0.124. Bond maturity is positively correlated with all return characteristics, except credit rating, implying that bonds with longer maturity (i.e., higher interest rate risk) have higher short-term reversal, momentum, and long-term reversal. Bond size is negatively correlated with STR, indicating that smaller bonds have higher short-term reversal. The correlations between size and rating and between size and maturity are economically and statistically weak.

3 Past Return Characteristics and the Cross-Section of Expected Bond Returns

3.1 Short-Term Reversal

We first examine the significance of short-term reversal in corporate bond returns using portfolio-level analysis. For each month from July 2002 to December 2015, we form quintile portfolios by sorting corporate bonds based on their previous month returns (STR), where quintile 1 contains the bonds with the lowest STR (short-term losers) and quintile 5 contains the bonds with the highest STR (short-term winners). To mitigate the impact of illiquid small bond transactions, we report results from the value-weighted portfolios using the bond's outstanding dollar values as weights. Table 2 shows, for each quintile, the average STR of the bonds in each quintile, the next month average excess return, and the alphas for each quintile. The last five columns report the average bond characteristics for each quintile,

[6]A bond is included in the LTR calculation if it has at least 24 months of return observations. Since the TRACE sample starts in July 2002, the LTR portfolio results cover the period from July 2005 to December 2015.

including the bond market beta, illiquidity, credit rating, time-to-maturity, and bond size. The last row displays the differences in the average returns and the alphas between quintile 5 and quintile 1. The average excess returns and alphas are defined in terms of monthly percentages. Newey-West (1987) adjusted t-statistics are reported in parentheses.

Moving from quintile 1 to quintile 5, the average excess return on the STR portfolios decreases monotonically from 1.16% to 0.38% per month. This result indicates a monthly average return difference of −0.78% between quintiles 5 and 1, with a Newey-West t-statistic of −5.09, showing that this negative return difference is economically and statistically significant. This result also indicates that corporate bonds in the lowest STR quintile generate 9.36% per annum higher returns than bonds in the highest STR quintile do.

In addition to the average excess returns, Table 2 presents the intercepts (alphas) from the regression of the quintile excess portfolio returns on well-known stock and bond market factors — the excess stock market return (MKT^{Stock}), a size factor (SMB), a book-to-market factor (HML), a momentum factor (MOM^{Stock}), and a liquidity factor (LIQ), following Fama and French (1993), Carhart (1997), and Pastor and Stambaugh (2003).[7] We also include the short-term stock return reversal factor (STR^{Stock}) and the long-term stock return reversal factor (LTR^{Stock}) to investigate whether these can explain our findings. The third column of Table 2 shows that, similar to the average excess returns, the 7-factor alpha on the STR portfolios also decreases monotonically from 1.13% to 0.35% per month, moving from the low-STR to the high-STR quintile, indicating a significant alpha difference of −0.78% per month (t-stat.= −5.65).

Beyond well-known stock market factors, we also test whether the significant return difference between high-STR bonds and low-LTR bonds can be explained by prominent bond market factors. Following Elton et al. (2001) and Bessembinder et al. (2009), we use the aggregate corporate bond market, default spread and term spread factors. The excess bond market return (MKT^{Bond}) is proxied by the Merrill Lynch Aggregate Bond Market Index returns in excess of the one-month T-bill return. Following Fama and French (1993),

[7]The factors MKT^{Stock} (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/.

the default factor (DEF) is defined as the difference between the return on a market portfolio of long-term corporate bonds (the composite portfolio on the corporate bond module of Ibbotson Associates) and the long-term government bond return. The term factor (TERM) is defined as the difference between the monthly long-term government bond return (from Ibbotson Associates) and the one-month Treasury bill rate. In addition to MKT^{Bond}, DEF, and TERM, we also use the liquidity factor (LIQ^{bond}) for the corporate bond market, which is generated based on the monthly change (i.e., innovations) in aggregate illiquidity.[8] Similar to our earlier findings for the average excess returns and the 7-factor alphas from stock market factors, the fourth column of Table 2 shows that, moving from the low-STR to the high-STR quintile, the 4-factor alpha from bond market factors decreases almost monotonically from 1.03% to 0.26% per month. The corresponding 4-factor alpha difference between quintiles 5 and 1 is negative and highly significant; −0.77% per month with a t-statistic of −4.83. The fifth column of Table 2 presents the 11-factor alpha for each quintile from the combined seven stock and four bond market factors. Consistent with our earlier results, moving from the low-STR to the high-STR quintile, the 11-factor alpha decreases almost monotonically from 1.07% to 0.31% per month, indicating a significant alpha difference of −0.75% per month (t-stat.= −4.61).[9]

Next, we investigate the source of the strong short-term reversal effect in the corporate bond market. As reported in Table 2, the 7-, 4-, and 11-factor alphas of bonds in quintile 1 (short-term losers) are positive and economically and statistically significant, whereas the corresponding alphas of bonds in quintile 5 (short-term winners) are statistically insignificant. Hence, we conclude that the significantly negative alpha spread between high- and low-STR bonds is due to outperformance of short-term losers, but not to underperformance of short-term winners. This is consistent with the evidence in Avramov et al. (2006) for short-term reversals in the equity market.

Finally, we examine the average characteristics of STR-sorted portfolios. As shown in

[8] Following Roll (1984), bond-level illiquidity is calculated as the autocovariance of the daily price changes in a month. The aggregate illiquidity of the corporate bond market is proxied by the value-weighted average illiquidity of individual corporate bonds.

[9] We try a variant where we skip one day at the beginning of month $t+1$ in the calculation of monthly bond return, in order to minimize the bid-ask bounce. Then we replicate Table 2 and the main findings turn out to be similar; the return and 11-factor alpha spreads between the high- and low-STR quintiles are −0.74% (t-stat. = −5.04) and −0.70% (t-stat. = −4.48) per month, respectively.

the last five columns of Table 2, bonds with low-STR (short-term losers) have somewhat lower market beta, higher liquidity and lower credit risk. However, there is no significant difference between the average portfolio characteristics of short-term losers vs. winners. Thus, the average bond characteristics of STR quintiles do not provide an explanation for the significant short-term reversal effect in the corporate bond market. Later in the paper, we will investigate if there is a liquidity-based explanation of the short-run reversal effect.

3.2 Momentum

In this section, we investigate the significance of momentum in corporate bond returns using portfolio-level analysis. For each month from July 2003 to December 2015, we form value-weighted quintile portfolios by sorting corporate bonds based on their past 11-month cumulative returns (MOM) from $t-12$ to $t-2$ (skipping month $t-1$), where quintile 1 contains the bonds with the lowest MOM (medium-term losers) and quintile 5 contains the bonds with the highest MOM (medium-term winners).

Table 3 presents a positive and statistically significant return difference between momentum winners and losers. The monthly average return difference between quintiles 5 and 1 is 0.61% per month with a Newey-West t-statistic of 2.61. The 11-factor alpha difference between quintiles 5 and 1 is 0.84% per month with a Newey-West t-statistic of 3.39, indicating that corporate bonds in the highest MOM quintile (momentum-winners) significantly outperform those in the lowest MOM quintile (momentum-losers).

Another notable point in Table 3 is that the 7-, 4-, and 11-factor alphas of bonds in quintile 5 (momentum winners) are positive and economically and statistically significant, whereas the corresponding alphas of bonds in quintile 1 (momentum losers) are statistically insignificant. Hence, we conclude that the significantly positive alpha spread between high- and low-MOM bonds is due to outperformance by momentum winners. Table 3 also shows that momentum winners have higher market beta, higher credit risk, and longer maturity (i.e., higher interest rate risk). Later in the paper, we will examine the relation between momentum and credit risk in more detail.

3.3 Long-Term Reversal

We now test the significance of long-term reversal in corporate bond returns using portfolio-level analysis. For each month from July 2005 to December 2015, we form value-weighted quintile portfolios by sorting corporate bonds based on their past 36-month cumulative returns (LTR) from month $t-48$ to $t-13$, skipping the 12-month momentum and the short-term reversal month. Quintile 1 contains the bonds with the lowest LTR (long-term losers) and quintile 5 contains the bonds with the highest LTR (long-term winners).

Table 4 shows that when moving from quintile 1 to quintile 5, the average excess return on the LTR portfolios decreases almost monotonically from 1.37% to 0.71%, producing a monthly average return difference of -0.66% with a Newey-West t-statistic of -3.19. In other words, corporate bonds in the lowest LTR quintile generate 7.89% per annum higher returns than bonds in the highest LTR quintile do. The 11-factor alpha also decreases from 1.29% in quintile 1 to 0.61% in quintile 5, showing a significantly negative alpha difference of -0.68% per month (t-stat.$= -3.80$). These results indicate that after we control for well-known stock and bond market factors, the return difference between high-LTR and low-LTR bonds remains negative and highly significant.

Table 4 also provides evidence that the strong long-term reversal effect is mainly driven by the outperformance of long-term losers. This evidence does not appear consistent with an overreaction-based rationale for LTR. This is because under short-selling constraints which impede arbitrage, that are particularly severe for bonds, one would expect that overvalued winners (that subsequently reverse) would also contribute to LTR. We will consider an alternative risk-based story for LTR in Section 8. Examining the average characteristics of individual bonds in the LTR-sorted portfolios, we find that low-LTR bonds in quintile 1 (long-term losers) have higher market beta, lower liquidity and size, and higher credit risk. Section 8 also revisits the link between LTR and bonds' creditworthiness.

3.4 Return Premia Over Time

We now investigate the significance of return reversals and momentum over time. The top panel in Figure 1 demonstrates a time-series plot of the STR-based trading strategy that consistently delivers positive returns in 112 out of the 161 months from August 2002 to December 2015 (70% of the sample). Figure 1 also provides evidence that the return spreads between STR-losers and STR-winners are economically larger during periods corresponding to economic downturns and high aggregate illiquidity. The middle panel in Figure 1 presents a time-series plot of the MOM-based trading strategy that generates positive returns in 81 out of the 150 months from July 2003 to December 2015 (57% of the sample). Figure 1 also shows that the return spreads between MOM-winners and MOM-losers are economically larger during recessionary periods with high market volatility and default risk. One may think that the long-term reversal effect is due to a post-crisis crash rebound and nothing else. To address this potential concern, the last panel in Figure 1 displays a time-series plot of the LTR-based trading strategy that produces positive returns in 81 out of the 136 months from July 2005 to December 2015 (60% of the sample). The figure also presents evidence that the return spreads between LTR-losers and LTR-winners are economically larger during economic downturns and periods of high market volatility.

Consistent with the visual evidence provided by Figure 1, Table 5 reports the average return spreads and the corresponding the t-statistics from the value-weighted quintile portfolios of STR, MOM, and LTR across different sample periods. Since illiquidity and systematic risk premia (including default, market and macroeconomic risk premia) are higher during financial and economic downturns, we first examine the liquidity/systematic risk premia on the return-based factors of corporate bonds during recessionary vs. non-recessionary periods, determined based on the Chicago Fed National Activity Index (CFNAI).[10] Table 5 shows that the value-weighted average return spread between STR-losers and STR-winners is higher, at 0.85% per month (t-stat. = 2.06) during recessionary periods (CFNAI ≤ -0.7), whereas it is 0.77% per month (t-stat. = 5.22) during non-recessionary periods (CFNAI >-0.7). The value-weighted average return spread between MOM-winners and MOM-losers is very high, at 2.15% per month (t-stat. = 1.80) during recessionary periods, but much lower at 0.33% per month (t-stat. = 2.01) during non-recessionary periods. Finally, the value-weighted av-

[10]The CFNAI is a monthly index designed to assess overall economic activity and related inflationary pressure. The CFNAI is a weighted average of 85 existing monthly indicators of national economic activity. It is constructed to have an average value of zero and a standard deviation of one. An index value below (above) -0.7 corresponds to recessionary (non-recessionary) period.

erage return difference between LTR-losers and LTR-winners is also very high, at 1.14% per month (t-stat. = 2.53) during recessionary periods, whereas it is much lower at 0.55% per month (t-stat. = 4.52) during non-recessionary periods.

Second, we investigate the significance of return premia conditioning on market volatility and find that the premia on the return-based factors are higher during volatile periods when the S&P500 index option implied volatility (VIX) is above its historical median (VIX $>$ VIX^{Median}), compared to periods of low market volatility (VIX $\leq$ VIX^{Median}). Table 5 shows that the STR premium is higher at 1.00% per month (t-stat. = 3.09) during volatile periods, whereas it is 0.56% per month (t-stat. = 4.19) during tranquil periods. The MOM premium is also high at 1.10% per month (t-stat. = 2.30) during bad market states, but insignificant during stable periods. Finally, the LTR premium is higher at 1.12% per month (t-stat. = 5.02) during periods of high market volatility, whereas it is much lower but still significant during periods of low market volatility.

Third, we test the significance of return premia conditioning on aggregate default risk, and find that the MOM and LTR premia are significantly high during periods of high default risk (ΔDEF > 0), but insignificant during periods of low default risk (ΔDEF ≤ 0). Table 5 shows that the MOM premium is 1.00% per month (t-stat. = 2.30) during states of high default risk whereas it is only 0.23% per month (t-stat. = 0.93) during states of low default risk. The LTR premium is 0.44% per month (t-stat. = 2.18) during periods of high default risk, whereas it is at 0.83% per month during periods of low default risk. The STR premium is significant and about the same magnitude during periods of high and low default risk.

Finally, we examine the significance of return premia conditioning on aggregate illiquidity, and find that the premia on the return-based factors are higher during periods of high aggregate illiquidity (ILLIQ$^{agg} > Median$), compared to periods of low aggregate illiquidity (ILLIQ$^{agg} \leq Median$).[11] Table 5 shows that the STR premium is significantly larger, at 1.15% per month (t-stat. = 3.65) during illiquid states, whereas it is 0.41% per month (t-stat. = 2.92), during liquid states. The MOM premium is also high, at 1.03% per month (t-stat. = 2.24) during periods of high illiquidity, but insignificant during periods of high

[11] Aggregate illiquidity (ILLIQ^{agg}) in the corporate bond market is proxied by the value-weighted average of the bond-level illiquidity measures of Roll (1984).

liquidity. Finally, the LTR premium is higher, at 1.26% per month (t-stat. = 4.76) during periods of high illiquidity, whereas it is much lower but still significant during periods of high liquidity.

3.5 Fama-MacBeth Regressions

We have so far tested the significance of short-term reversal (STR), momentum (MOM), and long-term reversal (LTR) at the portfolio level. We now examine the cross-sectional relation between past return characteristics 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 STR, MOM, LTR and the control variables, including the bond market beta (β^{Bond}), bond-level illiquidity (ILLIQ), credit rating, year-to-maturity (MAT), and bond amount outstanding (SIZE). Monthly cross-sectional regressions are run for the following econometric specification and nested versions thereof:

$$\begin{aligned} R_{i,t+1} &= \lambda_{0,t} + \lambda_{i,1} \cdot STR_{i,t} + \lambda_{i,2} \cdot MOM_{i,t} + \lambda_{i,3} \cdot LTR_{i,t} \\ &+ \sum_{k=1}^{K} \lambda_{i,k} Control_{k,t} + \epsilon_{i,t+1}, \end{aligned} \tag{2}$$

where $R_{i,t+1}$ is the excess return on bond i in month t+1.

Table 6 reports the time series average of the intercept, the slope coefficients (λ's), and the average adjusted R^2 values over the 137 months from July 2005 to December 2015. The Newey-West adjusted t-statistics are reported in parentheses. The univariate regression results show a negative and significant relation between STR and the cross-section of future bond returns. In Regression (1), the average slope $\lambda_{1,t}$ from the monthly regressions of excess returns on STR alone is -0.091 with a t-statistic of -5.75. The economic magnitude of the associated effect is similar to that documented in Table 2 for the univariate quintile portfolios of STR. The spread in average STR between quintiles 5 and 1 is approximately 9.42%, and multiplying this spread by the average slope of -0.091 yields an estimated monthly return difference of 86 basis points.[12]

[12]Note that the ordinary least squares (OLS) methodology used in Fama-MacBeth regressions gives an

Consistent with the univariate quintile portfolios of MOM in Table 3, the average slope, $\lambda_{2,t}$, from the univariate cross-sectional regressions of excess bond returns on MOM is positive and statistically significant. Regression (3) shows an average slope of 0.029 with a t-statistic of 2.79. This positive average slope on MOM represents an economic effect of an increase of 0.86% per month in the expected return of an average bond moving from the first to the fifth quintile of momentum. Similar to our findings for STR, the economic significance of momentum obtained from Fama-MacBeth regressions, 0.86% per month, is higher than 0.61% per month obtained from the value-weighted portfolios (see Table 3).

Regression (5) shows that the average slope, $\lambda_{3,t}$, from the univariate cross-sectional regressions of excess bond returns on LTR is negative, -0.015, and highly significant with a t-statistic of -2.93, consistent with the univariate quintile portfolios of LTR in Table 4. From the perspective of economic significance, this negative average slope on LTR represents a decrease of 84 basis points per month in the expected return of an average bond moving from the first to the fifth quintile of LTR.

Regression specifications (2), (4), and (6) in Table 6 show that, after we control for β^{bond}, illiquidity, credit rating, maturity, and size, the average slope coefficients on STR and LTR remain negative and highly significant, whereas the average slope coefficient on MOM remains positive and significant. In other words, controlling for bond characteristics does not affect the significance of short/long-term return reversals and momentum in the corporate bond market.

Regression (7) tests the cross-sectional predictive power of STR, MOM, and LTR simultaneously. The average slopes on STR and LTR are significantly negative at -0.056 (t-stat.$=$ -4.43) and -0.020 (t-stat.$= -2.52$), respectively. The average slope on MOM is significantly positive at 0.021 (t-stat.$=$ 2.21). The last specification, Regression (8), presents results from the multivariate regression with all bond return characteristics (STR, MOM, and LTR) while simultaneously controlling for β^{Bond}, illiquidity, credit rating, maturity, and size. Similar to our findings in Regression (7), the cross-sectional relations between future bond returns and

equal weight to each cross-sectional observation so that the regression results are more aligned with the equal-weighted portfolios. That is why the economic significance of STR obtained from Fama-MacBeth regressions, 0.86% per month, is somewhat higher than 0.78% per month obtained from the value-weighted portfolios (see Table 2).

STR and LTR are negative and highly significant, whereas MOM positively predicts future returns. These results show that the past return characteristics have distinct, significant information beyond bond size, maturity, rating, liquidity, and market risk, and they are strong and robust predictors of future bond returns.

3.6 Robustness Checks

3.6.1 Longer-term predictive power of momentum

In addition to the one-month-ahead predictability, we investigate the longer-term predictive power of momentum in the corporate bond market. Table A.1 of the online appendix presents results from the value-weighted univariate portfolios sorted by momentum for the 3-, 6-, and 12-month holding periods. To deal with overlapping portfolios in each month during the holding period, we follow Jegadeesh and Titman (1993) and compute the simple average of value-weighted returns across the momentum portfolios formed in different months. As shown in the last row of Table A.1, the results confirm a significant momentum effect in the corporate bond market for the 3-, 6-, and 12-month investment horizons.

3.6.2 Investigating momentum for investment-grade and non-investment-grade bonds

In this section, we re-examine the significance of momentum for investment-grade and non-investment-grade bonds separately. We sort investment-grade bonds into quintile portfolios based on their past 11-month cumulative returns and compute the average return and alpha spreads between momentum winners and losers. The first four columns in Table A.2 of the online appendix provide no evidence of momentum in the sample of investment-grade bonds of publicly traded firms, consistent the findings of Jostova et al. (2013) and Gebhardt et al. (2005). Specifically, the average return and alpha spreads are very low, in the range of 11 and 25 bps per month, and statistically insignificant. The last four columns in Table A.2 provide evidence of a strong momentum effect in the sample of non-investment-grade bonds as the average return and alpha spreads range from 0.81% to 1.09% per month and they are highly statistically significant.

3.6.3 Long-term reversal effect in the long-run

In addition to the one-month-ahead predictability, we investigate the longer-term predictive power of LTR in the corporate bond market. Table A.3 of the online appendix presents results from the value-weighted quintile portfolios sorted by LTR to predict the 12-, 24-, and 36-month ahead returns. The results confirm a significant long-term reversal effect in the corporate bond market for long-term investment horizons. Specifically, the average return and alpha spreads between LTR-winners and LTR-losers are in the range of −0.62% to −0.84% per month and highly significant for one-year- to three-year-ahead predictability.

3.6.4 Long-term reversal effect after accounting for defaulting bond returns

Corporate bonds occasionally default prior to reaching maturity. If default returns are simply treated as missing observations, return estimates can be overstated, particularly for high-yield bonds. To address this potential return bias, we follow Cici, Gibson, and Moussawi (2017) and compute a composite default return for all defaulted bonds. Specifically, we generate post-default prices for any bonds that defaulted before calculating monthly bond returns. We then compute the median return on these defaulted issues in the (−1, +1) month window around the default date and use the median return of −40.17% for defaulting investment-grade issues and −17.67% for defaulting non-investment-grade issues, which reflect higher expected default probability for high yield ex-ante. We then include these delisting return averages as proxies for delisting returns for all defaulting issues at the month of default, and we drop all observations for defaulted issues after their first default event. Using the in-sample composite default-month returns for defaulting bonds sharing similar credit quality – but without valid post-default pricing information – enables us to avoid delisting bias that has been documented in previous research on equity returns (Shumway (1997)).

Table A.4 of the online appendix presents results for the long-term reversal effect after accounting for defaulting bond returns. The results confirm the significant long-term reversal effect in the corporate bond market. The average return and 11-factor alpha spreads between LTR-winners and LTR-losers are −0.58% and −0.54% per month and highly significant, indicating that long-term reversal is not driven by survivorship bias for defaulting bonds.

3.6.5 Firm-level evidence

Our empirical analyses have so far based on bond-level data, since we test whether the past return characteristics of individual bonds predict their future returns. To control for bonds issued by the same firm in our cross-sectional regressions, for each month we pick one bond of median size as representative of the firm and re-run the Fama-MacBeth regressions using this firm-level dataset. As presented in Table A.5 of the online appendix, the value-weighted quintile portfolios indicate significant short-term and long-term reversals as well as medium-term momentum in the cross-section of firm-level bond returns. Specifically, the value-weighted average return and 11-factor alpha spreads between STR-winners and STR-losers are −0.82% (t-stat. = −3.84) and −0.74% (t-stat. = −3.72), respectively. The corresponding raw and risk-adjusted return spreads for the momentum portfolios are 0.59% (t-stat. = 2.46) and 0.52% (t-stat. = 2.23), respectively. The corresponding average return and alpha differences between LTR-winners and LTR-losers are −0.83% (t-stat. = −3.44) and −0.65% (t-stat. = −3.83), respectively.

As shown in Table A.6 of the online appendix, our main findings from the firm-level regressions remain qualitatively similar to those obtained from the bond-level regressions, except for momentum. Both the univariate and multivariate regression results present negative and highly significant relations between future firm-level bond returns and STR and LTR. Consistent with our previous findings, Regressions (3) – (4) in Table A.6 show that the average slope on MOM is positive and significant in univariate and multivariate regressions controlling for bond characteristics. However, Regressions (7) – (8) demonstrate that when all three past return characteristics (STR, MOM, LTR) are included simultaneously in the same regression, the cross-sectional relations between STR, LTR, and future firm-level bond returns remain negative and highly significant with and without accounting for all other controls, whereas the cross-sectional relation between MOM and future bond returns becomes insignificant.

Overall, these results indicate superior performance of STR and LTR in predicting the cross-sectional dispersion in firm-level bond returns relative to MOM.

3.6.6 Results from a longer sample period: 1977 – 2015

In this section, we present the main findings from an extended sample of bond data from January 1977 to December 2015. The extended sample is compiled from five data sources: Lehman Brothers fixed income database (Lehman), Datastream, National Association of Insurance Commissioners database (NAIC), Bloomberg, and the enhanced version of the Trade Reporting and Compliance Engine (TRACE).[13] We adopt the following principle to handle overlapping observations among different datasets. If two or more datasets have observations that overlap at any point in time, we give priority to the dataset that reports the transaction-based bond prices. Thus, TRACE dominates other datasets from July 2002 to December 2015. If there are no transactions data or the coverage of the data is too small, we give priority to the dataset that has a relatively larger coverage on bonds/firms. For example, Bloomberg daily quotes data are preferred to those of Datastream for the period 1998 – 2002 for its larger coverage. Finally, we filter out a few months at the beginning of the sample period, 1973 – 1976, during which there are insufficient number of bonds in the sequentially sorted portfolios to construct the return-based factors. Our final extended sample covers the period from January 1977 to December 2015.

With this comprehensive dataset, we replicate our main analyses and again find significant short- and long-term return reversals and momentum in the corporate bond market. Table A.7 of the online appendix presents results from the value-weighted quintile portfolios of corporate bonds sorted by STR, MOM, and LTR. The first two columns in Table A.7 show that bonds in the lowest STR quintile (short-term losers) generate 0.68% to 0.64% more raw and risk-adjusted monthly returns than bonds in the highest STR quintile (short-term winners), confirming strong evidence of short-term reversal from the longer sample period. The next two columns in Table A.7 show that the average return and 11-factor alpha spreads between MOM-winners and MOM-losers are 0.54% and 0.49% per month with the corresponding *t*-statistics of 3.14 and 3.10, respectively. Although the momentum effect from the

[13] The Lehman data cover the period from January 1973 to March 1998. Datastream reports corporate bond information from January 1990 to December 2015. NAIC reports the transaction information by insurance companies during January 1994 to December 2015. Bloomberg provides daily bond prices during January 1997 to December 2015. The two datasets, NAIC and TRACE, provide prices based on the real transactions, whereas other datasets, Lehman, Datastream, and Bloomberg, provide prices based on quotes and matrix calculations.

comprehensive dataset turns out to be somewhat weaker compared to the TRACE sample, it is highly significant, both economically and statistically. The last two columns in Table A.7 provide evidence that bonds in the lowest LTR quintile (long-term losers) generate 0.48% to 0.54% more raw and risk-adjusted monthly returns than bonds in the highest LTR quintile (long-term winners), validating the significant long-term reversal effect from a larger sample of corporate bonds with longer time-series coverage.

These results demonstrate that the cross-section of corporate bond returns strongly depends on past bond returns and the significant return reversals and momentum are robust to an extended sample of corporate bond data compiled from different sources including the quoted- and transaction-based bond data.[14]

4 Return-Based Factors in the Corporate Bond Market

In this section, we first introduce novel factors for corporate bonds that are based on the past return characteristics (STR^{Bond}, MOM^{Bond}, LTR^{Bond}) and then investigate the economic and statistical significance of these newly proposed bond factors. Second, we examine the significance of the return-based factors of individual stocks (STR^{Stock}, MOM^{Stock}, LTR^{Stock}) for the common sample period of 2002 – 2015. Third, we generate another set of STR, MOM, and LTR factors by picking one bond per firm (with its issue size as the median across all bonds issued by the firm), and test the significance of these factors obtained from the firm-level data. Finally, we investigate if the newly proposed bond factors are explained by well-established stock and bond market factors.

[14]Bessembinder, Maxwell, and Venkataraman (2006) highlight the importance of using TRACE transaction data when computing abnormal performance of corporate bond portfolios. One should also be cautious about the real time implementation of STR/MOM/LTR-sorted portfolios based on the bond returns from Lehman, Datastream, and Bloomberg, because these sources provide prices from price quotes and matrix calculations. In other words, the results reported in Table A.7 should be viewed with caution. For this reason, we rely on the transactions data from TRACE in the main text.

4.1 Return-Based Bond Factors: STR, MOM, and LTR

As discussed previously, corporate bonds with strong reversal and momentum effects also have higher credit risk and/or longer maturity both at the bond level and portfolio level. Thus, it is natural to use credit risk (proxied by credit rating) and time-to-maturity as the primary sorting variables in the construction of these new factors.

To construct the return-based factors, we form mimicking portfolios by first sorting bonds into terciles based on their credit rating and then, within each rating portfolio, we further sort the bonds into sub-terciles based on their time-to-maturity, and finally, we further sort the bonds into terciles based on either STR, MOM or LTR. Thus, for each month from July 2002 to December 2015, the short-term reversal factor (STR^{Bond}) is constructed using 3×3×3 trivariate conditional sorts of credit rating, time-to-maturity, and STR. The short-term reversal factor, STR^{Bond}, is the value-weighted average return difference between the lowest STR minus the highest STR portfolio across the rating/maturity portfolios.

Similarly, for each month from July 2003 to December 2015, the momentum factor (MOM^{Bond}) is constructed using 3×3×3 trivariate conditional sorts of credit rating, time-to-maturity, and MOM. The momentum factor, MOM^{Bond}, is the value-weighted average return difference between the highest MOM minus the lowest MOM portfolio across the rating/maturity portfolios. Finally, the long-term reversal factor (LTR^{Bond}) is constructed using 3×3×3 trivariate conditional sorts of credit rating, time-to-maturity, and LTR for the period July 2005 – December 2015. LTR^{Bond} is the value-weighted average return difference between the lowest LTR minus the highest LTR portfolio across the rating/maturity portfolios.

4.2 Testing the Significance of the Return-Based Factors

Panel A of Table 7 presents results from testing the significance of the return-based bond factors (STR^{Bond}, MOM^{Bond}, LTR^{Bond}). Over the period from July 2002 to December 2015, the corporate bond market risk premium, MKT^{Bond}, is 0.37% per month with a t-statistic of 2.79. The value-weighted STR^{Bond} factor has an economically and statistically significant premium of 0.56% per month with a t-statistic of 8.41. It is also important to note that the STR^{Bond} factor has an annualized Sharpe ratio of 1.86 (0.95) before (after) adjusting for transaction costs.[15] The value-weighted MOM^{Bond} and LTR^{Bond} factors also have significant premia of 0.45% per month (t-stat.= 3.50) and 0.57% per month (t-stat.= 4.41), respectively. The annualized Sharpe ratios for the MOM^{Bond} and LTR^{Bond} factors are 0.76 (0.32) and 1.12 (0.73) before (after) adjusting for transaction costs, respectively. As reported in Table 7, the Sharpe ratios of the newly proposed bond factors (STR^{Bond}, MOM^{Bond}, LTR^{Bond}) are also higher than those of the aggregate stock and bond market factors.[16]

The most striking result in Panel B of Table 7 is that the return-based stock market factors (STR^{Stock}, MOM^{Stock}, LTR^{Stock}) are insignificant over the common sample period of bond factors, 2002 – 2015.[17] Specifically, the value-weighted STR^{Stock} factor has an economically and statistically insignificant premium of 0.14% per month with a t-statistic of 0.63 for the period August 2002 – December 2015. The average return on the value-weighted MOM^{Stock} factor is also insignificant at 16 basis points per month with a t-statistic of 0.36 for the period July 2003 – December 2015. The long-term stock return reversal factor does not even have a positive premium over the common sample period. The average return on the value-weighted LTR^{Stock} factor is negative, but economically and statistically insignificant; -0.09% per month with a t-statistic of -0.42 for the period July 2005 – December 2015.

The magnitudes and statistical significance of the premia on the newly proposed bond factors are even more striking because for the same time period the return-based factors of individual stocks are insignificant, whereas the return-based factors of corporate bonds are highly significant with large Sharpe ratios.[18]

[15]Following Chordia et al. (2016), we estimate the portfolio transaction costs as the time-series average of the illiquidity measure multiplied by the time-series average of the portfolio turnover rate.

[16]Panel B of Table 7 shows that, over the same period of July 2002 - December 2015, the stock market risk premium, MKT^{Stock}, is 0.70% per month with a t-statistic of 2.08, yielding an annualized Sharpe ratio of 0.48.

[17]The return-based stock market factors (STR^{Stock}, MOM^{Stock}, LTR^{Stock}) are described in and obtained from Kenneth French's data library: http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/.

[18]We also replicate the return-based factors for the longer sample period 1977 – 2015 and find similar evidence. Specifically, the value-weighted STR^{Bond} factor has an economically and statistically significant premium of 0.49% per month with a t-statistic of 7.81. The value-weighted MOM^{Bond} and LTR^{Bond} factors also have significant premia of 0.32% per month (t-stat.= 4.85) and 0.33% per month (t-stat.= 7.54), respectively.

4.3 Do Existing Factor Models Explain the STR, MOM, and LTR Factors?

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

$$Factor_t^{Return-based} = \alpha + \sum_{k=1}^{K} \beta_k \cdot Factor_{k,t}^{Stock} + \sum_{l=1}^{L} \beta_l \cdot Factor_{l,t}^{Bond} + \varepsilon_t, \qquad (3)$$

where $Factor_t^{Return-based}$ is one of the three bond market factors: STR^{Bond}, MOM^{Bond}, and LTR^{Bond}. $Factor_{k,t}^{Stock}$ denotes a vector of existing stock market factors and $Factor_{k,t}^{Bond}$ denotes a vector of existing bond market factors.

Equation (3) is estimated separately for each of the newly proposed return-based bond factors on the left hand side. These factor regression results are presented in Table 8. The intercepts (alphas) from these time-series regressions represent abnormal returns not explained by the standard stock and bond market factors. The alphas are defined in terms of monthly percentages. Newey-West (1987) adjusted t-statistics are reported in parentheses.

We consider seven different factor models and investigate their explanatory power for each of the newly proposed return-based bond factors. Models 1 to 4 include only the stock market factors. Model 5 includes only the bond market factors. Models 6 and 7 combine the stock and bond market factors.

- Model 1: The 5-factor model of Fama-French (1993), Carhart (1997), and Pastor-Stambaugh (2003) with MKT^{Stock}, SMB, HML, MOM^{Stock}, and LIQ^{Stock} factors.
- Model 2: The 5-factor model of Fama-French (2015) with MKT^{Stock}, SMB, HML, RMW, and CMA factors.
- Model 3: The 4-factor model of Hou-Xue-Zhang (2015) with MKT^{Stock}, SMB, IA, and ROE factors.
- Model 4: The 4-factor model with return-based stock market factors; MKT^{Stock}, STR^{Stock}, MOM^{Stock}, and LTR^{Stock}.

- Model 5: The 4-factor model with bond market factors; MKT^{Bond}, DEF, TERM, and LIQ^{Bond}.
- Model 6: The 11-factor model with combined stock and bond market factors; [MKT^{Stock}, SMB, HML, MOM^{Stock}, LIQ^{Stock}, IA, ROE] + [MKT^{Bond}, DEF, TERM, LIQ^{Bond}].
- Model 7: The 11-factor model with combined stock and bond market factors; [MKT^{Stock}, SMB, HML, MOM^{Stock}, LIQ^{Stock}, RMW, CMA] + [MKT^{Bond}, DEF, TERM, LIQ^{Bond}].

Panel A of Table 8 reports the regression results for the STR^{Bond} factor. As shown in Panel A, all of the intercepts (alphas) are economically and statistically significant ranging from 0.56% to 0.69% per month, indicating that the existing stock and bond market factors are not sufficient to capture the information content in STR^{Bond}. The adjusted-R^2 values from these regressions are in the range of −1.81% to 13.11%, suggesting that the commonly used stock and bond market factors have low explanatory power for the STR^{Bond} factor of corporate bonds.

Panel B of Table 8 shows the regression results for the MOM^{Bond} factor. All of the intercepts are statistically and economically significant, ranging from 0.40% to 0.53% per month. The adjusted-R^2 values from these regressions are in the range of 11.95% to 25.11%, which indicates that the commonly used stock and bond market factors do not have high explanatory power for the momentum factor, either.

Panel C of Table 8 presents the regression results for the LTR^{Bond} factor. The results are similar to our findings in Panels A and B. The alphas generated from all factor models are economically and statistically significant, ranging from 0.53% to 0.79% per month, so that the existing stock and bond market factors are not sufficient to capture the information content in the long-term reversal factor of corporate bonds.

Overall, combining all factors together (i.e., Models 6 and 7), they explain at best about 13.11% of the STR^{Bond} factor (Panel A), 25.11% of the MOM^{Bond} factor (Panel B), and 28.45% of the LTR^{Bond} factor (Panel C). More importantly, the alphas on the STR^{Bond}, MOM^{Bond}, and LTR^{Bond} factors obtained from Models 6 and 7 are positive and highly significant, both economically and statistically. These findings suggest that our new bond factors represent an important source of bond return variation missing from long-established stock and bond market risk factors.[19]

5 Alternative Test Portfolios

In this section, we examine the explanatory power of the return-based bond factors for three different sets of test portfolios of corporate bonds. The first set is based on 5×5 independently sorted bivariate portfolios of size and maturity. The second involves 5×5 independently sorted bivariate portfolios of size and rating. The third is 12-industry portfolios of corporate bonds. We then examine the relative performance of factor models in explaining the time-series and cross-sectional variations in the 25-size/maturity, 25-size/rating, and 12-industry sorted portfolios of corporate bonds. The monthly returns of the test portfolios cover the period from July 2002 to December 2015.

Previously, in Section 4.3, we investigated the empirical performance of existing factor models. We now assess the performance of the newly proposed return-based bond factor model (Model 8):

- Model 8: MKT^{Bond}, STR^{Bond}, MOM^{Bond}, and LTR^{Bond}

where STR^{Bond}, MOM^{Bond}, and LTR^{Bond} are the short-term reversal, momentum, and long-term reversal factors proposed in Section 4.1.

5.1 25-Size/Maturity-Sorted Portfolios

Table 9 reports the adjusted R^2 values from the time-series regressions of the 25-size/maturity-sorted portfolios' excess returns on the newly proposed and existing stock and bond factors. Overall, the results indicate that the commonly used stock and bond market factors do not

[19] Bai, Bali, and Wen (2016) introduce credit risk and liquidity risk factors based on the bivariate portfolios of bond-level credit rating and bond-level illiquidity. After extending the 3-factor model of Elton, Gruber, and Blake (1995) with the credit risk (CRF) and liquidity risk (LRF) factors of Bai, Bali, and Wen (2016), we estimate the alpha on the newly proposed return-based factors using the extended 5-factor model with MKT^{Bond}, DEF, TERM, CRF, and LRF. Although adding CRF and LRF factors improves the explanatory power of the factor model, the alphas on STR^{Bond}, MOM^{Bond}, and LTR^{Bond} factors remain economically and statistically significant; 0.58% per month (t-stat. = 7.27), 0.64% per month (t-stat. = 4.19), and 0.31% per month (t-stat. = 2.20), respectively.

perform as well as the newly proposed factors in explaining the cross-sectional variation in the returns of bond portfolios.

Specifically, Panels A to D of Table 9 show that the adjusted R^2, averaged across the 25 portfolios, is in the range from 3% to 10% for Models 1 to 4, implying that a large fraction of the variance in the returns of the 25 bond portfolios is not explained by the commonly used stock market factors. The adjusted R^2, averaged across the 25 portfolios, is improved to 14% for Model 5 mainly because of the predictive power of traditional bond market factors. However, combining all commonly used stock and bond market factors, Models 6 and 7 show that the adjusted R^2 is at most 22%. Compared to these existing factor models, the average R^2 from Model 8, the return-based bond factor model, is much stronger. As shown in Panel H of Table 9, when we augment MKT^{Bond} with our newly proposed return-based factors (STR^{Bond}, MOM^{Bond}, and LTR^{Bond}), the average adjusted R^2 is almost doubled, increasing from 22% to 43%, suggesting that these new factors of corporate bonds capture significant cross-sectional information about the portfolio returns that is not fully picked up by standard stock and bond market factors. Overall, the results in Table 9 indicate that the newly proposed 4-factor model with the market, STR^{Bond}, MOM^{Bond} and LTR^{Bond} factors outperforms the existing factor models in explaining the returns of the size/maturity-sorted portfolios of corporate bonds.

As an alternative way of evaluating the relative performance of the factor models, we focus on the magnitude and statistical significance of the alphas on the 25-size/maturity portfolios generated by the alternative factor models. Panels A, B, C, and D of Table 9 show that the stock market factors generate economically significant alpha for almost all 25 portfolios, ranging from 0.25% to 0.72% per month. As shown in the last row of Panels A to D in Table 9, the average alphas across the 25 portfolios are very large, ranging from 0.40% to 0.54% per month, and highly significant p-value according to the Gibbons, Ross, and Shanken (1989, GRS) test. Panel E shows that the magnitude and statistical significance of the alphas decrease when using Model 5 which includes the bond market factors. However, the 4-factor model with traditional bond market factors (Model 5) still generates an economically and statistically significant average alpha of 0.43% per month. Combining stock and bond market factors (Models 6 and 7), Panels F and G show that the average alpha across the 25 portfolios is large, ranging from 0.38% to 0.41% per month, and highly significant according to the GRS test.

Panel H of Table 9 presents substantially different results compared to Panels A through G. The newly proposed 4-factor model with STR^{Bond}, MOM^{Bond}, and LTR^{Bond} (Model 8) generates economically and statistically *insignificant* alphas for 23 out of 25 portfolios. As shown in the last row of Panel H, the average alpha across the 25 portfolios is very low, economically weak at 0.15% per month.[20] Overall, these results confirm the superior performance of the newly proposed return-based factors in accounting for cross-sectional variation in the returns of the 25-size/maturity-sorted portfolios of corporate bonds.

5.2 25-Size/Rating-Sorted Portfolios

We also investigate the relative performance of the factor models using the 25-size/rating portfolios. Panels A through G in Table 10 show that the adjusted R^2s, averaged across the 25-size/rating portfolios, are in the range of 7% and 22% for Models 1 to 7. However, Panel H shows that the average adjusted R^2 significantly increases to 41%, when the new bond factors are used in the time-series factor regressions. As reported in the last row of Panels A to G in Table 10, the average alphas across the 25 portfolios are economically large, ranging from 0.35% to 0.52% per month, and highly significant , with a p-value less than 0.01, according to the GRS test. In contrast, the newly proposed 4-factor model with STR^{Bond}, MOM^{Bond}, and LTR^{Bond} (Model 8) generates economically and statistically *insignificant* alphas for 19 out of 25 portfolios. As presented in the last row of Panel H, the average alpha across the 25 portfolios is much lower at 0.18% per month.

5.3 12-Industry-Sorted Portfolios

Finally, we test the relative performance of the factor models using the 12-industry portfolios of corporate bonds based on the Fama-French (1997) industry classification. As shown in Panel A of Table 11, Models 1 to 7 generate economically significant alphas for 11 out of the 12 portfolios. As shown in the last column of Panel A, the average alphas from Model

[20] Although the average alpha is only 15 bps per month, it is statistically significant with a p-value of 0.02 according to the GRS test.

1 through 7 are in the range of 0.42% to 0.82% per month, and highly significant, with a p-value less than 0.01, according to the GRS test. Panel C shows that the adjusted R^2 values averaged across the 12-industry portfolios are in the range of 5% to 26% for Models 1 to 7, implying that the commonly used stock and bond market factors have low explanatory power for the industry-sorted portfolios of corporate bonds.

Similar to our findings for the 25-size/maturity- and 25-size/rating-sorted portfolios, Model 8 provides a more accurate characterization of the returns on 12-industry portfolios. Model 8 with STR^{Bond}, MOM^{Bond}, and LTR^{Bond} generates economically and statistically *insignificant* alphas (at the 10% level) for 8 out of 12 portfolios. As shown in the last two columns of Panel A, the average alpha across the 12 portfolios is 0.29% per month. The adjusted R^2 values averaged across all 12-industry portfolios is 38% for Model 8. Overall, these results provide supporting evidence for the remarkable performance of the newly proposed return-based factors in predicting the cross-sectional variation in the returns of the 12-industry portfolios of corporate bonds.

6 Liquidity-Based Explanation of Short-term Reversals in the Corporate Bond Market

Table 12 presents the results from the bivariate sorts of STR and Roll's (1984) measure of illiquidity. In Panel A of Table 12, we form value-weighted quintile portfolios every month from August 2002 to December 2015 by first sorting corporate bonds into five quintiles based on their illiquidity (ILLIQ). Then, within each ILLIQ portfolio, the bonds are sorted further into five sub-quintiles based on their past one month return (STR). This methodology, within each ILLIQ-sorted quintile, produces sub-quintile portfolios of bonds with dispersion in STR and nearly identical ILLIQ (i.e., these newly generated STR sub-quintile portfolios control for differences in ILLIQ). Low-STR represents the lowest past one-month-ranked bond quintiles (STR-losers) within each of the five ILLIQ-ranked quintiles. Similarly, High-STR represents the highest STR-ranked quintiles (STR-winners) within each of the five ILLIQ-ranked quintiles.

Panel A of Table 12 shows that the value-weighted average return spread between High-

STR and Low-STR quintiles is negative in all quintiles of ILLIQ, but the short-term reversal effect is economically and statistically insignificant in Low-ILLIQ quintile; −0.21% per month with a t-statistic of −1.09, implying that the short-run reversal disappears in the sample of very liquid bonds. Another notable point in Table 12, Panel A, is that the average return spread between STR-winners and STR-losers is largest in High-ILLIQ quintile; −0.95% per month with a t-statistic of −3.81, implying that the short-run reversal is strongest in the sample of very illiquid bonds. In fact, the negative return spread between High-STR and Low-STR quintiles monotonically increases in absolute magnitude, from −0.21% to −0.95% per month, when moving from Low-ILLIQ to High-ILLIQ quintile. As shown in Panel A of Table 12, similar results are obtained from the 11-factor alpha estimates for the 25 portfolios of STR and ILLIQ.

We replicate these bivariate portfolio analyses by replacing Roll's (1984) measure with Amihud's (2002) illiquidity measure. Panel B of Table 12 presents even more striking results from Amihud's ILLIQ measure. The value-weighted average return spread between High-STR and Low-STR quintiles is not even negative, practically zero, in Low-ILLIQ quintile; 0.05% per month with a t-statistic of 0.37, whereas the STR effect is economically and statistically largest in High-ILLIQ quintile; −1.14% per month with a t-statistic of −4.34, implying that the short-run reversal disappears in the sample of very liquid bonds, whereas the STR effect is again strongest in the sample of very illiquid bonds. As reported in Panel B of Table 12, the 11-factor alpha differences between High-STR and Low-STR quintiles within each ILLIQ quintile produce very similar findings.

We further investigate the liquidity-based explanation by forming 5×5 value-weighted bivariate portfolios of STR and ILLIQ for investment-grade (IG) bonds only. Since IG bonds are more liquid, we expect the short-term reversal effect to be relatively weaker in all ILLIQ quintiles. Consistent with our expectation, Panel C of Table 12 shows that the STR effect is insignificant in the two most liquid quintiles, implying that the short-run reversal disappears in the sample of liquid, IG bonds. Similar results are obtained when we replace Roll's measure with Amihud's illiquidity measure in Panel D of Table 12.

Supporting these results, Table 5 shows that the average return spread between STR-winners and STR-losers is significantly positive at 1.15% per month (t-stat. = 3.65) during periods of high illiquidity, whereas it is much lower at 0.41% per month (t-stat. = 2.92) during periods of high liquidity.

Overall, these findings provide evidence of a strong relation between short-term return reversals and bond illiquidity. The largest short-run reversals occur in the sample of illiquid bonds, whereas the STR effect is economically and statistically insignificant in the sample of very liquid bonds. More importantly, the return and alpha spreads between STR-losers and STR-winners completely disappear in a large sample of liquid, investment-grade bonds. Thus, the results indicate an illiquidity-based explanation of short-term reversal in the corporate bond market, consistent with the illiquidity-based explanation of STR in the equity market.

7 Momentum and Credit Risk

In this section, we investigate if the strengths of the momentum effects in corporate bonds are uniform across bonds with high and low levels of credit risk. We first consider the significance of momentum in the sample of investment-grade (IG) and non-investment-grade (NIG) bonds separately. As presented in Table A.2 of the online appendix, we find stronger momentum effect in the sample of NIG bonds, but there is no evidence of momentum in the sample of IG bonds. Specifically, the value-weighted average return and alpha spreads between MOM-winners and MOM-losers are in the range of 0.81% and 1.09% per month and highly significant for NIG bonds, whereas the corresponding figures range from 11 to 25 basis points per month and statistically insignificant for IG bonds.

To investigate this further, we form value-weighted bivariate portfolios every month from July 2003 to December 2015 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 past 12-month return (skipping the short-term reversal month). Panel A of Table 13 shows that the value-weighted average return spread between High-MOM and Low-MOM quintiles is positive in all quintiles of credit risk, but the momentum effect is economically and statistically insignificant in the first three quintiles of credit risk; 0.04% per month (t-stat. = 0.16) in the lowest credit risk quintile (bonds with high credit quality), 0.19% per month (t-stat. = 1.65) in quintile 2, and 0.22% per month (t-stat. =

1.35) in quintile 3. Another notable point in Table 13, Panel A, is that the average return spread between MOM-winners and MOM-losers is largest in the highest credit risk quintile (bonds with low credit quality); 1.67% per month with a *t*-statistic of 2.91, implying that the momentum effect is strongest in the sample of bonds with high credit risk. In fact, the positive return spread between High-MOM and Low-MOM quintiles monotonically increases from 0.04% to 1.67% per month, when moving from the low to the high credit risk quintile. As shown in Panel B of Table 13, similar results are obtained from the 11-factor alpha estimates for the 25 portfolios of MOM and credit risk.

As discussed in Section 3.2, when we compute the average portfolio characteristics of bonds in the univariate quintile portfolios, momentum-winners are found to be more sensitive to fluctuations in the aggregate bond market portfolio, i.e., momentum-winners have higher market risk compared to momentum-losers. In this section, we extend this analysis by estimating bond exposures to the aggregate default and interest rate risk. For each month in our sample, we simultaneously estimate individual bond exposures to the change in default and term spreads along with their exposure to the aggregate bond market using the past 36 months of data. Panel A of Table 14 shows that the average market beta of momentum-winners is 0.82, whereas the average market beta of momentum-losers is lower at 0.50. Similarly, the average exposure to aggregate default risk increases monotonically from −1.54 to 4.54 when moving from the momentum-loser to the momentum-winner quintile. Although there is no monotonically increasing pattern, momentum-winners have higher exposure to interest rate risk with $\beta^{TERM} = 1.67$, compared to momentum-losers with $\beta^{TERM} = 0.99$.

We further examine the link between bond exposure to aggregate default risk and momentum by forming the value-weighted bivariate portfolios of β^{DEF} and MOM. Specifically, we first sort corporate bonds into five quintiles based on their exposure to aggregate default risk (β^{DEF}). Then, within each β^{DEF} portfolio, bonds are sorted further into five sub-quintiles based on MOM. Panel B of Table 14 shows that the average return spread between High-MOM and Low-MOM quintiles is positive in all quintiles of β^{DEF}, but the momentum effect is economically and statistically insignificant in the first two quintiles of β^{DEF}. Another noteworthy point in Table 14, Panel B, is that the average return spread between MOM-winners and MOM-losers is again largest in the highest β^{DEF} quintile; 1.92% per month with a t-statistic of 3.04, implying that the momentum effect is strongest in the sample of bonds with high exposure to aggregate default risk. As shown in Panel C of Table 14, similar results are obtained from the 11-factor alpha estimates for the 25 portfolios of MOM and β^{DEF}. Confirming these findings, Table 5 shows that the average return spread between MOM-winners and MOM-losers is economically and statistically insignificant during periods of low default risk (ΔDEF ≤ 0); 0.23% per month (t-stat. = 0.93).

Finally, we re-examine the significance of momentum excluding the recent financial crisis period with high default and macroeconomic risk. As shown in Table 3, the value-weighted average return and 11-factor alpha spreads between MOM-winners and MOM-losers are, respectively, 0.61% per month (t-stat. = 2.61) and 0.84% per month (t-stat. = 3.39) over the full sample period from July 2003 to December 2015. When we exclude the recent financial crisis period (July 2007 – March 2009), the corresponding return and alpha spreads become economically and statistically insignificant; 0.17 (t-stat. = 1.01) and 0.10 (t-stat. = 0.85), respectively. We also test the significance of the momentum factor MOM^{Bond} after removing the crisis period, and find that the average return on MOM^{Bond} is practically zero once we exclude periods of high default and macroeconomic risk; 0.11% per month (t-stat. = 0.95).

Overall, these results indicate that bond return momentum occurs in the sample of bonds with high default/credit risk, whereas the MOM effect is economically and statistically insignificant in the sample of bonds with low default/credit risk. We also find that the momentum effect is much stronger during economic downturns and periods of high default risk. In fact, the return spreads between MOM-winners and MOM-losers completely disappear when we exclude the recent financial crisis period or periods of high default risk. Thus, the results indicate that bond market momentum is limited in the cross-section to default-prone bonds and in the time series to the financial crisis period.[21]

[21] Momentum may arise because firms that get upgraded attract new investors like insurance companies, thus creating price pressures. Such pressures, however, should be temporary in nature. To investigate whether momentum is related to price pressure, we examine the returns from month $t+2$ to month $t+24$ and $t+36$. However, we do not find significant evidence of momentum return reversals. For month $t+2$ to $t+24$, the return and alpha spreads between momentum winners and losers are only 16 and 19bps per month, respectively. For month $t+2$ to $t+36$, the corresponding return and alpha spreads are even lower, 1 and 5bps per month, respectively.

8 Long-Term Reversal and Credit Risk

In Tables 15 and 16 we present the analogs of Tables 13 and 14 for long-term reversals. We find that just as for momentum, the long-term reversal effect is confined to the two quintiles with highest credit risk and the two quintiles with the highest default beta. Specifically, the return spread between extreme LTR portfolios is about −1.8% and significant for the bonds with the highest credit risk, as measured by either credit rating or default beta, and ranges from −0.4% to −0.9% for the bond portfolio with the second highest level of credit risk. The LTR return spread is insignificant for all other credit risk categories. Hence our analysis suggests that long-term reversals, like momentum, also are confined to default-prone bonds.[22]

A related interpretation of long-term reversal is the time variation in expected returns — an increase in discount rates generates an immediate price drop, followed by higher expected future returns. Given our evidence that long-term reversals are stronger for losers, we examine whether losers have recently experienced an increase in credit risk (i.e., credit rating downgrade) which results in immediate negative price response, followed by higher future returns. Thus, we compute the average change in credit ratings across the portfolio formation window for losers and winners separately. As shown in Panel A of Table 17, long-term losers indeed experience significant increases in credit risk (or ratings downgrade) during the portfolio formation window. Specifically, the average change in ratings (or average increase in the numerical score) for bonds in quintile 1 is economically large at 0.30, 0.79, 1.47, and 2.28 for the 12-, 24-, 36-, and 48-month measurement windows, respectively. However, the average change in ratings for long-term winners is almost zero for all measurement windows, suggesting that winners have not experienced an improvement in credit risk on average. As reported in the last row of Table 17, Panel A, the average differences in change in ratings between losers and winners are all significant at −0.27, −0.78, −1.47, and −2.25, respectively, for the 12-, 24-, 36-, and 48-month measurement windows. Overall, the results show that the discount rate channel, especially related to long-term losers, is part of the driving force

[22] Unreported analysis indicates that, unlike momentum, LTR is not sensitive to whether the financial crisis period is excluded. Specifically, when we exclude the recent financial crisis period (July 2007 – March 2009), the average return and alphas in Table 4 remain significant at the 1% level, as do the returns on the LTR factor.

behind long-term reversals in corporate bonds.

Panel B of Table 17 shows the negative price response associated with ratings downgrade. We form quintile portfolios based on the change in credit ratings from month $t-48$ to month $t-13$ (i.e., the same measurement window as LTR) and report the portfolio formation period returns associated with each quintile. Consistent with a negative price response to an increase in credit risk, bonds with ratings downgrades tend to experience lower returns.

If long-term reversal is related to bonds that have recently experienced an increase in credit risk, then LTR should be significantly reduced once we eliminate the bonds with the largest ratings downgrade. To test this hypothesis, for each portfolio formation month we sort bonds based on changes in credit ratings from the same measurement window (i.e., month $t-48$ to month $t-13$). We identify bonds that belong to the quintile with largest increase in credit risk and we eliminate them when forming portfolios. Then, we re-examine the long-term reversal effect and show in Table 17, Panel C that the average return and alpha spreads between LTR winners and losers are economically and statistically insignificant after excluding bonds with a large increase in credit risk. This further supports the notion that credit ratings downgrade is an important source of the long-term reversal effect.

The fact that losers from $t-48$ to $t-13$ experience increases in credit risk in $t-12$ to t implies a role for bond markets to anticipate the distress. To provide more direct evidence on this issue, we investigate whether long-term returns signal future shifts in credit risk. We examine the cross-sectional relation between LTR and alternative measures of credit risk at the bond level using Fama and MacBeth (1973) regressions. Table 18 reports results from the Fama-MacBeth regressions of two measures of credit risk in month $t+1$ on past 3-year return (LTR) ending in month t, with and without the control variables. Regressions (1) to (3) show a positive and significant relation between LTR and distance-to-default (DD) after controlling for other bond characteristics, indicating that long-term losers experience larger increases in future credit risk (or losers experience lower distance-to-default). Consistent with these results, Regressions (4) to (6) show a negative and significant relation between LTR and the credit default spread (CDS), indicating that long-term losers are exposed to larger future shifts in credit risk. Overall, the results in Table 18 show that long-term reversal has distinct, significant information beyond bond size, maturity, liquidity, and market risk, and is a strong predictor of future shifts in corporate bond default and credit quality. This evidence indicates that bond returns aid in price discovery by providing material information about future firm outcomes.

9 Conclusion

Inspired by the extensive literature on reversals and momentum in the equity market, this paper investigates whether past return characteristics of corporate bonds help predict cross-sectional variation in future bond returns. The results indicate significant short-term and long-term return reversals as well as momentum in the corporate bond market. We show that a substantial amount of variation in the cross-section of corporate bond returns can be explained by past returns. The phenomena of monthly reversals, medium-term momentum, and long-term reversals carry over to the corporate bond market, even as these phenomena disappear in the equity market during our sample period.

We then introduce novel corporate bond factors based on the short/long-term reversals and momentum and show that these new bond factors have economically and statistically significant premia, which cannot be explained by standard stock and bond market factors. The results indicate an illiquidity-based explanation of short-term reversal in the corporate bond market. We show that bond market momentum and long-term reversal are both stronger in the high credit risk sector. We also find that long-term reversals happen principally in recently-downgraded bonds that experience low returns. This accords with the view that long-term reversals represent an increase in required returns for bonds with increased credit risk.

We further examine the explanatory power of the newly proposed factors for alternative test portfolios constructed based on bond size, maturity, and industry. We find that the newly proposed four-factor model with the bond market factor and the three return-based factors (short-term reversals, momentum, and long-term reversals) outperforms existing factor models in predicting the returns of the industry- and size/rating/maturity-sorted portfolios of corporate bonds. Our work raises at least two issues. First, does the role of past returns in explaining future corporate bond returns extend to international markets? Second, does the pattern of short-term reversals, medium-term momentum, and long-term reversals extend to other asset classes? These and other topics are left for future research.

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Table 1: Descriptive Statistics

Panel A 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 credit rating, time-to-maturity (Maturity, year), amount outstanding (Size, $ million), short-term reversal (STR), momentum (MOM), and long-term reversal (LTR). Ratings are in conventional numerical scores, where 1 refers to an AAA rating and 21 refers to a C rating. Higher numerical score means higher credit risk. 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. STR is the previous month return. MOM is the 12-month momentum, defined as the past 11-month cumulative returns from $t-12$ to $t-2$, skipping month $t-1$. LTR is the past 36-month cumulative returns from $t-48$ to $t-13$, skipping the 12-month momentum and the short-term reversal month. Panel B reports the time-series average of the cross-sectional correlations. The sample period is from July 2002 to December 2015.

Panel A: Cross-sectional statistics over the sample period of July 2002 – December 2015

					Percentiles					
	N	Mean	Median	SD	1st	5th	25th	75th	95th	99th
Rating	1,261,667	8.29	7.46	4.10	1.63	2.14	5.58	10.18	16.40	19.48
Time-to-maturity (maturity, year)	1,261,667	9.26	6.52	7.79	1.09	1.48	3.49	12.59	26.39	29.93
Amount Out (size, $million)	1,261,667	335.68	214.29	449.54	0.70	2.64	29.11	432.75	1211.18	2359.76
STR (%)	1,106,644	0.72	0.47	3.76	-8.08	-4.02	-0.80	1.90	6.13	12.65
MOM (%)	594,028	7.55	5.59	16.38	-19.44	-8.37	1.20	10.75	30.83	59.56
LTR (%)	482,512	22.41	19.29	29.23	-26.32	-8.80	10.03	28.94	65.30	126.85

Panel B: Average cross-sectional correlations

	Rating	Maturity	Size	STR	MOM	LTR
Rating	1	-0.148	0.034	0.095	0.124	0.084
Maturity		1	-0.005	0.014	0.053	0.043
Size			1	-0.005	0.001	0.037
STR				1	0.000	-0.008
MOM					1	0.005
LTR						1

Table 2: Univariate Portfolios of Corporate Bonds Sorted by Short-term Reversal

Quintile portfolios are formed every month from July 2002 to December 2015 by sorting corporate bonds based on the short-term reversal (STR), proxied by previous month return. Quintile 1 is the portfolio with the lowest STR, and Quintile 5 is the portfolio with the highest STR. Table reports the average STR, the next-month average excess return, the 7-factor alpha from stock market factors, the 4-factor alpha from bond market factors, and the 11-factor alpha for each quintile. The portfolios are value-weighted using amount outstanding as weights. The last five columns report average portfolio characteristics including bond beta (β^{Bond}), illiquidity (ILLIQ), credit rating, time-to-maturity (years), and amount outstanding (size, in $billion) for each quintile. The last row shows the differences in monthly average returns, the differences in alphas with respect to the factor models. The 7-factor model with stock market factors includes the excess stock market return (MKT^{Stock}), the size factor (SMB), the book-to-market factor (HML), the stock momentum factor (MOM^{Stock}), the stock liquidity factor (LIQ), the short-term reversal factor (STR^{Stock}), and the long-term reversal factor (LTR^{Stock}). The 4-factor model with bond market factors includes the excess bond market return (MKT^{Bond}), the default spread factor (DEF), the term spread factor (TERM), and the bond liquidity factor (LIQ^{Bond}). The 11-factor model combines 7 stock market factors and 4 bond market factors. Average returns and alphas are defined in monthly percentage terms. Newey-West adjusted t-statistics are given in parentheses. *, **, and *** indicate the significance at the 10%, 5%, and 1% levels, respectively.

Quintiles	Average	Average	7-factor stock	4-factor bond	11-factor	Average portfolio characteristics				
	STR	return	alpha	alpha	alpha	β^{Bond}	ILLIQ	Rating	Maturity	Size
Low	-3.83	1.16	1.13	1.03	1.07	0.40	3.45	8.86	11.10	0.31
		(3.41)	(3.69)	(3.60)	(4.15)					
2	-0.58	0.39	0.38	0.34	0.36	0.25	1.48	7.74	8.16	0.42
		(3.05)	(3.17)	(3.32)	(3.82)					
3	0.44	0.27	0.27	0.22	0.25	0.23	1.29	7.80	7.51	0.45
		(2.17)	(2.41)	(1.41)	(1.24)					
4	1.54	0.28	0.29	0.23	0.27	0.29	1.73	8.34	8.86	0.41
		(1.74)	(2.10)	(1.19)	(1.36)					
High	5.41	0.38	0.35	0.26	0.31	0.48	4.37	9.60	11.51	0.31
		(1.14)	(1.33)	(1.11)	(1.35)					
High − Low		-0.78***	-0.78***	-0.77***	-0.75***					
Return/Alpha diff.		(-5.09)	(-5.65)	(-4.83)	(-4.61)					

Table 3: Univariate Portfolios of Corporate Bonds Sorted by Momentum

Quintile portfolios are formed every month from July 2003 to December 2015 by sorting corporate bonds based on their 12-month momentum (MOM), defined as the past 11-month cumulative returns from $t-12$ to $t-2$, skipping month $t-1$. Quintile 1 is the portfolio with the lowest MOM, and Quintile 5 is the portfolio with the highest MOM. Table reports the average MOM, the next-month average excess return, the 7-factor alpha from stock market factors, the 4-factor alpha from bond market factors, and the 11-factor alpha for each quintile. The last five columns report average portfolio characteristics including bond beta (β^{Bond}), illiquidity (ILLIQ), credit rating, time-to-maturity (years), and amount outstanding (size, in $billion) for each quintile. The last row shows the differences in monthly average returns, the differences in alphas with respect to the factor models. The 7-factor model with stock market factors includes the excess stock market return (MKT^{Stock}), the size factor (SMB), the book-to-market factor (HML), the stock momentum factor (MOM^{Stock}), the stock liquidity factor (LIQ), the short-term reversal factor (STR^{Stock}), and the long-term reversal factor (LTR^{Stock}). The 4-factor model with bond market factors includes the excess bond market return (MKT^{Bond}), the default spread factor (DEF), the term spread factor (TERM), and the bond liquidity factor (LIQ^{Bond}). The 11-factor model combines 7 stock market factors and 4 bond market factors. Average returns and alphas are defined in monthly percentage terms. Newey-West adjusted t-statistics are given in parentheses. *, **, and *** indicate the significance at the 10%, 5%, and 1% levels, respectively.

Quintiles	Average	Average	7-factor stock	4-factor bond	11-factor	Average portfolio characteristics				
	MOM	return	alpha	alpha	alpha	β^{Bond}	ILLIQ	Rating	Maturity	Size
Low	-6.12	-0.20	-0.40	-0.38	-0.47	0.35	4.95	8.97	8.30	0.47
		(-0.79)	(-1.43)	(-1.60)	(-1.58)					
2	2.03	0.21	0.16	0.13	0.14	0.21	1.68	7.75	6.97	0.52
		(1.43)	(0.92)	(1.06)	(0.98)					
3	5.42	0.27	0.25	0.24	0.25	0.21	1.22	7.89	7.37	0.53
		(2.32)	(2.00)	(2.20)	(2.13)					
4	9.29	0.31	0.30	0.30	0.30	0.24	1.15	8.59	8.41	0.50
		(3.02)	(2.74)	(2.86)	(2.80)					
High	23.67	0.41	0.39	0.38	0.38	0.52	2.18	10.88	10.82	0.45
		(2.93)	(2.58)	(2.68)	(2.58)					
High − Low		0.61***	0.79***	0.76***	0.84***					
Return/Alpha diff.		(2.61)	(2.97)	(3.37)	(3.39)					

Table 4: Univariate Portfolios of Corporate Bonds Sorted by Long-term Reversal

Quintile portfolios are formed every month from July 2005 to December 2015 by sorting corporate bonds based on their long-term reversal (LTR), proxied by the past 36-month cumulative returns from $t-48$ to $t-13$, skipping the 12-month momentum and short-term reversal month. Quintile 1 is the portfolio with the lowest LTR, and Quintile 5 is the portfolio with the highest LTR. Table reports the average LTR, the next-month average excess return, the 7-factor alpha from stock market factors, the 4-factor alpha from bond market factors, and the 11-factor alpha for each quintile. The last five columns report average portfolio characteristics including bond beta (β^{Bond}), illiquidity (ILLIQ), credit rating, time-to-maturity (years), and amount outstanding (size, in $billion) for each quintile. The last row shows the differences in monthly average returns, the differences in alphas with respect to the factor models. The 7-factor model with stock market factors includes the excess stock market return (MKT^{Stock}), the size factor (SMB), the book-to-market factor (HML), the stock momentum factor (MOM^{Stock}), the stock liquidity factor (LIQ), the short-term reversal factor (STR^{Stock}), and the long-term reversal factor (LTR^{Stock}). The 4-factor model with bond market factors includes the excess bond market return (MKT^{Bond}), the default spread factor (DEF), the term spread factor (TERM), and the bond liquidity factor (LIQ^{Bond}). Average returns and alphas are defined in monthly percentage terms. Newey-West adjusted t-statistics are given in parentheses. *, **, and *** indicate the significance at the 10%, 5%, and 1% levels, respectively.

Quintiles	Average LTR	Average return	7-factor stock alpha	4-factor bond alpha	11-factor alpha	Average portfolio characteristics				
						β^{Bond}	ILLIQ	Rating	Maturity	Size
Low	-3.66	1.37	1.33	1.31	1.29	0.76	3.95	10.27	8.20	0.30
		(3.23)	(4.27)	(3.52)	(4.88)					
2	11.50	0.56	0.55	0.53	0.56	0.33	1.94	8.13	7.30	0.45
		(2.56)	(3.35)	(2.79)	(3.82)					
3	18.52	0.50	0.50	0.50	0.53	0.23	1.53	7.88	7.18	0.51
		(2.73)	(3.69)	(2.91)	(4.08)					
4	25.81	0.51	0.51	0.52	0.55	0.23	1.85	8.23	8.72	0.51
		(2.43)	(3.33)	(2.58)	(3.74)					
High	52.12	0.71	0.68	0.68	0.61	0.36	2.57	9.94	10.45	0.45
		(2.92)	(3.73)	(3.35)	(4.65)					
High − Low		-0.66***	-0.65***	-0.63***	-0.68***					
Return/Alpha diff.		(-3.19)	(-3.83)	(-3.15)	(-3.80)					

Table 5: STR, MOM, and LTR Return Premia Over Time

This table reports the average monthly return spreads and their t-statistics from the long-short univariate portfolios of corporate bonds sorted by STR, MOM, and LTR, conditioning on different states of the economy (CFNAI), volatility (VIX), default risk (ΔDEF), and illiquidity (ILLIQ). The STR^{premia} is the average return spread between STR-losers (quintile 1) and STR-winners (quintile 5). The MOM^{premia} is the average return spread between MOM-winners (quintile 5) and MOM-losers (quintile 1). The LTR^{premia} is the average return spread between LTR-losers (quintile 1) and LTR-winners (quintile 5). The long-short portfolios are value-weighted using amount outstanding as weights. STR^{premia} covers the period from July 2002 to December 2015. MOM^{premia} covers the period from July 2003 to December 2015. LTR^{premia} covers the period from July 2005 to December 2015.

	STR^{premia}		MOM^{premia}		LTR^{premia}	
	Mean	t-stat	Mean	t-stat	Mean	t-stat
Non-recessionary periods (CFNAI > -0.7)	0.77	5.22	0.33	2.01	0.55	4.52
Recessionary periods (CFNAI ≤ -0.7)	0.85	2.06	2.15	1.80	1.14	2.53
Low market volatility (VIX $\leq VIX^{Median}$)	0.56	4.19	0.20	1.18	0.21	1.86
High market volatility (VIX $> VIX^{Median}$)	1.00	3.09	1.10	2.36	1.12	5.02
Aggregate default risk decrease (ΔDEF ≤ 0)	0.91	4.94	0.23	0.93	0.83	4.98
Aggregate default risk increases (ΔDEF > 0)	0.59	2.79	1.00	2.30	0.44	2.18
Low aggregagate illiqudity (ILLIQ $\leq ILLIQ^{Median}$)	0.41	2.92	0.25	1.41	0.28	2.50
High aggregate illiquidity (ILLIQ $> ILLIQ^{Median}$)	1.15	3.65	1.03	2.24	1.26	4.76

Table 6: Fama-MacBeth Cross-Sectional Regressions

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 short-term reversal (STR), momentum (MOM), and long-term reversal (LTR), with and without controls. Bond characteristics include time-to-maturity (years) and amount outstanding (size, in $billion). Ratings are in conventional numerical scores, where 1 refers to an AAA rating and 21 refers to a C rating. Higher numerical score means higher credit risk. β^{Bond} is the individual bond exposure to the aggregate bond market portfolio, proxied by the Merrill Lynch U.S. Aggregate Bond Index. ILLIQ is the bond-level illiquidity computed as the autocovariance of the daily price changes within each month. Newey-West (1987) t-statistics are reported in parentheses to determine the statistical significance of the average intercept and slope coefficients. The last column reports the average adjusted R^2 values. Numbers in bold denote statistical significance at the 5% level or below.

	Intercept	STR	MOM	LTR	β^{Bond}	ILLIQ	Rating	Maturity	Size	Adj. R^2
(1)	0.432	**-0.091**								0.037
	(2.40)	(-5.75)								
(2)	-0.043	**-0.089**			-0.005	**0.020**	0.021	0.008	0.087	0.143
	(-0.26)	(-5.03)			(-0.08)	(2.87)	(0.63)	(1.17)	(1.28)	
(3)	0.120		**0.029**							0.064
	(0.76)		(2.79)							
(4)	0.053		**0.029**		-0.047	-0.001	-0.003	0.005	0.044	0.153
	(0.40)		(3.00)		(-0.69)	(-0.12)	(-0.12)	(0.94)	(1.42)	
(5)	0.499			**-0.015**						0.020
	(2.92)			(-2.93)						
(6)	-0.060			**-0.012**	0.002	**0.021**	**0.049**	0.008	-0.012	0.123
	(-0.56)			(-2.83)	(0.05)	(4.73)	(3.33)	(1.51)	(-0.46)	
(7)	0.388	**-0.056**	**0.021**	**-0.020**						0.109
	(2.52)	(-4.43)	(2.21)	(-2.52)						
(8)	-0.027	**-0.139**	**0.020**	**0.010**	-0.039	**0.026**	**0.041**	0.006	0.023	0.198
	(-0.22)	(-8.33)	(2.28)	(-2.45)	(-0.68)	(4.38)	(2.42)	(0.97)	(0.95)	

Table 7: Summary Statistics for the Return-Based Bond and Stock Factors

Panel A reports the descriptive statistics for the return-based factors of corporate bonds. MKT^{Bond} is the corporate bond market excess return constructed using the U.S. Merrill Lynch Aggregate Bond Index. The short-term reversal factor (STR^{Bond}) is constructed by 3×3×3 trivariate conditional sorts of credit rating, time-to-maturity, and STR. STR^{Bond} is the value-weighted average return difference between the lowest STR minus the highest STR portfolio within each rating/maturity portfolio. The bond momentum factor (MOM^{Bond}) is constructed by 3×3×3 trivariate conditional sorts of credit rating, time-to-maturity, and MOM. MOM^{Bond} is the value-weighted average return difference between the highest MOM minus the lowest MOM portfolio within each rating/maturity portfolio. The long-term reversal factor (LTR^{Bond}) is constructed by 3×3×3 trivariate conditional sorts of credit rating, time-to-maturity, and LTR. LTR^{Bond} is the value-weighted average return difference between the lowest LTR minus the highest LTR portfolio within each rating/maturity portfolio. STR^{Bond} covers the period from July 2002 to December 2015. MOM^{Bond} covers the period from July 2003 to December 2015. LTR^{Bond} covers the period from July 2005 to December 2015. Panel B reports the descriptive statistics for the same type of stock factors for the same time period. MKT^{Stock} is the value-weighted stock market excess return. STR^{Stock} is the stock short-term reversal factor. MOM^{Stock} is the stock momentum factor. LTR^{Stock} is the stock long-term reversal factor. The return-based stock market factors (STR^{Stock}, MOM^{Stock}, LTR^{Stock}) are described in and obtained from Kenneth French's data library: http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/.

Panel A: Bond market factors

	Mean	*t*-stat	Annualized Sharpe ratio	TranCost-adj. Sharpe ratio
MKT^{Bond}	0.37	2.79	0.54	-
STR^{Bond}	0.56	8.41	1.86	0.95
MOM^{Bond}	0.45	3.50	0.76	0.32
LTR^{Bond}	0.57	4.41	1.12	0.73

Panel B: Stock market factors

	Mean	*t*-stat	Annualized Sharpe ratio
MKT^{Stock}	0.70	2.08	0.48
STR^{Stock}	0.14	0.63	0.04
MOM^{Stock}	0.16	0.36	0.04
LTR^{Stock}	-0.09	-0.42	-0.27

Table 8: Do the Existing Stock and Bond Market Factors Explain the Return-Based Bond Factors?

This table reports the intercepts (α) and their t-statistics from time-series regressions of the return-based bond factors on the commonly used stock and bond market factors. The return-based bond factors include the short-term reversal factor (STR^{Bond}), the momentum factor (MOM^{Bond}), and the long-term reversal factor (LTR^{Bond}) constructed using corporate bond returns. STR^{Bond} covers the period from July 2002 to December 2015. MOM^{Bond} covers the period from July 2003 to December 2015. LTR^{Bond} covers the period from July 2005 to December 2015.

Stock market factors

Model 1: 5-factor model of Fama-French (1993), Carhart (1997), and Pastor-Stambaugh (2003) with MKT^{Stock}, SMB, HML, MOM^{Stock}, LIQ^{Stock} factors.
Model 2: 5-factor model of Fama-French (2015) with MKT^{Stock}, SMB, HML, RMW, CMA.
Model 3: 4-factor model of Hou-Xue-Zhang (2015) with MKT^{Stock}, SMB, IA, ROE.
Model 4: 4-factor model with return-based stock market factors; MKT^{Stock}, STR^{Stock}, MOM^{Stock}, LTR^{Stock}.

Bond market factors
Model 5: 4-factor model with bond market factors; MKT^{Bond}, DEF, TERM, LIQ^{Bond}.

Stock and bond market factors combined
Model 6: 11-factor model with combined stock and bond market factors; [MKT^{Stock}, SMB, HML, MOM^{Stock}, LIQ^{Stock}, IA, ROE] + [MKT^{Bond}, DEF, TERM, LIQ^{Bond}].
Model 7: 11-factor model with combined stock and bond market factors; [MKT^{Stock}, SMB, HML, MOM^{Stock}, LIQ^{Stock}, RMW, CMA] + [MKT^{Bond}, DEF, TERM, LIQ^{Bond}].

Panel A: Dep. Var = STR^{Bond}

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7
Alpha	0.56	0.57	0.62	0.57	0.56	0.69	0.58
t-stat	(8.70)	(8.20)	(8.23)	(8.60)	(7.53)	(8.54)	(7.11)
Adj. R^2 (%)	6.29	-2.09	-1.81	6.67	0.60	13.11	7.98

Panel B: Dep. Var = MOM^{Bond}

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7
Alpha	0.52	0.52	0.40	0.54	0.51	0.47	0.53
t-stat	(2.98)	(3.89)	(2.26)	(2.96)	(4.31)	(3.29)	(4.23)
Adj. R^2 (%)	13.73	12.14	19.19	11.95	16.69	25.11	24.17

Panel C: Dep. Var = LTR^{Bond}

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7
Alpha	0.61	0.54	0.79	0.60	0.53	0.73	0.57
t-stat	(3.49)	(3.05)	(3.14)	(3.30)	(3.37)	(3.00)	(3.29)
Adj. R^2 (%)	16.81	-2.88	-2.88	20.91	20.91	20.91	28.45

Table 9: Explanatory Power of Alternative Factor Models for Size and Maturity-Sorted Bond Portfolios

The table reports the intercepts (alphas), the t-statistics, and the adjusted R^2 values for the time-series regressions of the test portfolios' excess returns on alternative factor models. The 25 test portfolios are formed by independently sorting corporate bonds into 5 by 5 quintile portfolios based on size (amount outstanding) and maturity and then constructed from the intersections of the size and maturity quintiles. The portfolios are value-weighted using amount outstanding as weights. The alternative models include:

Stock market factors

Model 1: 5-factor model of Fama-French (1993), Carhart (1997), and Pastor-Stambaugh (2003) with MKT^{Stock}, SMB, HML, MOM^{Stock}, LIQ^{Stock} factors.
Model 2: 5-factor model of Fama-French (2015) with MKT^{Stock}, SMB, HML, RMW, CMA.
Model 3: 4-factor model of Hou-Xue-Zhang (2015) with MKT^{Stock}, SMB, IA, ROE.
Model 4: 4-factor model with return-based stock market factors; MKT^{Stock}, STR^{Stock}, MOM^{Stock}, LTR^{Stock}.

Bond market factors

Model 5: 4-factor model with bond market factors; MKT^{Bond}, DEF, TERM, LIQ^{Bond}.

Stock and bond market factors combined

Model 6: 11-factor model with combined stock and bond market factors; [MKT^{Stock}, SMB, HML, MOM^{Stock}, LIQ^{Stock}, IA, ROE] + [MKT^{Bond}, DEF, TERM, LIQ^{Bond}].
Model 7: 11-factor model with combined stock and bond market factors; [MKT^{Stock}, SMB, HML, MOM^{Stock}, LIQ^{Stock}, RMW, CMA] + [MKT^{Bond}, DEF, TERM, LIQ^{Bond}].

Return-based bond factor model

Model 8: MKT^{Bond}, STR^{Bond}, MOM^{Bond}, LTR^{Bond}

Panel A: Model 1

Alpha (α)

	Short	2	3	4	Long
Small	0.44	0.50	0.56	0.40	0.44
2	0.34	0.45	0.47	0.35	0.47
3	0.34	0.42	0.43	0.46	0.54
4	0.32	0.37	0.43	0.41	0.49
Big	0.25	0.35	0.51	0.46	0.62
Average $\|\alpha\|$	0.43				
p-GRS	< 0.01				

t-statistics

	Short	2	3	4	Long
Small	2.34	2.04	2.09	1.89	1.99
2	3.19	2.81	2.44	1.18	2.48
3	4.34	3.24	2.49	3.03	2.71
4	3.73	3.21	2.44	2.50	2.19
Big	2.68	3.10	2.89	2.76	2.52

Adj. R^2

	Short	2	3	4	Long
Small	0.08	0.14	0.08	0.10	0.14
2	0.12	0.15	0.11	0.14	0.10
3	0.23	0.17	0.15	0.07	0.04
4	0.17	0.12	0.12	0.04	0.04
Big	0.03	0.04	0.06	0.02	0.04
Average R^2	0.10				

Panel B: Model 2

	Short	2	3	4	Long
Small	0.37	0.40	0.43	0.36	0.41
2	0.32	0.41	0.43	0.28	0.43
3	0.32	0.40	0.40	0.44	0.50
4	0.31	0.37	0.41	0.40	0.44
Big	0.23	0.35	0.49	0.45	0.56
Average $\|\alpha\|$	0.40				
p-GRS	< 0.01				

	Short	2	3	4	Long
Small	2.42	1.98	2.14	1.92	1.98
2	3.41	2.66	2.29	1.04	2.38
3	4.36	3.13	2.37	2.96	2.59
4	3.81	3.15	2.38	2.46	2.01
Big	3.08	3.34	3.00	2.94	2.53

	Short	2	3	4	Long
Small	-0.01	0.04	0.03	0.03	0.07
2	0.06	0.05	0.06	0.09	0.03
3	0.08	0.07	0.07	0.03	0.02
4	0.05	0.04	0.07	0.00	0.00
Big	-0.01	-0.02	0.00	-0.01	0.01
Average R^2	0.03				

Panel C: Model 3

	Short	2	3	4	Long
Small	0.54	0.63	0.62	0.47	0.53
2	0.43	0.64	0.63	0.45	0.55
3	0.44	0.57	0.60	0.54	0.65
4	0.42	0.51	0.60	0.48	0.60
Big	0.29	0.46	0.67	0.53	0.72
Average $\|\alpha\|$	0.54				
p-GRS	< 0.01				

	Short	2	3	4	Long
Small	2.36	2.05	1.82	1.71	1.84
2	3.42	3.54	2.81	1.22	2.47
3	4.96	4.07	3.22	3.21	3.03
4	4.29	3.95	3.23	2.69	2.41
Big	2.68	3.40	3.24	2.75	2.54

	Short	2	3	4	Long
Small	0.09	0.15	0.09	0.08	0.13
2	0.14	0.18	0.14	0.17	0.11
3	0.22	0.19	0.17	0.07	0.04
4	0.17	0.11	0.15	0.02	0.00
Big	0.03	0.04	0.07	-0.01	0.00
Average R^2	0.10				

Panel D: Model 4

Alpha (α)	Short	2	3	4	Long
Small	0.54	0.63	0.62	0.47	0.53
2	0.43	0.64	0.63	0.45	0.55
3	0.44	0.57	0.60	0.54	0.65
4	0.42	0.51	0.60	0.48	0.60
Big	0.29	0.46	0.67	0.53	0.72
Average $\lvert\alpha\rvert$	0.54				
p-GRS	< 0.01				

t-statistics	Short	2	3	4	Long
Small	2.36	2.05	1.82	1.71	1.84
2	3.42	3.54	2.81	1.22	2.47
3	4.96	4.07	3.22	3.21	3.03
4	4.29	3.95	3.23	2.69	2.41
Big	2.68	3.40	3.24	2.75	2.54

Adj. R^2	Short	2	3	4	Long
Small	0.09	0.15	0.09	0.08	0.13
2	0.14	0.18	0.14	0.17	0.11
3	0.22	0.19	0.17	0.07	0.04
4	0.17	0.11	0.15	0.02	0.00
Big	0.03	0.04	0.07	-0.01	0.00
Average R^2	0.10				

Panel E: Model 5

	Short	2	3	4	Long
Small	0.44	0.49	0.58	0.41	0.44
2	0.34	0.45	0.47	0.34	0.47
3	0.34	0.42	0.42	0.45	0.53
4	0.31	0.37	0.41	0.40	0.48
Big	0.25	0.35	0.51	0.46	0.60
Average $\lvert\alpha\rvert$	0.43				
p-GRS	< 0.01				

	Short	2	3	4	Long
Small	2.31	2.08	2.32	1.91	1.95
2	3.11	2.67	2.28	1.15	2.41
3	4.08	2.96	2.24	2.76	2.46
4	3.47	2.91	2.17	2.23	1.94
Big	2.58	3.04	2.79	2.65	2.38

	Short	2	3	4	Long
Small	0.14	0.19	0.19	0.12	0.13
2	0.12	0.16	0.10	0.17	0.12
3	0.22	0.15	0.13	0.03	0.03
4	0.17	0.08	0.09	0.00	0.01
Big	0.04	0.04	0.07	0.02	0.04
Average R^2	0.14				

Panel F: Model 6

	Short	2	3	4	Long
Small	0.41	0.48	0.41	0.37	0.43
2	0.33	0.44	0.42	0.28	0.40
3	0.32	0.41	0.39	0.38	0.47
4	0.31	0.39	0.42	0.33	0.43
Big	0.26	0.39	0.56	0.46	0.64
Average $\lvert\alpha\rvert$	0.41				
p-GRS	< 0.01				

	Short	2	3	4	Long
Small	1.88	1.61	1.50	1.48	1.56
2	2.64	2.29	1.70	0.74	1.76
3	3.51	2.58	1.92	2.16	2.16
4	2.97	2.75	1.94	1.71	1.69
Big	2.62	2.99	2.62	2.45	2.42

	Short	2	3	4	Long
Small	0.27	0.23	0.29	0.25	0.21
2	0.20	0.25	0.21	0.20	0.21
3	0.36	0.29	0.36	0.23	0.17
4	0.29	0.27	0.28	0.15	0.14
Big	0.25	0.11	0.16	0.08	0.13
Average R^2	0.22				

Panel G: Model 7

	Short	2	3	4	Long
Small	0.34	0.37	0.36	0.30	0.35
2	0.56	0.31	0.28	0.24	0.34
3	0.25	0.32	0.28	0.32	0.37
4	0.76	0.49	0.31	0.48	0.32
Big	0.25	0.31	0.45	0.38	0.64
Average $\lvert\alpha\rvert$	0.38				
p-GRS	< 0.01				

	Short	2	3	4	Long
Small	1.76	1.38	1.55	1.34	1.42
2	2.33	1.75	1.23	0.71	1.59
3	3.04	2.12	1.47	1.92	1.73
4	2.66	2.14	1.48	2.53	1.32
Big	2.74	2.61	2.31	2.28	2.24

	Short	2	3	4	Long
Small	0.27	0.23	0.29	0.25	0.21
2	0.20	0.26	0.20	0.20	0.19
3	0.35	0.28	0.34	0.20	0.14
4	0.29	0.25	0.26	0.13	0.13
Big	0.26	0.12	0.17	0.09	0.14
Average R^2	0.22				

Panel H: Model 8

	Short	2	3	4	Long
Small	0.03	0.22	0.16	0.11	0.08
2	0.10	0.05	0.04	0.14	0.19
3	0.16	0.13	0.06	0.22	0.43
4	0.06	0.05	0.09	0.19	0.34
Big	-0.01	0.05	0.12	0.23	0.49
Average $\lvert\alpha\rvert$	0.15				
p-GRS	0.02				

	Short	2	3	4	Long
Small	0.15	0.90	0.57	0.46	0.29
2	0.98	0.31	0.20	0.46	0.82
3	1.92	0.95	0.38	1.29	1.78
4	0.63	0.43	0.51	1.09	1.27
Big	-0.08	0.37	0.68	1.15	1.54

	Short	2	3	4	Long
Small	0.66	0.68	0.47	0.40	0.44
2	0.63	0.68	0.49	0.63	0.28
3	0.61	0.53	0.54	0.31	0.17
4	0.61	0.43	0.45	0.17	0.09
Big	0.57	0.40	0.45	0.09	0.06
Average R^2	0.43				

Table 10: Explanatory Power of Alternative Factor Models for Size and Rating-Sorted Bond Portfolios

The table reports the intercepts (alphas), the t-statistics, and the adjusted R^2 values for the time-series regressions of the test portfolios' excess returns on alternative factor models. The 25 test portfolios are formed by independently sorting corporate bonds into 5 by 5 quintile portfolios based on size (amount outstanding) and rating and then constructed from the intersections of the size and maturity quintiles. The portfolios are value-weighted using amount outstanding as weights. The alternative models are the same as in Table 9.

Panel A: Model 1

	Alpha (α)						t-statistics						Adj. R^2				
	Short	2	3	4	Long		Short	2	3	4	Long		Short	2	3	4	Long
Low	0.29	0.16	0.47	0.91	1.62	Low	2.41	0.99	1.86	2.29	2.47	Low	0.05	0.10	0.11	0.13	0.15
2	0.30	0.25	0.34	0.44	0.82	2	2.51	1.76	2.43	1.91	2.01	2	0.05	0.05	0.08	0.07	0.23
3	0.35	0.39	0.43	0.44	0.70	3	3.18	3.15	3.43	2.63	2.12	3	0.00	0.01	0.06	0.12	0.28
4	0.36	0.39	0.41	0.42	0.74	4	3.26	3.06	3.05	2.67	2.00	4	0.02	0.04	0.04	0.11	0.20
High	0.34	0.38	0.45	0.47	1.04	High	3.15	2.88	3.20	2.60	2.28	High	0.06	0.02	0.04	0.07	0.13
Average $\lvert\alpha\rvert$	0.52											Average R^2	0.09				
p-GRS	< 0.01																

Panel B: Model 2

	Short	2	3	4	Long		Short	2	3	4	Long		Short	2	3	4	Long
Low	0.30	0.14	0.32	0.82	1.50	Low	2.67	0.81	1.58	1.79	2.40	Low	0.01	0.03	0.05	0.03	0.04
2	0.30	0.22	0.29	0.38	0.83	2	2.57	1.49	2.13	1.49	2.09	2	0.01	0.00	0.04	0.03	0.15
3	0.34	0.38	0.41	0.44	0.73	3	3.16	3.22	3.35	2.47	2.16	3	0.00	-0.01	-0.01	0.05	0.16
4	0.35	0.36	0.39	0.42	0.82	4	3.17	3.11	2.90	2.50	2.12	4	0.00	0.01	-0.02	0.04	0.12
High	0.32	0.36	0.41	0.48	1.06	High	3.18	2.87	2.87	2.38	2.38	High	0.04	0.02	-0.01	0.02	0.07
Average $\lvert\alpha\rvert$	0.57											Average R^2	0.07				
p-GRS	< 0.01																

Panel C: Model 3

	Short	2	3	4	Long		Short	2	3	4	Long		Short	2	3	4	Long
Low	0.30	0.20	0.54	1.05	1.95	Low	2.35	1.06	1.94	2.00	2.62	Low	0.04	0.05	0.12	0.10	0.13
2	0.28	0.24	0.35	0.49	1.04	2	2.16	1.47	2.19	1.87	2.37	2	0.03	0.01	0.08	0.08	0.25
3	0.32	0.37	0.43	0.50	0.90	3	2.68	2.73	2.95	2.53	2.57	3	-0.01	-0.02	0.02	0.11	0.30
4	0.32	0.36	0.42	0.46	0.95	4	2.71	2.63	2.64	2.49	2.48	4	0.00	-0.01	0.01	0.09	0.22
High	0.31	0.36	0.46	0.51	1.24	High	2.73	2.55	2.76	2.37	2.69	High	0.03	0.02	0.00	0.05	0.15
Average $\lvert\alpha\rvert$	0.54											Average R^2	0.10				
p-GRS	< 0.01																

Panel D: Model 4

	Short	2	3	4	Long		Short	2	3	4	Long		Short	2	3	4	Long
Low	0.29	0.15	0.49	0.91	1.59	Low	2.29	0.77	2.49	2.37	2.24	Low	0.04	0.15	0.19	0.17	0.14
2	0.29	0.24	0.33	0.44	0.80	2	2.33	1.50	2.49	1.89	1.87	2	0.03	0.12	0.08	0.07	0.22
3	0.35	0.38	0.41	0.42	0.67	3	3.06	3.01	3.10	2.29	1.92	3	-0.01	0.00	0.02	0.09	0.26
4	0.35	0.37	0.39	0.39	0.70	4	3.18	2.89	2.76	2.29	1.79	4	0.02	0.01	0.02	0.07	0.18
High	0.33	0.36	0.42	0.44	1.00	High	2.97	2.79	2.88	2.22	2.10	High	0.08	0.07	0.03	0.04	0.10
Average $\lvert\alpha\rvert$	0.50											Average R^2	0.09				
p-GRS	< 0.01																

Panel E: Model 5

	Alpha (α)				
	Short	2	3	4	Long
Low	0.19	0.07	0.24	0.49	1.23
2	0.19	0.16	0.16	0.22	0.62
3	0.26	0.27	0.29	0.26	0.46
4	0.27	0.27	0.26	0.25	0.52
High	0.29	0.32	0.33	0.32	0.88
Average $\lvert\alpha\rvert$	0.35				
p-GRS	< 0.01				

	t-statistics				
	Short	2	3	4	Long
Low	1.49	0.33	1.15	1.39	2.10
2	1.44	0.81	1.40	1.01	1.54
3	2.49	2.36	2.53	1.61	1.52
4	2.48	2.23	2.09	1.60	1.38
High	2.41	2.33	2.30	1.70	2.26

	Adj. R^2				
	Short	2	3	4	Long
Low	0.16	0.04	0.17	0.14	0.19
2	0.14	0.06	0.29	0.17	0.16
3	0.11	0.14	0.20	0.29	0.31
4	0.06	0.14	0.19	0.28	0.26
High	0.07	0.06	0.17	0.22	0.28
Average R^2	0.17				

Panel F: Model 6

	Short	2	3	4	Long
Low	0.23	0.20	0.32	0.61	1.72
2	0.21	0.23	0.17	0.24	0.85
3	0.25	0.28	0.30	0.31	0.62
4	0.25	0.27	0.28	0.29	0.72
High	0.28	0.34	0.35	0.37	1.12
Average $\lvert\alpha\rvert$	0.43				
p-GRS	< 0.01				

	Short	2	3	4	Long
Low	1.68	0.87	1.41	1.34	2.74
2	1.55	1.12	1.28	0.94	2.12
3	2.40	2.34	2.56	1.76	2.05
4	2.27	2.15	2.21	1.76	1.97
High	2.46	2.42	2.35	1.76	2.74

	Short	2	3	4	Long
Low	0.22	0.24	0.34	0.21	0.26
2	0.16	0.20	0.33	0.14	0.26
3	0.11	0.14	0.21	0.29	0.39
4	0.07	0.17	0.19	0.27	0.29
High	0.13	0.11	0.18	0.20	0.29
Average R^2	0.22				

Panel G: Model 7

	Short	2	3	4	Long
Low	0.25	0.15	0.29	0.55	1.46
2	0.26	0.22	0.17	0.20	0.75
3	0.27	0.28	0.30	0.29	0.56
4	0.27	0.27	0.28	0.29	0.67
High	0.30	0.34	0.33	0.39	1.04
Average $\lvert\alpha\rvert$	0.41				
p-GRS	< 0.01				

	Short	2	3	4	Long
Low	1.84	0.70	1.42	1.27	2.72
2	1.91	1.12	1.43	0.80	2.02
3	2.81	2.56	2.80	1.67	1.82
4	2.65	2.32	2.32	1.77	1.77
High	2.74	2.68	2.41	1.83	2.68

	Short	2	3	4	Long
Low	0.23	0.25	0.34	0.21	0.28
2	0.18	0.21	0.33	0.14	0.26
3	0.12	0.15	0.20	0.27	0.37
4	0.09	0.18	0.19	0.25	0.29
High	0.14	0.13	0.19	0.20	0.30
Average R^2	0.22				

Panel H: Model 8

	Short	2	3	4	Long
Low	0.09	-0.16	-0.12	0.13	0.18
2	0.17	0.02	0.14	0.06	0.09
3	0.30	0.26	0.35	0.15	0.25
4	0.34	0.30	0.24	0.12	0.15
High	0.36	0.16	0.33	0.04	0.02
Average $\lvert\alpha\rvert$	0.18				
p-GRS	0.02				

	Short	2	3	4	Long
Low	0.60	-0.74	-0.42	0.35	0.44
2	1.14	0.12	0.99	0.22	0.32
3	1.87	1.71	2.99	1.02	0.90
4	2.15	2.06	1.95	0.96	0.53
High	2.51	1.08	2.48	0.25	0.06

	Short	2	3	4	Long
Low	0.51	0.56	0.77	0.60	0.76
2	0.41	0.45	0.54	0.39	0.69
3	0.14	0.11	0.26	0.46	0.60
4	0.02	0.08	0.27	0.41	0.50
High	0.17	0.26	0.30	0.43	0.60
Average R^2	0.41				

Table 11: Explanatory Power of Alternative Factor Models for Industry-Sorted Portfolios of Corporate Bonds

The table reports the intercepts (alphas), the *t*-statistics, and the adjusted R^2 values for the time-series regressions of the test portfolios' excess returns on alternative factor models. The industry portfolios are formed by univariate sorting corporate bonds into 12 portfolios based on the Fama-French industry classifications. The portfolios are value-weighted using amount outstanding as weights. The alternative models are the same as in Table 9.

Panel A: Alpha

Industry #	1	2	3	4	5	6	7	8	9	10	11	12	Average	
Description	NoDur	Durables	Manuf	Enrgy	Chems	BusEq	Telcm	Utils	Shops	Hlth	Finance	Other	Alpha	*p*-GRS
Model 1	0.60	0.71	0.76	0.54	0.56	0.45	0.42	0.33	0.53	0.58	0.54	0.75	0.56	< 0.01
Model 2	0.57	0.63	0.75	0.55	0.48	0.47	0.41	0.29	0.56	0.55	0.53	0.68	0.54	< 0.01
Model 3	0.83	1.10	1.10	1.02	0.85	0.63	0.62	0.42	0.78	0.71	0.66	1.05	0.82	< 0.01
Model 4	0.58	0.71	0.73	0.57	0.52	0.45	0.40	0.32	0.54	0.57	0.54	0.73	0.55	< 0.01
Model 5	0.44	0.59	0.59	0.29	0.37	0.38	0.32	0.21	0.43	0.46	0.40	0.54	0.42	< 0.01
Model 6	0.61	0.88	0.84	0.72	0.53	0.53	0.46	0.26	0.69	0.60	0.55	0.78	0.62	< 0.01
Model 7	0.52	0.64	0.68	0.36	0.42	0.48	0.37	0.20	0.55	0.47	0.48	0.63	0.48	< 0.01
Model 8	0.54	0.53	0.60	-0.35	0.57	0.31	0.20	0.20	0.14	0.16	0.25	0.31	0.29	0.02

Panel B: *t*-statistics

Industry #	1	2	3	4	5	6	7	8	9	10	11	12
Description	NoDur	Durables	Manuf	Enrgy	Chems	BusEq	Telcm	Utils	Shops	Hlth	Finance	Other
Model 1	3.76	2.47	3.39	0.87	2.83	2.85	2.59	2.81	2.75	3.03	3.96	3.36
Model 2	3.11	1.93	3.05	0.85	2.11	2.72	2.33	2.40	2.67	2.76	3.62	2.74
Model 3	4.36	3.09	4.04	1.37	3.68	3.34	3.16	3.02	3.36	3.08	4.04	3.87
Model 4	3.56	2.38	3.23	0.90	2.66	2.73	2.41	2.66	2.70	2.91	4.03	3.20
Model 5	2.78	1.98	2.57	0.47	1.74	2.59	2.24	1.96	2.34	2.47	2.93	2.49
Model 6	3.13	2.46	2.90	0.88	2.19	2.86	2.55	1.99	2.96	2.44	3.24	2.87
Model 7	3.21	2.21	2.87	0.53	2.10	3.18	2.45	1.80	2.89	2.33	3.46	2.84
Model 8	2.89	1.63	2.14	-1.37	2.45	1.72	1.10	1.39	0.71	1.06	1.73	1.26

Panel C: Adj. R^2

Industry #	1	2	3	4	5	6	7	8	9	10	11	12	Average
Description	NoDur	Durables	Manuf	Enrgy	Chems	BusEq	Telcm	Utils	Shops	Hlth	Finance	Other	R^2
Model 1	0.23	0.25	0.15	0.00	0.33	0.15	0.11	0.06	0.14	0.02	0.08	0.19	0.14
Model 2	0.07	0.09	0.04	-0.02	0.16	0.05	0.04	0.01	0.06	0.00	0.01	0.06	0.05
Model 3	0.25	0.23	0.14	-0.01	0.38	0.19	0.11	0.01	0.17	0.04	0.10	0.19	0.15
Model 4	0.22	0.19	0.14	0.00	0.35	0.11	0.07	0.01	0.11	-0.01	0.11	0.17	0.12
Model 5	0.28	0.21	0.17	0.02	0.26	0.31	0.35	0.27	0.25	0.09	0.12	0.27	0.22
Model 6	0.34	0.34	0.18	-0.02	0.42	0.35	0.36	0.30	0.29	0.09	0.18	0.32	0.26
Model 7	0.32	0.33	0.19	-0.02	0.40	0.33	0.33	0.26	0.28	0.07	0.18	0.31	0.25
Model 8	0.41	0.44	0.25	0.28	0.47	0.37	0.49	0.20	0.41	0.38	0.41	0.46	0.38

Table 12: Bivariate Portfolios of Short-term Reversal Controlling for Illiquidity

Quintile portfolios are formed every month from July 2002 to December 2015 by first sorting corporate bonds based on bond-level illiquidity into quintiles, then within each illiquidity portfolio, corporate bonds are sorted into sub-quintiles based on short-term reversal (STR), proxied by previous month return. Panels A and B report bivariate portfolio results for All bonds, and Panels C and D present bivariate portfolio results for investment-grade (IG) bonds. Illiquidity is proxied by the Roll's (1984) measure in Panels A and C, and the Amihud's (2002) measure in Panels B and D. Table reports the 5×5 next-month average returns and 11-factor alphas for each of the 25 portfolios. The 11-factor model combines 7 stock market factors and 4 bond market factors. Average returns and alphas are defined in monthly percentage terms. Newey-West adjusted t-statistics are given in parentheses. *, **, and *** indicate the significance at the 10%, 5%, and 1% levels, respectively.

Panel A: First sort on ILLIQ then on STR, all bonds

	Average return							11-factor alpha					
	Low STR	2	3	4	High STR	High − Low		Low STR	2	3	4	High STR	High − Low
Low ILLIQ	0.20	0.11	0.12	0.14	-0.02	-0.21	Low ILLIQ	0.00	0.02	0.04	0.08	-0.11	-0.11
	(0.70)	(1.11)	(1.44)	(1.54)	(-0.10)	(-1.09)		(0.00)	(0.15)	(0.58)	(1.05)	(-0.73)	(-0.69)
2	0.39	0.16	0.09	0.08	-0.01	-0.40***	2	0.28	0.08	0.02	0.03	-0.05	-0.33***
	(2.54)	(1.98)	(1.24)	(1.01)	(-0.09)	(-4.27)		(1.86)	(0.95)	(0.25)	(0.33)	(-0.48)	(-3.96)
3	0.48	0.24	0.12	0.05	-0.11	-0.60***	3	0.32	0.14	0.05	-0.02	-0.19	-0.51***
	(2.53)	(2.37)	(1.34)	(0.49)	(-0.85)	(-5.32)		(1.70)	(1.46)	(0.50)	(-0.27)	(-1.55)	(-4.62)
4	0.58	0.27	0.11	0.03	-0.26	-0.84***	4	0.40	0.16	-0.01	-0.08	-0.40	-0.79***
	(2.43)	(2.29)	(0.94)	(0.21)	(-1.40)	(-5.90)		(1.72)	(1.33)	(-0.07)	(-0.67)	(-2.28)	(-6.24)
High ILLIQ	0.51	0.25	0.12	-0.05	-0.44	-0.95***	High ILLIQ	0.26	0.03	-0.06	-0.22	-0.66	-0.92***
	(1.24)	(1.05)	(0.62)	(-0.26)	(-1.48)	(-3.81)		(0.69)	(0.12)	(-0.31)	(-1.12)	(-2.51)	(-4.06)

Panel B: First sort on Amihud then on STR, all bonds

	Average return							11-factor alpha					
	Low STR	2	3	4	High STR	High − Low		Low STR	2	3	4	High STR	High − Low
Low Amihud	0.15	0.14	0.14	0.16	0.20	0.05	Low Amihud	0.00	0.06	0.06	0.09	0.15	0.15
	(0.67)	(1.42)	(1.67)	(1.75)	(1.54)	(0.37)		(0.02)	(0.52)	(0.67)	(0.96)	(1.18)	(1.31)
2	0.26	0.17	0.13	0.11	0.06	-0.20	2	0.13	0.09	0.06	0.04	-0.00	-0.13
	(1.31)	(1.95)	(1.65)	(1.25)	(0.44)	(-1.58)		(0.67)	(0.93)	(0.83)	(0.53)	(-0.01)	(-1.30)
3	0.36	0.23	0.11	0.05	-0.08	-0.44***	3	0.17	0.13	0.02	-0.02	-0.20	-0.37***
	(1.71)	(2.27)	(1.26)	(0.48)	(-0.55)	(-3.50)		(0.84)	(1.36)	(0.24)	(-0.25)	(-1.44)	(-3.41)
4	0.52	0.24	0.10	-0.02	-0.33	-0.85***	4	0.30	0.11	-0.01	-0.14	-0.47	-0.78***
	(2.01)	(1.88)	(0.96)	(-0.18)	(-1.56)	(-4.98)		(1.11)	(0.80)	(-0.10)	(-1.07)	(-2.58)	(-4.13)
High Amihud	0.61	0.25	0.03	-0.13	-0.54	-1.14***	High Amihud	0.37	0.08	-0.12	-0.27	-0.73	-1.09***
	(1.65)	(1.32)	(0.23)	(-0.75)	(-2.06)	(-4.34)		(0.99)	(0.38)	(-0.81)	(-1.70)	(-3.25)	(-3.98)

Table 12. (Continued)

Panel C: First sort on ILLIQ then on STR, investment-grade bonds

	Average return					
	Low STR	2	3	4	High STR	High − Low
Low ILLIQ	0.00	0.07	0.10	0.11	-0.10	-0.11
	(0.01)	(0.60)	(1.18)	(1.32)	(-0.71)	(-0.47)
2	0.22	0.14	0.09	0.08	-0.02	-0.24
	(2.01)	(1.80)	(1.14)	(0.95)	(-0.21)	(-1.41)
3	0.36	0.21	0.10	0.03	-0.16	-0.52***
	(1.78)	(2.04)	(1.12)	(0.30)	(-1.22)	(-4.34)
4	0.39	0.22	0.07	-0.02	-0.32	-0.70***
	(1.41)	(1.74)	(0.62)	(-0.12)	(-1.80)	(-4.31)
High ILLIQ	0.04	0.09	0.02	-0.16	-0.62	-0.66**
	(0.08)	(0.29)	(0.10)	(-0.78)	(-2.19)	(-2.24)

	11-factor alpha					
	Low STR	2	3	4	High STR	High − Low
Low ILLIQ	-0.20	-0.03	0.03	0.05	-0.18	0.02
	(-0.67)	(-0.22)	(0.32)	(0.72)	(-1.20)	(0.12)
2	0.09	0.06	0.01	0.02	-0.07	-0.16
	(1.23)	(0.78)	(0.12)	(0.26)	(-0.66)	(-1.00)
3	0.18	0.11	0.02	-0.05	-0.24	-0.42***
	(0.93)	(1.00)	(0.25)	(-0.48)	(-1.87)	(-3.77)
4	0.17	0.10	-0.05	-0.12	-0.44	-0.62***
	(0.66)	(0.78)	(-0.38)	(-0.89)	(-2.43)	(-4.53)
High ILLIQ	-0.18	-0.16	-0.16	-0.32	-0.81	-0.63***
	(-0.46)	(-0.51)	(-0.77)	(-1.55)	(-3.04)	(-2.75)

Panel D: First sort on Amihud then on STR, investment-grade bonds

	Average return					
	Low STR	2	3	4	High STR	High − Low
Low Amihud	0.02	0.12	0.12	0.15	0.12	0.10
	(0.09)	(1.16)	(1.45)	(1.65)	(1.03)	(0.60)
2	0.15	0.15	0.12	0.10	-0.00	-0.15
	(0.71)	(1.67)	(1.53)	(1.10)	(-0.00)	(-1.24)
3	0.12	0.20	0.10	0.02	-0.17	-0.29
	(0.96)	(1.98)	(1.10)	(0.21)	(-1.16)	(-1.62)
4	0.28	0.20	0.06	-0.07	-0.40	-0.68***
	(0.92)	(1.44)	(0.55)	(-0.51)	(-2.05)	(-3.58)
High Amihud	0.23	0.15	-0.04	-0.20	-0.65	-0.88***
	(0.53)	(0.66)	(-0.23)	(-1.15)	(-2.74)	(-2.88)

	11-factor alpha					
	Low STR	2	3	4	High STR	High − Low
Low Amihud	-0.13	0.03	0.04	0.08	0.08	0.21
	(-0.58)	(0.30)	(0.46)	(0.82)	(0.61)	(1.62)
2	0.00	0.06	0.05	0.03	-0.05	-0.05
	(0.00)	(0.67)	(0.65)	(0.38)	(-0.44)	(-0.57)
3	0.02	0.10	0.01	-0.06	-0.18	-0.20
	(0.08)	(0.99)	(0.09)	(-0.58)	(-1.86)	(-1.27)
4	0.06	0.06	-0.05	-0.18	-0.53	-0.59***
	(0.18)	(0.38)	(-0.45)	(-1.34)	(-2.88)	(-3.14)
High Amihud	-0.01	-0.04	-0.20	-0.33	-0.81	-0.80***
	(-0.02)	(-0.18)	(-1.21)	(-1.93)	(-3.72)	(-2.69)

Table 13: Bivariate Portfolios of Momentum Controlling for Credit Risk

Quintile portfolios are formed every month from July 2002 to December 2015 by first sorting corporate bonds based on their credit rating into quintile portfolios, then within each rating portfolio, corporate bonds are sorted into sub-quintiles based on their 12-month momentum. Table reports the 5×5 next-month average returns and 11-factor alphas for each of the 25 portfolios. The 11-factor model combines 7 stock market factors and 4 bond market factors. Average returns and alphas are defined in monthly percentage terms. Newey-West adjusted t-statistics are given in parentheses. *, **, and *** indicate the significance at the 10%, 5%, and 1% levels, respectively.

Panel A: First sort on rating then on MOM, average return

	Low MOM	2	3	4	High MOM	High − Low
Low credit risk	0.22	0.22	0.27	0.24	0.26	0.04
	(0.78)	(1.43)	(2.61)	(2.34)	(2.17)	(0.16)
2	0.05	0.15	0.21	0.24	0.24	0.19
	(0.30)	(1.45)	(2.37)	(2.57)	(1.99)	(1.65)
3	0.13	0.27	0.29	0.29	0.35	0.22
	(0.58)	(1.90)	(2.38)	(2.37)	(2.61)	(1.35)
4	-0.05	0.23	0.30	0.32	0.39	0.45*
	(-0.14)	(0.96)	(1.50)	(2.01)	(1.90)	(1.77)
High credit risk	-0.86	-0.21	0.07	0.48	0.87	1.67***
	(-1.14)	(-0.33)	(0.14)	(1.26)	(2.44)	(2.91)

Panel B: First sort on rating then on MOM, 11-factor alpha

	Low MOM	2	3	4	High MOM	High − Low
Low credit risk	0.35	0.26	0.30	0.24	0.27	-0.08
	(1.14)	(1.51)	(2.32)	(1.96)	(2.02)	(-0.30)
2	0.00	0.12	0.21	0.20	0.10	0.10
	(0.01)	(0.97)	(1.85)	(1.82)	(1.47)	(1.74)
3	0.18	0.32	0.32	0.31	0.36	0.18
	(0.82)	(1.89)	(2.17)	(2.08)	(2.43)	(1.23)
4	0.01	0.27	0.32	0.34	0.42	0.41*
	(0.02)	(1.06)	(1.58)	(1.98)	(1.82)	(1.82)
High credit risk	-0.47	-0.19	0.00	0.51	0.94	1.34***
	(-0.75)	(-0.32)	(0.00)	(1.46)	(2.58)	(2.60)

Table 14: Bivariate Portfolios of Momentum Controlling for Default Beta

Panel A reports the univariate momentum portfolios' exposure to the three bond market factors: MKT^{Bond}, DEF, and TERM. In Panel B, quintile portfolios are formed every month from July 2002 to December 2015 by first sorting corporate bonds based on default beta (β^{DEF}) into quintiles, then within each β^{DEF} portfolio, corporate bonds are sorted into sub-quintiles based on their 12-month momentum. Table reports the 5×5 next-month average returns and 11-factor alphas for each of the 25 portfolios. The 11-factor model combines 7 stock market factors and 4 bond market factors. Average returns and alphas are defined in monthly percentage terms. Newey-West adjusted t-statistics are given in parentheses. *, **, and *** indicate the significance at the 10%, 5%, and 1% levels, respectively.

Panel A: Momentum exposures to the standard bond market factors

	β^{Bond}	β^{DEF}	β^{TERM}
Low MOM	0.50	-1.54	0.99
2	0.28	0.04	0.21
3	0.27	2.65	0.19
4	0.32	2.92	0.27
High MOM	0.82	4.54	1.67

Panel B: First sort on β^{DEF} then on MOM, average return

	Low MOM	2	3	4	High MOM	High − Low
Low β^{DEF}	0.18	0.39	0.38	0.43	0.52	0.34
	(0.46)	(1.58)	(1.70)	(1.78)	(1.64)	(1.34)
2	0.12	0.28	0.31	0.30	0.38	0.26
	(0.42)	(1.69)	(2.36)	(2.43)	(2.59)	(1.24)
3	-0.16	0.10	0.17	0.25	0.35	0.52**
	(-0.57)	(0.93)	(2.49)	(3.05)	(2.95)	(2.25)
4	-0.39	0.00	0.15	0.26	0.33	0.72*
	(-0.80)	(0.02)	(1.33)	(2.65)	(2.01)	(1.84)
High β^{DEF}	-1.19	-0.25	0.10	0.33	0.74	1.92***
	(-1.41)	(-0.44)	(0.26)	(1.10)	(2.11)	(3.04)

Panel C: First sort on β^{DEF} then on MOM, 11-factor alpha

	Low MOM	2	3	4	High MOM	High − Low
Low β^{DEF}	0.20	0.45	0.43	0.48	0.54	0.33
	(0.54)	(1.72)	(1.73)	(1.68)	(1.40)	(1.17)
2	0.20	0.33	0.35	0.31	0.38	0.18
	(0.77)	(1.80)	(2.26)	(2.10)	(2.13)	(1.12)
3	-0.18	0.13	0.20	0.28	0.38	0.56***
	(-0.73)	(1.05)	(2.43)	(2.81)	(2.73)	(2.93)
4	-0.43	0.01	0.18	0.30	0.33	0.76**
	(-1.03)	(0.09)	(1.49)	(2.74)	(1.82)	(2.25)
High β^{DEF}	-0.85	-0.15	0.16	0.40	0.85	1.67***
	(-1.10)	(-0.30)	(0.48)	(1.41)	(2.32)	(2.66)

Table 15: Bivariate Portfolios of Long-term Reversal Controlling for Credit Risk

Quintile portfolios are formed every month from July 2005 to December 2015 by first sorting corporate bonds based on their credit rating into quintile portfolios, then within each rating portfolio, corporate bonds are sorted into sub-quintiles based on their LTR. Table reports the 5×5 next-month average returns and 11-factor alphas for each of the 25 portfolios. The 11-factor model combines 7 stock market factors and 4 bond market factors. Average returns and alphas are defined in monthly percentage terms. Newey-West adjusted t-statistics are given in parentheses. *, **, and *** indicate the significance at the 10%, 5%, and 1% levels, respectively.

Panel A: First sort on rating then on LTR, average return

	Low LTR	2	3	4	High LTR	High − Low
Low credit risk	0.23	0.23	0.31	0.31	0.32	0.09
	(1.41)	(1.94)	(2.87)	(3.18)	(2.59)	(0.89)
2	0.38	0.37	0.45	0.39	0.48	0.11
	(1.30)	(1.89)	(2.10)	(2.46)	(2.41)	(0.87)
3	0.57	0.46	0.47	0.43	0.48	-0.09
	(1.74)	(2.05)	(2.32)	(2.62)	(2.49)	(-0.51)
4	0.87	0.66	0.57	0.49	0.45	-0.42**
	(1.43)	(1.67)	(1.82)	(1.78)	(1.94)	(-2.05)
High credit risk	3.89	2.52	2.31	2.06	2.13	-1.76***
	(2.17)	(1.59)	(1.69)	(1.79)	(2.71)	(-2.71)

Panel B: First sort on rating then on LTR, 11-factor alpha

	Low LTR	2	3	4	High LTR	High − Low
Low credit risk	0.17	0.17	0.28	0.27	0.26	0.10
	(1.00)	(1.51)	(2.64)	(2.46)	(1.74)	(0.94)
2	0.28	0.31	0.45	0.36	0.39	0.11
	(1.63)	(2.57)	(2.66)	(2.61)	(2.52)	(1.15)
3	0.35	0.33	0.37	0.32	0.33	-0.02
	(1.26)	(1.66)	(1.51)	(2.41)	(2.14)	(-0.20)
4	0.72	0.57	0.46	0.37	0.28	-0.43**
	(1.71)	(2.27)	(2.11)	(1.68)	(1.53)	(-1.96)
High credit risk	3.87	2.54	2.26	2.11	2.08	-1.79***
	(3.12)	(2.42)	(2.61)	(2.72)	(4.04)	(-2.32)

Table 16: Bivariate Portfolios of Long-term Reversal Controlling for Default Beta

Panel A reports the univariate LTR portfolios' exposure to the three bond market factors: MKT^{Bond}, DEF, and TERM. In Panel B, quintile portfolios are formed every month from July 2005 to December 2015 by first sorting corporate bonds based on default beta (β^{DEF}) into quintiles, then within each β^{DEF} portfolio, corporate bonds are sorted into sub-quintiles based on their LTR. Table reports the 5×5 average next-month returns and 11-factor alphas for each of the 25 portfolios. The 11-factor model combines 7 stock market factors and 4 bond market factors. Average returns and alphas are defined in monthly percentage terms. Newey-West adjusted t-statistics are given in parentheses. *, **, and *** indicate the significance at the 10%, 5%, and 1% levels, respectively.

Panel A: LTR exposure to the standard bond market factors

	β^{Bond}	β^{DEF}	β^{TERM}
Low LTR	1.22	4.80	1.96
2	0.48	2.90	0.38
3	0.34	2.89	0.22
4	0.33	3.30	0.13
High LTR	0.52	3.50	0.45

Panel B: First sort on β^{DEF} then on LTR, average return

	Low LTR	2	3	4	High LTR	High − Low
Low β^{DEF}	0.62	0.30	0.32	0.28	0.41	-0.21
	(3.04)	(2.92)	(3.70)	(2.91)	(3.59)	(-1.50)
2	0.75	0.44	0.43	0.47	0.55	-0.20
	(3.41)	(3.30)	(3.98)	(4.13)	(3.61)	(-1.34)
3	0.54	0.27	0.27	0.27	0.40	-0.14
	(3.22)	(3.20)	(4.42)	(3.55)	(3.79)	(-1.09)
4	1.91	1.17	0.92	0.83	1.00	-0.91***
	(3.62)	(3.41)	(3.37)	(3.48)	(3.97)	(-2.46)
High β^{DEF}	3.25	1.93	1.40	1.25	1.38	-1.87***
	(3.89)	(3.04)	(2.71)	(2.62)	(3.96)	(-3.48)

Panel C: First sort on β^{DEF} then on LTR, 11-factor alpha

	Low LTR	2	3	4	High LTR	High − Low
Low β^{DEF}	0.48	0.22	0.26	0.21	0.30	-0.18
	(2.42)	(2.02)	(2.89)	(2.28)	(2.55)	(-1.15)
2	0.68	0.35	0.35	0.36	0.42	-0.26
	(2.65)	(2.50)	(3.12)	(2.97)	(2.61)	(-1.50)
3	0.46	0.19	0.21	0.19	0.28	-0.18
	(2.62)	(2.04)	(3.22)	(2.06)	(2.43)	(-1.22)
4	1.86	1.09	0.90	0.86	0.90	-0.96***
	(3.65)	(3.29)	(3.15)	(3.09)	(3.04)	(-2.99)
High β^{DEF}	3.07	1.78	1.31	1.16	1.26	-1.81***
	(4.47)	(3.54)	(3.38)	(3.28)	(4.84)	(-3.59)

Table 17: Long-term Reversal and Credit Ratings Downgrade

In Panel A, quintile portfolios are formed every month by sorting corporate bonds based on their long-term reversal (LTR), proxied by the past 36-month cumulative returns from $t-48$ to $t-13$, skipping the 12-month momentum and short-term reversal months. Panel A reports the average change in credit ratings for the 12-, 24-, 36-, and 48-month portfolio formation windows for bonds in each quintile. The last row in Panel A shows the average differences in change in ratings between quintiles 5 and 1. In Panel B, portfolios are formed every month based on the change in ratings from $t-48$ to $t-13$. Panel B reports the corresponding average cumulative bond excess returns, as well as the average return and the 11-factor alpha for month t. Hodrick (1992) t-statistics are given in parentheses to account for overlapping longer-horizon returns. In Panel C, portfolios are formed by sorting bonds based on LTR, after eliminating the quintile of bonds with the largest rating downgrades (i.e., quintile 5 in Panel B). Panel C reports the average one-month-ahead bond excess returns and the 11-factor alpha for each quintile, The last row in Panel C shows the differences in average returns and the 11-factor alphas in percentage terms. *, **, and *** indicate the significance at the 10%, 5%, and 1% levels, respectively. The sample period is from July 2005 to December 2015.

Panel A: Quintile portfolios sorted by LTR

	ΔRating			
	$t-12:t$	$t-24:t$	$t-36:t$	$t-48:t$
Low LTR	0.30	0.79	1.47	2.28
LTR2	0.21	0.46	0.74	1.03
LTR3	0.20	0.38	0.57	0.73
LTR4	0.17	0.31	0.45	0.56
High LTR	0.03	0.01	0.00	0.03
High − Low	-0.27**	-0.78***	-1.47***	-2.25***
t-stat	(-2.50)	(-4.96)	(-10.03)	(-11.85)

Panel B: Quintile portfolios sorted by change in ratings

	Cumulative returns from $t-48:t-13$	Average return for month t	11-factor alpha for month t
Low Δrating	32.13	1.10	0.82
2	23.96	0.44	0.31
3	12.00	0.40	0.29
4	-3.45	0.42	0.30
High Δrating	-7.80	0.62	0.42
High − Low	-43.92***	-0.48***	-0.40***
t-stat	(-12.29)	(-3.23)	(-2.95)

Panel C: LTR returns after eliminating the quintile of bonds with the largest rating downgrades

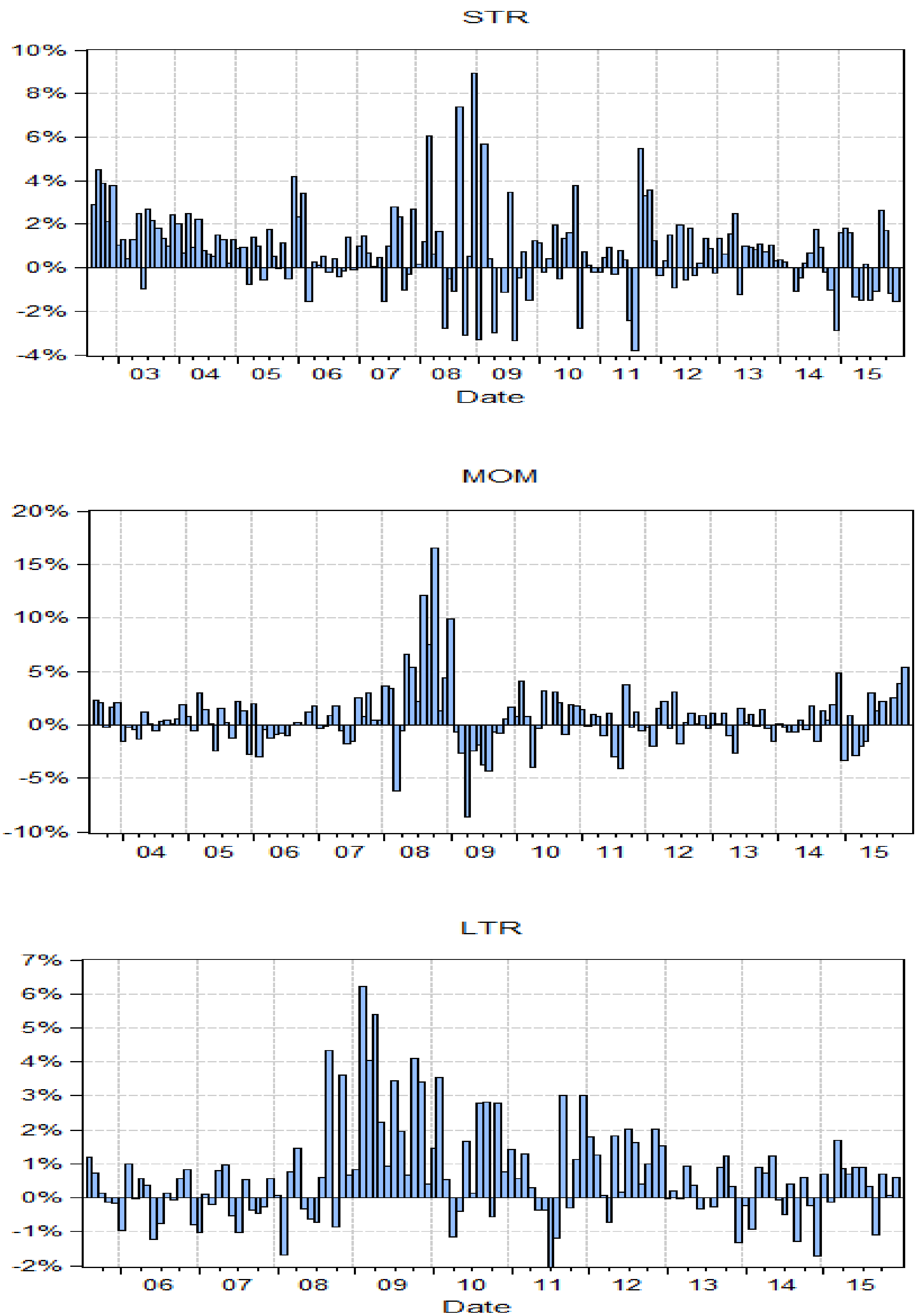
	Average return	7-factor stock alpha	4-factor bond alpha	11-factor alpha
Low LTR	0.83	0.79	0.72	0.73
LTR2	0.51	0.48	0.53	0.53
LTR3	0.48	0.48	0.47	0.49
LTR4	0.47	0.46	0.48	0.49
High LTR	0.64	0.62	0.60	0.63
High − Low	-0.19	-0.17	-0.12	-0.10
Return/Alpha diff.	(-0.64)	(-0.73)	(-0.48)	(-0.57)

Table 18: Does Long-term Reversal Signal Future Shifts in Credit Risk?

This table reports average slope coefficients from Fama and MacBeth (1973) cross-sectional regressions of one-month-ahead measures of credit risk on long-term reversal (LTR), with and without control variables. The two measures of credit risk are the distance-to-default (DD) and the credit default spread (CDS). LTR is defined as the past 36-month cumulative returns from $t-48$ to $t-13$, skipping the 12-month momentum and the short-term reversal month. Bond characteristics include time-to-maturity (years), amount outstanding (size), illiquidity (ILLIQ), and bond market beta (β^{Bond}). The Fama and MacBeth regressions are run each month for the period from July 2005 to December 2015. Newey-West (1987) t-statistics are reported in parentheses to determine the statistical significance of the average intercept and slope coefficients. The last column reports the average adjusted R^2 values. Numbers in bold denote statistical significance at the 5% level or better.

Model	Dep.var	LTR	Maturity	Size	ILLIQ	β^{Bond}	Adj. R^2
(1)	DD	**0.004**					0.044
		(3.24)					
(2)	DD	**0.003**	0.017	0.157	-0.038		0.080
		(2.84)	(12.74)	(5.20)	(-9.27)		
(3)	DD	**0.003**	0.018	0.123	-0.032	-0.234	0.122
		(2.93)	(11.83)	(3.54)	(-8.35)	(-1.93)	
(4)	CDS	**-4.409**					0.045
		(-2.40)					
(5)	CDS	**-3.986**	-5.124	-31.079	15.631		0.095
		(-2.36)	(-4.86)	(-3.41)	(10.48)		
(6)	CDS	**-4.201**	-5.144	-26.522	14.652	7.269	0.134
		(-2.47)	(-5.31)	(-2.77)	(9.55)	(0.30)	

Figure 1: Monthly Return Spreads from Univariate Sorts on STR, MOM, and LTR



This figure presents the monthly time-series plots of the return spreads between STR-losers and STR-winners (top panel), between MOM-winners and STR-losers (middle panel), and between LTR-losers and LTR-winners (bottom panel).

Return-Based Factors for Corporate Bonds

Online Appendix

To save space in the paper, we present the robustness check results in the Online Appendix. Table A.1 presents results from the quintile portfolios of corporate bonds sorted by MOM for different holding periods such as 3-, 6-, and 12-month. Table A.2 presents results from the quintile portfolios of corporate bonds sorted by MOM within investment-grade (IG) and non-investment-grade (NIG) bonds. Table A.3 presents results from the quintile portfolios of corporate bonds sorted by LTR for the 12-, 24-, and 36-month ahead returns. Table A.5 presents results from the firm-level univariate portfolios of corporate bonds sorted by STR, MOM, and LTR. Table A.6 presents results from the firm-level Fama and MacBeth (1973) cross-sectional regressions of one-month-ahead corporate bond excess returns on the STR, MOM, and LTR, with and without controls. Table A.7 presents results from the quintile portfolios of corporate bonds sorted by STR, MOM, and LTR using extended sample over the period January 1977 to December 2015.

Table A.1: Univariate Portfolios of Corporate Bonds Sorted by Momentum for Different Holding Periods

Quintile portfolios are formed every month from July 2003 to December 2015 by sorting corporate bonds based on their 12-month momentum, defined as the past cumulative returns from $t-12$ to $t-2$, skipping month $t-1$. Quintile 1 is the portfolio with the lowest MOM, and Quintile 5 is the portfolio with the highest MOM. The portfolios are value-weighted, rebalanced every month and are held for 3-, 6-, and 12-months. To deal with overlapping portfolios in each holding month, we follow Jegadeesh and Titman (1993) to take the equal-weighted average return across portfolios formed in different months. Table reports the average excess return, and the 11-factor alpha for each quintile. The last row shows the differences in monthly average returns, the differences in alphas with respect to the factor models. The 11-factor model combines 7 stock market factors and 4 bond market factors. The 7-factor model with stock market factors includes the excess stock market return (MKT^{Stock}), the size factor (SMB), the book-to-market factor (HML), the stock momentum factor (MOM^{Stock}), the stock liquidity factor (LIQ), the short-term reversal factor (STR^{Stock}), and the long-term reversal factor (LTR^{Stock}). The 4-factor model with bond market factors includes the excess bond market return (MKT^{Bond}), the default spread factor (DEF), the term spread factor (TERM), and the bond liquidity factor (LIQ^{Bond}). Average returns and alphas are defined in monthly percentage terms. Newey-West adjusted t-statistics are given in parentheses. *, **, and *** indicate the significance at the 10%, 5%, and 1% levels, respectively.

	$K=3$		$K=6$		$K=12$	
Quintiles	Average return	11-factor alpha	Average return	11-factor alpha	Average return	11-factor alpha
Low	-0.18	-0.45	-0.16	-0.42	-0.05	-0.28
	(-0.76)	(-1.70)	(-0.66)	(-1.60)	(-0.24)	(-1.17)
2	0.19	0.06	0.20	0.07	0.21	0.09
	(1.31)	(0.35)	(1.37)	(0.38)	(1.60)	(0.55)
3	0.28	0.19	0.28	0.19	0.28	0.20
	(2.43)	(1.41)	(2.44)	(1.41)	(2.51)	(1.52)
4	0.31	0.26	0.31	0.26	0.30	0.24
	(3.03)	(2.21)	(3.03)	(2.24)	(3.03)	(2.15)
High	0.39	0.33	0.35	0.29	0.26	0.17
	(2.81)	(2.25)	(2.52)	(1.98)	(1.81)	(1.08)
High − Low	0.57***	0.78***	0.51**	0.71***	0.31*	0.45**
Return/Alpha diff.	(2.48)	(3.20)	(2.23)	(2.94)	(1.70)	(2.28)

Table A.2: Univariate Portfolios of Investment-Grade and Non-Investment-Grade Bonds Sorted by Momentum

Quintile portfolios are formed every month from July 2003 to December 2015 by sorting corporate bonds based on their 12-month momentum (MOM), defined as the past 11-month cumulative returns from $t-12$ to $t-2$, skipping month $t-1$, within investment-grade and non-investment-grade bonds. Quintile 1 is the portfolio with the lowest MOM, and Quintile 5 is the portfolio with the highest MOM. Table reports the average MOM, the next-month average excess return, the 7-factor alpha from stock market factors, the 4-factor alpha from bond market factors, and the 11-factor alpha for each quintile. The last row shows the differences in monthly average returns, the differences in alphas with respect to the factor models. The 7-factor model with stock market factors includes the excess stock market return (MKT^{Stock}), the size factor (SMB), the book-to-market factor (HML), the stock momentum factor (MOM^{Stock}), the stock liquidity factor (LIQ), the short-term reversal factor (STR^{Stock}), and the long-term reversal factor (LTR^{Stock}). The 4-factor model with bond market factors includes the excess bond market return (MKT^{Bond}), the default spread factor (DEF), the term spread factor (TERM), and the bond liquidity factor (LIQ^{Bond}). The 11-factor model combines 7 stock market factors and 4 bond market factors. Average returns and alphas are defined in monthly percentage terms. Newey-West adjusted t-statistics are given in parentheses. *, **, and *** indicate the significance at the 10%, 5%, and 1% levels, respectively.

	Investment-Grade				Non-Investment-Grade			
	Average return	7-factor stock alpha	4-factor bond alpha	11-factor alpha	Average return	7-factor stock alpha	4-factor bond alpha	11-factor alpha
Low	0.28	0.23	0.10	0.10	-0.02	-0.38	-0.38	-0.45
	(1.19)	(1.41)	(0.64)	(0.65)	(-0.05)	(-0.80)	(-0.97)	(-1.01)
2	0.27	0.25	0.18	0.17	0.22	-0.06	-0.01	0.04
	(1.78)	(2.00)	(1.46)	(1.33)	(0.62)	(-0.15)	(-0.02)	(0.09)
3	0.27	0.27	0.22	0.21	0.41	0.22	0.16	0.17
	(2.31)	(2.50)	(2.01)	(1.94)	(1.60)	(0.75)	(0.63)	(0.58)
4	0.32	0.32	0.28	0.26	0.57	0.54	0.40	0.45
	(2.93)	(3.06)	(2.49)	(2.45)	(2.89)	(2.31)	(1.99)	(1.97)
High	0.39	0.39	0.35	0.34	0.79	0.71	0.62	0.61
	(2.97)	(3.00)	(2.50)	(2.43)	(3.43)	(2.77)	(2.72)	(2.57)
High − Low	0.11	0.16	0.25	0.23	0.81**	1.09***	1.00***	1.05***
Return/Alpha diff.	(0.57)	(1.27)	(1.67)	(1.65)	(2.31)	(2.68)	(2.92)	(2.70)

Table A.3: Longer-term Predictability from Univariate Portfolios of Corporate Bonds Sorted by Long-term Reversal

Quintile portfolios are formed every month from July 2005 to December 2015 by sorting corporate bonds based on their past 36-month cumulative returns (LTR) from $t-48$ to $t-13$, skipping the 12-month momentum and short-term reversal month. Quintile 1 is the portfolio with the lowest LTR, and Quintile 5 is the portfolio with the highest LTR. Table reports the average excess return and the 11-factor alpha for each quintile, for 12-, 24-, and 36-month ahead returns. The 11-factor model combines 7 stock market factors and 4 bond market factors. The 7-factor model with stock market factors includes the excess stock market return (MKT^{Stock}), the size factor (SMB), the book-to-market factor (HML), the stock momentum factor (MOM^{Stock}), the stock liquidity factor (LIQ), the short-term reversal factor (STR^{Stock}), and the long-term reversal factor (LTR^{Stock}). The 4-factor model with bond market factors includes the excess bond market return (MKT^{Bond}), the default spread factor (DEF), the term spread factor (TERM), and the bond liquidity factor (LIQ^{Bond}). Average returns and alphas are defined in monthly percentage terms. Newey-West adjusted t-statistics are given in parentheses. *, **, and *** indicate the significance at the 10%, 5%, and 1% levels, respectively.

	Average return			11-factor alpha		
	12-month ahead	24-month ahead	36-month ahead	12-month ahead	24-month ahead	36-month ahead
Low	1.44	1.62	1.62	1.33	1.42	1.56
	(3.53)	(3.59)	(3.64)	(3.81)	(3.46)	(4.94)
2	0.58	0.72	0.67	0.48	0.66	0.68
	(2.54)	(2.97)	(3.13)	(2.68)	(2.69)	(3.41)
3	0.58	0.63	0.70	0.51	0.58	0.69
	(3.03)	(3.11)	(2.77)	(3.43)	(2.98)	(3.71)
4	0.63	0.73	0.69	0.55	0.61	0.66
	(2.60)	(2.58)	(2.41)	(2.96)	(2.35)	(2.88)
High	0.81	0.80	0.77	0.70	0.64	0.72
	(2.71)	(2.72)	(2.97)	(2.73)	(2.56)	(2.85)
High − Low	-0.63***	-0.82***	-0.84***	-0.62***	-0.78***	-0.84***
Return/Alpha diff.	(-2.83)	(-3.71)	(-3.03)	(-2.84)	(-3.30)	(-4.33)

Table A.4: Long-term reversal effect after accounting for defaulting bond returns

Quintile portfolios are formed every month from July 2005 to December 2015 by sorting corporate bonds based on their past 36-month cumulative returns (LTR) from $t-48$ to $t-13$, skipping the 12-month momentum and short-term reversal month. Quintile 1 is the portfolio with the lowest LTR, and Quintile 5 is the portfolio with the highest LTR. Table reports the next-month average excess return, the 7-factor alpha from stock market factors, the 4-factor alpha from bond market factors, and the 11-factor alpha for each quintile. Default returns for all the defaulting issues are adjusted using the delisting return average. The 11-factor model combines 7 stock market factors and 4 bond market factors. The 7-factor model with stock market factors includes the excess stock market return (MKT^{Stock}), the size factor (SMB), the book-to-market factor (HML), the stock momentum factor (MOM^{Stock}), the stock liquidity factor (LIQ), the short-term reversal factor (STR^{Stock}), and the long-term reversal factor (LTR^{Stock}). The 4-factor model with bond market factors includes the excess bond market return (MKT^{Bond}), the default spread factor (DEF), the term spread factor (TERM), and the bond liquidity factor (LIQ^{Bond}). Average returns and alphas are defined in monthly percentage terms. Newey-West adjusted t-statistics are given in parentheses. *, **, and *** indicate the significance at the 10%, 5%, and 1% levels, respectively.

Quintiles	Average return	7-factor stock alpha	4-factor bond alpha	11-factor alpha
Low LTR	0.94	0.85	0.70	0.65
	(2.42)	(2.75)	(2.55)	(2.58)
2	0.43	0.40	0.32	0.30
	(2.12)	(2.42)	(2.20)	(2.23)
3	0.40	0.38	0.32	0.31
	(2.37)	(2.86)	(2.58)	(2.62)
4	0.38	0.35	0.28	0.14
	(1.98)	(2.29)	(1.94)	(1.82)
High LTR	0.36	0.33	0.20	0.11
	(2.16)	(2.32)	(1.99)	(1.85)
High − Low	-0.58***	-0.52**	-0.50**	-0.54**
Return/Alpha diff.	(-2.84)	(-2.65)	(-2.59)	(-2.63)

Table A.5: Firm-level Univariate Portfolios of Corporate Bonds Sorted by STR, MOM, and LTR

This table reports the firm-level univariate portfolios of corporate bonds sorted by STR, MOM, and LTR. To control for bonds issued by the same firm, for each month in our sample, we pick one bond with the median size as the representative for the firm. The portfolios are value-weighted using amount outstanding as weights. Table reports the average excess return and the 11-factor alpha for each quintile. The 11-factor model combines 7 stock market factors and 4 bond market factors. The 7-factor model with stock market factors includes the excess stock market return (MKT^{Stock}), the size factor (SMB), the book-to-market factor (HML), the stock momentum factor (MOM^{Stock}), the stock liquidity factor (LIQ), the short-term reversal factor (STR^{Stock}), and the long-term reversal factor (LTR^{Stock}). The 4-factor model with bond market factors includes the excess bond market return (MKT^{Bond}), the default spread factor (DEF), the term spread factor (TERM), and the bond liquidity factor (LIQ^{Bond}). Average returns and alphas are defined in monthly percentage terms. Newey-West adjusted t-statistics are given in parentheses. *, **, and *** indicate the significance at the 10%, 5%, and 1% levels, respectively.

	STR		MOM		LTR	
	Average return	11-factor alpha	Average return	11-factor alpha	Average return	11-factor alpha
Low	1.08	1.16	-0.21	-0.16	1.69	1.33
	(3.36)	(4.49)	(-0.74)	(-0.55)	(3.25)	(4.27)
2	0.36	0.45	0.23	0.27	0.73	0.55
	(3.07)	(3.42)	(1.29)	(1.39)	(2.75)	(3.35)
3	0.26	0.31	0.32	0.32	0.64	0.50
	(2.24)	(2.50)	(2.22)	(2.08)	(2.81)	(3.69)
4	0.26	0.31	0.34	0.33	0.66	0.51
	(1.81)	(2.08)	(2.66)	(2.53)	(2.43)	(3.33)
High	0.26	0.42	0.38	0.36	0.86	0.68
	(0.95)	(1.51)	(2.73)	(2.64)	(2.84)	(3.73)
High − Low	-0.82***	-0.74***	0.59***	0.52**	-0.83***	-0.65***
Return/Alpha diff.	(-3.84)	(-3.72)	(2.46)	(2.23)	(-3.44)	(-3.83)

Table A.6: Firm-level Fama-MacBeth Cross-Sectional Regressions

This table reports the average intercept and slope coefficients from the firm-level Fama and MacBeth (1973) cross-sectional regressions of one-month-ahead corporate bond excess returns on the short-term reversal (STR), momentum (MOM), and long-term reversal (LTR), with and without controls. Bond characteristics include time-to-maturity (years) and amount outstanding (size, in $billion). Ratings are in conventional numerical scores, where 1 refers to an AAA rating and 21 refers to a C rating. Higher numerical score means higher credit risk. β^{Bond} is the individual bond exposure to the aggregate bond market portfolio, proxied by the Merrill Lynch U.S. Aggregate Bond Index. ILLIQ is the bond-level illiquidity computed as the autocovariance of the daily price changes within each month. Newey-West (1987) t-statistics are reported in parentheses to determine the statistical significance of the average intercept and slope coefficients. The last column reports the average adjusted R^2 values. Numbers in bold denote statistical significance at the 5% level or below.

	Intercept	STR	MOM	LTR	β^{Bond}	ILLIQ	Rating	Maturity	Size	Adj. R^2
(1)	0.573	**-0.056**								0.019
	(3.44)	(-4.45)								
(2)	-0.066	**-0.077**			0.084	**0.048**	0.029	**0.014**	0.053	0.133
	(-0.40)	(-4.72)			(1.52)	(3.96)	(1.17)	(1.96)	(1.33)	
(3)	0.190		**0.025**							0.034
	(1.02)		(2.67)							
(4)	0.184		**0.030**		0.036	-0.010	-0.009	0.011	-0.022	0.125
	(1.16)		(3.72)		(0.50)	(-0.83)	(-0.38)	(1.65)	(-0.51)	
(5)	1.035			**-0.011**						0.022
	(2.99)			(-2.06)						
(6)	-0.552			**-0.015**	0.104	**0.119**	**0.115**	0.009	0.149	0.176
	(-2.75)			(-2.32)	(1.13)	(6.75)	(3.61)	(1.32)	(1.70)	
(7)	0.522	**-0.099**	0.006	**-0.014**						0.080
	(2.95)	(-7.49)	(0.73)	(-2.33)						
(8)	-0.005	**-0.150**	0.005	**-0.002**	0.010	**0.035**	**0.044**	0.010	0.015	0.186
	(-0.03)	(-9.71)	(1.01)	(-2.21)	(0.20)	(3.86)	(2.26)	(1.42)	(0.47)	

Table A.7: Univariate Portfolios of Corporate Bonds Sorted by STR, MOM, and LTR Using Extended Sample

Quintile portfolios are formed every month from January 1977 to December 2015 by sorting corporate bonds based on the short-term reversal (STR), the 12-month momentum (MOM), and the long-term reversal (LTR). STR is measured by the previous month return. MOM is the past 11-month cumulative returns from $t-12$ to $t-2$, skipping month $t-1$. LTR is the past 36-month cumulative returns from $t-48$ to $t-13$, skipping the 12-month momentum and short-term reversal months. Table reports the next-month average excess return and the 11-factor alpha for each quintile. The portfolios are value-weighted using amount outstanding as weights. The 11-factor model combines 7 stock market factors and 4 bond market factors. Average returns and alphas are defined in monthly percentage terms. Newey-West adjusted t-statistics are given in parentheses. *, **, and *** indicate the significance at the 10%, 5%, and 1% levels, respectively.

	Average return	11-factor alpha		Average return	11-factor alpha		Average return	11-factor alpha
Low STR	0.69	0.46	Low MOM	-0.37	-0.31	Low LTR	1.10	0.98
2	0.27	0.03	2	-0.20	-0.03	2	0.45	0.26
3	0.18	-0.05	3	-0.15	-0.08	3	0.38	0.19
4	0.14	-0.09	4	0.13	0.09	4	0.36	0.16
High STR	0.00	-0.18	High MOM	0.17	0.18	High LTR	0.63	0.44
High − Low	-0.68***	-0.64***	High − Low	0.54***	0.49***	High − Low	-0.48***	-0.54***
t-stat	(-3.85)	(-3.80)	t-stat	(3.14)	(3.10)	t-stat	(-2.70)	(-2.85)