Reaching for Yield and Overpricing in Bonds

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Abstract

Reaching for yield, which we define as investor preference for bonds with higher yields at a given rating or for bonds with higher ratings given yields, forecasts lower returns in the cross section than are predicted by yields. Controlling for ratings (yields), alphas are lower for higher yield (rated) bonds. Future returns on bonds associated with reaching for yield are particularly low when interest rates are low, when demand for such bonds among leverage-constrained investors (insurance companies, pension funds, and mutual funds) is strong, and when funding costs to less constrained investors (dealer banks and hedge funds) are high. These bonds also default more often than bonds with similar yields.

JEL Classification: G11, G12, G14

Keywords: Reaching for yield; Credit rating; Overpricing in Corporate Bonds

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1. Introduction

Since the great recession, academics and policymakers have increasingly shown interest in the effects of unconventional monetary policies on risk-taking behaviors. One such phenomenon receiving considerable attention is investor preference for high-risk securities, commonly referred to as "reaching for yield" (henceforth "RFY"), particularly when interest rates are low.[1] Such risk-taking behavior has indeed been widespread across asset markets and investors in the wake of the financial crisis.[2]

What is the impact of RFY on asset prices? The answer to this question lies at the heart of understanding the implications of such risk-taking behavior. Demand for risky securities could have a positive effect on economic growth if it were to elevate asset prices and thus alleviate financial constraints on distressed issuers who would otherwise be unable to access capital markets (Rajan 2013). At the same time, to the extent that increased demand for risky securities induces overpricing, RFY can not only affect investor performance negatively,[3] it can also be accompanied by credit overheating and future economic downturns.[4] As such, identifying the link between RFY and asset prices is an important first step towards understanding the economic and financial implications of RFY. Thus, we examine the effect of RFY on corporate bond prices and seek to reveal the economic mechanism underlying the pricing effect.

In frictionless markets, risk is assumed to be adequately priced under rational pricing. Prices can, however, deviate from what is implied by fair compensation of risk, because of either

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[1] Rajan (2005) and Feroli et al. (2014), for example, show the economic mechanisms for why low interest rates incentivize investors to reach for yield.

[2] See, e.g., Becker and Ivashina (2015), Hanson and Stein (2015), Di Maggio and Kacperczyk (2017), Choi and Kronlund (2018), Iannotta, Pennacchi, and Santos (2018), and Lian, Ma, and Wang (2018).

[3] Becker and Ivashina (2015) for insurance companies and Choi and Kronlund (2018) for mutual funds show that that RFY is associated with poor investment performance.

[4] See, e.g., Greenwood and Hanson (2013) and Lopez-Salido, Stein, and Zakrajšek (2017).

market frictions or noisy investor demand. Apropos of this, we hypothesize that overpricing can arise in bonds that are associated with RFY. In a frictionless market with no leverage constraints, there should be no effect of investor risk appetite on the pricing of risky securities, as investors can simply lever up their positions and achieve desired risk levels even without holding risky assets. As documented in previous studies, however, RFY is essentially a response of leverage-constrained investors to leverage constraints, as is shown by the portfolio choices of insurance companies (Becker and Ivashina, 2015) and money market and mutual funds (Di Maggio and Kacperczyk, 2017; Choi and Kronlund, 2018). These constrained investors will overweight risky bonds instead of employing leverage, which will reduce the risk premium of such assets. Therefore, we expect that bonds that are associated heavily with RFY bring lower future returns or alphas after risk adjustment. This economic channel is also similar to the mechanism outlined in Frazzini and Pedersen (2014), who show that demand for risky assets combined with leverage constraints lowers the risk premia of such assets and drives alphas lower.

Using U.S. corporate bond prices recorded in the Trade Reporting and Compliance Engine (TRACE) from 2002 through 2014, we show that bonds associated with strong RFY earn lower future returns. Our empirical measure of RFY for a bond is calculated relative to its credit rating. We base this choice largely on findings reported in previous studies (e.g., Becker and Ivashina, 2015; Choi and Kronlund, 2018) but also in part because the investment mandate of large fixed-income asset managers is expressed in terms of credit ratings. In particular, we define RFY for a given bond ($RFY \equiv y - y^R$) as the difference between the yield of the bond (y) and the average yield of bonds with the same rating (y^R). Thus, a bond is associated with strong RFY when its yield relative to its rating is high (i.e., y is high), as investors with RFY incentives will prefer bonds with higher yields but the same ratings because these bonds appear safer. The RFY measure is also high when the bond has a higher rating than bonds with similar yields (i.e., y^R is low), which captures another dimension wherein investors choose safer-looking bonds over bonds with similar yields but lower ratings. Using these measures, we find evidence suggesting that the underperformance of bonds registering high RFY measures is driven mainly by demand for such bonds among leverage-constrained investors.

We report a series of findings as empirical evidence showing that bonds that are associated with RFY tend to earn lower future returns. In our portfolio-level analysis, we show that high-RFY bonds have negative alphas, using portfolios double-sorted on yields and ratings. In our first set of portfolios, which we sort first on ratings and then on yields, we find a remarkably monotonically decreasing pattern between yields and future alphas. For example, the alpha of the high-minus-low value-weighted portfolios is -0.27% per month for the following 12 months. In the second set of portfolios, which we sort first on yields and then on ratings, we also find a monotonic, negative pattern between ratings and future alphas, also showing that returns on high-RFY bonds are not as high as the risk associated with such bonds. These results are quite robust, as we find consistent results after controlling for various risk factors and also using subsamples based on bond liquidity and ratings.

In our main empirical analyses, we employ rich individual bond-level data to show further evidence that investor demand for high-risk bonds leads to lower future bond returns than otherwise similar bonds. Our bond-level regression specification is motivated by the following approximation of a return on a bond R_{t+1}^B, expressed in terms of a change in the yield of the bond: $R_{t+1}^B \approx Y_t - D\Delta Y_{t+1}$, where Y_t is the yield and D is the modified duration of the bond. The first term shows that bond returns should be linear to yields, other things being equal. We hypothesize that the overpricing effect of RFY works through the second term. That is, strong investor demand for an RFY bond is associated with the lower current yield of the bond (i.e., an elevated bond price). The bond yield will eventually revert to the fundamental level over subsequent months (i.e., ΔY_{t+1} tends to be positive) as investor demand reverts over time. Thus, to the extent that RFY is associated with temporarily depressed yields, we expect future bond returns, after controlling for bond yields, to be negatively associated with current RFY. In contrast, if RFY is not associated with depressed yields, bond returns should be fully predicted by yields and RFY should have no forecasting power.

Guided by the bond returns equation outlined above, we examine whether our measure of bond RFY forecasts lower future returns after controlling for bond yields. In the baseline pooled regressions of individual bond returns, we find that a one-percentage-point increase in RFY is associated with returns of -0.38% on investment-grade (IG) bonds and returns of -0.36% on high-yield (HY) bonds over the following twelve-month horizons, while, not surprisingly, bond yields positively predict future returns. Thus, high-RFY bonds do earn high returns (the yield effect), but the returns are not as high as their yields predict (the RFY effect) because these bonds are likely overpriced. In other words, without investor demand for risky securities, their yields would have been even higher. These lower returns subsides after twelve-month horizons, consistent with temporary overpricing is high-RFY bonds.

We then examine the extent to which these results can be attributed to RFY on the part of leverage-constrained investors. We first focus on the differential effects of interest rates and funding costs on future bond returns and RFY. On the one hand, investor incentives to reach for yield strengthen with low interest rates. Feroli et al. (2014) show that asset managers chase after riskier securities to earn higher returns particularly when interest rates are low, even in the face of high downside risk. Furthermore, end investor demand for subsistence yields will create an effect that is essentially similar to the effect of fixed-rate liabilities, as argued by Rajan (2005), which induces stronger incentives to reach for yield when interest rates are low. On the other hand, as shown by Frazzini and Pedersen (2014), higher funding costs to unconstrained arbitrageurs, i.e., dealers and hedge funds, will make it more difficult for these arbitrageurs to trade against RFY investors and, thus, the price effect of RFY will be stronger when funding costs are higher.

Using the interactions of RFY with interest rates and funding-cost variables, we show that the effect of RFY is indeed stronger when interest rates are low or funding costs are higher. We use several proxies for interest rates in the fixed-income market, e.g., the 1-month T-bill rate, the term spread, and the default spread, and show that interaction between these variables and RFY is positively associated with future bond returns. Furthermore, we also find that interaction between RFY and the TED spread is reliably negatively associated with future bond returns, consistent with the story that lower funding costs to unconstrained investors help them trade against RFY.

We also relate the price effect of RFY to actual holdings of fixed-income investors. In particular, we expect the negative effect of RFY on future bond returns to be stronger when leverage-constrained investors increase holdings, whereas the effect should be weaker when unconstrained investors increase holdings. Employing the interactions of RFY with holding changes in corporate bonds, we find that the negative effect of RFY on bond returns is stronger when leverage-constrained investors, i.e., insurance companies, pension funds, and mutual funds, increase holdings. In contrast, we also find that increases in the bond positions of dealer banks and hedge funds, who are typically less constrained in taking levered positions, actually weakens the effect of RFY on future bond returns.

In the subsequent analysis, we test another implication of overpricing due to RFY. If bonds with strong RFY are overpriced compared with their risk, then these bonds should default more often relative to otherwise similar bonds, in particular bonds that are similar in terms of yields. We indeed find that, after controlling for bond yields, bonds associated with high degrees of RFY default more, consistent with higher risk relative to yields. In other words, a 5% bond with an A rating would more likely default than a 5% bond with a BBB rating bond. These results suggest that bonds associated with RFY are overpriced relative to their true risk (i.e., default risk) and, thus, controlling for bond-level characteristics, these bonds have relatively higher default rates.

Lastly, we examine the flip side of RFY-driven overpricing. That is, we directly examine the response of bond prices when interest rates drop, providing further evidence suggesting that RFY on the part of bond investors is the economic mechanism the explains the previous results for returns. To do so, we focus on the announcement effects of quantitative easing (QE). As Hanson and Stein (2015) note, upon the announcement of a change in or a new monetary policy, long-term interest rates respond disproportionately, which they attribute to RFY on the part of investors. Regarding QE announcements in the post-financial crisis period, the motivation for RFY is particularly stronger, as short-term interest rates are practically zero and investors search for higher-yielding investment opportunities. Using difference-in-differences analyses, we find that, during the two-day periods around QE announcements, the yields of bonds with high RFY measures decrease much more than those of bonds with low RFY measures. These results are consistent with the price effect of shifting investor portfolios towards riskier bonds.

We contribute to the growing literature that studies the effect of investors' risk-seeking behaviors on asset pricing. In a closely related, contemporaneous working paper, Berndt and Helwege (2018) study how a long-term low-interest-rate environment affect the pricing of CDS spreads and find evidence RFY reduces risk premia in high-yield CDS contracts, employing a decomposition of CDS spreads into risk premia and expected default components. Our study differs from theirs insofar as we show that reduced risk premia are associated with overpricing by linking RFY to future bond returns and portfolio choices of constrained investors. In another related, contemporaneous study, Murry and Nikolova (2018) show evidence that bonds with high systematic risk (i.e., betas) tend to earn lower alphas, which they link to risk-seeking by insurance companies due to the capital requirement rules. The economic mechanisms of our paper are different from theirs, as the overpricing effects that we document in our paper are independent of the systematic risk effects of Murry and Nikolova (2018) and we also show evidence consistent with RFY due to leverage-constrained investors when interest rates are low.

Our paper also contributes to the broad body of literature that examine the cross-section of corporate bond returns. Gebhardt, Hvidkjaer, and Swaminathan (2005a) examine whether characteristics or betas drive cross-sectional bond returns. Jostova et al. (2013), building on Gebhardt, Hvidkjaer, and Swaminathan (2005b), document the momentum effect in bond returns. Choi and Kim (2018) and Chordia et al. (2017) study whether cross-sectional patterns in bond returns are consistent with those found in equity returns. Bai, Bali, and Wen (2018) show which returns factors explain the cross-sectional bond returns. Our paper contributes to this literature by showing that relative yields in a given rating category are an important driver of long-run bond returns in the cross section.

2. Model

In this section, we provide a simple model to show one mechanism through which reaching for yield can drive overpricing of risky asset. The model is based largely on the setting of Allen and Gale (2010), which we extent to capture the economic mechanism of reaching for yield.

We consider a two period model $t = 1, 2$ in which there are two assets, a safe asset that pays a risk free rate, r, whose price is one, and a risky asset that pays R at $t = 2$. The distribution function of payoff R is given as $h(R)$, which takes a positive value on the support $R > 0$. The mean and standard deviation of R are $\overline{R}$ and σ, respectively. The price of the risky asset is P and determined at $t = 1$.

We assume a continuum of two types of investors: RFY and non-RFY investors. The RFY investors use borrowed money to make investments (no wealth of their own) in the risky and risk-free securities. They borrow amount W and have to pay back the amount of rW at $t = 2$. Each RFY investor purchases X_R units of the risky assets and X_S units of the risk-free assets. Unlike RFY investors, non-RFY investors do not borrow but invest from their own money W in the risky and risk-free assets.

We first model the non-RFY investor demand. The payoff to the non-RFY investors at time 2 is $rX_{NS} + RX_{NR} = rW + (R - rP)X_{NR}$ where X_{NS} and X_{NR} are the units of the risky and risk-free securities, respectively. The non-RFY investors maximize their utility:

$$\max_{X_{NR}} \left(\overline{R} - rP\right)X_{NR} - \frac{\gamma}{2}\sigma^2 X_{NR}^2$$

where γ is the risk aversion coefficient. Solving the maximization problem, we obtain

$$P = \frac{1}{r}(R - \gamma\sigma^2 X_{NR})$$

We next model the demand of the RFY investors. The key assumption is limited liability for the RFY investors. When the payoff of their investments are not sufficient to repay their debt, they declare bankruptcy and walk away. When the payoff is high, they keep the remainder of their investment values after debt repayment. This assumption gives the RFY investors risk-shifting incentives.

The payoff at time 2 to the RFY investors is call-option-like, that is, $\left(rX_S + RX_R - r(X_S + P\,X_R)\right)^+ = \left((R - rP)X_R\right)^+$. Thus, if $R < rP \equiv R^*$, then the payoff is zero, and otherwise, it is $(R - rP)X_R$. The RFY investor maximizes the utility:

$$\max_{X_R} \int_{R^*} (R\,X_R - r\,P\,X_R)h(R)dR\ -\frac{\gamma}{2}\sigma^2 X_R^2.$$

Thus, we assume the RFY investors are a mean-variance optimizer, where they use truncated distribution because of the limited liability assumption. For the tractability reason, we assume that the investors are penalized the variance of the original distribution, instead of using the variance of the truncated payoff. This assumption allows us to have quasi-closed-form solutions.

Solving the maximization problem, we obtain the demand function for the RFY investors:

$$P = \frac{1}{rS}\left(\overline{R^S} - \gamma\sigma^2 X_R\right)$$

where $S \equiv \int_{R^*} h(R)dR$ is the survival probability and $\overline{R^S} \equiv \int_{R^*} R\,h(R)dR$.

There is aggregate supply of one for the risky assets and we assume mass w for the RFY investors and $1 - w$ for the non-RFY investors. Using the demand functions X_{NR} and X_R above and the market clearing condition $1 = wX_R + (1 - w)X_{NR}$, we get the equilibrium price of the risky asset:

$$P = \frac{w\overline{R^S} + (1 - w)\overline{R} - \gamma\sigma^2}{wrS + (1 - w)r}$$

To show overpricing, we need to define the fair value of the risky asset, which is the benchmark price of the risk asset. The fair value $\overline{P}$ obtains when there are no RFY investors in the economy: $\overline{P} = \frac{1}{r}(R - \gamma\sigma^2)$. In the following proposition, we show that the risky asset is overpriced relative to the fair value in this economy.

Proposition 1. With the presence of RFY investors, there is overpricing in the risky security, that is, $P > \overline{P}$.

Proof.

$$P = \frac{w\overline{R^S} + (1-w)\overline{R} - \gamma\sigma^2}{wrS + (1-w)r} = \frac{R - \gamma\sigma^2 + w\left(\overline{R^S} - \overline{R}\right)}{r(wS + 1 - w)}$$

$$= \frac{r\overline{P} + w\left(\overline{R^S} - \overline{R}\right)}{r(wS + 1 - w)} = \frac{r\overline{P} + w\left(-\int_0^{R^*} R\, h(R)dR\right)}{r(wS + 1 - w)}$$

$$> \frac{r\overline{P} - wR^*(1-S)}{r(wS + 1 - w)} = \frac{r\overline{P} - wrP(1-S)}{r(wS + 1 - w)}$$

where the inequality follows from the fact that $h(R)$ is positive in all support. Therefore

$$rP(wS + 1 - w) > r\overline{P} - wrP(1-S)$$

and it follows that $P > \overline{P}$.

To the extent that there exist agents who risk-shift, there will be overpricing in the risky assets. In the next proposition, we show that in the model overpricing will be greater as the risk-free rate becomes lower. This happens because as risk-free rates are lower, risky assets provide more utility to the risk-shifting agents, as the opportunity cost of not investing in the risky asset increases.

Proposition 2. Overpricing becomes greater as the risk-free rate decreases, that is, $\frac{\partial(P-\overline{P})}{\partial r} < 0$.

Proof.

From the equilibrium price equation, it is obvious that both rP and $r\overline{P}$ are constant. By taking the derivative of the difference, we have $\frac{\partial}{\partial r}\left(r\left(P-\overline{P}\right)\right)=0$. Rearranging, $\left(P-\overline{P}\right)+r\frac{\partial\left(P-\overline{P}\right)}{\partial r}=0$. Thus it follows that $\frac{\partial\left(P-\overline{P}\right)}{\partial r}=-\frac{P-\overline{P}}{r}<0$.

The model also shows that overpricing is going to be greater as there is more RFY investors in the economy. We formalize in the following proposition:

Proposition 3. Overpricing becomes greater as there is more RFY investors, that is, $\frac{\partial\left(P-\overline{P}\right)}{\partial w}>0$.

Proof.

By taking the derivative with respect to w, it is identical to show that $\left(\overline{R^S}-\overline{R}\right)r-\left(\overline{R}-\gamma\sigma^2\right)(s-1)r>0$.

$$\left(\overline{R^S}-\overline{R}\right)r-\left(\overline{R}-\gamma\sigma^2\right)(s-1)r$$

$$=r\left(\overline{R^S}-\overline{R}S+\gamma\sigma^2S-\gamma\sigma^2\right)=r\left(\left(\overline{R^S}-\gamma\sigma^2\right)-S\left(\overline{R}-\gamma\sigma^2\right)\right)=r\left(rPS-r\overline{P}S\right)>0$$

3. Data and Variable constructions

To examine RFY and bond returns, we combine multiple sources of data: (1) the enhanced Trade Reporting and Compliance Engine (TRACE) database for corporate bond transaction prices and yields, (2) the Mergent Fixed Income Securities Database (FISD) for bond characteristics data including coupons, ratings, maturities and amounts outstanding, (3) Thomson Reuters eMAXX for institutional holding data on corporate bonds, and (4) Compustat and CRSP for bond issuer information.

3.1. Corporate bond data

The main data source for corporate bond prices and yields is the enhanced TRACE database from Financial Industry Regulatory Authority (FINRA). Compared with the standard TRACE database, the enhanced TRACE provides actual trade volumes, covering the period from 2002 through 2014. After the data filtering procedures described in Dick-Nielsen (2009, 2014), bond prices in TRACE are merged with the Mergent FISD for coupons, ratings, maturity, amounts outstanding, and other relevant bond characteristics. We also filter out bonds with less than one year to maturity because these bonds are relatively illiquid. After merging with the FISD, our bond data have 10731 bonds from July 2002 through December 2014.

In our main bond-level regressions, we occasionally employ issuer-level variables to control for firm characteristics, which are drawn from the Compustat and CRSP databases. These databases are merged with the bond price data using the bond link file available in the Wharton Research Data Services (WRDS). We also obtain institutional holdings of corporate bonds from Thomson Reuters eMAXX. This database has comprehensive coverage of quarterly fixed income holdings for insurance companies, mutual funds, pension funds, and other institutional investors.

3.2. Variable Constructions and Summary Statistics

3.2.1. Bond Returns and Ratings

We first calculate daily bond prices by averaging within-day transaction prices weighted using trading volumes after eliminating transactions less than \$100,000, following the procedure in Bessembinder, Kahle, Maxwell, and Xu (2009). The month-end price is then taken to be the last available daily price from the last five trading days of the month. The return of bond i in month t is computed as

$$r_{i,t} = \frac{P_{i,t} + AI_{i,t} + Cpn_{i,t}}{P_{i,t-1} + AI_{i,t-1}} - 1$$

where $P_{i,t}$ is a clean price at the end of month, $AI_{i,t}$ is accrued interest at the end of month, and $Cpn_{i,t}$ is the bond's coupon paid during month *t.*[5]

We follow the rating assignment of major bond index rules, e.g., the Barclays Aggregate Bond Index. That is, when all three ratings are available from Standard & Poor's, Moody's, and Fitch, we employ the median rating of the three. When less than two ratings are available from these agencies, we use the minimum (i.e., lower) rating.

3.2.2. Measuring Bond-Level RFY

We define bond-level RFY as a deviation of a bond's yield from the aggregate yield of the same rating and maturity of bonds, following Choi and Kronlund (2018). Specifically, for each bond *i* and month *t*, RFY within rating (RFY^{WR}) is defined as the deviation of a bond's yield from the weighted average yield in the same rating category:

$$RFY_{i,t}^{WR} \equiv y_{i,t} - y_{i,t}^{R}$$

where $y_{i,t}$ is the yield of bond i, and y_t^R is the value-weighted average yield of all the corporate bonds with the same rating category (We use 17 rating categories: AAA, AA+, AA, AA-, A+, A, A-, BBB+, BBB, BBB-, BB+, BB, BB-, B+, B, B- and lower than B-).

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[5] Note that we do not exclude default month returns to avoid any survivorship bias. Among 905 defaulted bonds in our sample, the TRACE database reports transactions for 697 cases and we use default month returns using prices recorded in TRACE. As robustness checks reported in the online Appendix, we assume several levels of default returns for the missing default month returns and find that our main results are robust. These results are expected, because any survivorship bias due to failure to include default month returns should make our results weaker (i.e., high RFY bonds default more often).

As longer-maturity bonds typically have higher yields, we further decompose RFY within rating into two components: RFY within rating and maturity (RFY^{WRM}) and reaching for maturity (RFM):

$$RFY_{i,t}^{WR} \equiv y_{i,t} - y_{i,t}^{R} = \left(y_{i,t} - y_{i,t}^{R,M}\right) + \left(y_{i,t}^{R,M} - y_{i,t}^{R}\right) = RFY_{i,t}^{WRM} + RFM_{i,t}$$

where $y_{i,t}^{R,M}$ is the weighted average yield of all the corporate bonds with the same category and maturity bucket (we use five buckets for maturity: <3 years, 3-5 years, 5-7 years, 7-10 years, and >10 years) as bond *i*, and weights are determined by amounts outstanding.

3.2.3. Summary Statistics

Table 1 provides the summary statistics of our sample, which contains 318908 observations for the period from July 2002 to Dec 2014, after merging the aforementioned data sources and constructing key variables. Panel A presents bond-level statistics, which shows wide variation in RFY in our sample, as shown by the interquartile range of -1.20% to 0.83% for $RFY^{WR}$and -0.54% to 0.33% for RFY^{WRM}. Even among IG bonds (Panel B), we find a similar degree of heterogeneity in RFY with the interquartile range of RFY^{WR} is from -1.11% to 0.81%, showing that yields of bonds in the same rating can differ substantially.

4. RFY and Bond Returns: Portfolio-Level Analysis

Our main hypothesis is that bonds that are associated with RFY tend to be overpriced and their risk-adjusted returns will be lower than otherwise similar bonds. To test this hypothesis, we first examine the alphas of portfolios sorted on RFY, over various horizons of portfolio holding periods. Once we establish portfolio-level results, in the main anlayses provided in next section we examine the extent to which individual bond returns are associated with reaching for yield, using the rich bond-level data.

We employ two sets of dependent portfolio-sorting. In the first set of portfolios, we sort bonds on rating and within each rating we further sort on yields. If RFY is associated with overpricing, high yield bonds within each rating will earn lower alphas than low yield bonds. In the second set of portfolios, we control for yields by first sorting on yield and then sort on credit ratings. Our hypothesis predicts that high rating bonds will have lower alphas than lower rating bonds in the same rating category, as investors will prefer bonds with higher credit rating over bonds with lower credit rating and similar yields.

4.1. Yield-Sorted Portfolios Within Each Rating

In Table 2, we examine portfolio alphas sorted on yields within the same rating. Specifically, in each credit rating, bonds are sorted into three terciles based on their yields at the end of each month. As ratings are controlled for, low-yield (high-yield) portfolios correspond to low (high) RFY portfolios. We measure portfolios returns by skipping one month from portfolio formation to avoid potential look-ahead bias arising from asynchronous trading in bonds.[6] To examine bond pricing over a long horizon, we hold portfolios for the next 3, 6, 12 months, similar to the portfolio formation strategy in Jegadeesh and Titman (1993).

As there is no strong consensus as to which factors to use for corporate bond returns, we follow existing studies to estimate bond portfolio alphas. We use stock market and Treasury market (e.g., term) factors following Fama and French (1993). As default-related risk can be priced differentially in IG and HY bonds, we use separate bond market factors for IG and HY by forming value-weighted portfolios using bonds in our sample. In addition, we control for liquidity risk by including the liquidity factor, which is constructed using portfolios sorted on bond market liquidity

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[6] Monthly bond returns are calculated the last available price within one week of the end of months.

measures.[7] We then estimate alphas by regressing excess returns on the rating-yield portfolios on excess returns on these five factors. Note that we correct for measurement errors due to asynchronous trading by including one month lead and lag factor returns in regressions as in Dimson's (1979) sum beta approach.[8]

Table 2 reports alphas (Panel A1) and average excess returns (Panel A2) of value-weighted rating-yield portfolios over three-, six-, and twelve-month holding periods. Note first from Panel A2 that high yield portfolios (H) tend to have higher average returns than low RFY portfolios (L), as bond returns should increase with yields, other things being equal.

After risk adjustment, however, Panel A1 of Table 2 shows that the alphas of high yield portfolios tend to be negative, while the alphas of low yield portfolios are positive. In particular, across all portfolio holding horizons and rating categories, the alphas of the high-minus-low (H-L) portfolios are negative and statistically significant at conventional levels, except for AA-rated bonds. For example, the alpha estimate of the AAA-rated high-minus-low portfolio is -0.30%, -0.26%, and -0.25% per month for the three-, six-, and twelve-month holding period horizons, respectively. We find similar patterns of alphas across other ratings. In the top row for the all-bonds portfolio, which is the simple average of all the rating portfolios, we also find that the high-minus-low portfolios are also all negative and highly statistically significant. We also provide these alphas graphically in Figure 1A, which show a clear monotonic and negative relation between yield and alphas across ratings.

Panels B1 and B2 of Table 2 reports alphas and average returns for equal-weighted portfolios. We find results that are consistent largely with those found in Panels A1 and A2. That

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[7] We sort bonds into terciles based on zero trading days (ZTD) at the end of each month. Low (high) liquidity portfolios correspond to the value-weighted or equal-weighted portfolios of bonds in the highest (lowest) ZTD tercile. The liquidity factor is constructed as a high-minus-low liquidity portfolio.

[8] We report these sum beta estimation results in the Appendix.

is, the alphas of the high-minus-low portfolios are negative and highly statistically significant, although their average returns are positive.

An alternative explanation to our findings is that lower returns on high RFY bonds are due to downgrades. This explanation assumes that higher yield bonds in a rating category are more likely to be downgraded but investors do not properly price in the downgrade probability. In the Online Appendix, we provide a robustness check to show that our results are not driven by higher likelihood of downgrade for high RFY bonds. Specifically, we exclude from portfolio holding periods bond-month observations with downgrades or upgrades and find that our results are qualitatively similar.[9] Also note that these results are not driven by inherent difference in liquidity between high and low RFY bonds, as another robustness check provided in the Online Appendix we find qualitatively similar results from subsample analyses based on bond liquidity. In summary, the results obtained from the within-rating yield-sorted portfolios suggest that RFY is associated with negative alphas for up to the next 12 month.

4.2. Rating-Sorted Portfolios Within Yield Sorts

In Table 3, we examine whether RFY is associated with overpricing by analyzing alphas of portfolios that are sorted on rating controlling for yields. Specifically, we first sort bonds into yield deciles each month and then, in each yield decile, we sort bonds into two groups based on their ratings. Similar to the previous analysis in Table 2, we examine the performance of the portfolios for the next three-, six-, and twelve-month horizons.

In Panel A of Table 3, we first provide the summary statistics of the high (H) and low (L) rating portfolios across the yield deciles to examine the extent to which our two-way sorting

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[9] The Online Appendix provides this robustness check for all of our main results in the paper.

controls for yields. Except for the top and bottom yield deciles, the high and low rating portfolios have similar yield statistics. In the two extreme yield deciles, the average and standard deviation of yields are meaningfully different across the high and low rating portfolios. This is because yield and rating are correlated; rating-sorted portfolios in the extreme yield deciles are essentially yield-sorted portfolios. Therefore, we exclude the bottom and the top yield deciles in the following portfolio analysis.

In Panels B1 and B2 of Table 3, we report alphas and average excess returns of value-weighted portfolios, respectively. We find that across the eight yield deciles, the alphas tend to be negative for high rating portfolios and positive for low rating portfolios and the high-minus-low alphas are negative and statistically significant at conventional levels. For example, the high-minus-low alpha estimates of yield decile 5 are -0.17%, -0.17%, and -0.16% per month for the three-, six-, and twelve- month holding period horizons and are statistically significant at the 5% level. This pattern is more pronounced for low yield deciles, while we find weaker results for yield deciles 8 and 9, wherein the high-minus-low alphas are not statistically significant. This weaker results for high yield decile may be because yields are not properly controlled for in high yield buckets. Figure 1B graphically show these high-minus-low alphas of rating portfolios.

In panel C1 of Table 3, we further show the alpha estimation results of equal-weighted portfolios. We find largely similar or even stronger results from equal-weighted portfolios. For example, the high-minus-low alpha is now statistically significant at the 10% level for yield decile 8 in Column 3. Overall, we find that after controlling for yields high rating bonds have more negative alphas than low rating portfolios. These results suggest that high rating bonds tend to be overpriced than low rating bonds, as investors might seek for safer-looking securities given the same level of yields.

5. RFY and Bond Returns: Individual Bond Level Regressions

The previous section reports the results that bonds associated with RFY are overpriced relative to their risk loadings. One potential issue of the previous results is that the risk factors considered can miss out other sources of risk that might be associated with relatively high-yielding bonds. In this section, we employ bond-level data to control for a wide range of variables that can explain future bond returns and further show the extent to which RFY is associated with overpricing. This bond-level regression approach also allows us to test a rich set of implications of RFY.

5.1. Empirical Model

To lay out the main idea of our regression framework, consider a bond pricing equation:

$$B_t = \Sigma_{j=1}^{n} I e^{-Y_t(T_j - t)} + F e^{-Y_t(T-t)}$$

where B_t is the price of the bond, I is the coupon, F is the face value, Y_t is the yield-to-maturity, T_j is the coupon payment period, and T is the maturity. Suppose that the bond yield follows a diffusion process, $dY_t = \mu_t dt + \sigma_t dW_t$, upon no default, where μ_t and σ_t are drift and volatility of the diffusion process and W_t is a standard Brownian motion. By applying Ito's formula, we obtain the following expression for an instantaneous return on the bond:

$$\frac{dB_t}{B_t} = \frac{1}{B_t}\frac{\partial B_t}{\partial t}dt + \frac{1}{B_t}\frac{\partial B_t}{\partial Y_t}dY_t + \frac{1}{2}\frac{1}{B_t}\frac{\partial^2 B_t}{\partial Y_t^2}(dY_t)^2 = Y_t dt - D_t dY_t + \frac{1}{2}C_t\sigma_t^2 dt$$

where the abused notation, $(dY_t)^2$, stands for quadratic variation $d[Y_t]^2$ and D_t and C_t are modified duration and convexity, respectively. In a discrete time representation, we can write

$$R_{t+1}^{B} = Y_t - D_t \Delta Y_{t+1} + \tfrac{1}{2} C_t \sigma_t^2 \qquad (1)$$

The above equation shows that bond returns should be linear to bond yields, other things being equal. This is an intuitive result; when bond yields are constant, for example, bond return is simply the same as the yield. The third term is also a deterministic term due to the convexity of the bond pricing function, which increases with convexity and the volatility of yields.

The effect of RFY on bond returns works through the second term, which is due to the change in bond yield, dY_t. As RFY drives overpricing, the current yield of the bond is too low and reverts (i.e., increases) later, which causes future bond returns to be lower.

In our regressions, we thus examine whether future bond returns are negatively associated with RFY even after *controlling for yields*. As can be seen from Eq. (1), yields are a dominant predictor of bond returns. As RFY measures relative yield within ratings or relative ratings within similar yields, the linear link between yields and bond returns are broken to the extent that RFY is associated with overpricing. High RFY bonds do not earn as high returns as predicted by their yields, because of potential overpricing.

5.2. RFY and Bond Returns: Baseline Regressions

In Table 4, we examine the extent to which future returns on individual bonds are negatively associated with RFY. In particular, we regress bond returns over up to the next 12 months on RFY within rating and maturity and also on RFM to further tease out which dimension of RFY is associated with overpricing. The dependent variables are cumulative bond returns for the next 3, 6 and 12 months, correcting for nonsynchronous trading by skipping one month. As the previous bond return equation shows in Eq. (1), we control for yields and also convexity times the variance of yield changes.[10] In addition to these two controls, we include zero trading days (ZTD), log bond amounts outstanding, log bond age, and cumulative probability of default to control for liquidity and credit risk.[11] We also include previous one-month returns and six-month returns, to control for return reversal and momentum, as well as bond betas with respect to the term and default factors to address systematic risk of bonds. Standard errors are double-clustered at both the bond and time levels.

Table 4 provides the estimation results. Panel A shows that RFY is negatively associated with future bond returns, indicating that high RFY bonds are overpriced. In Column 1, for example, the coefficient estimate on RFY^{WR} is -0.085 with a t-statistic of -2.00. We find that lower future returns are associated more with within-rating-maturity RFY, as shown by the coefficient coefficients on RFY^{WRM}, which is negative and statistically significant at the 5% level. For longer horizons in Columns 4 and 6, we find even stronger results with the coefficient estimates on RFY^{WRM} being -0.186 and -0.293, respectively, indicating that bond returns are 0.186% and 0.293% lower for the next six and twelve months for a one-percentage-point increase in RFY^{WRM}. Meanwhile, we do not find strong association of RFM with future bond price.

In Panel B and C, we report the estimation results for IG and HY bonds, respectively. We find largely consistent results with those in Panel A for all bonds. In particular, within-rating-maturity RFY predicts lower future returns, while RFM does not. Overall, the results in Panel 4 suggest that bonds that are associated with RFY are overpriced, particularly when such bonds have higher yields than bonds with the same rating and maturity.

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[10] More precisely, we estimate the variance of yield changes by using bond duration and standard deviation of bond returns R_t, i.e., $\sigma_t^2 = D_t Var(R_t)$.

[11] Specifically, we estimate default probability as $N(d_1)$ where $N(\cdot)$ is the normal probability function and $d_1 = \frac{ln(V/F)+(\mu-\sigma^2/2)*T}{\sigma\sqrt{T}}$ where V is asset value, F is book value of debt, μ is asset returns, σ is asset volatility and T is weighted average of time-to-maturity from the same issuer.

In Figure 2, we visually show the evidence of overpricing by plotting the coefficients on RFY over long-run horizons. The coefficient estimates become more negative until around 12 months and flatten out afterwards. This pattern in the coefficient estimates on RFY is consistent with temporary overpricing, which reverts in the long run as overpricing subsides.

5.3. Is Overpricing Stronger When Bond Market is Expensive or Funding Condition is Not Favorable?

Recent theoretical studies suggest that RFY should be stronger when interest rates are low (i.e., Feroli et al., 2014 and Acharya and Naqvi, 2016). Choi and Kronlund (2018) also show that stronger RFY in mutual funds during low interest rate periods. Funding conditions can also affect bond pricing, as unconstrained investors such as dealer banks and hedge funds can alleviate overpricing associated with RFY, similar to the idea in Frazzini and Pedersen (2014). Thus, we expect that in a low interest rate environment overpricing due to RFY should be stronger, whereas when a funding condition is favorable overpricing is weaker.

In Table 5, we examine the differential effects of RFY by using interactions with interest rate and funding condition variables in our regressions of individual bond returns. In particular, we interact RFY^{WR} with variables that represent interest rates in the fixed income market such as the 1-month T-bill rate (TB), term spread (TS), which is the difference between the 30- and 10-year Treasury yields, and default spread (DS), which is the Baa-Aaa corporate bond yield, following Choi and Kronlund (2018) who employ these variables to examine how RFY in mutual funds vary with interest rates. Also following Frazzini and Pedersen (2014) we also interact RFY^{WR} with the TED spread (3-Month LIBOR based on US dollars and 3-Month Treasury Bill) to proxy for the funding condition of unconstrained investors.

Table 5 provides the estimation results using these interaction variables. Consistent with our story, we find that bond returns are even lower when the interest rates are low and bond returns are higher when the funding condition is worse. Specifically, the coefficient estimates on TB, TS and DS interactions tend to be positive and statistically significant. In Column 1, for example, the coefficient estimates on the interactions with TB, TS and DS are positive and statistically significant at the conventional levels, indicating that bond returns over the next three months are particularly lower when interest rates are low. We find similar results for other time horizons of bond returns in Columns 2 and 3 and also for IG and HY bond subsamples in Columns 4-9, although we find weaker statistical significance for the interaction with TB, which might be because RFY in corporate bonds is motivated more by long-term yields (i.e., TS and DS) rather than by short-term interest rates. Also, we find that bond returns associated with RFY are higher when funding costs proxied by the TED spread is higher. Across all the bond return horizons and subsamples in Columns 1-9, the coefficient estimates on the interaction between RFY and TED are negative and statistically significant.

5.4. Is Overpricing Stronger When Constrained Investors Increase Bond Holdings?

We further examine the implications of RFY-driven overpricing by employing holdings information of major institutional investors in the corporate bond market. On the one hand, RFY will lead to greater overpricing in corporate bonds as constrained investors including insurance companies, pension funds, and mutual funds increase their position in corporate bonds, to the extent that investor demand of high RFY securities drives overpricing. On the other hand, the overpricing will alleviate as unconstrained investors increase their holdings, as these investors might trade against the constrained investors.

In Table 6, we examine the effect of holdings of institutional investors on future bond returns by including in our regressions the interactions of RFY with changes in corporate bond holdings of institutional investors. In particular, we measure bond positions of constrained investors (i.e., insurance companies, pension funds, and mutual funds) and unconstrained investors (dealers and hedge funds) using bond holdings data available in the Thomson Reuters eMaxx database.[12] In our regressions, we interact RFY with yearly changes in corporate bond holdings of these investors, $\Delta Constrained$ and $\Delta Unconstrained$.

The results in Table 6 show that the negative effect of RFY on future bond returns is stronger with an increase in institutional holdings of constrained investors. Specifically, for the full sample of bonds in Panel A, the coefficient estimates on $RFY^{WR} \cdot \Delta Constrained$ reported in Columns 1, 3, and 5 are all negative and statistically significant at the 5% level. The economic magnitude is also sizeable, as 10% increase in holdings of constrained investors lead to a decrease of -0.04 in the coefficient on RFY^{WR}, which translates into a 27% increase in the magnitude of the coefficient. Thus, as constrained investors increase holdings in corporate bonds, such bonds will have even lower returns in the future.

In Columns 2, 4, and 6 of Panel A, we decompose changes in holdings of constrained institutions into those of insurance companies, pension funds and mutual funds and interact them separately with RFY. In addition, we also examine the effect of unconstrained investor holdings on future returns by including the interaction of RFY with changes in holdings of unconstrained investors. The results show that the coefficient estimates of interactions of RFY^{WR} with changes in holdings of constrained investors are negative, in particular for insurance companies and

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[12] Specifically, insurance companies are eMaxx fund classes INS, LIN, PIN, and RIN. Pension funds are CPF, GPE, and UPE. Mutual funds are BAL, END, QUI, FOF, MUT, MMM, and INM. Unconstrained investors are BKG, BKM, BKP, SVG, BKT, BFM, BMS, CRU, and HGE.

pension funds. Also interestingly, we find the effect of RFY on bond returns tends to be weaker (i.e., more positive) when unconstrained investors increase holdings, as shown by the positive coefficient of 0.44 with a t-statistic of 2.28 in Column 6. These results suggest that constrained investors tend to drive overpricing, while unconstrained investors mitigate the overpricing effect by trading against constrained investors.

Panels B and C report the estimation results for the IG and HY subsamples, respectively. We find largely similar results to those reported in Panel A. In Column 6 of Panel B, we now find that the coefficient on interaction with changes in mutual fund holdings is negative and statistically significant at the 1% level, showing that mutual fund holdings are associated with overpricing in particular for IG-rated bonds. This result is consistent with those reported in Choi and Kronlund (2018) who show that RFY is stronger for IG mutual funds. In comparison, we find weaker results for HY-rated bonds in Panel C, indicating that overpricing effect due to institutional holdings is in general weaker for such bonds.

5.5. Reaching for Yield and Default

In Table 7, we analyze whether bonds with a high level of RFY (both within-rating RFY and within-rating-and-maturity RFY) also default more often than is predicted by their yields. We regress an indicator for default within the next three- or five-year horizons on the firm-level RFY, which is obtained by value-weighting bond-level RFY of the same issuers, after controlling for bond yield, each rating notch, maturity, and time fixed effects.

The results reported in Table 7 suggests that greater degrees of RFY predict higher default rates, even after controlling for bond yields. The coefficients on RFY are all positive with highly statistically significant t-statistics. In Column (4) of Panels A and B, for example, a one-percentage-point increase in within-rating RFY predicts a 1% (0.2%) higher default rate within the next three (five) years. We also find similar results for within-rating-and-maturity RFY, reported in Columns 2 and 5. These results indicate that the relative level of yields (within-rating RFY and within-rating-and-maturity RFY) matters for future default predictions over and above what the absolute level of bond yields signals regarding default risk.

The overall results in Table 7 are consistent with overpricing of high-RFY bonds. That is, bonds with relatively high yields with respect to their peer groups tend to be sought after by investors and be overpriced relative to their true default risk.

5.6. Does RFY Lead to Contemporaneous Price Increase? Micro-level Evidence

Our previous results show that future returns on bonds that are associated with greater degrees of RFY are negative particularly when interest rates are low. The flip side implication of this result is that we should observe positive responses of bond prices when interest rates fall, as RFY investors lift up risky bond prices. Hansen and Stein (2015), for example, provide evidence consistent with RFY in response to interest rate shocks by documenting disproportionately large changes in long-term interest rates on Federal Open Markets Committee announcements.

Likewise, we examine the responses of corporate bond yields to shocks in monetary policies during the recent quantitative easing 1 (QE1) and quantitative easing 2 (QE2) events. We employ a difference-in-differences regression approach to examine the announcement effects of the QEs on bond prices. Our treated group is composed of the bonds in the highest tercile of bonds sorted on RFY on the day before the QE announcements. The control group is a set of bonds matched to the bonds in the treatment group based on yield, zero trading days and time-to-maturity. We match 5 bonds to each treated bond. The timing of QE announcement is based on and Vising-Jorgensen (2011, 2013). For QE1, we choose four event dates: Nov. 25, 2008, Dec. 1, 2008, Dec. 16, 2008 and Mar. 18, 2009. For QE2, we choose two event dates: Aug. 10, 2010 and Sep. 21,

2010. In the difference-in-differences regressions, a treatment dummy takes the value of one for the treated group of bonds and zero otherwise and an event dummy is one for the date following the QE announcement and zero for the previous date before. Thus, we examine two-day changes of bond yields around the QE announcements.

In Table 8, we report the results from the regressions of bond yields in our treated and control group bonds on the interaction between the treatment and event dummy variables. We find that the coefficient estimates on the interaction are negative and tend to be highly statistically significant. In Column 3, for example, the coefficient estimate is -0.601, indicating that treated bond yields decrease by 0.60% on the date following the QE1 announcements. We find similar results in other announcement dates, although statistical significance is weaker in Columns 1 and 2. In Column 5 wherein we include all the announcement dates in one regression, the coefficient estimate is -0.482 with a t-statistic of 8.36. These results show that the effect of QE is negative on treated bonds following the announcement, indicating that RFY leads to lower contemporaneous yields.

6. Conclusion

Since the Great Recession, a growing body of literature documents RFY on the part of investors and its implications for financial markets (Becker and Ivashina, 2015; Di Maggio and Kacperczyk, 2017; Choi and Kronlund, 2018; Daniel, Garlappi, and Xiao 2018) In this paper, we contribute to the literature by showing the impact of RFY on asset prices. We show that bonds that are associated with stronger degrees of RFY, i.e., bonds with higher yields in a given rating category and higher rated bonds than otherwise similar yield bonds have lower returns after risk adjustment. We also show that in pooled regressions bonds with high RFY earn lower returns after controlling for yields and such effect of RFY is stronger when interest rates are low, funding conditions are unfavorable, leverage-constrained investors increase bond positions, and unconstrained investors decrease bond positions. We also show micro-level evidence through difference-in-differences regressions that upon the announcements of QEs high RFY bond prices increase more than otherwise similar bonds. Our overall results suggest that portfolio choices of institutional investors, which is driven by the RFY incentives, can distort asset prices, or overpricing in the bond market. To further examine the effect of RFY, in particular the real effect on the economy is fruitful potential future research.

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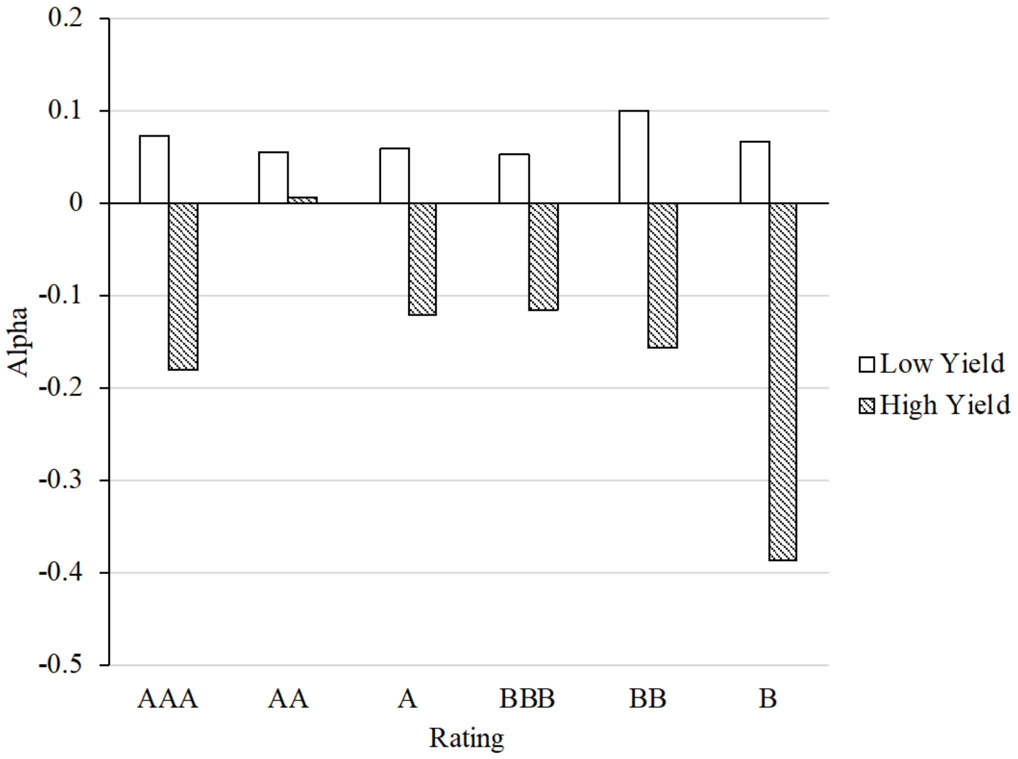
Figure 1. Alphas of portfolios sorted on yield and rating

This figure plots the alphas of high and low yield portfolios within each rating (Panel A) and the alphas of high and low rating portfolios within each yield bucket (Panel B). In Panel A, at the end of each month we sort bonds into yield tercile portfolios within each rating. We form value-weighted portfolios held for 12 months, skipping one month from portfolio formation. Monthly portfolio returns are measured by taking simple averages of returns on the portfolios formed durinng the past 12 months, similar to Jegadeesh and Titman (1993). We estimate alphas from the time-series regressions of the portfolio excess returns on factor excess returns, as described in Section 3.1. In Panel B, at the end of each calendar month, we first sort bonds into yield deciles and next sort them into high and low rating portfolios within each yield decile. We drop the top and bottom yield deciles, as yields are not properly controlled for in rating portfolios of these deciles (see Section 3.2). We estimate portfolio alphas as in Panel A, using value-weighted portfolios held for 12 months, skipping one month from portfolio formation. The sample period is from 2002 through 2014.

Panel A: Portfolios sorted on yields within each rating



Panel B: Portfolios sorted on rating within each yield bucket

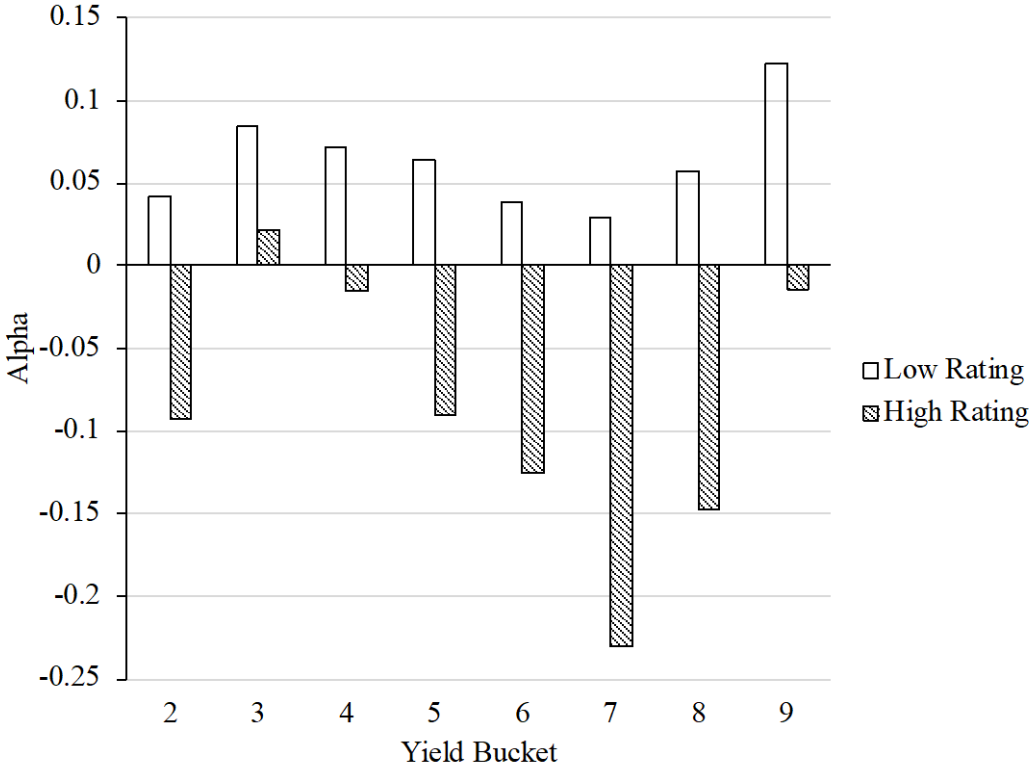


Figure 2. Long-run coefficients

This figure plots long-run coefficients estimated from the pooled regressions of future bond returns on within-rating RFY. The dependent variables are cumulative excess returns over horizons form 1 month to 24 months. The independent variable are within-rating RFY and other control variables as described in Section 4.2. Shaded areas indicate 95 percent confidence intervals. Standard errors are two-way clustered at the bond and month levels. The sample period is from 2002 through 2014.

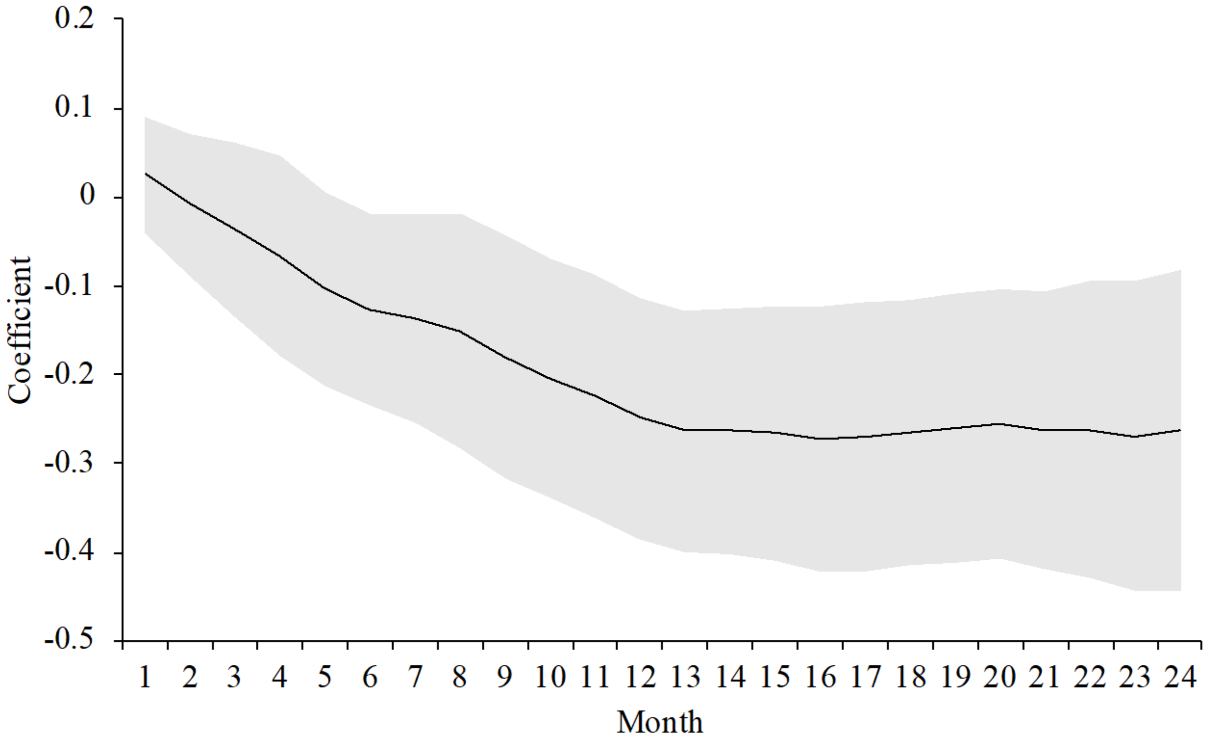


Table 1. Summary statistics

This table reports summary statistics for all bonds (Panel A), investment-grade bonds (Panel B), and high-yield bonds (Panel C) in our sample from July 2002 to December 2014. We report the number of observations (*N*), means, standard deviation (*Std.*), and 10th, 25th, 50th, 75th and 90th percentiles. *Yield (%)* is month-end bond yield. *$Return_{1M}$ (%)* is one-month excess bond return. *$Return_{6M}$ (%)* is six-month cumulative excess bond return. *$Return_{12M}$ (%)* is twelve-month cumulative excess bond return. RFY^{WR} and RFY^{WRM} are within-rating and within-rating-and-maturity RFY measures, respectively. *Rating* is a numerical translation of Standard & Poor's rating: 1=AAA and 25=D. *Amount Outstanding* is the dollar amount of bonds outstanding in millions of dollars. *TTM* is time-to-maturity of bonds in years. *Age* is the age of a bond in years since issuance. *Zero Trading Days* (ZTD) is the percentage of days on which a bond is not traded during a month. *Coupon* is coupon rate in percent. Amount outstanding is winsorized at the bottom and top 1%. Other variables are winsorized at the bottom and top 0.5%.

Panel A: All bonds

	N	Mean	Std.	P10	P25	P50	P75	P90
Yield (%)	318908	5.60	4.84	1.57	3.27	5.17	6.67	8.80
$Return_{1M}$ (%)	318908	0.44	3.23	-1.93	-0.46	0.31	1.36	3.02
$Return_{6M}$ (%)	282398	2.57	7.57	-2.53	0.01	1.62	4.74	9.20
$Return_{12M}$ (%)	265457	4.98	11.40	-2.30	0.62	3.12	8.22	15.37
RFY^{WR} (%)	318908	-0.05	3.26	-2.16	-1.20	-0.22	0.83	2.11
RFY^{WRM} (%)	318908	-0.03	3.04	-1.25	-0.54	-0.10	0.33	1.12
Rating	318908	9	3.96	4	6	8	11	15
		BBB		AA-	A	BBB+	BB+	B
Amount Outstanding ($MM)	318908	631	549.57	186	280	500	750	1250
TTM (years)	318908	7.69	7.25	1.76	2.92	5.17	8.12	21.31
Age (years)	318908	5.55	3.99	1.82	2.63	4.31	7.25	11.07
Zero Trading Days (ZTD)	318908	50.97	17.64	30.00	35.48	48.39	64.52	77.42
Coupon	318908	6.42	1.81	4.38	5.40	6.50	7.50	8.63

Table 1, *continued*

Panel B: Investment-grade bonds

	N	Mean	Std.	P10	P25	P50	P75	P90
Yield (%)	231661	4.24	2.53	1.27	2.55	4.48	5.58	6.53
Return_{1M} (%)	231661	0.39	2.54	-1.60	-0.42	0.25	1.17	2.56
Return_{6M} (%)	209066	2.24	5.65	-1.97	-0.01	1.27	4.00	7.88
Return_{12M} (%)	200225	4.39	8.56	-1.61	0.57	2.54	6.99	13.28
RFY^{WR} (%)	231661	-0.07	2.01	-1.92	-1.11	-0.21	0.81	2.03
RFY^{WRM} (%)	231661	-0.03	1.60	-0.85	-0.42	-0.08	0.26	0.82
Rating	231661	7	2.22	4	6	7	9	10
Amount Outstanding ($MM)	231661	688	582.58	200	300	500	900	1500
TTM (years)	231661	8.01	7.78	1.63	2.70	5.01	8.47	22.97
Age (years)	231661	5.70	4.02	1.87	2.73	4.53	7.48	11.16
Zero Trading Days (ZTD)	231661	50.74	17.88	30.00	35.48	46.67	64.52	77.42
Coupon	231661	5.88	1.61	3.95	5.10	6.00	6.88	7.75

Panel C: High-yield bonds

	N	Mean	Std.	P10	P25	P50	P75	P90
Yield (%)	87247	9.21	7.13	4.96	6.29	7.57	9.52	13.90
Return_{1M} (%)	87247	0.57	4.57	-3.14	-0.71	0.56	1.97	4.37
Return_{6M} (%)	73332	3.52	11.33	-6.29	0.16	3.05	6.90	13.74
Return_{12M} (%)	65232	6.81	17.30	-9.21	1.27	5.64	12.07	22.86
RFY^{WR} (%)	87247	0.01	5.30	-3.69	-1.54	-0.27	0.89	2.60
RFY^{WRM} (%)	87247	-0.04	5.19	-3.20	-1.18	-0.24	0.71	2.40
Rating	87247	14	2.35	11	12	14	16	17
Amount Outstanding ($MM)	87247	478	413.30	150	245	360	556	977
TTM (years)	87247	6.83	5.51	2.30	3.68	5.41	7.46	14.39
Age (years)	87247	5.15	3.88	1.72	2.41	3.87	6.50	10.80
Zero Trading Days (ZTD)	87247	51.58	16.96	32.14	36.67	48.39	64.52	76.67
Coupon	87247	7.86	1.50	6.25	6.88	7.63	8.75	10.00

Table 2. Performance of portfolios sorted on yield within each rating

This table reports alphas and excess returns of portfolios sorted on yield within each rating. At the end of each calendar month, we sort bonds into high (H) and low (L) value- and equal-weighted tercile portfolios within each sub-rating (e.g., A+, A, and A-). H-L is the difference between H portfolios and L portfolios. We take averages of the portfolios across sub-ratings to obtain H, L, and H-L portfolios for each rating and take averages across all sub-ratings to obtain all-bonds portfolios (the top row in each panel). Portfolios are held for K months (K=3, 6, and 12), skipping one month from portfolio formation and monthly returns are calculated similar to the procedure in Jegadeesh and Titman (1993). Alphas are estimated using factor excess returns, using Dimson's (1979) sum beta approach. Panels A1 and A2 report alpha and average excess return estimates of the value-weighted portfolios, respectively. Panels B1 and B2 report alpha and average excess return estimates of the equal-weighted portfolios, respectively. Standard errors are adjusted following Newey and West (1987) using three lags. *, ** and *** indicate significance at the 10%, 5% and 1% levels, respectively. The sample period is from 2002 to 2014.

Table 2, *continued*

Panel A1: Alphas (value weighted)

	K=3			K=6			K=12		
	L	H	H-L	L	H	H-L	L	H	H-L
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
All Bonds	0.079***	-0.187***	-0.266***	0.074***	-0.191***	-0.265***	0.064***	-0.205***	-0.269***
	(0.025)	(0.049)	(0.069)	(0.024)	(0.046)	(0.067)	(0.024)	(0.042)	(0.062)
AAA	0.075*	-0.224***	-0.299***	0.079**	-0.182**	-0.261***	0.073**	-0.179**	-0.252***
	(0.039)	(0.077)	(0.090)	(0.037)	(0.081)	(0.088)	(0.034)	(0.079)	(0.086)
AA	0.051	0.042	-0.009	0.055*	0.027	-0.027	0.056**	0.007	-0.048
	(0.032)	(0.051)	(0.055)	(0.028)	(0.051)	(0.054)	(0.026)	(0.056)	(0.057)
A	0.060**	-0.141*	-0.201**	0.057**	-0.147**	-0.205**	0.060**	-0.121*	-0.181**
	(0.029)	(0.077)	(0.101)	(0.029)	(0.073)	(0.095)	(0.027)	(0.067)	(0.087)
BBB	0.062*	-0.129	-0.191**	0.056*	-0.129	-0.186**	0.053*	-0.115	-0.168**
	(0.032)	(0.090)	(0.093)	(0.033)	(0.085)	(0.088)	(0.032)	(0.075)	(0.079)
BB	0.150**	-0.098	-0.247*	0.136**	-0.118	-0.254**	0.101*	-0.157**	-0.258***
	(0.063)	(0.108)	(0.129)	(0.061)	(0.083)	(0.112)	(0.059)	(0.072)	(0.096)
B	0.082	-0.283*	-0.365*	0.065	-0.318**	-0.383**	0.068	-0.385***	-0.453***
	(0.053)	(0.168)	(0.204)	(0.044)	(0.142)	(0.172)	(0.043)	(0.112)	(0.138)
Lower	0.061	-1.129***	-1.190***	0.068	-1.008**	-1.076**	0.002	-0.997**	-0.999**
	(0.076)	(0.398)	(0.434)	(0.074)	(0.402)	(0.453)	(0.078)	(0.385)	(0.446)

Panel A2: Average excess returns (value weighted)

	K=3			K=6			K=12		
	L	H	H-L	L	H	H-L	L	H	H-L
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
All Bonds	0.273***	0.557**	0.284*	0.263***	0.526**	0.263*	0.254***	0.476**	0.221
	(0.102)	(0.246)	(0.168)	(0.099)	(0.234)	(0.158)	(0.096)	(0.221)	(0.146)
AAA	0.123**	0.279	0.156	0.126***	0.319*	0.193	0.119***	0.318*	0.199
	(0.051)	(0.186)	(0.155)	(0.047)	(0.184)	(0.154)	(0.044)	(0.179)	(0.151)
AA	0.142***	0.462**	0.320**	0.134***	0.447**	0.313**	0.124***	0.429**	0.305**
	(0.050)	(0.182)	(0.147)	(0.045)	(0.181)	(0.149)	(0.040)	(0.180)	(0.153)
A	0.176**	0.524**	0.349*	0.173**	0.506**	0.333*	0.170***	0.502**	0.332*
	(0.069)	(0.241)	(0.192)	(0.069)	(0.235)	(0.186)	(0.065)	(0.224)	(0.178)
BBB	0.239***	0.604**	0.365*	0.236***	0.562**	0.326*	0.224***	0.547**	0.323*
	(0.086)	(0.252)	(0.185)	(0.084)	(0.237)	(0.172)	(0.082)	(0.227)	(0.163)
BB	0.353**	0.644*	0.291	0.335**	0.618**	0.284	0.317**	0.567**	0.250
	(0.152)	(0.327)	(0.229)	(0.145)	(0.307)	(0.216)	(0.144)	(0.284)	(0.194)
B	0.369**	0.697*	0.328	0.354**	0.625*	0.271	0.368**	0.483	0.115
	(0.179)	(0.388)	(0.286)	(0.176)	(0.367)	(0.257)	(0.172)	(0.350)	(0.230)
Lower	0.686**	0.404	-0.282	0.655**	0.353	-0.302	0.591**	0.183	-0.408
	(0.306)	(0.605)	(0.445)	(0.293)	(0.547)	(0.402)	(0.278)	(0.477)	(0.353)

Table 2, *continued*

Panel B1: Alphas (equal weighted)

	K=3			K=6			K=12		
	L	H	H-L	L	H	H-L	L	H	H-L
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
All Bonds	0.071***	-0.192***	-0.263***	0.064**	-0.199***	-0.263***	0.059***	-0.203***	-0.261***
	(0.026)	(0.047)	(0.070)	(0.025)	(0.046)	(0.068)	(0.021)	(0.044)	(0.061)
AAA	0.077**	-0.100	-0.177**	0.068**	-0.090	-0.158**	0.063*	-0.080	-0.143**
	(0.035)	(0.067)	(0.082)	(0.034)	(0.065)	(0.075)	(0.033)	(0.058)	(0.067)
AA	-0.003	-0.041	-0.038	-0.008	-0.067	-0.059	-0.010	-0.081	-0.070
	(0.055)	(0.049)	(0.084)	(0.046)	(0.049)	(0.077)	(0.040)	(0.052)	(0.072)
A	0.077**	-0.194**	-0.270***	0.073**	-0.177**	-0.251***	0.078***	-0.148**	-0.226***
	(0.031)	(0.075)	(0.098)	(0.029)	(0.069)	(0.091)	(0.027)	(0.063)	(0.082)
BBB	0.078**	-0.166***	-0.244***	0.072**	-0.173***	-0.245***	0.071**	-0.168***	-0.239***
	(0.037)	(0.060)	(0.067)	(0.036)	(0.063)	(0.069)	(0.034)	(0.061)	(0.068)
BB	0.118**	-0.169**	-0.287**	0.109**	-0.171**	-0.280**	0.096**	-0.184**	-0.280***
	(0.051)	(0.081)	(0.113)	(0.049)	(0.076)	(0.109)	(0.041)	(0.074)	(0.097)
B	0.077	-0.283**	-0.360**	0.061	-0.327***	-0.388***	0.056	-0.381***	-0.437***
	(0.053)	(0.124)	(0.166)	(0.048)	(0.110)	(0.148)	(0.038)	(0.096)	(0.120)
Lower	0.082	-0.610**	-0.692**	0.097	-0.542*	-0.639**	0.058	-0.483*	-0.541*
	(0.059)	(0.277)	(0.304)	(0.060)	(0.292)	(0.320)	(0.055)	(0.286)	(0.312)

Panel B2: Average excess returns (equal weighted)

	K=3			K=6			K=12		
	L	H	H-L	L	H	H-L	L	H	H-L
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
All Bonds	0.285***	0.602**	0.317*	0.282***	0.587**	0.305*	0.284***	0.564**	0.280*
	(0.107)	(0.246)	(0.168)	(0.108)	(0.243)	(0.163)	(0.106)	(0.237)	(0.154)
AAA	0.120**	0.326*	0.206	0.119**	0.341*	0.221	0.112**	0.342**	0.229*
	(0.051)	(0.179)	(0.147)	(0.048)	(0.177)	(0.146)	(0.045)	(0.167)	(0.138)
AA	0.134**	0.444**	0.310**	0.123**	0.427**	0.304**	0.117**	0.419**	0.302**
	(0.067)	(0.171)	(0.135)	(0.061)	(0.172)	(0.139)	(0.056)	(0.173)	(0.141)
A	0.178**	0.535**	0.357*	0.178**	0.533**	0.355*	0.180***	0.539**	0.359**
	(0.069)	(0.240)	(0.191)	(0.070)	(0.238)	(0.187)	(0.067)	(0.229)	(0.179)
BBB	0.252***	0.633**	0.380**	0.251***	0.606**	0.354**	0.243***	0.597**	0.355**
	(0.088)	(0.248)	(0.181)	(0.087)	(0.239)	(0.172)	(0.085)	(0.232)	(0.167)
BB	0.368**	0.696**	0.328	0.365**	0.689**	0.324	0.364**	0.667**	0.303
	(0.155)	(0.323)	(0.226)	(0.153)	(0.317)	(0.220)	(0.153)	(0.309)	(0.207)
B	0.402**	0.760*	0.358	0.402**	0.720*	0.318	0.437**	0.634	0.197
	(0.186)	(0.394)	(0.286)	(0.192)	(0.390)	(0.273)	(0.192)	(0.388)	(0.253)
Lower	0.717**	0.708	-0.009	0.711**	0.709	-0.001	0.689**	0.671	-0.018
	(0.291)	(0.592)	(0.428)	(0.288)	(0.574)	(0.414)	(0.282)	(0.543)	(0.388)

Table 3. Performance of portfolios sorted on rating within each yield decile

This table reports alphas and excess returns of portfolios sorted on rating within each yield decile. At the end of each calendar month, we sort bonds into high (H) and low (L) rating portfolios within each yield decile. H-L is the difference between H portfolios and L portfolios. The highest and lowest yield decile portfolios are dropped. We take averages of the portfolios across the eight yield deciles to obtain all-bonds portfolios (the top row in each panel). Portfolios are held for K months (K=3, 6, and 12), skipping one month from portfolio formation and monthly returns are calculated similar to the procedure in Jegadeesh and Titman (1993). Alphas are estimated using factor excess returns, using Dimson's (1979) sum beta approach. Panel A reports the summary statistics for each yield decile, including average of yield, standard deviation of yield, average of rating and number of bonds in each decile (# Bonds). Panels B1 and B2 report alpha and average excess return estimates of the value-weighted portfolios, respectively. Panels C1 and C2 report alpha and average excess return estimates of the equal-weighted portfolios, respectively. Standard errors are adjusted following Newey and West (1987) using three lags. *, ** and *** indicate significance at the 10%, 5% and 1% levels, respectively. The sample period is from 2002 to 2014.

Panel A: Summary Statistics

Yield Decile		L (1)	H (2)
1	Average of Yield	2.451	1.688
	Std. of Yield	0.688	1.850
	Average of Rating	7	3
	# Bonds	123	113
2	Average of Yield	3.072	3.052
	Std. of Yield	0.143	0.144
	Average of Rating	8	5
	# Bonds	120	117
3	Average of Yield	3.557	3.550
	Std. of Yield	0.144	0.143
	Average of Rating	8	5
	# Bonds	119	118
4	Average of Yield	4.078	4.060
	Std. of Yield	0.155	0.153
	Average of Rating	9	5
	# Bonds	113	124
5	Average of Yield	4.636	4.622
	Std. of Yield	0.170	0.169
	Average of Rating	10	6
	# Bonds	120	116
6	Average of Yield	5.284	5.273
	Std. of Yield	0.205	0.205
	Average of Rating	10	6
	# Bonds	120	117
7	Average of Yield	6.024	5.978
	Std. of Yield	0.212	0.207
	Average of Rating	11	7
	# Bonds	118	119
8	Average of Yield	6.860	6.782
	Std. of Yield	0.276	0.275
	Average of Rating	13	8
	# Bonds	118	119
9	Average of Yield	8.275	8.071
	Std. of Yield	0.558	0.538
	Average of Rating	15	10
	# Bonds	119	118
10	Average of Yield	16.228	11.766
	Std. of Yield	9.166	3.080
	Average of Rating	18	13
	# Bonds	121	115

Table 3, *Continued*

Panel B1: Alphas (value weighted)

	K=3			K=6			K=12		
	L (1)	H (2)	H-L (3)	L (4)	H (5)	H-L (6)	L (7)	H (8)	H-L (9)
All Bonds	0.040	-0.099***	-0.140**	0.048	-0.100***	-0.149***	0.042	-0.093***	-0.135**
	(0.033)	(0.031)	(0.053)	(0.032)	(0.030)	(0.051)	(0.031)	(0.030)	(0.052)
Yield Decile 2	0.085**	0.005	-0.080***	0.084***	0.017	-0.068**	0.084***	0.022	-0.062**
	(0.033)	(0.030)	(0.030)	(0.032)	(0.026)	(0.026)	(0.030)	(0.026)	(0.027)
Yield Decile 3	0.074**	-0.026	-0.100***	0.068**	-0.025	-0.092**	0.072**	-0.015	-0.087**
	(0.035)	(0.028)	(0.037)	(0.032)	(0.028)	(0.038)	(0.031)	(0.029)	(0.041)
Yield Decile 4	0.040	-0.120**	-0.160**	0.051	-0.101**	-0.151**	0.064*	-0.090**	-0.154**
	(0.042)	(0.050)	(0.064)	(0.038)	(0.043)	(0.064)	(0.036)	(0.041)	(0.062)
Yield Decile 5	0.004	-0.169***	-0.173***	0.033	-0.134***	-0.166***	0.038	-0.125***	-0.163**
	(0.048)	(0.049)	(0.063)	(0.041)	(0.044)	(0.062)	(0.038)	(0.045)	(0.066)
Yield Decile 6	0.043	-0.224***	-0.267***	0.056	-0.246***	-0.302***	0.029	-0.230***	-0.258***
	(0.055)	(0.065)	(0.077)	(0.052)	(0.062)	(0.074)	(0.045)	(0.057)	(0.068)
Yield Decile 7	0.095	-0.116	-0.211**	0.075	-0.156*	-0.232**	0.058	-0.148*	-0.206**
	(0.072)	(0.104)	(0.103)	(0.063)	(0.087)	(0.094)	(0.060)	(0.076)	(0.087)
Yield Decile 8	0.124**	-0.091	-0.214*	0.140**	-0.041	-0.181*	0.122**	-0.014	-0.136
	(0.060)	(0.105)	(0.126)	(0.059)	(0.092)	(0.106)	(0.052)	(0.094)	(0.106)
Yield Decile 9	-0.142*	-0.053	0.088	-0.119	-0.118	0.000	-0.132	-0.144	-0.012
	(0.079)	(0.112)	(0.130)	(0.080)	(0.094)	(0.122)	(0.082)	(0.097)	(0.132)

Table 3, *Continued*

Panel B2: Average excess returns (value weighted)

	K=3			K=6			K=12		
	L	H	H-L	L	H	H-L	L	H	H-L
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
All Bonds	0.366**	0.436**	0.069	0.364**	0.423**	0.060	0.352**	0.412**	0.060
	(0.151)	(0.186)	(0.093)	(0.147)	(0.182)	(0.092)	(0.142)	(0.177)	(0.089)
Yield Decile 2	0.212***	0.194**	-0.018	0.204***	0.203**	-0.002	0.195***	0.200**	0.005
	(0.077)	(0.092)	(0.045)	(0.073)	(0.090)	(0.042)	(0.068)	(0.087)	(0.043)
Yield Decile 3	0.263***	0.261**	-0.002	0.252***	0.260**	0.008	0.247***	0.258**	0.011
	(0.096)	(0.121)	(0.059)	(0.093)	(0.121)	(0.059)	(0.089)	(0.118)	(0.061)
Yield Decile 4	0.321**	0.302*	-0.020	0.315***	0.317**	0.002	0.311***	0.317**	0.006
	(0.125)	(0.159)	(0.083)	(0.118)	(0.160)	(0.087)	(0.113)	(0.156)	(0.086)
Yield Decile 5	0.366**	0.373*	0.007	0.381***	0.395**	0.014	0.373***	0.384**	0.011
	(0.150)	(0.196)	(0.085)	(0.143)	(0.192)	(0.086)	(0.138)	(0.185)	(0.090)
Yield Decile 6	0.379**	0.398*	0.018	0.402**	0.384*	-0.018	0.393**	0.397*	0.004
	(0.159)	(0.218)	(0.123)	(0.160)	(0.223)	(0.123)	(0.160)	(0.221)	(0.117)
Yield Decile 7	0.426**	0.598**	0.173	0.404**	0.549**	0.145	0.398**	0.539**	0.141
	(0.193)	(0.248)	(0.160)	(0.184)	(0.239)	(0.153)	(0.180)	(0.236)	(0.144)
Yield Decile 8	0.497**	0.658**	0.161	0.497**	0.650**	0.153	0.476**	0.620**	0.144
	(0.211)	(0.273)	(0.156)	(0.207)	(0.255)	(0.138)	(0.196)	(0.242)	(0.124)
Yield Decile 9	0.464	0.701**	0.237	0.453	0.629**	0.176	0.423	0.581**	0.158
	(0.302)	(0.299)	(0.148)	(0.290)	(0.287)	(0.140)	(0.276)	(0.277)	(0.135)

Table 3, *Continued*

Panel C1: Alphas (equal weighted)

	K=3			K=6			K=12		
	L (1)	H (2)	H-L (3)	L (4)	H (5)	H-L (6)	L (7)	H (8)	H-L (9)
All Bonds	0.022	-0.117***	-0.140***	0.029	-0.118***	-0.147***	0.029	-0.113***	-0.143***
	(0.025)	(0.027)	(0.046)	(0.024)	(0.025)	(0.045)	(0.023)	(0.026)	(0.044)
Yield Decile 2	0.093**	0.036	-0.057**	0.094**	0.041	-0.053**	0.097***	0.046*	-0.051**
	(0.039)	(0.027)	(0.026)	(0.037)	(0.025)	(0.023)	(0.034)	(0.025)	(0.024)
Yield Decile 3	0.078**	0.012	-0.067**	0.072**	0.002	-0.070**	0.082**	0.003	-0.079**
	(0.037)	(0.023)	(0.027)	(0.034)	(0.022)	(0.030)	(0.033)	(0.023)	(0.033)
Yield Decile 4	0.065*	-0.084**	-0.149***	0.067*	-0.078***	-0.144***	0.077**	-0.069**	-0.145***
	(0.038)	(0.033)	(0.046)	(0.037)	(0.029)	(0.047)	(0.035)	(0.030)	(0.046)
Yield Decile 5	0.030	-0.150***	-0.181***	0.046	-0.129***	-0.175***	0.047	-0.124***	-0.172***
	(0.038)	(0.035)	(0.051)	(0.037)	(0.034)	(0.052)	(0.034)	(0.037)	(0.054)
Yield Decile 6	0.029	-0.285***	-0.313***	0.035	-0.289***	-0.324***	0.028	-0.259***	-0.287***
	(0.047)	(0.055)	(0.076)	(0.043)	(0.054)	(0.073)	(0.035)	(0.054)	(0.070)
Yield Decile 7	0.016	-0.190**	-0.206**	0.014	-0.204***	-0.218***	0.022	-0.183***	-0.205***
	(0.057)	(0.079)	(0.090)	(0.053)	(0.068)	(0.083)	(0.047)	(0.062)	(0.076)
Yield Decile 8	0.036	-0.151*	-0.187*	0.062	-0.134**	-0.195**	0.050	-0.127**	-0.177**
	(0.048)	(0.077)	(0.096)	(0.043)	(0.067)	(0.080)	(0.038)	(0.063)	(0.076)
Yield Decile 9	-0.169***	-0.127	0.042	-0.154***	-0.154**	0.000	-0.169**	-0.193***	-0.025
	(0.059)	(0.080)	(0.088)	(0.055)	(0.074)	(0.091)	(0.068)	(0.072)	(0.095)

Table 3, *Continued*

Panel C2: Average excess returns (equal weighted)

	K=3			K=6			K=12		
	L	H	H-L	L	H	H-L	L	H	H-L
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
All Bonds	0.384**	0.441**	0.057	0.391**	0.436**	0.045	0.394***	0.433**	0.039
	(0.151)	(0.181)	(0.089)	(0.151)	(0.181)	(0.089)	(0.149)	(0.179)	(0.085)
Yield Decile 2	0.216***	0.200**	-0.016	0.212***	0.209**	-0.003	0.207***	0.208**	0.001
	(0.077)	(0.090)	(0.040)	(0.075)	(0.089)	(0.037)	(0.069)	(0.086)	(0.037)
Yield Decile 3	0.272***	0.273**	0.000	0.264***	0.268**	0.003	0.264***	0.268**	0.004
	(0.094)	(0.119)	(0.054)	(0.093)	(0.120)	(0.052)	(0.090)	(0.119)	(0.054)
Yield Decile 4	0.332***	0.315**	-0.017	0.333***	0.329**	-0.004	0.331***	0.331**	-0.001
	(0.123)	(0.159)	(0.074)	(0.119)	(0.160)	(0.079)	(0.114)	(0.157)	(0.080)
Yield Decile 5	0.371**	0.371*	-0.000	0.391***	0.397**	0.006	0.394***	0.398**	0.004
	(0.145)	(0.194)	(0.083)	(0.143)	(0.193)	(0.085)	(0.141)	(0.188)	(0.087)
Yield Decile 6	0.398**	0.397*	-0.001	0.421**	0.390*	-0.031	0.423**	0.412*	-0.011
	(0.160)	(0.221)	(0.125)	(0.163)	(0.227)	(0.125)	(0.163)	(0.228)	(0.123)
Yield Decile 7	0.443**	0.600**	0.158	0.444**	0.574**	0.130	0.460**	0.579**	0.119
	(0.193)	(0.240)	(0.152)	(0.193)	(0.238)	(0.149)	(0.190)	(0.236)	(0.139)
Yield Decile 8	0.509**	0.667***	0.158	0.526**	0.649***	0.123	0.526**	0.628***	0.101
	(0.213)	(0.253)	(0.135)	(0.218)	(0.245)	(0.124)	(0.215)	(0.239)	(0.111)
Yield Decile 9	0.535*	0.708**	0.174	0.535*	0.669**	0.135	0.546*	0.638**	0.092
	(0.299)	(0.285)	(0.137)	(0.296)	(0.278)	(0.137)	(0.293)	(0.281)	(0.122)

Table 4. RFY and future bond returns: Pooled regressions

This table reports the results from the pooled regressions of future bond returns on RFY and other bond characteristics. The observations are at the bond-month level. The dependent variables are cumulative excess returns for the next 3, 6 and 12 months, skipping one month. The independent variables are within-rating RFY (RFY^{WR}), within-rating-and-maturity RFY (RFY^{WRM}), and reaching for maturity (RFM). We control for yield, zero trading days (*ZTD*), the log of amounts outstanding, the log of age, time to maturity (*TTM*), the cumulative probability of default (*N(DTD)*), the previous bond excess returns ($Return_{t-1}$), the cumulative excess returns in the past 6 months ($Return_{t-6}$), TERM beta ($Beta^{TERM}$) and DEF beta ($Beta^{DEF}$) obtained from the regressions of bond returns on the term and default factor, and the interaction between convexity, the square of duration, and the square of volatility ($C \cdot D^2\sigma^2$). We include time fixed effects in all regressions. Panel A reports the regression results for all bonds. Panel B and panel C report the regression results for IG and HY bonds, respectively. Standard errors are two-way clustered at both the bond and month levels. *, ** and *** indicate significance at the 10%, 5% and 1% levels, respectively. The sample period is from 2002 through 2014.

Table 4, *Continued*

Panel A: All Bonds

Dependent Variable:	3 Month Return		6 Month Return		12 Month Return	
	(1)	(2)	(3)	(4)	(5)	(6)
RFY^{WR}	-0.085**		-0.173***		-0.268***	
	(-2.00)		(-3.21)		(-3.39)	
RFY^{WRM}		-0.091**		-0.186***		-0.293***
		(-2.14)		(-3.52)		(-3.98)
RFM		-0.011		-0.027		-0.028
		(-0.16)		(-0.24)		(-0.14)
Yield	0.236***	0.234***	0.537***	0.533***	1.074***	1.068***
	(4.79)	(4.67)	(7.54)	(7.29)	(12.00)	(11.57)
ZTD	0.006**	0.006**	0.013***	0.013***	0.026***	0.027***
	(2.40)	(2.43)	(3.48)	(3.53)	(4.46)	(4.53)
Amt_out (log)	0.023	0.027	0.120*	0.129*	0.277***	0.291***
	(0.48)	(0.57)	(1.71)	(1.85)	(2.64)	(2.78)
Age (log)	0.021	0.019	0.079	0.075	0.284**	0.278**
	(0.44)	(0.41)	(1.16)	(1.11)	(2.55)	(2.52)
TTM	0.025*	0.018	0.033	0.018	0.039	0.015
	(1.71)	(1.22)	(1.52)	(0.82)	(1.10)	(0.37)
N(DTD)	0.157	0.157	0.667**	0.667**	1.461***	1.458***
	(0.86)	(0.85)	(2.33)	(2.32)	(3.58)	(3.57)
$\text{Return}_{\text{t-1}}$	0.040	0.039	0.038	0.037	0.049	0.048
	(0.92)	(0.90)	(0.60)	(0.58)	(0.66)	(0.63)
$\text{Return}_{\text{t-6}}$	0.003	0.002	-0.001	-0.004	-0.030	-0.034
	(0.15)	(0.09)	(-0.04)	(-0.11)	(-0.66)	(-0.76)
$\text{Beta}^{\text{TERM}}$	0.301	0.268	0.654**	0.586*	1.410***	1.292***
	(1.33)	(1.20)	(2.09)	(1.90)	(3.27)	(3.04)
Beta^{DEF}	-0.039	-0.044	-0.110	-0.120	-0.089	-0.108
	(-0.66)	(-0.75)	(-1.30)	(-1.43)	(-0.74)	(-0.89)
$C \cdot D^2\sigma^2$	0.000	0.000	0.000	0.000	0.000***	0.000***
	(0.44)	(0.54)	(1.41)	(1.53)	(3.07)	(3.19)
Month FEs	Y	Y	Y	Y	Y	Y
N	292160	292160	285888	285888	268528	268528
Adj. R^2	0.313	0.313	0.393	0.394	0.478	0.478

Table 4, *Continued*

Panel B: IG Bonds

Dependent Variable:	3 Month Return		6 Month Return		12 Month Return	
	(1)	(2)	(3)	(4)	(5)	(6)
RFY^{WR}	-0.145*		-0.296***		-0.384**	
	(-1.94)		(-2.64)		(-2.28)	
RFY^{WRM}		-0.231***		-0.479***		-0.725***
		(-3.03)		(-5.12)		(-6.25)
RFM		0.065		0.166		0.460*
		(0.62)		(1.02)		(1.82)
Yield	0.446***	0.484***	0.855***	0.935***	1.551***	1.687***
	(6.30)	(7.24)	(7.42)	(9.15)	(9.71)	(12.33)
ZTD	0.001	0.001	0.004	0.004	0.009***	0.009**
	(0.87)	(0.85)	(1.47)	(1.43)	(2.70)	(2.57)
Amt_out (log)	0.012	0.031	0.016	0.056	0.049	0.116
	(0.35)	(0.92)	(0.30)	(1.07)	(0.61)	(1.57)
Age (log)	-0.015	-0.015	-0.040	-0.043	-0.104	-0.109
	(-0.44)	(-0.46)	(-0.89)	(-0.98)	(-1.38)	(-1.52)
TTM	0.005	-0.023	0.003	-0.058***	-0.007	-0.117***
	(0.36)	(-1.43)	(0.14)	(-2.62)	(-0.20)	(-2.82)
N(DTD)	-0.238**	-0.263***	-0.358**	-0.412***	-0.148	-0.250
	(-2.58)	(-2.82)	(-2.61)	(-3.03)	(-0.69)	(-1.17)
$Return_{t-1}$	-0.002	-0.002	0.011	0.010	0.049	0.046
	(-0.05)	(-0.07)	(0.24)	(0.22)	(0.90)	(0.85)
$Return_{t-6}$	-0.005	-0.013	-0.030	-0.048	-0.113**	-0.146***
	(-0.21)	(-0.60)	(-0.95)	(-1.55)	(-2.60)	(-3.48)
$Beta^{TERM}$	0.095	-0.045	0.259	-0.049	0.595*	0.016
	(0.46)	(-0.23)	(0.92)	(-0.19)	(1.71)	(0.05)
$Beta^{DEF}$	-0.028	-0.062	0.003	-0.071	0.110	-0.017
	(-0.45)	(-1.02)	(0.04)	(-0.86)	(1.02)	(-0.15)
$C\ D^2\sigma^2$	0.000	0.000	0.000**	0.000**	0.000***	0.000***
	(1.04)	(1.45)	(2.00)	(2.61)	(3.35)	(4.13)
Month FEs	Y	Y	Y	Y	Y	Y
N	213958	213958	211431	211431	202304	202304
Adj. R^2	0.411	0.413	0.480	0.486	0.567	0.575

Table 4, *Continued*

Panel C: HY Bonds

Dependent Variable:	3 Month Return		6 Month Return		12 Month Return	
	(1)	(2)	(3)	(4)	(5)	(6)
RFY^{WR}	-0.071*		-0.164***		-0.355***	
	(-1.70)		(-2.79)		(-4.47)	
RFY^{WRM}		-0.072*		-0.164***		-0.345***
		(-1.74)		(-2.83)		(-4.44)
RFM		-0.060		-0.162		-0.475**
		(-0.83)		(-1.40)		(-2.27)
Yield	0.201***	0.200***	0.542***	0.541***	1.200***	1.201***
	(2.68)	(2.67)	(4.90)	(4.88)	(9.15)	(9.14)
ZTD	0.017***	0.017***	0.035***	0.035***	0.071***	0.070***
	(4.18)	(4.20)	(4.62)	(4.64)	(5.15)	(5.16)
Amt_out (log)	-0.082	-0.082	0.083	0.084	0.177	0.175
	(-0.79)	(-0.79)	(0.50)	(0.50)	(0.58)	(0.57)
Age (log)	-0.025	-0.027	0.189	0.188	0.869***	0.889***
	(-0.25)	(-0.27)	(1.16)	(1.16)	(3.02)	(3.11)
TTM	0.015	0.015	0.039	0.039	0.031	0.035
	(0.80)	(0.77)	(1.16)	(1.12)	(0.53)	(0.57)
N(DTD)	0.174	0.173	1.147**	1.147**	2.648***	2.652***
	(0.50)	(0.50)	(2.18)	(2.18)	(3.56)	(3.57)
$Return_{t-1}$	0.075	0.075	0.079	0.079	0.072	0.074
	(1.61)	(1.61)	(1.20)	(1.20)	(0.88)	(0.91)
$Return_{t-6}$	-0.001	-0.001	-0.003	-0.003	-0.038	-0.037
	(-0.05)	(-0.05)	(-0.08)	(-0.08)	(-1.02)	(-1.01)
$Beta^{TERM}$	0.326	0.326	0.532	0.532	1.524**	1.538**
	(1.10)	(1.10)	(1.17)	(1.17)	(2.40)	(2.43)
$Beta^{DEF}$	-0.011	-0.011	-0.151	-0.151	-0.055	-0.054
	(-0.14)	(-0.14)	(-1.21)	(-1.21)	(-0.32)	(-0.32)
$C\ D^2\sigma^2$	0.000**	0.000**	0.000**	0.000**	0.000***	0.000***
	(2.47)	(2.46)	(2.37)	(2.35)	(3.62)	(3.53)
Month FEs	Y	Y	Y	Y	Y	Y
N	78202	78202	74457	74457	66224	66224
Adj. R^2	0.378	0.378	0.467	0.467	0.537	0.537

Table 5. Regressions of bond returns on RFY, interest rates, and funding costs

This table reports the results from the pooled regressions of future bond returns on RFY and its interaction with interest rate and funding cost measures. The observations are at the bond-month level. The dependent variables are cumulative excess returns for the next 3, 6 and 12 months, skipping one month. The independent variables are within-rating RFY (RFY^{WR}), within-rating-and-maturity RFY (RFY^{WRM}), and reaching for maturity (RFM). We also include interactions with TB (one-month Treasury rate), TS (10-year Treasury yield minus 1-year Treasury yield), DS (Baa corporate bond yield minus Aaa corporate bond yield), and TED (3-Month LIBOR based on US dollars and 3-Month Treasury Bill). We control for yield, zero trading days (*ZTD*), the log of amounts outstanding, the log of age, time to maturity (*TTM*), the cumulative probability of default (*N(DTD)*), the previous bond excess returns ($Return_{t-1}$), the cumulative excess returns in the past 6 months ($Return_{t-6}$), TERM beta ($Beta^{TERM}$) and DEF beta ($Beta^{DEF}$) obtained from the regressions of bond returns on the term and default factor, and the interaction between convexity, the square of duration, and the square of volatility ($C \cdot D^2\sigma^2$). We include time fixed effects in all regressions. Columns 1 through 3 report the regression results for all bonds. Columns 4 through 6 and 7 through 9 report the regression results for IG and HY bonds, respectively. Standard errors are two-way clustered at both the bond and month levels. *, ** and *** indicate significance at the 10%, 5% and 1% levels, respectively. The sample period is from 2002 through 2014.

	All Bonds			IG Bonds			HY Bonds		
	3M	6M	12M	3M	6M	12M	3M	6M	12M
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
RFY^{WR}	-0.444***	-0.799***	-1.383***	-0.709**	-1.192***	-1.874***	-0.427***	-0.869***	-1.460***
	(-3.06)	(-3.64)	(-3.15)	(-2.47)	(-3.18)	(-3.43)	(-2.68)	(-3.17)	(-2.68)
RFY^{WR}*TB	0.050*	0.030	0.012	0.026	-0.012	-0.079	0.085**	0.099*	0.110
	(1.67)	(0.64)	(0.12)	(0.45)	(-0.16)	(-0.69)	(2.59)	(1.67)	(0.85)
RFY^{WR}*TS	0.094*	0.126*	0.280**	0.274***	0.438***	0.724***	0.032	0.008	0.015
	(1.94)	(1.79)	(2.12)	(3.05)	(3.79)	(4.50)	(0.58)	(0.09)	(0.09)
RFY^{WR}*DS	0.172***	0.321***	0.368***	0.046	0.108*	0.130	0.301***	0.553***	0.676***
	(2.89)	(6.50)	(4.83)	(0.64)	(1.77)	(1.16)	(6.45)	(8.99)	(6.42)
RFY^{WR}*TED	-0.219**	-0.279***	-0.195**	-0.153*	-0.267***	-0.342***	-0.390***	-0.453***	-0.278*
	(-2.11)	(-4.17)	(-2.19)	(-1.76)	(-5.90)	(-4.04)	(-5.72)	(-5.04)	(-1.72)
Bond Controls	Y	Y	Y	Y	Y	Y	Y	Y	Y
Time FEs	Y	Y	Y	Y	Y	Y	Y	Y	Y
N	292160	285888	268528	213958	211431	202304	78202	74457	66224
Adj. R^2	0.321	0.404	0.487	0.427	0.510	0.599	0.395	0.486	0.550

Table 6. RFY and institutional holdings change

This table reports the results from the pooled regressions of future bond returns on RFY and its interaction with changes in institutional holdings. The observations are at the bond-month level. The dependent variables are cumulative excess returns for the next 3, 6 and 12 months, skipping one month. The independent variables are within-rating RFY (RFY^{WR}), within-rating-and-maturity RFY (RFY^{WRM}), and reaching for maturity (RFM). ΔConstrained (%) is a yearly change in constrained institutional holdings, including insurance companies, pension funds and mutual funds. ΔInsurance (%) is a yearly change in holdings for insurance companies. ΔPF (%) is a yearly change in holdings for pension funds. ΔMF (%) is in a yearly change in holdings for mutual funds. ΔUnconstrained (%) is a yearly change in unconstrained institutional holdings, including banks, brokers, hedge funds and credits. We control for yield, zero trading days (*ZTD*), the log of amounts outstanding, the log of age, time to maturity (*TTM*), the cumulative probability of default (*N(DTD)*), the previous bond excess returns ($Return_{t-1}$), the cumulative excess returns in the past 6 months ($Return_{t-6}$), TERM beta ($Beta^{TERM}$) and DEF beta ($Beta^{DEF}$) obtained from the regressions of bond returns on the term and default factor, and the interaction between convexity, the square of duration, and the square of volatility ($C \cdot D^2\sigma^2$). We include time fixed effects in all regressions. Panel A reports the regression results for all bonds. Panel B and panel C report the regression results for IG and HY bonds, respectively. Standard errors are two-way clustered at both the bond and month levels. *, ** and *** indicate significance at the 10%, 5% and 1% levels, respectively. The sample period is from 2002 through 2014.

Table 6, *continued*

Panel A: All Bonds

Dependent Variable:	$Return_{3M}$		$Return_{6M}$		$Return_{12M}$	
	(1)	(2)	(3)	(4)	(5)	(6)
RFY^{WR}	-0.146***	-0.148***	-0.267***	-0.261***	-0.371***	-0.350***
	(-2.85)	(-2.94)	(-3.80)	(-3.89)	(-4.01)	(-3.90)
ΔConstrained (%)	-0.005**		-0.006		0.001	
	(-2.15)		(-1.64)		(0.38)	
RFY^{WR}*ΔConstrained (%)	-0.004**		-0.007***		-0.008***	
	(-2.23)		(-3.20)		(-3.10)	
ΔInsurance (%)		-0.006**		-0.006		0.003
		(-2.06)		(-1.33)		(0.62)
RFY^{WR}*ΔInsurance (%)		-0.007***		-0.011***		-0.015***
		(-2.95)		(-3.95)		(-4.03)
ΔPF (%)		0.009		0.010		-0.010
		(1.13)		(0.94)		(-0.88)
RFY^{WR}*ΔPF (%)		-0.024***		-0.035***		-0.030**
		(-3.54)		(-3.22)		(-2.11)
ΔMF (%)		-0.001		-0.001		0.006
		(-0.19)		(-0.14)		(0.71)
RFY^{WR}*ΔMF (%)		0.001		0.001		0.003
		(0.44)		(0.53)		(0.90)
ΔUnconstrained (%)		-0.015		-0.204		-0.438
		(-0.13)		(-1.05)		(-1.65)
RFY^{WR}*ΔUnconstrained (%)		0.126		0.238		0.440**
		(0.99)		(1.07)		(2.28)
Bond Controls	Y	Y	Y	Y	Y	Y
Time FEs	Y	Y	Y	Y	Y	Y
N	206482	206482	201826	201826	190961	190961
Adj. R^2	0.327	0.330	0.409	0.412	0.502	0.504

Table 6, *Continued*

Panel B: IG Bonds

Dependent Variable:	Return_{3M}		Return_{6M}		Return_{12M}	
	(1)	(2)	(3)	(4)	(5)	(6)
RFY^{WR}	-0.211**	-0.211**	-0.335**	-0.340**	-0.437**	-0.442**
	(-2.30)	(-2.28)	(-2.46)	(-2.57)	(-2.06)	(-2.18)
ΔConstrained (%)	-0.003**		-0.003*		-0.002	
	(-2.55)		(-1.87)		(-1.31)	
RFY^{WR}*ΔConstrained (%)	-0.005***		-0.006***		-0.008**	
	(-3.13)		(-2.90)		(-2.55)	
ΔInsurance (%)		-0.003**		-0.003		-0.001
		(-2.33)		(-1.24)		(-0.25)
RFY^{WR}*ΔInsurance (%)		-0.005***		-0.006**		-0.006*
		(-2.89)		(-2.24)		(-1.88)
ΔPF (%)		-0.005		-0.010		-0.020**
		(-0.66)		(-1.08)		(-2.04)
RFY^{WR}*ΔPF (%)		-0.013*		-0.016**		-0.011
		(-1.86)		(-2.10)		(-0.97)
ΔMF (%)		-0.002		-0.006		-0.013**
		(-0.72)		(-1.52)		(-2.35)
RFY^{WR}*ΔMF (%)		-0.004		-0.011*		-0.022***
		(-1.10)		(-1.91)		(-2.67)
ΔUnconstrained (%)		0.181*		0.127		0.202
		(1.87)		(0.84)		(0.86)
RFY^{WR}*ΔUnconstrained (%)		0.339***		0.489***		0.984***
		(2.75)		(2.79)		(3.20)
Bond Controls	Y	Y	Y	Y	Y	Y
Time FEs	Y	Y	Y	Y	Y	Y
N	151206	151206	149431	149431	143983	143983
Adj. R^2	0.442	0.443	0.515	0.515	0.596	0.597

Table 6, *Continued*

Panel C: HY Bonds

Dependent Variable:	$Return_{3M}$		$Return_{6M}$		$Return_{12M}$	
	(1)	(2)	(3)	(4)	(5)	(6)
RFY^{WR}	-0.126*	-0.141**	-0.275***	-0.307***	-0.491***	-0.525***
	(-1.94)	(-2.07)	(-3.13)	(-3.34)	(-4.64)	(-4.86)
ΔConstrained (%)	-0.003		-0.010		-0.016*	
	(-0.80)		(-1.55)		(-1.83)	
RFY^{WR}*ΔConstrained (%)	-0.002		-0.006**		-0.008**	
	(-0.91)		(-2.01)		(-2.15)	
ΔInsurance (%)		-0.008		-0.021*		-0.020
		(-1.16)		(-1.93)		(-1.25)
RFY^{WR}*ΔInsurance (%)		-0.002		-0.011**		-0.015**
		(-0.36)		(-2.32)		(-2.08)
ΔPF (%)		0.044		0.019		-0.133**
		(1.59)		(0.48)		(-2.33)
RFY^{WR}*ΔPF (%)		-0.041***		-0.066**		-0.065*
		(-2.78)		(-2.24)		(-1.72)
ΔMF (%)		-0.002		-0.003		-0.006
		(-0.48)		(-0.40)		(-0.64)
RFY^{WR}*ΔMF (%)		-0.001		-0.001		-0.004
		(-0.37)		(-0.51)		(-1.06)
ΔUnconstrained (%)		0.115		0.191		-0.496
		(0.62)		(0.60)		(-1.17)
RFY^{WR}*ΔUnconstrained (%)		-0.086		-0.020		0.233
		(-0.56)		(-0.09)		(1.29)
Bond Controls	Y	Y	Y	Y	Y	Y
Time FEs	Y	Y	Y	Y	Y	Y
N	55276	55276	52395	52395	46978	46978
Adj. R^2	0.395	0.397	0.489	0.492	0.568	0.570

Table 7. Default and RFY

This table reports results of the panel regressions of indicators for default on yields, within-rating RFY, as well as within-rating-and-maturity RFY. The observations are at the firm-month level. The dependent variables are default indicators. Panel A reports results for predicting default within 3 years and panel B for default within 5 years. Standard errors are two-way clustered at the firm and time levels. *, ** and *** indicate significance at the 10%, 5% and 1% levels, respectively. The sample period is from 2002 through 2014.

Panel A: Predicting default within three years

Dependent variable: Default (within three years)					
	(1)	(2)	(3)	(4)	(5)
RFY^{WR}	0.010***			0.010***	
	(7.13)			(4.39)	
RFY^{WRM}		0.010***			0.009***
		(7.27)			(5.15)
Yield			0.008***	-0.000	0.001
			(6.54)	(-0.09)	(0.84)
Time FEs	Y	Y	Y	Y	Y
Maturity Fes	Y	Y	Y	Y	Y
Rating Fes	Y	Y	Y	Y	Y
N	128061	128061	128061	128061	128061
Adj. R^2	0.351	0.352	0.343	0.351	0.352

Panel B: Predicting default within five years

Dependent variable: Default (within five years)					
	(1)	(2)	(3)	(4)	(5)
RFY^{WR}	0.001***			0.002***	
	(2.64)			(3.33)	
RFY^{WRM}		0.002***			0.003***
		(3.28)			(3.85)
Yield			0.001*	-0.001*	-0.002**
			(1.67)	(-1.93)	(-2.55)
Time FEs	Y	Y	Y	Y	Y
Maturity Fes	Y	Y	Y	Y	Y
Rating Fes	Y	Y	Y	Y	Y
N	128061	128061	128061	128061	128061
Adj. R^2	0.170	0.171	0.169	0.170	0.172

Table 8. Difference-in-differences regressions of bond yields on the QE Announcements

This table reports the results from difference-in-differences regressions. The dependent variable is bond yield. Bonds are sorted into terciles according to RFY^{WR} on the previous day of each QE event date. The treated group is composed of the bonds in the highest tercile. The control group is a set of bonds matched to the bonds in the treatment group based on yield, zero trading days and time-to-maturity. We allow up to 5 matches for each treated bond. $Treat_i$ is an indicator variable for a treated bond. $Event_{i,t}$ is an event dummy variable, which is one if day t is the next day of the event. We include both bond fixed effects and day fixed effects in all regressions. Standard errors are clustered at the bond level. *, ** and *** indicate significance at the 10%, 5% and 1% levels, respectively.

	Nov. 25, 2008 (1)	Dec. 1, 2008 (2)	Dec. 16, 2008 (3)	Mar. 18, 2009 (4)	ALL (5)
$Treat_i$*$Event_{i,t}$	-0.335*	-0.086	-0.601***	-0.559***	-0.482***
	(-1.87)	(-0.70)	(-6.15)	(-8.44)	(-8.36)
Bond FEs	Y	Y	Y	Y	Y
Day FEs	Y	Y	Y	Y	Y
N	1038	666	1518	1384	4606
Adj. R^2	0.973	0.989	0.990	0.993	0.987