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ABSTRACT

We study the role played by "bond book-to-market" ratios in U.S. corporate bond pricing. Controlling for numerous risk factors tied to default and priced asset risk, including yield-to-maturity, we find that the ratio of a corporate bond's book value to its market price strongly predicts the bond's future return. The quintile of bonds with the highest book-to-market ratios outperforms the quintile with the lowest ratios by more than 3% per year, other things equal. Additional evidence on signal delay, scope of signal efficacy, and factor risk rejects the thesis that the corporate bond market is perfectly informationally efficient, although significant positive alpha spreads are erased by transaction costs.

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1 Introduction

One of modern finance's greatest puzzles is why the book-to-market ratio of a firm's equity plays such a central role in the cross-section of equity returns. One view is that the book-to-market ratio, a scaling of a firm's share price, proxies for priced risk. For example, Berk (1995) points out that high risk firms discount future cash flows at higher rates, implying that high risk firms should have both low market prices and high book-to-market ratios other things equal. Thus, whenever alpha measurement imperfectly controls for risk, book-to-market will proxy for omitted risk factors and spuriously generate alpha.

An alternative and equally plausible explanation is that high book-to-market ratios reflect underpriced shares and vice versa. This interpretation of book-to-market as a mispricing metric views book equity a crude measure of equity fair value. Here, high book-to-market firms' high equity returns express rates that translate excessively low prices into future payoffs. A similar perspective, with time's arrow in reverse, is that share prices require irrationally high discount rates to undervalue the firm's future payoffs. If investor mistakes rather than omitted risk factors account for the relation between book-to-market and returns, alpha's correlation with book-to-market warrants active management that profits from the valuation errors of market participants.

To better understand book-to-market's role in asset pricing, we focus on another asset class: corporate bonds. As an asset class, corporate bonds rival stocks in importance, yet little is known about their cross-section of returns. Book-to-market's importance in equity pricing makes the ratio a natural starting point for studying the drivers of corporate bond returns and the informational efficiency of the corporate bond market.

The corporate bond market possesses unique attributes that may aid understanding of why the book-to-market ratio influences asset returns, like equities. Unlike equities, bond maturities tend to be finite, and bond cash flow streams are not only contractual, but also of shorter duration than equity streams. These factors make the magnitude and timing of bonds' future cash flows more transparent than those of equities. Indeed, the future cash flows of many bonds are known with relative certainty, as it is only the more extreme and relatively infrequent outcomes for the economy or a company's prospects that affect the likelihood of the bonds' promised payments being made.

Given that the future cash flows of corporate bonds, particularly senior bonds, are far less risky than their equity counterparts, bond price movements have to arise largely from discount rate variation rather than from changes in projections of future cash flows. Thus, our key finding—that a book-to-market signal for bonds generates risk-adjusted bond alphas that are almost as large as the alphas book-to-market generates in equity markets—favors mispricing over risk mismeasurement as the better explanation of the book-to-market phenomenon. Even with bonds for which asset risk plays a larger role, the bond researcher has control variables like yield-to-maturity ("YTM") and default risk estimates that are far superior to the risk controls available for equity analysis. Such superior risk controls buttress mispricing as the better explanation of our findings.

We define the "bond book-to-market ratio" ("BBM") as the bond's book (or carrying) value per unit of face amount divided by the bond's market price per unit of face amount. At the time a bond is issued, and in the vast majority of cases, coupons are set so that the BBM ratio starts at close to one (a par bond). Over time, the ratio then rises above one (a discount bond) or falls below one (a premium bond). These price movements depend on the evolution of economic forces and perhaps sentiment.

If sentiment plays any role, it tends to mean revert. Hence, on average, low book-to-market ratios that are driven by sentiment will rise, making risk-adjusted returns abnormally low. Likewise, sentiment driven high book-to-market ratios will tend to fall, making returns abnormally high. The abnormal returns generated by sentiment's tendency to mean revert generates bond prices with proclivities to converge towards their fair values.

Most of BBM's variation depends on a bond's price path since issuance. If the price path has generated returns that closely track the bond's initial yield-to-maturity, BBM remains close to one. However, if the bond's return has exceeded its initial yield-to-maturity, its past return will be high, and its yield-to-maturity will fall. What is noteworthy about BBM's ability to predict bond returns is that it survives controls that also influence returns, including past returns, yield-to-maturity and default likelihood.

The yield-to-maturity, like BBM, is a transformation of a bond's price. At issuance, the YTM is close to the bond's coupon rate, but as suggested above, YTM evolves like BBM to differ from its initial value. Neither yield-to-maturity nor bond book-to-market directly measure an expected return. However, one expects differences in bonds' YTMs—particularly when yield is deployed as a set of rank-based dummy variables—to better map into expected returns than their corresponding differences in the cruder BBM ratio. Nevertheless, when controlling for YTM rank in this fashion along with a host of other variables, the highest BBM bond quintile outperforms the lowest by more than 3% per year.

A primary deterrent to the study of corporate bond returns is their relatively thin trading. While many corporate bonds trade more than once per day, quite a few do not trade for days or even weeks at a time. We apply the martingale property of informationally efficient asset prices to overcome the obstacle of infrequent trading. This property enables imputation of the hypothetical mid-market prices one would trade at from transactions on other dates. While the imputed prices represent noisy estimates, the lower volatility of bonds offsets the enhanced return noise from measurement error, facilitating detection of significant pricing inefficiencies.

The risk-adjusted profits from BBM signal deployment do not survive transaction costs, which are substantially higher in the corporate bond market than in the stock market. These transaction costs remain an obstacle for hedge funds and other arbitrageurs, whether we estimate these costs from the prices of all bond trades that are exclusively executed between dealer and customers, or from trades between dealers and customers transacting in volumes of more than 100,000 U.S. dollars.

A comprehensive portrait of asset pricing also requires understanding the informational efficiency of the corporate bond market in its own right. In contrast to an abundant literature on equity market efficiency that dates back more than 50 years,[1] research on whether corporate bonds as a whole reflect public information is fairly nascent.[2] Fundamental differences between the equity and bond markets may have ramifications for

[1] Most equity studies relate return premia to various firm characteristics (or factors derived from them), including earnings surprises (Ball and Brown, 1968), size (Banz 1981), book-to-market (Fama and French, 1992), momentum (Jegadeesh and Titman, 1993), accruals (Sloan, 1996), cash flow-to-price (Hou, Karolyi, and Kho, 2011), profitability (Novy-Marx, 2013), and equity mispricing (Bartram and Grinblatt, 2018, 2020). Harvey, Liu, and Zhu (2016) and Green, Hand, and Zhang (2013) document more than 300 predictors of returns.

[2] Return predictability in the corporate bond market has been studied by Bai, Bali, and Wen (2019), Bali et al. (2020), Bali, Subrahmanyam, and Wen (2019), Choi and Kim (2018), Chordia et al. (2017), Gebhardt, Hvidkjaer, and Swaminathan (2005), and Jostova et al. (2013). For U.S. government bonds, research includes Fama and Bliss (1987) and Cochrane and Piazzesi (2005), who find that a linear combination of forward rates predicts the returns of bonds at various maturities, while Joslin, Priebsch and Singleton (2014) document evidence that forward rates do not span risk premia. Furthermore, Cieslak and Povala (2015) enhance the return predictability by accounting for long-term inflation. In the cross-section, Asness, Moskowitz, and Pedersen (2013) document the value and momentum effect in government bond indices. More

the relative efficiency of these two financial markets. On the one hand, corporate bond prices may be more efficient than their equity counterparts due to the more sophisticated institutional investor base that dominates bond trading. Alternatively, the corporate bond market may be less efficient due to its differing (primarily over-the-counter) market structure. The bond market's over-the-counter trading likely engenders greater transaction costs and less pre-trade price transparency, preventing arbitrageurs from correcting mispricing. Corporate bonds also tend to trade with less liquidity than stocks, and they are held for long periods by their primary investors: pension funds, insurance companies, endowments, and mutual funds.

We employ two different approaches to estimate trading profits adjusted for risk. Our primary approach utilizes cross-sectional Fama and MacBeth (1973) regressions. These regressions control for bond characteristics, such as yield-to-maturity, bond credit ratings, nearness to default, and bond past returns, among others. They also control for several equity characteristics tied to the cross section of equity returns—among them, accruals, earnings yield, gross profitability, and several market microstructure controls. As a robustness check, we also study whether the abnormal returns of the BBM signal can be explained by factor models. Here, we develop a 21-pair factor model that generates the alphas of BBM-stratified quintile portfolios from time series regression intercepts. The factor portfolios are an amalgamation of those used in other studies of bond and equity returns. They appear as contemporaneous and lead pairs to adjust for nonsynchronous trading in the bond and the factor portfolios. After controlling for these risk factors, the risk-adjusted profits to the BBM strategy remain economically and statistically significant, both for equal- and value-weighted bond portfolios.

We also analyze robustness, testing whether BBM is a better or worse predictor of risk-adjusted returns of all corporate bonds—as opposed to the those that are senior, unsecured, and lacking exotic options. In specifications with more risk controls, the BBM anomaly is stronger for the more comprehensive bond universe that includes junior and puttable bonds.

recently, Brooks and Moskowitz (2017) show that value, momentum and carry factors help predict government bond returns outside of the United States.

For the 20% of bonds that are closest to default, the BBM signal has about the same efficacy as it does for the remaining 80%. The irrelevance of default risk for BBM efficacy casts doubt on the omitted risk factor explanation of the BBM anomaly. Moreover, for government bonds, BBM offers no return predictability, indicating that our controls are adequate for capturing the return effects of the term structure. Finally, we show that the efficacy of the BBM signal for corporate bonds decays rapidly as the signal becomes stale, making strategies with lower turnover and lower transaction costs, like buy-and-hold for one year, as unprofitable (net of trading costs) as their higher turnover counterparts. The rapid decay in efficacy—particularly when compared to the slower evolution of the BBM attribute—is also more suggestive of mispricing rather than risk mismeasurement as the source of the BBM anomaly. Indeed, the transaction cost friction that rapid decay imposes on arbitrageurs could explain why a BBM strategy generates positive pre-transaction cost alpha to begin with.

Our study of bond returns and their cross-sectional relationship with book-to-market is the most extensive study of corporate bond returns to date. The sample period comprises 184 calendar months from January 2003 to April 2018 for trading signals, and from February 2003 to May 2018 for bond returns, covering 7,430 different bonds, 787 firms, and 363,516 bond-month observations.[3] The large sample is facilitated by the paper's key methodological contribution—showing how to utilize the martingale property to construct monthly returns when trading is thin. Prior studies, like Chordia et al. (2017), and Bao, Pan and Wang (2011), largely focus on the most liquid bonds in the Trade Reporting and Compliance Engine (TRACE) database. It is fairly straightforward to construct monthly returns for bonds that trade nearly every day, often multiple times. However, studies of such bonds cannot easily draw unbiased conclusions about the corporate bond market as a whole. Liquidity could be correlated with returns, or liquidity may affect correlations of bond returns with other variables. If this is the case, filtering out the larger set of less liquid bonds leads to conclusions that apply only to the narrow set of bonds studied. By contrast, analysis of liquidity's impact here suggests that our conclusions are, if anything, conservative.

[3] While TRACE data commence in July 2002, our performance analysis commences February 2003 to ensure data on the bond momentum control in Fama-MacBeth regressions. The end of our sample period is determined by the availability of point-in-time fundamental information from Compustat.

Next, Section 2 describes the data and methodology used. Section 3 presents the main empirical results. Section 4 analyzes whether mispricing or defective risk measurement better explains the BBM anomaly. Section 5 studies whether the BBM anomaly is merely a crude proxy for other known mispricing anomalies, whether it exists for a larger cross-section of corporate bonds (like junior bonds) that researchers typically do not study, and whether it can be implemented at low transaction costs. Section 6 concludes the paper.

2 Data and Methodology

We analyze the profitability in month $t + 1$ of trading signals, primarily BBM, formulated in month t. After discussing data and filters sourced from the transaction data in the enhanced TRACE database, we discuss the construction of monthly bond returns for each corporate bond in our sample, as well as signal construction.

2.1 Data Sources and Filters

The sample is initially limited to USD-denominated, senior, unsecured corporate bonds issued by non-financial firms with no embedded options other than call provisions. (Robustness tests later study all corporate bonds with fixed coupon rates in TRACE.) We exclude cancelled transactions, those that TRACE specifies as occurring before the issue date or after the maturity date of a bond, and transactions in the bonds of financial firms (SIC codes 60-69). We modify prices to be TRACE's corrected prices (or any other trade terms) when TRACE indicates the trading counterparties retroactively corrected the prices (or other trade terms). Following Bai, Bali, and Wen (2019), we also remove observations with a transaction price below 1/20 or above 10 times their face amount, as well as bonds with remaining maturity of less than one year and bonds in default at the time of the signal. For the Bartram and Grinblatt (BG) mispricing signal, on the day of the transaction that provides the trading signal, the issuing firm must be in the Center for Research in Security Prices' (CRSP) Monthly Stock File as the only common equity share class of a U.S. corporation (share classes 10 and 11), and be listed on NYSE, Amex or Nasdaq (exchange codes 1-3) with a share price of at least \$5, positive total assets, and a positive number of common shares outstanding.

2.2 Return Construction

Bonds, unlike equities, trade infrequently and often at large bid-ask spreads. To address these two issues, we apply the martingale property of asset pricing. According to the martingale property, an unbiased estimate of an asset's price on some date is its transaction price at some other date, adjusted for time's impact due to the accumulation of risk premia, the riskless time value of money, and any payouts. These adjustments are small and closely captured by the bond's interest earned when the transaction date is close to the desired price estimation date.

TRACE reports bond transactions' "flat" (or equivalently "clean") prices. Unless a bond is in default, these flat prices are not the transaction prices one pays for a bond. Instead, one pays the sum of the flat price and interest accrued. While daily, weekly, or monthly changes in accrued interest plus any distributions do not perfectly match the compensation for the time value of money and risk, they are close approximations, particularly over short time periods. Hence, for almost all bonds, the flat price of a bond approximately follows a martingale—validating substitution of flat prices from transactions in a bond at nearby dates for the flat prices that would be experienced on days without transactions in the same bond.

End-of-month Flat Bond Prices. The martingale property implies that the end-of-month flat bond prices we estimate, P^E, are the mid-market end-of-month flat prices at which the bonds would trade plus noise. The noise, which we try to minimize, depends on bond price volatility between the end of the month and the date of the transaction used for estimation, as well as the spread charged by the transacting party (bond seller or buyer) who provides liquidity. For bond j's end-of-month $t + 1$ flat price, we use the flat price of the last bond j transaction in month $t + 1$ or, if nearer in time, the flat price of the first transaction in month $t + 2$. For example, to obtain the end-of-April 2013 end-of-month flat price of a bond, we might use the flat price of an April 26, 2013 trade. However, if the same bond has a May 3, 2013 trade as the first trade in May, its end-of-April price would use the flat price transacted at the more proximate date, May 3. Thus, the estimated end-of-month prices derive from transaction dates that differ depending on when a particular bond trades. If no transaction in bond j takes place in month $t + 1$ or $t + 2$, we consider the bond's end-of-month $t + 1$ price as missing.

Beginning-of-month Flat Bond Prices. Unlike the end-of-month bond price, we estimate each bond's beginning of month flat prices, P^B, as the flat first transaction price of the month. Thus, a bond's March 2013 beginning-of-month price has to come from a March 2013 trade. If the bond does not trade in the month, its beginning-of-month price is missing. If there is one transaction in a month, the price of that transaction can serve multiple roles. For example, if March 4, 2013 is the only transaction in March, it qualifies as the beginning of March 2013 price. However, it would also serve as the February and March 2013 end-of-month prices if the last February 2013 transaction is prior to February 24 and the first April 2013 transaction was after April 27. This is because March 4 is closer to February 28 than February 24 and closer to March 31 than April 28.

Monthly Bond-level Returns. Using the end-of-month and beginning-of-month flat bond price estimates described above, we construct month $t + 1$ returns as:

$$R_{t+1} = \frac{P_{t+1}^{E} + AI_{t+1} + C_{t+1}}{P_{t+1}^{B} + AI_{t}} - 1, \tag{1}$$

where P^{B}_{t+1} is the estimated beginning-of-month $t + 1$ flat price, P^{E}_{t+1} is the estimated end-of-month $t + 1$ flat price, AI_{t+1} is the accrued interest owed at the end of month $t + 1$, and C_{t+1} is the coupon of the bond (if any) awarded to investors holding the bond in month $t + 1$. We consider the returns in two consecutive months to be missing if their product is less than –0.04. (A 20% monthly price increase followed by more than 20% decrease, or the reverse, likely reflects false recording of a price used to compute one or more of the returns.)

Cumulated returns over six months, used for a momentum control variable, are computed analogously to equation (1). The return is computed from a single beginning and ending price over the past return horizon. As in equation (1), the return is adjusted for beginning and ending accrued interest (to convert the estimated flat price into a price paid for the transaction), as well as any coupons paid during the interval.

Note that the prices in the numerator and denominator are noisy estimates of the flat prices we would observe if trades occurred at the end of each month. Because these return estimates contain noise in the denominator, equation (1)'s return estimates (like those for equities) are upwardly biased due to Jensen's inequality (Blume and Stambaugh, 1983). However, our results are based on the return spread between two quintile portfolios. If the bias affects the long and short legs of portfolios in the same way, it is eliminated by looking at their return spread. Alternatively, if the bias is greater in the short leg (as implied by evidence on trading frequency), our alpha spreads underestimate the true alpha spreads and are therefore conservative.

Recall that the sample omits bonds in default at the time a trading signal is received (month *t*). However, it includes bonds that commence default in the month our strategies invest in them (*t* + 1) to avoid data censorship. Defaulted bond trade "flat," obviating the need for equation (1)'s accrued interest adjustments to convert estimates of flat prices into transaction prices. Moreover, the coupons promised by defaulted bonds are never paid in month *t* + 1.

Unlike the flat prices of bond that trade with accrued interest due, transaction prices, and thus the flat prices of defaulted bonds, do not follow a martingale process—motivating adjustment of their beginning- and end-of-month price estimates. The adjustment we apply deliberately underestimates defaulted bonds' returns, thus making our return spread estimates conservative because there are no defaulted bonds in our strategies' short positions.[4] The conservative approach may be "overkill," as transactions in bonds that commence default in month *t* + 1 are quite rare, even for the strategies' long positions—constituting only 0.02% of their transactions.

A similarly rare situation, where we opt for no modification, exists for the few bonds that are issued at deep discounts. Fewer than 0.1% of bonds have offering prices less than 50, and 99.7% have offering prices above 90. Moreover, the average issue prices of the five BBM quintile portfolios are all close to 99.5 and about the same. The flat prices of such original issue discount bonds appreciate rather than (approximately) follow a martingale. Ignoring the original issue discount upwardly biases equation (1)'s denominator as an estimate of the true purchase price. However, sizable discounts are rare, and the numbers of days of amortization are generally small. For these reasons, adjusting the martingale price estimate for original issue discounts increases the returns of BBM quintile portfolios by only negligible amounts. The adjustment is eschewed because it has

[4] Specifically, if the transaction price used for the beginning of month price is quote flat due to default, we substitute the flat price of the first transaction preceding the transaction price used for the signal as P^B in equation (1)'s denominator and the nearest to end-of-month post-default transaction price for P^E in equation (1) and do not add accrued interest or a coupon in the numerator. This understates the return for the quintile portfolio we take a long position in and has no effect on the short position (which lacks defaulted bonds).

no detectable effect on the return difference between any pair of quintile portfolios.

2.3 Signal Construction

Our trading signals, largely BBM, utilize the market prices of transactions, as do the returns described above. Hence, measurement error in the bond's market price that affects both the bond's month t signal and its month $t + 1$ return would cause spurious correlation between the two. To avoid this measurement pitfall, we construct a month t trading signal from prices of transactions occurring at least seven calendar days prior to the end of month t.[5] We then estimate month $t + 1$ returns with the procedure described in Section 2.2. Signals constructed in this fashion cannot correlate with the estimated return for the next month: both the beginning- and end-of-month transaction prices are formed at least seven days after the signal is publicly known.

Bond Book-to-Market Signal. The book value per \$100 face amount is an adjustment of the issue price of the bond, sourced from the Mergent Fixed Income Securities Database (FISD). The distribution of issue prices can be seen in Table 1 Panel A. For most bonds, the FISD issue price is close to \$100.[6] If the bond is issued at a discount or premium, we apply the accounting rule that linearly amortizes the premium or discount to maturity on the month-end dates to arrive at the bond's current book value for the end of month t. In the approximately 30% of cases where FISD lacks the issue price, we omit the bond as a candidate for a potential trade.[7]

Our month t BBM signal is B/P, the reciprocal of the flat price of the bond per dollar of book amount. The flat price per \$100 of face amount, P, is taken from the bond's most recent transaction, excluding transactions within six calendar days before the end of month t. Hence, a BBM signal to trade at the end of June 2015 could be based on a transaction from February 2015. Table 1 Panel B reports the distribution of time between the signal formation transaction (the source for P in B/P) and the transaction that determines the beginning-

[5] To illustrate, if a signal uses the last month t transaction price to predict bond returns in month $t + 1$, and the latter returns depend on the same month-t price due to trade splitting and workouts over a few days, market microstructure noise (such as bid-ask bounce) could artificially generate return predictability in the absence of the one-week gap.

[6] The BBM signal's ability to predict returns is highly significant, but slightly reduced, if 100 is substituted for the Mergent issue price of the bonds.

[7] With all controls in Fama MacBeth regressions, the spread between the Q5 and Q1 BBM portfolios are 28 bp per month for the FISD subsample we focus on in the paper, but 18 bp (21 bp) for the subsample lacking FISD issue price data using subsample (full sample) break points. For the FISD-deficient subsample, 100 replaces book value.

of-period price used to construct the bond's return in month $t + 1$. For the senior unsecured bonds that researchers traditionally study (e.g., Bai, Bali, and Wen, 2019; Chung, Wang, and Wu, 2019) and that we focus on (first row), the median gap between the signal date and that latter price is 11 days, while the average is 17 days. About 7% of these observations have a gap exceeding one month. 99% of the observations for the BBM signal reflect transactions with one- to fourteen-week gaps.

Bartram and Grinblatt Mispricing Signal. A later robustness check studies whether a bond-centric implementation of Bartram and Grinblatt's (2018) mispricing measure generates a signal that predicts a bond's future return and subsumes the BBM signal. Each bond is assigned a firm-level mispricing measure, denoted "BG." The BG signal first computes an estimated month t market value of each firm's total liabilities—including bonds and other debt obligations (e.g., commercial paper, accounts payable, bank loans) that lack TRACE-reported transactions. Our estimate of the month t market value of firm i's total liabilities, $V_{i,t}$, is the sum of the market capitalization of its bonds, computed from their most recent TRACE transaction prices (excluding the last 6 calendar days of a month), plus the aggregate book value of firm i's other liabilities.

The BG bond mispricing signal, a metric of the degree to which each firm's aggregate debt obligations are under- or overvalued, is derived from monthly cross-sectional regressions of $V_{i,t}$ on firm i's 28 most commonly reported items in Compustat's point-in-time (PIT) accounting database as of month t.[8] The regression predictions—essentially peer-implied norms for $V_{i,t}$ implicit in all firms' accounting data—represent month t fair values for each firm's total liabilities. We then assign to each bond the BG mispricing signal of its issuing firm, which is the percentage deviation of the firm's predicted $V_{i,t}$ from its actual value.[9] In contrast to month t's market capitalization estimate used to construct the firm-based signal, the instrument level trading strategy uses only bonds for which we can compute month $t + 1$ returns with Section 2.2's procedures.

[8] These 28 items, listed in Appendix A, are the same regressors used in Bartram and Grinblatt's (2018) signal construction for equities.

[9] PIT data ensure that the information used to estimate debt fair value was available to market participants at the point in time where the mispricing signal suggests particular trades.

2.4 Alpha Tests for Signal Efficacy and Control Variables

Our BBM and BG signals sort bonds into quintiles at the end of month t, with quintile 5 having the most value-oriented bonds (BBM signal) or the most underpriced bonds (BG signal). We then analyze the returns of the bonds within these quintile portfolios in month $t + 1$. Our primary tests for the alpha generating efficacy of the signals are Fama and MacBeth (1973) cross-sectional regressions ("FM regressions").

FM Regressions. When returns are analyzed with FM regressions, the month t regression's unit of analysis is the bond. We cross-sectionally regress a bond's month $t + 1$ return (computed with Section 2.2's procedures) on quintile rank dummies or normal scores computed from BBM and numerous control variables. The controls consist of bond characteristics and issuing firms' equity characteristics measured as close to the end of month t as possible. They include yield-to-maturity, bond credit rating, bond value outstanding, time to maturity, bond age, bond momentum, bond reversal, bond bid-ask spread, nearness-to-default, as well as equity characteristics, including market beta, equity market capitalization, equity book-to-market, stock reversal, stock momentum, accruals, earnings momentum, gross profitability, and earnings yield. Some of the FM regressions also include market microstructure controls that are measured in the return period, month $t + 1$. We employ four specifications of regression controls. The first has no controls, the second has market microstructure controls; the third has controls for bond characteristics as well as market microstructure controls; the fourth controls for bond characteristics, the characteristics of the equity of the firm issuing the bond, and market microstructure effects. Appendix A describes the characteristics used in the regression in more detail.

Factor Model Time Series Regressions. We also control for risk by regressing the time series of returns of five BBM quintile portfolios in excess of LIBOR on 21 pairs of factor portfolios. Because bond return proxies can use prices from one of two months as the end-of-month price, the factor model uses current (month t + 1) and lead (month $t + 2$) portfolio returns as factor proxies. There are 21 pairs of such factors, including 13 equity factor pairs: all five equity factors of the Fama and French (2014) model, i.e. market excess return, size, book-to-market, profitability, and investment; three equity past-return factors: short-term reversal, momentum, and long-term reversal, all sourced from the Kenneth French data library;[10] and finally, the excess returns of the equity of the bonds in the five BBM quintiles. The 21 factor pairs also include eight factors that are more directly related to bonds: two bond factors for the default spread and term spread, as used in Chordia et al. (2017); two factors, bond momentum and bond value, as computed from government bonds in Asness, Moskowitz, and Pedersen (2013), and four excess return factors (above the risk-free rate) tied to bond indices from DataStream: U.S. Treasury Intermediate Index, U.S. Long-Term Treasury Index, U.S. Corporate Investment Grade Index, and the U.S. Corporate High-Yield Index. The indices measure growth in investment values including price changes, coupon payments and changes in accrued interests for the underlying bond portfolios. Appendix A describes all factors in more detail.

2.5 Summary Statistics for the Overall Sample

Table 2 Panel A reports summary statistics for BBM and other characteristics of the senior unsecured bonds we primarily study and their issuing firms. Each row reports the time series average of cross-sectional means of each variable using all bonds (first column) and the bonds within each BBM quintile (third to seventh column). Q1 represents bonds with the smallest 20% of BBM, averaging a BBM of 0.85; Q5 represents the highest BMM quintile, averaging a BBM of 1.10. The panel also reports the time series average of the cross-sectional correlations of the characteristic with BBM (second column).

The BG bond mispricing signal, with an average correlation of 0.30, positively correlates with BBM and monotonically increases across BBM quintiles. Many other characteristics also correlate with BBM. High BBM bonds tend to have poorer credit ratings (AAA=1,…, D=22, with 10 or less indicating investment grade) and are closer to default.[11] They also have higher YTMs, lower market values, higher bid-ask spreads, and been issued more recently. Lastly, they come from firms with higher equity beta, poorer returns over the past year,

[10] See https://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html.

[11] Because these are senior bonds, their default risk is relatively low, even for the highest BBM quintile, which averages to an investment grade rating. We also employ nearness to default (the negative of the distance to default measured by Schaefer and Strebulaev, 2008). Nearness to default is the z-value corresponding to the default probability from an adaptation of the Black-Scholes model. Quintiles for nearness to default are thus identical to quintiles for default probability. The firm is in default when nearness to default is positive infinity and less than one-half when nearness to default is negative.

larger equity book-to-market, and lower earnings/stock price ratios. By contrast, the lowest quintile of BBM bonds have the highest returns over the past six months (bond momentum, as used in prior research). These bonds also come from firms with the highest stock returns over the past year (equity momentum) and are attached to larger firms.[12] Finally, as one might expect, longer bond maturity, which is tied to bond price risk, is concentrated in the two extreme BBM quintiles.

Table 2 Panel B reports the average month $t + 1$ returns of five BBM-sorted portfolios in the columns labelled Q1-Q5. The panel's two rows correspond to equal- and value-weighted quintile portfolio returns, respectively, both of which exhibit a nearly monotonic increase across BBM quintiles. For example, the lowest BBM equal-weighted quintile portfolio earns 52 bp per month, while the highest earns 98 bp per month. The table also shows the average monthly return for the full sample (63 bp equal-weighted and 53 bp value-weighted), the average monthly correlation between the cross-section of returns and BBM (0.05), the average monthly spread between the returns in the largest and smallest BBM quintile (47 bp per month when equal weighted and 42 bp per month when value weighted—both significant), as well as the fraction of months in which the Q5 – Q1 return spread is positive (62% equal-weighted and 59% value-weighted—both significant).

Both the equal- and value-weighted annualized return spreads between the extreme BBM quintiles are above 5% per year. While the relatively low volatility of bond returns makes a 5% spread look large, many bond and firm attributes that influence returns correlate with BBM. For this reason, we need to analyze the marginal effect of BBM controlling for these other attributes.

3 Bond Book-to-Market and the Cross-Section of Expected Bond Returns

We now investigate whether BBM contains return-relevant information that is distinct from other known return predictors. Both cross-sectional FM regressions and time series factor model regressions show that BBM is not a proxy for commonly used characteristics or risk attributes that predict return premia.

[12] Nozawa (2017) and Chordia et al. (2017) show that most corporate bonds are issued by large firms (i.e., with market capitalization above the NYSE 50th percentile).

3.1 Fama-MacBeth Cross-sectional Regressions

The Fama-MacBeth approach regresses next month's bond return (in percentage form) cross-sectionally on the bond book-to-market signal and other lagged bond and equity characteristics:

$$R_{j,t+1} = a_t + \gamma_t BBM_{j,t} + \sum_{s=1}^{S} c_{s,t} X_{j,s,t} + e_{j,t+1} \quad (2)$$

In equation (2), $BBM_{j,t}$ is the month t bond book-to-market signal for bond j, and $X_{j,s,t}$ is the end-of-month t value of characteristic s of bond j (or its issuer), including industry fixed effects. The Fama-MacBeth procedure then averages the monthly coefficients over time and tests whether the average significantly differs from zero.

To assess the economic magnitudes of bond book-to-market and other predictors, Table 3's four odd-numbered specifications transform all exogenous variables into five quintile dummies Q1-Q5 and regress bond returns on dummy variables corresponding to Q2 through Q5, with Q1 omitted due to the regression intercept. For brevity, Table 3 only reports the coefficients for the Q5 dummy variables. Even-numbered columns (2, 4, 6, and 8), which study a parametric version of the signal, replace the BBM quintile dummies with the BBM score, transformed into a normally distributed regressor.

Columns 1 and 2 regress bond returns on BBM and industry dummies. Columns 3 and 4 add a set of market microstructure controls to the specifications in Columns 1 and 2, which roughly proxy for the precision with which the martingale approach estimates month $t + 1$ returns. They include the number of bonds from the issuing firm that trade in month $t + 1$, the percentage of the market value of the issuing firm's bonds that trade in month $t + 1$ as a fraction of the market value of the firm's bonds with signals in month t, and a pair of controls for the (absolute value of the) number of calendar days between the first (last) day of the month and the transaction date used for beginning-of- (end-of-)month $t + 1$ prices. Columns 5 and 6 add bond attribute controls to Columns 3 and 4. These include quintile dummy variables for the bond's yield-to-maturity, credit rating, market capitalization, time to maturity, age since issuance, bid-ask spread, past returns (over short and intermediate horizons), and the firm's nearness-to-default. These bond-specific controls are rooted in the finance literature.[13] Perhaps the most important, yield-to-maturity, is the long-term return if the bond has no default. Finally, "kitchen sink" Columns 7 and 8 add equity and firm characteristics to the specifications in Columns 5 and 6. These include equity beta, equity market capitalization, equity book-to-market, and past equity returns (for 3 horizons) of the issuing firm, as well as its accruals, earnings surprises, gross profitability, and earning yield, which have all been studied in the finance literature.[14]

All columns tell a similar story about BBM's importance for the cross-section of bond returns. Column 1 shows that BBM Quintile 5 bonds outperform Q1 bonds by an average of 48 bp per month (t = 3.63), controlling for industry fixed effects. The coefficient of 0.15 on the parametric BBM signal is also significant (t = 3.15) as Column 2 shows. Columns 3 and 4 illustrate that the market microstructure controls have little effect on the results: BBM's average coefficient is virtually the same, whether comparing Column 3 with 1, or 4 with 2. Although not reported for brevity, the relatively small effect of the market microstructure regressors applies to the remaining two specifications as well. This suggests that our martingale procedure for identifying month $t + 1$ returns is unlikely to have altered what might be inferred if corporate bonds traded far more frequently.[15] The addition of bond-specific controls (in Columns 5 and 6), measured as closely to the end of month t as possible, halve BBM's influence on a bond's month $t + 1$ return, but the BBM effect remains highly significant. Columns 7 and 8's addition of controls known to be related to equity returns increases the BBM coefficients by about 10% compared to Columns 5 and 6 and also increases their significance.

[13] Gebhardt, Hvidkjaer, and Swaminathan (2005) report that bonds with higher default risk earn 7 bp higher monthly returns than those with low default risk, and bonds with longer time to maturity earn 4 bp higher returns than those with short-term bonds. Chordia et al. (2017), Jostova et al. (2013), and Bai, Bali and Wen (2019) show that bond returns are correlated with past bond returns.

[14] See Banz (1979) and Fama and French (1992) for size, Rosenberg, Reid, and Lanstein (1985) for book-to-market, Jegadeesh (1990) and Jegadeesh and Titman (1993) for past returns, Sloan (1996) for accruals, Chordia and Shivakumar (2006) for earnings surprise, Novy-Marx (2013) for gross profitability, and Basu (1983) and Haugen and Baker (1996) for earnings yield. Bartram and Grinblatt (2018, 2020) also use the same set of equity controls in their FM regressions

[15] We also considered other sorts of liquidity-related biases. For example, bonds tend to be called by their issuing firms when their fair value (in the absence of a call) exceeds the call price. Could superior unobserved returns for bonds that would otherwise be classified as BBM Q1 bonds be filtered out, biasing the Q1 portfolio returns downward? We tested this hypothesis, both by filtering out bond returns in months approaching call dates and by adding controls for bond call dates. However, (in unreported results) our statistical tests suggest callability has little effect on the BBM alpha spread.

Our use of quintile dummies for these controls allows flexibility in the relationship between the control variable's parametric value and returns. For example, bond expected returns tend to be concave functions of yield-to-maturity as promises of very high yields are less likely to be met than promises of lower yields. Likewise, depending on the month, the term structure can be upward sloping, downward sloping, or hump shaped. Expressing the control regressors as nonparametric quintile dummies captures the dynamic and nonlinear relationship between the controls and expected returns more accurately.

So, how strong are these results? Compared to equity returns, bond returns have far lower cross-sectional volatility and predominantly come from transactions associated with larger firms, making the size of the bond book-to-market anomaly relatively more impressive. Moreover, compared to its equity cousin, the BBM effect has far superior risk controls. In addition to quintile dummies for yield-to-maturity, defaults risk, bond age, and liquidity, equation (2)'s cross-sectional regressions control for the effect of maturity and industry. In light of these controls and the CAPM beta risk of corporate bonds as a whole of 0.2 to 0.3, which implies a risk premium of only 2.0%-2.5% per year, it seems disingenuous to rationalize the 3-4% BBM-related annualized alpha spread as the outcome of an omitted risk control.

3.2 Factor Model Time Series Regressions

As an alternative to FM regressions, Table 4 reports 21-factor model alphas and factor betas of equal- (Panel A) and value-weighted (Panel B) quintile portfolios sorted on the BBM signal. Compared to the Fama-MacBeth cross-sectional analysis of Table 3, Table 4's time series factor model regressions have the advantage of including bond observations that lack data on the controls. They also facilitate alpha analysis of each of the BBM quintile portfolios and the use of both equal and value weighting.

For BBM quintile portfolio *q*, we run Black, Jensen, and Scholes (1972) time series regressions of the quintile portfolio's returns (in excess of 1-month USD LIBOR), on 21 pairs of risk factors,

$$r_{q,t+1} = a_q + \sum_{l=1}^{21} \beta_{q,l,t+1} F_{l,t+1} + \sum_{l=1}^{21} \beta_{q,l,t+2} F_{l,t+2} + \varepsilon_{q,t+1} \tag{3}$$

The intercept a_q is the risk-adjusted return or "alpha" of the quintile portfolio. Equation (3) indicates that the risk factors include both their contemporaneous as well as lead values. Because the ending price for some individual bond returns is estimated from a month $t + 2$ transaction, some factor risk would be missed without inclusion of the lead factor. Note that the inclusion of regressors spanning two months induces serial correlation in the residuals. For this reason, all factor model regressions report test statistics derived from Newey and West (1987) standard errors.

If systematic risk factors explain differences in bond returns for portfolios stratified by BBM, the risk-adjusted returns a_q of the BBM quintile portfolio should be indistinguishable from zero. The first row of Panels A and B of Table 4 reports the alphas on the five BBM portfolios as well as the spread in the Q5–Q1 risk-adjusted returns. The two panels' remaining rows show each factor beta pair (contemporaneous as well as lead beta) for all 21 factors.

The first row of both panels shows that all of the quintile portfolios have positive risk-adjusted returns. However, recall from Section 2.2 that the returns of the quintile portfolios may be upwardly biased due to noise in the beginning price for the return. We believe this bias is greater for Quintile 1 than for Quintile 5 because Quintile 5 bonds transact more frequently than Quintile 1 bonds. On average, the bonds in Quintile 5 trade 192 times in months $t + 1$ and $t + 2$ whereas those in Quintile 1 trade on average 84 times over this pair of months. This makes Panel A's 25 bp per month Q5 – Q1 spread (about 3.0% per year), as well as Panel B's 18 bp per month spread, conservative estimates of their true alpha spreads.

The alphas increase almost monotonically from the first to the fifth BBM quintile. Panel A's 25 bp alpha spread is strikingly similar to the 28 bp per month alpha spread from Table 3's "kitchen-sink" specification (Column 7). Because the excess returns are upwardly biased, we cannot easily ascertain if the spread is driven more by the long than the short end, or whether the profitability of a BBM strategy would be reduced by short-sale constraints.[16] However, if the bias was the same across all five quintile portfolios and the true alphas of the five equal-weighted quintile portfolios averaged to zero, each of the reported alphas in Panel A would be 19 bp per month higher than the corresponding true alpha. Reducing each alpha by the 19 bp bias

[16] Asquith, Au, Covert, and Pathak (2013) show that the cost of shorting corporate bonds is comparable to that of stocks.

would then generate a Q1 intercept of -0.07 and a Q5 intercept of 0.18. Under these assumptions, about 70% of the true alpha spread comes from the long end (Q5) and about 30% from the short end (Q1). Under most plausible assumptions about the bias we investigate, more than half the alpha spread comes from the Q5 (long) leg of the BBM strategy.

4 Understanding the BBM Alpha: Risk or Mispricing?

We now assess further evidence pertinent to the two competing explanations for BBM's success at predicting returns in Tables 3 and 4: first, that the BBM signal proxies for an omitted risk control; second, that extreme BBM quintiles contain mispriced bonds. This evidence includes the efficacy of the BBM signal when the signal is delayed, BBM's relative ability to predict the returns of the 20% most default-prone fixed income securities, and finally, the size and premium attached to common covariation among corporate bonds with similar BBM attributes.

4.1 Signal Delay

Figure 1 plots alphas (coefficient on the BBM Q5 dummy in Column 7 of Table 3) for signal delays ranging from zero to eleven months. In contrast to Table 3, which has BBM signals and returns beginning in January and February 2003, respectively, Figure 1's signals commence between January 2003 and December 2003, depending on the lag; its returns always commence January 2004. Starting all return series at the same month, irrespective of the signal lag, facilitates an apples-to-apples comparisons across lags. The alpha spread is 24 bp per month with no delay, i.e., a first signal from December 2003. This value is similar to the 28 bp per month coefficient reported in Table 3, despite the shorter return series. Figure 1 also indicates that alpha declines by about 1/4 (to 18 bp per month) when the signal is delayed by one month; with a seven-months or greater delay, the signal has virtually no predictive value.

Figure 1's pattern is more consistent with the mispricing hypothesis. Bonds with extreme BBM ratios may ultimately end up with less extreme BBM ratios. However, BBM is an attribute that evolves slowly, and it requires large price changes to move a bond from one BBM quintile to another. Thus, most of the Q5 and Q1 quintile bonds remain Q5 and Q1 bond for a few months.[17] In contrast to Figure 1's rapid decay in signal efficacy, the slow evolution of the BBM attribute implies that stale BBM signals should predict bond returns if the predictability stems from BBM's correlation with an omitted risk attribute. The secondary risk attributes that BBM might proxy for do not carry large enough return premia to explain Table 3's results unless they apply to almost every bond within a quintile. However, if the latter condition holds, the departure rate and destination quintiles of bonds that start out in the two extreme quintiles cannot dissipate a BBM risk premium effect as rapidly as Figure 1 indicates it should. For example, after one month, about 14% of the bonds in the two extreme quintiles departed their quintiles, yet signal efficacy is diminished by 28%. At the three-month lag, alpha has declined by 2/3, but about 1/3 of the bonds in Quintiles 1 and 5 depart from those quintiles after three months. Moreover, as time evolves, bonds departing from the extreme quintiles tend to move to adjacent quintiles, which have alphas that resemble those of their more extreme neighbors.

By contrast, if the mispricing hypothesis explains BBM's effect on returns, delays in implementing the BBM signal could easily lead to Figure 1's pattern of rapid alpha decay. This is because mispricing is unlikely to be distributed evenly within extreme BBM quintiles. A few highly mispriced bonds within those quintiles can explain Table 3's results even when the quintile's remaining bonds trade at prices much closer to fair value.[18] Once the mispriced bonds experience convergence, the BBM quintile will consist of bonds that are close to being fairly valued and the BBM signal becomes useless. For example, if the originally mispriced bonds' convergence to fair value is distributed uniformly over the next year, the BBM signal will lose 1/12 of its efficacy each month. Indeed, Figure 1's pattern suggests that 2/3 of mispriced bonds return to their fair values on a staggered schedule within the first three months of extreme BBM classification, and almost all bonds converge

[17] Because BBM is a stable trait with wide cross-sectional variation, it takes many months, if not years, to evolve into a substantially different value, just as Gerakos and Linnainmaa (2017) document for equity book-to-market. To verify the stability of our quintile portfolios, we compute the ratio of bonds that were in the quintile in month $t-1$ and leave for other quintiles in month t to the total number of bonds in the quintile in month $t-1$. The time-series average of the fraction of bonds leaving each quintile is 12%, 27%, 32%, 31%, 16% for Q1, Q2, Q3, Q4, and Q5, respectively. These values suggest that the quintiles with the highest and lowest BBM tend to be more stable than those in the middle.

[18] Chordia et al. (2017) argue that most corporate bonds are more likely to be priced efficiently because institutional investors dominate in this market. Furthermore, as bonds have finite maturity, their market prices may converge to fair values more quickly than stock prices do.

to their fair values over 4-7 months.

4.2 Default Risk and Signal Efficacy

If BBM proxies for an inadequate risk control, the BBM anomaly should be stronger with bonds that are closer to default. Table 5 adds interaction dummy variables to Table 3's regressions as a control. The interaction terms multiply each of the BBM quintile dummies by a dummy for the 20% of bonds that are nearest to default (Panel A) or the 20% with the lowest credit rating (Panel B). The coefficient on the interaction dummy measures whether the BBM alpha spread between BBM Q5 bonds and BBM Q1 bonds is larger for bonds ranked among the top 20% in default risk. For brevity, Table 5 only reports coefficients on the BBM Q5 dummy and the interaction between the BBM Q5 dummy and the default-related dummies.

In all of Table 5's specifications, the coefficient on the BBM Q5 dummy is significant, indicating that the BBM anomaly remains for the 80% of bonds least likely to default, while the coefficient on the interaction dummy is insignificant. For example, in Specification 7 of Panel A, the bonds issued by firms nearer to default have a 15 bp per month lower alpha spread than the bonds that are further from default. All 16 interactions terms in the 16 specifications of Panels A and B are statistically insignificant. These results support our claim that mispricing, rather an omitted risk control, drives our result. Next, we study whether an omitted risk control tied to the riskless term structure might explain our findings.

4.3 BBM and Lower Risk Treasury Notes and Bonds

BBM may also be a risk proxy because it better captures duration or related interest rate risk measures that are common to all bonds. However, if this is the case, Treasury securities should exhibit a BBM anomaly. Table 6 repeats Table 3 using U.S. Treasury notes and bonds instead of corporate bonds.[19] Panel A covers the period from July 1961 to May 2018; Panel B covers the period prior to the period we study with TRACE; finally, Panel C studies the return period over which we study corporate bond pricing with TRACE—February 2003 to May 2018. The coefficient on the BBM Q5 dummy is insignificant for all specifications and all time periods. By

[19] We exclude T-bills, TIPS and Treasuries with special tax provisions. Also, control variables that cannot be applied to Treasuries are necessarily excluded.

contrast, YTM is a significant predictor of U.S. Treasury returns. This finding is consistent with our controls for duration and term risk being adequate, leaving other risks or, more likely, mispricing as the better explanation for the BBM anomaly in the corporate bond market.

4.4 Does BBM Factor Risk Explain the BBM Alpha?

According to Davis, Fama and French (2000), models that use the sensitivity to the high-minus-low book-to-market ratio (HML) factor as a risk proxy explain the equity book-to-market anomaly as well as the book-to-market attribute itself. The authors use this to argue that equity book-to-market is driven by risk. Here, we construct a bond market version of HML and show that it has only modest ability to diminish the BBM effect.

To create an HML-like factor, we parrot Fama and French's (1993) procedure. Each month, we divide bonds into one of six categories based on two bond size categories (market value outstanding) and three BBM categories. Within each of the two bond size categories (large and small), we compute each month's return spread between a value weighting (with weights proportional to each bond's market capitalization) of the top- and bottom-third BBM bonds. Averaging the "large" and "small" bond return spreads generates that month's Bond HML factor (BHML).

Table 7 repeats Table 4 Panel A's time series regression specification, adding as regressors the Bond HML factor returns for the contemporaneous and lead months, referred to as BHML(t + 1) and BHML(t + 2). For brevity, Table 7 only reports intercepts (alpha) and factor betas on the additional pair of factors. Panel A's rightmost column indicates that the 22-pair factor model has a significant Q5 – Q1 beta spread on the contemporaneous Bond HML factor, but not on the lead Bond HML factor. The rightmost column and first row of Panel A also displays an alpha spread of 12 bp per month (t = 2.65)— more than a 50% reduction from Table 4 Panel A's 25 bp per month spread. This reduction is not entirely surprising. If we had constructed the BHML Factor as an equal-weighting of the top and bottom BBM quintile returns, mathematics would ensure a zero-alpha spread. The modestly differing design of BHML similarly leads to a downward bias in the alpha spreads, albeit a less dramatic one. Such a bias makes the significance of the Q5 – Q1 intercept, even at 12 bp per month, quite telling. It suggests that it would be conservative to argue that factor risk does not fully explain the BBM anomaly.

5 Alternative Signals, Junior Bonds, Trading Frequency, and Transaction Costs

The previous section argues that BBM's ability to predict returns is better explained by mispricing than an omitted risk control. This section analyzes whether BBM's ability to predict returns survives competition with a related mispricing metric, whether it generalizes to a sample that includes junior bonds, and whether a BBM trading strategy can be implemented in a cost-effective manner.

5.1 An Alternative Signal Rooted in Mispricing

We first study whether the BBM signal is simply a crude representation of a mispricing anomaly discovered by Bartram and Grinblatt (2018). The BG signal, described in Section 2.3, can be viewed as a sophisticated BBM signal. In lieu of a single accounting construct, book debt, the BG signal uses predictions from the 28 most commonly reported accounting variables to scale a bond's price. Bartram and Grinblatt (2018) refer to the scaling as a "fair value," obtained as the cross-sectional OLS regression prediction from a set of accounting items. Thus, the BG signal's fair value is simply month *t*'s market-wide norm for the linear function of 28 accounting variables that best explains the aggregate market values of firms' bonds. Sorting the percentage price deviation from the linear prediction is identical to a firm-level sort of the price to fair value ratio. Within each firm, we assign the same BG mispricing percentage to each bond that trades in month $t + 1$.

Table 8 reports coefficients on some of the key regressors in a pair of FM regressions that mimic Table 3's kitchen sink specification. For comparison purposes, Table 8's first column repeats Table 3's kitchen sink specification (Table 3 Column 7), but narrows the sample to firms that have all of the accounting variables needed to compute the BG signal. The second column runs a horse race between the BBM and BG signals by adding BG quintile dummies to the regression.

Row 1 indicates that the BBM signal's alpha is only slightly diminished by the inclusion of its more sophisticated BG cousin, but remains highly significant when in a horse race with the BG mispricing metric. In particular, BBM produces a 27 bp per month more alpha spread ($t = 3.79$) on its own. This drops to 22 bp per month ($t = 3.28$) when BBM competes with BG, controlling for all the other attributes in Table 3's Column 7.

The relatively small decline in BBM's alpha when the two signals compete indicates that the two signals are "marginally quasi-orthogonal." By this, we mean that after we control for other bond attributes, like yield-to-maturity, default nearness, bond credit rating, bond age, etc., the remaining randomness in the two signals is relatively uncorrelated. Table 8's horse race regression thus confirms that BBM is not a proxy for the BG anomaly. If the BG anomaly is the real driver of Table 3's findings, we would expect BBM to lose almost all of its return predictive power once we include BG quintile dummies in the regression.

5.2 BBM's Return-Predictive Ability for All Bonds

Up to this point, our tests include only senior unsecured bonds with no embedded options other than call provisions. As noted earlier, this is the group of bonds that researchers traditionally study, as risk controls for this subsample of TRACE are well established. As a robustness check, Table 9, which repeats Table 3 and 4's methodologies, but for all TRACE bonds, including junior bonds and bonds with put options attached to them as well as the senior unsecured bonds without exotic options studied earlier. For brevity, Table 9 Panel A, which parrots Table 3's Fama-MacBeth regressions on the larger bond sample, reports coefficients only for selected regressors of interest. Panel B repeats Table 4 Panel A's factor model regression, reporting only the intercept for brevity. Panel C repeats Table 7's factor model regression, reporting only intercepts and factor betas on the pair of BHML factors for brevity.

The newly incorporated bonds studied in Table 9's sample generally trade less frequently and are riskier than the senior unsecured bonds of the traditional sample. With a full set of controls, (specifications 7 and 8) Table 9 Panel A's results are stronger than those in Table 3. For example, the coefficient on the BBM Q5 dummy variable in Column 7 of Panel A is 37 bp per month (t = 5.02)—representing an alpha of about 4.4% per year. By contrast, the corresponding coefficient from Table 3 Column 7 is 28 bp per month (t = 4.44). Likewise, Panel B and C's alpha spreads between BBM Q5 and Q1, 45 bp and 25 bp per month, both significant, exceed those from the restricted sample's factor models, as outlined in Table 4 Panel A and Table 7, respectively. Thus, provided that the extensive risk controls are adequate for both the traditional and all-bond samples, the BBM alpha spread anomaly is stronger for the all-bond sample.

5.3 Buy-and-Hold Returns

Pension funds and other institutional investors may buy and hold bonds without rebalancing their portfolios frequently. These investors could earn higher returns from high BBM bonds if the return predictability was due to an omitted risk factor because they would be bearing that risk. However, if the BBM anomaly is explained by mispricing that quickly reverts to fair value, as we contend, the low turnover of these investors' portfolios may prevent them from taking full advantage of the anomaly. Here, we study if BBM delivers abnormal returns when portfolios tilt away from overpriced bonds and towards underpriced bonds, but maintain their positions unaltered for twelve months.

The analysis of the buy-and-hold strategy follows Jegadeesh and Titman (1993). Their method computes the return to a twelve-month buy-and-hold BBM quintile from returns to twelve (equal-weighted) partially overlapping strategies that are simultaneously implemented each month. Each of the twelve strategies is based on a BBM quintile indicator that has one of the prior twelve months as lags for indicator delay. This yields a single series of monthly returns that, except for minor effects from endpoint months and compounding, aggregate to the buy-and-hold returns of the quintile portfolio. Differencing the buy and hold monthly returns of quintiles 5 and 1, and then averaging, yields the alpha spread for the buy-and-hold BBM strategy.

Table 10 reports the alphas of the five buy-and-hold BBM quintiles and the long-short BBM strategy. The alphas are the intercepts from the 21-pair factor model of Table 4. The difference in the 21-factor model alpha spread between the Q5 and Q1 portfolios is an insignificant 9 bp per month (t = 1.44), which falls below the 5% significance level. The weak alpha difference suggests that unless an institution is willing to rebalance relatively frequently, profits from the BBM anomaly will be small if they exist at all. This finding, like that for signal delay, lends support for the mispricing hypothesis as the explanation for the BBM anomaly. It also suggests that transaction costs, which eliminate even significance at the 10% level for the buy and hold strategy, are likely to be a major factor in deterring the economic forces of arbitrage that might eliminate these kinds of anomalies. We turn to this issue next.

5.4 Transaction Costs

The average return associated with the BBM signal before accounting for transaction costs is a useful metric for assessing bond market efficiency. However, deviations of bond prices from their fair values do not represent profit opportunities for market participants if transaction costs exceed gross profits. The corporate bond market is known to be illiquid, and transaction costs are generally high (Chen, Lesmond, and Wei, 2007; Edwards, Harris, and Piwowar, 2007; Bao, Pan, and Wang, 2011; Feldhütter, 2012). Therefore, the alphas arising from the BBM signal may not be exploitable by arbitragers as a stand-alone trading strategy.

Our methodology applies the martingale property of asset prices to estimate end-of-month hypothetical transaction prices. These hypothetical transactions would incur transaction costs in the form of a half-spread between the transaction price and a "mid-market" price at which the transaction would take place if transaction costs were zero. Assuming a transaction cost that is symmetric for buys and sells, we can measure the effective half spread by halving the effective full spread computed from actual transactions.

We use a unique feature of TRACE to first quantify a single homogenous effective half spread per transacting dollar for every month t transaction in a BBM quintile q bond, denoted $T_{q,t}$. TRACE labels a large proportion of its transactions as customer buys from a dealer or as customer sells to a dealer. The TRACE label is meaningful because corporate bonds largely trade in dealer over-the-counter markets, and dealers provide all of the liquidity in these transactions. We study all trades in bonds from quintile q (as defined by the BBM signal at the end of month $t-1$) that take place in month t. Each day within the month, we separately compute the average price of customer buys and the average price of customer sells of bonds in that quintile. Equally weighting each day (as opposed to each transaction) yields month t's average buy price and average sell price for quintile q. Subtracting the two monthly averages and dividing by the sum of the two averages yields $T_{q,t}$, the effective month t half-spread per dollar of transaction in a quintile q bond. $T_{q,t}$ accurately estimates the bond-type's monthly effective half-spread provided that month t's average mid-market price is the same for buys and sells. (Note that identical mid-market prices for buys and sells are more likely to be approximated with monthly than with daily averages.). One of five $T_{q,t}$ values are assigned to each transaction, depending on the bond's quintile assignment from the signal at the end of month t.

To understand how this transaction cost affects returns, we have to combine it with turnover data. Turnover both initiates and concludes each return month. To avoid double-counting, we assign $T_{q,t}$ costs from turnover that would occur (hypothetically) at the end of a month to the return in month t. To illustrate, while transactions that generate costs on Friday, May 31, 2013 can be assigned to reduce either the May or June 2013 returns, we assign them to May. Quintile q's end-of-May turnover per dollar of investment is the absolute value of the difference between its portfolio weights assigned at the end of May and those assigned at the end of April, with the latter weights adjusted for the relative returns of the bonds in the quintile portfolio.

In particular, for month t's return, we denote the weight difference as $\mathbf{w}_{q,t+1} - \mathbf{D}_t \mathbf{w}_{q,t}$, where $\mathbf{D}_t$ is an N×N diagonal matrix, with the j-th diagonal element being the month t gross return ($1 + R_{j,t}$) of bond j divided by the month t gross return of BBM quintile portfolio q. $\mathbf{w}_{q,t}$ is an N-vector with each element corresponding to the vector of portfolio weights for quintile q in month t. This weight reflects each bond's (out of the N bonds in our sample) month t (zero or positive but equal) weight assigned by the end of month $t-1$ signal. The beginning-of-month weights change over the course of the month as a result of the bond return $R_{j,t}$—hence the scaling by $\mathbf{D}_t$.[20] Each element of month t's difference vector is assigned one of five half-spreads tied to the quintile the bond belongs to throughout month t. If the j-th element of $\mathbf{w}_{q,t+1}$ is positive, bond j is assigned month t's effective half spread for bonds in quintile q. Algebraically, month t's transaction cost per dollar for updating quintile q's portfolio at the end of month t is

$$\mathit{Transaction\,Cost}_{q,t} = \sum\nolimits_{j\in N} \left| w_{q,t+1}(j) - \frac{w_{q,t}(j)(1+R_{j,t})}{\sum_{j\in N} w_{q,t}(j)(1+R_{j,t})} \right| \sum\nolimits_{k=1}^{5} I^{+}\left(w_{k,t+1}(j)\right) T_{k,t}\,, \tag{4}$$

where N is the universe of bonds in the data set, $I^{+}(x)$ is a {0,1} indicator function that takes on the value of 1 only if x is strictly positive, and $v(j)$ is element j of any vector $\mathbf{v}$, corresponding to bond j. Subtracting this cost from month t's quintile q's return produces a month-t return net of transaction costs.

[20] If an element of $\mathbf{D}_t$ is lacking because the bond matured, has yet to be issued, or did not trade, the corresponding portfolio weight will be zero and we treat the product of the missing $\mathbf{D}_t$ element and the weight as zero.

While dealers meeting customer liquidity needs are able to execute on the profitable side of the bid-ask midpoint, customers can bilaterally negotiate prices. As a result, transaction costs for corporate bonds may depend on the type of investor, the type of trade, and the relative market power that dealers have over the customer. Consistent with this thesis, Bao, Pan, and Wang (2011) show that corporate bond transaction costs are larger for small transactions.

To account for the potential heterogeneity across investors, we compute the transaction cost measure described above for two alternative sets of transactions. The first set includes all dealer-to-customer transactions in TRACE, while the second is limited to dealer-to-customer transactions with volumes of at least 100,000 U.S. dollars. The latter subset of observations likely captures trades that have lower transaction costs due to larger customers' relatively smaller disadvantage in bargaining power.[21]

Figure 2 graphs the monthly bid-ask spreads for all trades (Panel A) and for large trades (Panel B). It displays the equal-weighted average of bid-ask spreads for an equal weighting of all quintiles as well as for bonds in the first and fifth quintiles. The overall bid-ask spread patterns are fairly consistent with the findings of Choi and Huh (2019). Not surprisingly, costs spiked during the 2008-2009 financial crisis.

Table 11 reports average portfolio turnover and transaction costs as well as gross and net performance for trades restricted to the lowest and highest BBM quintiles. The alpha column reproduces the 21-factor pair alpha from Tables 4 Panel A (monthly rebalancing). The long-short BBM strategy has a pre-transaction cost (i.e., gross) alpha of 25 bp per month. The transaction costs associated with its turnover of 31% amounts to 53 bp for all investors, which exceed the alphas computed for the strategy. Even applying the (more than 50%) lower transaction costs of 20 bp for large transactions to the same gross alpha offers no consolation, as we still end up with an insignificant 2 bp per month net alpha.[22] Since short sales costs and constraints may also be a consideration, the BBM anomaly is not attractive to fund managers pursuing long-short strategies.

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[21] See Bessembinder et al. (2009).

[22] Factor model net performance is the intercept from regressing quintile portfolio excess returns net of monthly transaction costs on factors. Subtracting transaction costs monthly alters factor betas, implying that Table 11's net performance does not exactly equal the difference between Table 4 Panel A's average (gross) alpha and average transaction costs.

6 Conclusion

This paper studied bond book-to-market's role in the pricing of corporate bonds. The alpha difference between extreme BBM quintile portfolios—28 bp per month with the most extensive controls—is sizable considering the volatility of corporate bond returns compared to stock returns. It also presented evidence that the BBM trading strategy's alpha is unlikely to stem from an omitted risk control. For one, it is difficult to conceive of omitted risk controls with sufficient risk premia when cross-sectional FM regressions already control for most of the return-related bond and equity characteristics studied in the literature. Moreover, time series factor model regressions with 21 pair bond and equity market risk factors confirm a similar alpha (25 bp per month). Alpha spreads are of larger economic magnitude when the sample include junior bonds and bonds with exotic options.

This leaves mispricing as the best explanation for the BBM anomaly. That explanation is reinforced by the pattern of profits earned when the BBM signal is delayed, similar BBM signal efficacy for bonds with more default risk, and the inability of factor betas to explain BBM profits, even with an additional HML-like factor for bonds. Nothing in the term structure of riskless interest rates, including improper controls for duration, can explain BBM, as the BBM signal does not predict the returns of U.S. Treasury bonds.

In both reported and unreported analyses, we contemplated the possibility that the illiquidity of bonds could account for our findings. Moreover, reported results suggest that the Jensen's inequality bias in returns makes the reported magnitude of the BBM alpha spread conservative. BBM Q1 portfolio bonds trade less frequently than the BBM Q5 bonds. Thus, if bond returns are upwardly biased due to Jensen's inequality, they are more upwardly biased for the short leg (Q1) than the long leg (Q5) of the BBM strategy.

It is not entirely surprising that the convergence of the market values of corporate bonds to their fair values is the more plausible explanation for the alpha generated by the BBM anomaly. Bond trading faces greater trading and liquidity frictions than several other asset classes, which allows deviations from fair value to exist initially. Indeed, transaction costs, which we estimate for different sized transactions, are sufficiently high to deter arbitrageurs from profiting off of the anomaly. And strategies with lower turnover, like one-year buy-and-hold strategies, earn profits that are low and marginally insignificant, even gross of transaction costs. However, compared to other asset classes, the future values of bonds are pinned down by their contractual future cash flows. This feature makes deviations from fair value relatively transparent, promoting the rapid dissipation of such deviations. Long-term investors, who will incur transaction costs anyway, benefit from knowing which bonds have the highest and lowest risk-adjusted returns. Their decisions to trade mispriced bonds could be the source of relatively rapid convergence to fair value that we think occurs over four to seven months.

The mispricing explanation for BBM may offer insights for book-to-market effects in other asset classes. If the bond asset class, where we can more adequately control for risk, favors the mispricing explanation for the BBM anomaly, we need to take mispricing more seriously in other asset classes, like equity, where risk controls are harder to come by. Consistent with the equity mispricing explanation is the decline in equity HML since 2002 as trading frictions in equities declined and the equity book-to-market anomaly became widely known in hedge fund circles.

Bond book-to-market is a characteristic that is highly negatively correlated with the price of a bond. While quintile sorts on the price of a bond also predict returns, we presented evidence that bond book-to-market is a better return predictor. The differences are not striking, however, and it would be acceptable to believe that the difference between a bond price anomaly and a bond book-to-market anomaly is merely semantic. In the equity world, this is largely the case as well. It is just that equity shares are an arbitrary way to scale a price, making equity book-to-market a less noisy metric of mispricing than the share price. This, of course, assumes that both the bond and equity book-to-market premia stem from the same source: mispricing. However, given the many price-related anomalies in the equity literature,[23] including book-to-market, we see no reason to doubt that they are all part of the same phenomenon.

Alas, sentiments about a potential role for sentiment in asset pricing is controversial. This controversy is puzzling for researchers who long for a synthesis between two competing views of asset pricing. We do not believe that our results should be the source of any controversy. At one level, it is possible to say that at best,

[23] See, for example, Fritzemeier (1936), Bachrach and Galai (1979), Basu (1978), Dubofsky and French (1988), and Lamont (1998).

about 40% of bond prices deviate from their fair values by an average of no more than 0.55%.[24] For a bond with 10-year modified duration, this corresponds to a yield deviation from fair value of at most 6 basis points. Markets may not be perfectly efficient, but it would be petty to dismiss efficient markets entirely for such a small sum.

[24] In Table 10, the annualized buy-and-hold return is 1.1%, which implies that the average bond in Q1 and Q5 is mispriced by 0.55%.

References

Asness, C., T. J. Moskowitz, and L. Pedersen, 2013. Value and momentum everywhere. Journal of Finance 68, 929–985.

Asquith, P., A. S. Au, T. Covert, P. A. Pathak, 2013. The market for borrowing corporate bonds. Journal of Financial Economics 107, 155–182.

Bachrach, B., and Galai, D., 1979. The risk-return relationship and stock prices. Journal of Financial and Quantitative Analysis 14, 421–441.

Bai, J., T. G. Bali, and Q. Wen, 2019. Common risk factors in the cross-section of corporate bond returns. Journal of Financial Economics 131, 619–642.

Bali, T. G., A. Goyal, D. Huang, F. Jiang, and Q. Wen, 2020. The cross-sectional pricing of corporate bonds using big data and machine learning, Working Paper.

Bali, T. G., A. Subrahmanyam, and Q. Wen, 2019. Long-term reversals in the corporate bond market. Journal of Financial Economics, forthcoming.

Ball, R., and P. Brown, 1968. An empirical evaluation of accounting income numbers. Journal of Accounting Research 6, 159–178.

Banz, R. W., 1981. The relationship between return and market value of common stocks. Journal of Financial Economics 9, 3–18.

Bao, J., Pan, J., and J. Wang, 2011. The illiquidity of corporate bonds. Journal of Finance 66, 911–946.

Bartram, S. M., and M. Grinblatt, 2018. Agnostic fundamental analysis works. Journal of Financial Economics 128, 125–147.

Bartram, S. M., and M. Grinblatt, 2020. Global market inefficiencies. Journal of Financial Economics, forthcoming.

Bessembinder, H., K. M. Kahle, W. F. Maxwell, D. Xu, 2009. Measuring abnormal bond performance. Review of Financial Studies 22, 4219–4258.

Basu, S., 1978. The effect of earnings yield on assessments of the association between annual accounting income numbers and security prices. Accounting Review 53, 599–625.

Basu, S., 1983. The relationship between earnings yield, market value and return for NYSE common stocks: further evidence. Journal of Financial Economics 12, 129–156.

Berk, J., 1995. A critique of size-related anomalies. Review of Financial Studies 8, 275–286.

Bessembinder, H., K. Kahle, W. Maxwell, and D. Xu, 2009. Measuring abnormal bond performance. Review of Financial Studies 22, 4219–4258.

Black, F., M. C. Jensen, and M. Scholes, 1972. The capital asset pricing model: some empirical tests. In: Jensen, M. C. (Ed.), Studies in the theory of capital markets. Praeger, New York, 79-124.

Blume, M. E., and R. F. Stambaugh, 1983. Biases in computed returns: an application to the size effect. Journal of Financial Economics 12, 387–404.

Brooks, J., and T. J. Moskowitz, 2017. Yield curve premia. Unpublished working paper. AQR Capital and Yale University Working paper.

Chen, L., D. Lesmond, and J. Wei, 2007. Corporate yield spreads and bond liquidity. Journal of Finance 62, 119–149.

Choi, J., and Y. Huh, 2019. Customer liquidity provision: implications for corporate bond transaction costs. Unpublished working paper. University of Illinois at Urbana-Champaign and Federal Reserve Board.

Choi, J., and Y. Kim, 2018. Anomalies and market (dis)integration. Journal of Monetary Economics 100, 16–34.

Chordia, T., A. Goyal, Y. Nozawa, A. Subrahmanyam, and Q. Tong, 2017. Are capital market anomalies common to equity and corporate bond markets? Journal of Financial and Quantitative Analysis 52, 1301–1342.

Chordia, T., and L. Shivakumar, 2006. Earnings and price momentum. Journal of Financial Economics 80, 627–656.

Chung, K. H., J. Wang, and C. Wu, 2019. Volatility and the cross-section of corporate bond returns. Journal of Financial Economics 133, 397–417.

Cieslak, A., and P. Povala, 2015. Expected returns in Treasury bonds. Review of Financial Studies 28, 2859–2901.

Cochrane, J. H., and M. Piazzesi, 2005. Bond risk premia. American Economic Review 95, 138–160.

Davis, J., E. F. Fama, and K. R. French, 2000. Characteristics, covariances, and average returns: 1929 to 1997. Journal of Finance 55, 389–406.

Dubofsky, D. A. and French, D. W., 1988. Share price level and risk: implications for financial management. Managerial Finance 14, 6–15.

Edwards, A. K., L. E. Harris, and M. S. Piwowar, 2007. Corporate bond market transaction costs and transparency. Journal of Finance 62, 1421–1451.

Fama, E. F., and J. D. MacBeth, 1973. Risk and return: some empirical tests. Journal of Political Economy 81, 607–636.

Fama, E. F., and K. R. French, 1992. The cross-section of expected stock returns. Journal of Finance 47, 427–465.

Fama, E. F., and K. R. French, 1993. Common risk factors in the returns on stocks and bonds. Journal of Financial Economics 33, 3–56.

Fama, E. F., and K. R. French, 2014. A five-factor asset pricing model. Journal of Financial Economics 116, 1–22.

Fama, E. F., and R. R. Bliss, 1987. The information in long-maturity forward rates. American Economic Review 77, 680–92.

Feldhütter, P., 2012. The same bond at different prices: identifying search frictions and selling pressures. Review of Financial Studies 25, 1155–1206.

Fritzemeier, L., 1936. Relative price fluctuations of industrial stocks in different price groups. Journal of Business 9, 133–154.

Gebhardt, W. R., A. Hvidkjaer, and B. Swaminathan, 2005. The cross section of expected corporate bond returns: betas or characteristics? Journal of Financial Economics 75, 85–114.

Gerakos, J., and J. T. Linnainmaa, 2017. Decomposing value. Review of Financial Studies 31, 1825–1854.

Green, J., J. Hand, and F. Zhang, 2013. The supraview of return predictive signals. Review of Accounting Studies 18, 692–730.

Harvey, C., Y. Liu, and H. Zhu, 2016. …and the cross-section of expected returns. Review of Financial Studies 29, 5–68.

Haugen, A., and N. Baker, 1996. Commonality in the determinants of expected stock returns. Journal of Financial Economics 41, 401–439.

Hou, K., G. A. Karolyi, and B. - C. Kho, 2011. What factors drive global stock returns? Review of Financial Studies 24, 2527–2574.

Jegadeesh, N., 1990. Evidence of predictable behavior of security returns. Journal of Finance 45, 881–898.

Jegadeesh, N., and S. Titman 1993. Returns to buying winners and selling losers: implications for stock market efficiency. Journal of Finance 48, 65–91.

Jegadeesh, N., and S. Titman, 2001. Profitability of momentum strategies: an evaluation of alternative explanations. Journal of Finance 56, 699–720.

Joslin, S., M. Priebsch, and K. J. Singleton. 2014. Risk premiums in dynamic term structure models with unspanned macro risks. Journal of Finance 69, 1197–233.

Jostova, G., S. Nikolova, A. Philipov, and C. Stahel, 2013. Momentum in corporate bond returns. Review of Financial Studies 26, 1649–1693.

Lamont, O., 1998. Earnings and expected returns. Journal of Finance 53, 1563–1587.

Livnat, J., and R. Mendenhall, 2006. Comparing the post-earnings announcement drift for surprises calculated from analyst and time series forecasts. Journal of Accounting Research 44, 177–205.

Newey, W. K., and K. D. West, 1987. A simple, positive semi-definite, heteroskedasticity and autocorrelation consistent covariance matrix. Econometrica 55, 703–708.

Novy-Marx, R., 2013. The other side of value: the gross profitability premium. Journal of Financial Economics 108, 1–28.

Nozawa, Y., 2017. What drives the cross-section of credit spreads? A variance decomposition approach. Journal of Finance 72, 2045–2072.

Rosenberg, B., K. Reid, and R. Lanstein, 1985. Persuasive evidence of market inefficiency. Journal of Portfolio Management 11, 9–17.

Schaefer, S. M., and I. A. Strebulaev, 2008. Structural models of credit risk are useful: evidence from hedge ratios on corporate bonds. Journal of Financial Economics 90, 1–19.

Sloan, R. G., 1996. Do stock prices fully reflect information in accruals and cash flows about future earnings? Accounting Review 71, 289–315.

Figure 1: Signal Delay

The figure shows average coefficients from Fama and MacBeth (1973) regressions of monthly bond returns on bond book-to-market, controlling for other bond and equity characteristics (Specification (7) in Table 3). Returns are regressed against the book-to-market quintile dummies lagged one to twelve months. Control variables include bond yield to maturity, bond value, bond age, bond maturity, bond bid-ask spreads, lagged bond returns, bond momentum, bond credit rating, nearness to default, equity market beta, equity book-to-market, equity market capitalization, equity short-term reversal, equity momentum, equity long-term reversal, accruals, standardized unexpected earnings (SUE), gross profitability, and earnings yield. The table employs quintile dummies for Quintiles 2, 3, 4, and 5 of each characteristic as regressors, but the figure displays only the coefficient on the Quintile 5 dummy for bond book-to-market. Each month's quintiles are determined from sorts of firms with non-missing values for all characteristics. Size (market capitalization) quintiles are based on NYSE breakpoints. Additional controls are the number of outstanding bonds of a firm, the percentage of bond market capitalization of a firm that trade in a month, and the number of days from the beginning and end of the month of bond price data used to calculate the bond return. All regressions include industry dummy variables based on the 38 Fama and French industry classifications. The return sample period is January 2004 to May 2018. All variables are defined in Appendix A.

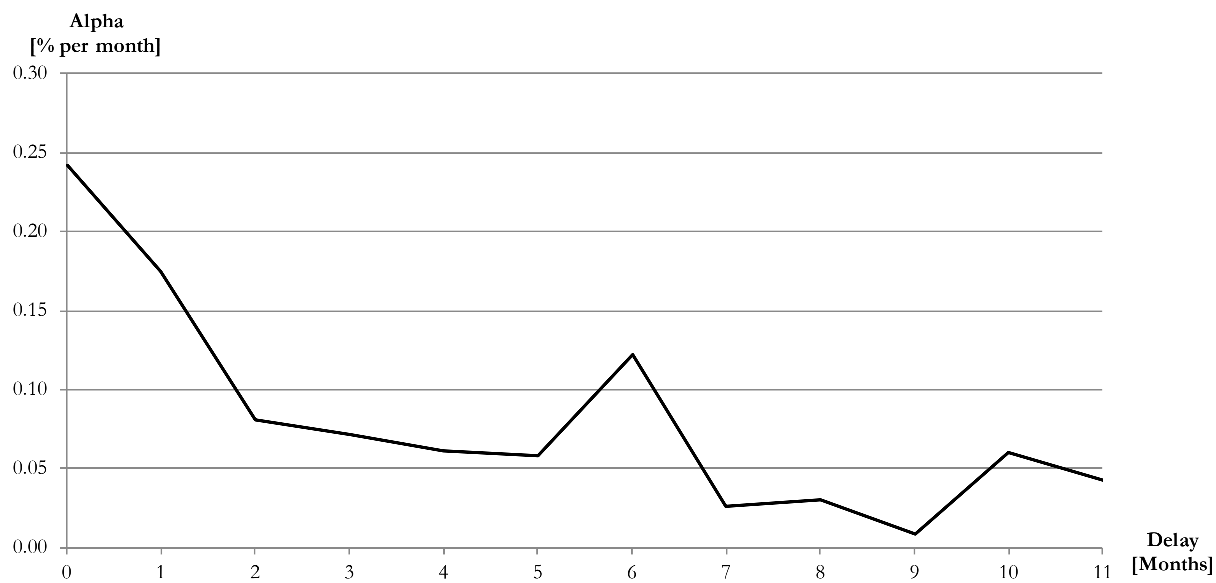
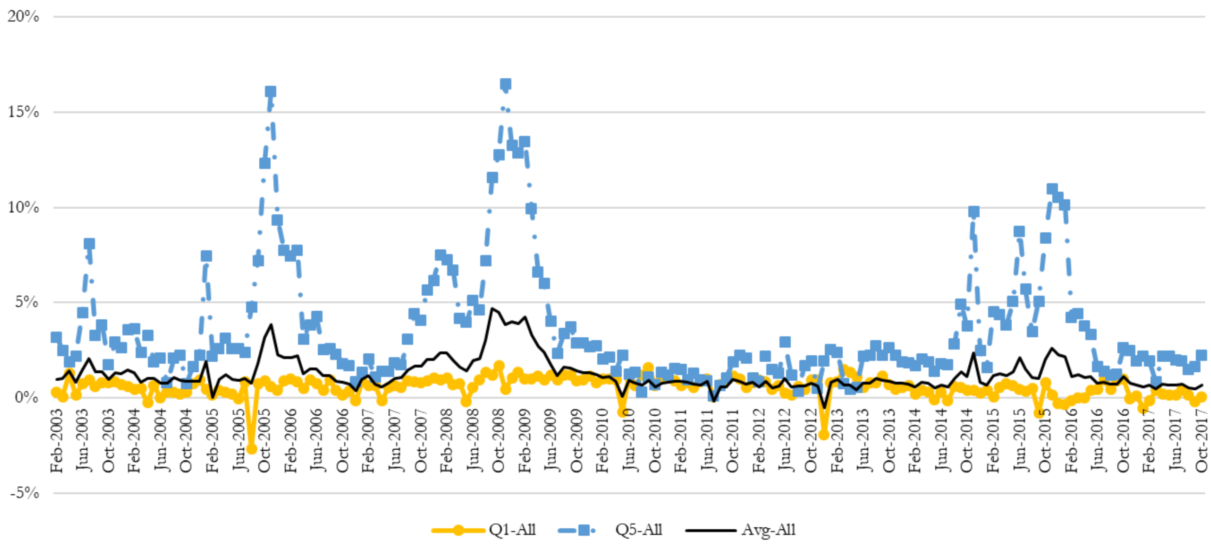


Figure 2: Monthly Bid-Ask Spreads for Bond Book-to-Market Quintiles

The figure shows monthly bid-ask spreads by bond book-to-market quintiles, separately for all transactions (Panel A) and institutional transactions (Panel B). Every day, we take the average of buy transactions and sell transactions for all bonds in each quintile. We take the average of daily prices in a month separately for buys and sells, and compute the quintile-level bid-ask spreads from the average buys and sells for the month. The figure shows the spreads for Quintile 1 (lowest BBM), Quintile 5 (highest BBM) and the average of five quintiles.

Panel A: All Transactions



Panel B: Institutional Transactions

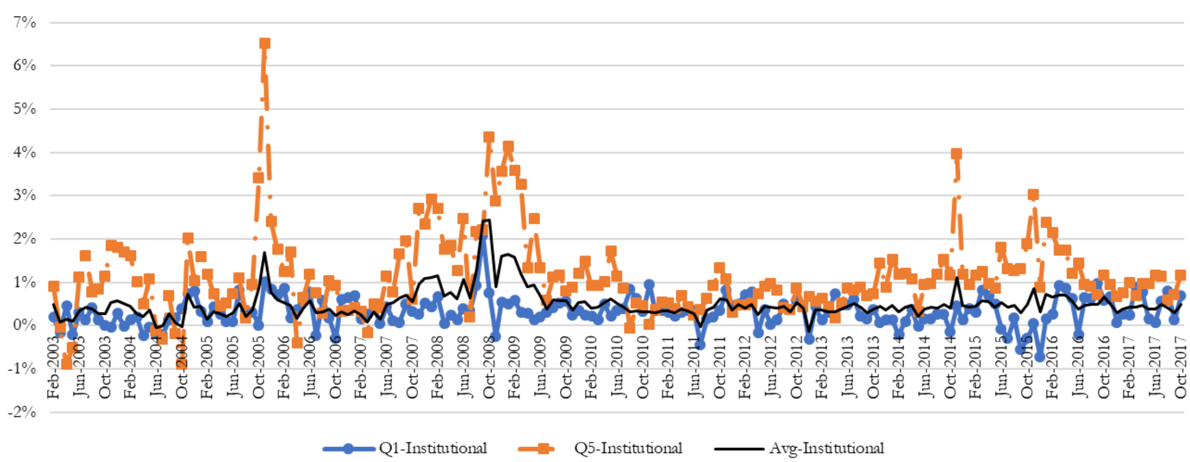


Table 1: Summary Statistics

The table reports statistics on the offering price of corporate bonds (Panel A), and the time difference between the bond market values used to construct the bond book-to-market signal in month *t* and bond market values used to construct bond returns in month *t* + 1 (Panel B). Panel A reports the distribution of an offering price per 100 of face value, separately for the sample of senior, unsecured bonds (Traditional Bonds) and all bonds including junior bonds or bonds with embedded options (All Bonds). Panel B reports the difference in calendar days between the transaction date for beginning-of-month price in month *t* + 1 (used to construct the bond's return in month *t* + 1) and the transaction date for month-*t* trading signal. Statistics are computed using the bond-level panel data, separately for traditional bonds as well as all bonds. The return sample period is February 2003 to May 2018. All variables are defined in Appendix A.

Panel A: Offering Price Statistics

				Percentiles									
	N	Mean	Minimum	1	5	10	25	50	75	90	95	99	Maximum
Traditional Bonds	7,430	99.5	40.8	97.1	98.6	99.1	99.5	99.8	99.9	100.0	100.0	100.0	106.9
All Bonds	10,804	99.6	25.0	97.4	98.9	99.2	99.6	99.92	100	100	100	100	112.6

Panel B: Time Difference Between Trading Signals and Bond Return

			Percentiles								
	N	Mean	1	5	10	25	50	75	90	95	99
Traditional Bonds	363,516	16.7	8.0	8.0	8.0	9.0	11.0	15.0	27.0	40.0	97.0
All Bonds	459,513	20.5	8.0	8.0	8.0	10.0	12.0	20.0	36.0	56.0	142.0

Table 2: Portfolio Sorts by Bond Book-to-Market

The table reports summary statistics of bond and firm characteristics by bond book-to-market (BBM) quintiles (Panel A) as well as averages and selected test statistics of monthly portfolio returns (Panel B). Panel A reports averages of various characteristics of bonds and issuing firms, including the time series average of the monthly mean characteristics across all observations ("All"), and the average of the monthly mean characteristics across quintiles of bonds sorted by bond book-to-market from Q1 (lowest) to Q5 (highest). Panel B reports equal- and value-weighted average returns on these portfolios, as well as the returns on the hedge portfolios with a long position in Q5 and a short position in Q1. The sample consists of nonfinancial firms with U.S. dollar-denominated, senior unsecured corporate bonds with no embedded options other than call options. The return sample period is February 2003 to May 2018. All variables are defined in Appendix A.

Panel A: Bond and Firm Characteristics

			Bond Book/Market (BBM) Quintiles				
	All	Correlation	Q1 (low BBM)	Q2	Q3	Q4	Q5 (high BBM)
Bond Book/Market	0.964	1.00	0.849	0.921	0.959	0.994	1.096
Bond Mispricing	-0.001	0.30	-0.010	-0.004	-0.001	0.003	0.011
Bond Yield	4.951	0.42	4.795	4.326	4.526	4.687	6.409
Bond Value	501.1	-0.12	593.3	531.7	486.0	472.5	421.6
Bond Face Value	472.1	-0.04	496.6	487.0	464.5	467.2	445.1
Bond Age	4.808	-0.14	6.800	5.156	4.485	3.710	3.890
Bond Maturity	11.08	-0.09	15.92	9.680	9.002	8.649	12.14
Bond Rating	8.235	0.25	7.514	7.931	8.210	8.288	9.240
Bond Reversal	0.644	-0.03	0.704	0.606	0.616	0.646	0.724
Bond Momentum	3.454	-0.19	4.442	3.537	3.312	3.026	3.297
Bond Bid/Ask Spread	0.525	0.19	0.481	0.460	0.481	0.502	0.726
Number of Bonds	37.90	0.01	36.56	30.01	32.54	40.34	50.11
Number of Days from Beginning of Month	3.08	-0.06	3.92	3.03	2.81	2.79	2.96
Number of Days from End of Month	2.45	-0.06	3.13	2.40	2.21	2.22	2.36
Nearness to Default	-9.57	0.17	-10.21	-9.88	-9.547	-9.547	-8.662
Investment Grade	0.854	-0.250	0.951	0.908	0.861	0.841	0.711
Non-Investment Grade	0.146	0.250	0.050	0.092	0.139	0.159	0.289
Offering Price	99.47	0.04	99.21	99.48	99.52	99.59	99.55
Equity Mispricing	0.062	-0.01	0.040	0.064	0.073	0.064	0.088
Equity Market Capitalization	35,835	-0.07	40,837	33,807	33,725	37,700	33,097
Equity Book/Market	0.671	0.20	0.604	0.617	0.623	0.667	0.843
Equity Beta	0.993	0.17	0.907	0.936	0.975	1.001	1.148
SUE	-0.001	-0.09	0.001	0.001	0.001	0.000	-0.009
Gross Profitability	0.227	-0.04	0.233	0.234	0.231	0.227	0.210
Earnings Yield	0.019	-0.27	0.057	0.056	0.048	0.039	-0.106
Equity Short-term Reversal	1.057	-0.02	1.072	1.090	1.048	1.080	0.996
Equity Momentum	11.28	-0.14	13.77	12.79	12.43	11.08	6.330
Equity Long-term Reversal	54.43	-0.10	59.25	58.28	56.36	54.04	44.23
Accruals	0.082	-0.04	0.085	0.088	0.097	0.088	0.057

(continued)

Table 2: Portfolio Sorts by Bond Book-to-Market (continued)

Panel B: Portfolio Returns

	All	Correlation	Bond Book/Market (BBM) Quintiles Q1 (low BBM)	Q2	Q3	Q4	Q5 (high BBM)	Q5-Q1 (high BBM - low BBM) Fraction > 0	*p-value*	Average	*t-stat*
Equal-weighted Bond Return (t+1)	0.628	0.05	0.518	0.509	0.552	0.632	0.984	0.62	[0.00]	0.466	[3.60]
Value-weighted Bond Return (t+1)	0.532	0.05	0.469	0.460	0.506	0.562	0.887	0.59	[0.02]	0.418	[3.34]

Table 3: Fama-MacBeth Cross-Sectional Regressions

The table shows average coefficients and test statistics from Fama and MacBeth (1973) regressions of monthly bond returns on bond and stock characteristics. Across different specifications, returns are regressed against end-of-prior-month values for bond book-to-market, bond yield to maturity, bond value, bond age, bond maturity, bond bid-ask spreads, lagged bond returns, bond momentum, bond credit rating, nearness to default, equity market beta, equity book-to-market, equity market capitalization, equity short-term reversal, equity momentum, equity long-term reversal, accruals, standardized unexpected earnings (SUE), gross profitability, and earnings yield. The table employs quintile dummies for the characteristics as regressors except for bond book-to-market in even-numbered specifications, which employ the normal score of bond book-to-market. Each month's quintiles are determined from sorts of firms with non-missing values for all characteristics. Size (market capitalization) quintiles are based on NYSE breakpoints. The regressions include dummy variables for Quintiles 2, 3, 4, and 5 of each characteristic, but the table displays only the coefficients of the quintile dummy with the largest amount of the characteristic (Q5) for brevity. Additional controls are the number of outstanding bonds of a firm, the percentage of bond market capitalization of a firm that trade in a month, and the number of days from the beginning and end of the month of bond price data used to calculate the bond return. All regressions include industry dummy variables based on the 38 Fama and French industry classifications. The table also shows the average number of observations and average adjusted R-Squared. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% level, respectively. The return sample period is February 2003 to May 2018. All variables are defined in Appendix A.

(continued)

Table 3: Fama-MacBeth Cross-Sectional Regressions (continued)

	(1)		(2)		(3)		(4)		(5)		(6)		(7)		(8)	
	Coef	*t*-stat	Coef	*t*-stat	Coef	*t*-stat	Coef	*t*-stat	Coef	*t*-stat	Coef	*t*-stat	Coef	*t*-stat	Coef	*t*-stat
Bond Book/Market Q5	0.478	[3.63] ***			0.483	[3.67] ***			0.245	[3.77] ***			0.284	[4.44] ***		
Bond Book/Market (normal score)			0.152	[3.15] ***			0.153	[3.17] ***			0.083	[2.36] **			0.098	[3.19] ***
Bond Characteristic Controls																
Bond Yield Q5									0.410	[5.84] ***	0.420	[5.90] ***	0.437	[6.46] ***	0.452	[6.45] ***
Bond Value Q5									-0.070	[-1.28]	-0.065	[-1.19]	-0.084	[-1.62]	-0.076	[-1.50]
Bond Age Q5									0.026	[0.61]	0.020	[0.43]	0.010	[0.20]	0.004	[0.09]
Bond Maturity Q5									0.257	[2.17] **	0.275	[2.29] **	0.240	[2.12] **	0.253	[2.21] **
Bond Bid/Ask Spread Q5									0.106	[2.40] **	0.096	[2.34] **	0.110	[2.76] ***	0.102	[2.71] ***
Bond Reversal Q5									-0.286	[-5.54] ***	-0.285	[-5.53] ***	-0.320	[-6.35] ***	-0.318	[-6.34] ***
Bond Momentum Q5									-0.062	[-1.15]	-0.070	[-1.40]	-0.074	[-1.50]	-0.079	[-1.69] *
Bond Rating Q5									-0.145	[-1.54]	-0.158	[-1.73] *	-0.080	[-0.71]	-0.093	[-0.85]
Nearness to Default Q5									0.032	[0.45]	0.023	[0.34]	0.099	[1.07]	0.095	[1.06]
Stock Characteristic Controls																
Beta Q5													0.004	[0.05]	-0.010	[-0.13]
Market Capitalization Q5													0.119	[1.38]	0.118	[1.35]
Book/Market Q5													0.023	[0.25]	0.020	[0.23]
Short-term Reversal Q5													0.287	[4.53] ***	0.282	[4.47] ***
Momentum Q5													-0.057	[-0.72]	-0.053	[-0.70]
Long-term Reversal Q5													-0.070	[-1.08]	-0.057	[-0.89]
Accruals Q5													-0.037	[-0.64]	-0.048	[-0.82]
SUE Q5													0.176	[2.78] ***	0.178	[2.87] ***
Gross Profitability Q5													0.155	[1.88] *	0.152	[1.83] *
Earnings Yield Q5													0.072	[0.99]	0.073	[1.02]
Market Microstructure Controls																
Number of Bonds in t+1					0.000	[-0.35]	0.000	[0.27]	0.000	[-1.15]	0.000	[-1.09]	0.000	[-0.92]	0.000	[-0.71]
Percent of Bond Market Cap Traded in t+1					-0.117	[-1.13]	-0.064	[-0.62]	-0.304	[-2.93] ***	-0.287	[-2.92] ***	-0.336	[-3.02] ***	-0.317	[-2.92] ***
Number of Days from Beginning of Month t+1					0.009	[2.99] ***	0.009	[3.03] ***	0.006	[2.18] **	0.006	[2.05] **	0.006	[2.00] **	0.006	[2.01] **
Number of Days from End of Month t+1					0.027	[4.27] ***	0.027	[4.40] ***	0.019	[3.38] ***	0.019	[3.41] ***	0.018	[3.16] ***	0.018	[3.17] ***
Intercept	0.496	[2.81] ***	0.630	[3.36] ***	0.551	[2.58] **	0.640	[2.89] ***	0.780	[4.00] ***	0.839	[4.46] ***	1.920	[1.18]	2.361	[1.19]
Observations	993		993		993		993		992		992		992		992	
Adj. R-Squared	0.10		0.09		0.11		0.10		0.23		0.23		0.26		0.27	
Industry Control	Yes		Yes		Yes		Yes		Yes		Yes		Yes		Yes	

Table 4: Factor Model Time Series Regressions

The table shows intercepts, slope coefficients, and *t*-statistics from time series regressions of monthly portfolio returns (in excess of 1-month USD LIBOR) on twenty-one pairs of factors. Bonds are sorted each month into quintiles based on bond book-to-market (BBM) and combined into equal-weighted (Panel A) or value-weighted (Panel B) portfolios. The table reports regression statistics separately for each of the five portfolios, Q1–Q5, and for the return spreads between the highest bond book-to-market (Q5) and lowest bond book-to-market (Q1) quintiles. Regressors for the factor model are the excess return on the market portfolio, SMB (small minus big), HML (high minus low), CMA (conservative minus aggressive), RMW (robust minus weak), Momentum, Short-term Reversal, and Long-term Reversal, obtained from the Kenneth French data library (http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html). The model also includes the equal- (Panel A) and value- (Panel B) weighted average stock return (in excess of the risk-free rate) of the firms in the bond book-to-market quintile. Furthermore, the model includes the Default Spread and the Term Spread, obtained from Amit Goyal's website (http://www.hec.unil.ch/agoyal/), the fixed income value strategy returns and the fixed income momentum strategy returns, obtained from Toby Moskowitz's website (https://faculty.som.yale.edu/tobymoskowitz/research/data/), as well as the returns on the Bloomberg Barclays U.S. Treasury Intermediate Index, U.S. Long-Term Treasury Index, U.S. Corporate Investment Grade Index, and the U.S. Corporate High-Yield Index, all in excess of the risk-free rate. All risk models include one lead of each factor. Standard errors are estimated using the Newey West (1987) procedure. The table also shows the number of observations and R-squared. *, **, and *** indicate significance at the 10%, 5%, and 1% level, respectively. The return sample period is February 2003 to May 2018. All variables are defined in Appendix A.

Panel A: Equal-weighted Portfolios

	Q1 (low BBM)		Q2		Q3		Q4		Q5 (high BBM)		Q5-Q1	
	Coef	*t*-stat	Coef	*t*-stat	Coef	*t*-stat	Coef	*t*-stat	Coef	*t*-stat	Coef	*t*-stat
Intercept	0.117	[2.12] **	0.139	[4.74] ***	0.175	[4.98] ***	0.157	[3.35] ***	0.366	[4.71] ***	0.249	[2.96] ***
Excess Return on Market Portfolio (*t*+1)	-0.020	[-0.46]	-0.011	[-0.43]	-0.034	[-1.21]	-0.025	[-0.74]	-0.088	[-1.08]	-0.068	[-0.84]
Excess Return on Market Portfolio (*t*+2)	0.058	[1.10]	-0.039	[-1.35]	-0.029	[-0.97]	-0.039	[-0.90]	-0.073	[-0.83]	-0.131	[-1.40]
SMB (*t*+1)	0.002	[0.10]	-0.001	[-0.10]	0.002	[0.12]	0.037	[1.85] *	0.069	[1.65]	0.067	[1.63]
SMB (*t*+2)	-0.012	[-0.52]	-0.023	[-1.66] *	-0.009	[-0.70]	0.006	[0.35]	-0.025	[-0.70]	-0.013	[-0.34]
HML (*t*+1)	-0.003	[-0.15]	-0.023	[-1.67] *	-0.041	[-2.37] **	-0.041	[-2.01] **	-0.064	[-1.42]	-0.061	[-1.33]
HML (*t*+2)	-0.021	[-0.80]	-0.024	[-1.48]	-0.029	[-1.48]	-0.017	[-0.73]	-0.083	[-2.44] **	-0.063	[-1.65]
CMA (*t*+1)	-0.067	[-1.69] *	-0.013	[-0.54]	0.001	[0.03]	0.030	[0.78]	0.042	[0.52]	0.110	[1.38]
CMA (*t*+2)	0.009	[0.24]	-0.012	[-0.52]	0.004	[0.22]	0.072	[2.40] **	0.125	[1.89] *	0.116	[1.58]
RMW (*t*+1)	-0.040	[-1.15]	-0.018	[-0.92]	0.011	[0.55]	0.038	[1.57]	0.033	[0.60]	0.073	[1.18]
RMW (*t*+2)	0.043	[1.38]	-0.003	[-0.15]	-0.020	[-0.99]	-0.019	[-0.77]	-0.129	[-2.24] **	-0.172	[-2.78] ***
Momentum (*t*+1)	0.036	[2.38] **	0.021	[2.03] **	0.014	[1.04]	0.007	[0.42]	0.010	[0.36]	-0.027	[-1.03]
Momentum (*t*+2)	0.014	[0.83]	0.000	[0.01]	-0.026	[-2.43] **	-0.013	[-0.86]	0.002	[0.07]	-0.012	[-0.31]
Short-term Reversal (*t*+1)	-0.008	[-0.46]	0.011	[1.09]	0.002	[0.15]	0.009	[0.63]	0.009	[0.31]	0.017	[0.57]
Short-term Reversal (*t*+2)	-0.006	[-0.37]	-0.002	[-0.26]	0.006	[0.59]	-0.001	[-0.09]	0.017	[0.71]	0.023	[0.94]
Long-term Reversal (*t*+1)	0.082	[2.67] ***	0.043	[2.50] **	0.058	[3.56] ***	0.044	[1.97] *	0.017	[0.29]	-0.065	[-1.05]
Long-term Reversal (*t*+2)	-0.018	[-0.64]	-0.004	[-0.22]	-0.006	[-0.34]	-0.038	[-1.68] *	-0.069	[-1.68] *	-0.051	[-0.99]

(continued)

Table 4: Factor Model Time Series Regressions (continued)

Panel A: Equal-weighted Portfolios (continued)

	Q1 (low BBM)		**Q2**		**Q3**		**Q4**		**Q5 (high BBM)**		**Q5-Q1**	
	Coef	*t*-stat	Coef	*t*-stat	Coef	*t*-stat	Coef	*t*-stat	Coef	*t*-stat	Coef	*t*-stat
Excess Stock Return Bond Book/Market Quintile 1 (*t*+1)	0.058	[0.65]	-0.005	[-0.10]	-0.007	[-0.11]	-0.016	[-0.21]	0.167	[1.03]	0.110	[0.70]
Excess Stock Return Bond Book/Market Quintile 1 (*t*+2)	0.101	[1.19]	0.023	[0.44]	0.059	[1.30]	-0.022	[-0.28]	-0.063	[-0.58]	-0.164	[-1.16]
Excess Stock Return Bond Book/Market Quintile 2 (*t*+1)	0.073	[0.65]	0.064	[0.88]	0.068	[0.78]	-0.120	[-0.99]	-0.050	[-0.27]	-0.123	[-0.66]
Excess Stock Return Bond Book/Market Quintile 2 (*t*+2)	-0.033	[-0.28]	0.038	[0.49]	-0.009	[-0.13]	0.096	[0.77]	0.119	[0.53]	0.152	[0.60]
Excess Stock Return Bond Book/Market Quintile 3 (*t*+1)	-0.157	[-1.57]	-0.069	[-1.14]	-0.090	[-1.39]	-0.037	[-0.41]	-0.081	[-0.56]	0.076	[0.51]
Excess Stock Return Bond Book/Market Quintile 3 (*t*+2)	0.017	[0.19]	-0.032	[-0.54]	-0.104	[-1.49]	-0.204	[-1.62]	-0.047	[-0.24]	-0.065	[-0.32]
Excess Stock Return Bond Book/Market Quintile 4 (*t*+1)	0.041	[0.61]	-0.002	[-0.05]	0.059	[1.27]	0.199	[1.61]	-0.138	[-0.98]	-0.179	[-1.27]
Excess Stock Return Bond Book/Market Quintile 4 (*t*+2)	-0.170	[-2.31] **	-0.010	[-0.26]	0.067	[1.48]	0.155	[2.04] **	-0.067	[-0.63]	0.103	[0.87]
Excess Stock Return Bond Book/Market Quintile 5 (*t*+1)	0.019	[0.76]	0.012	[0.81]	-0.010	[-0.64]	-0.045	[-1.38]	0.151	[2.95] ***	0.132	[2.45] **
Excess Stock Return Bond Book/Market Quintile 5 (*t*+2)	0.071	[3.11] ***	0.026	[2.21] **	-0.011	[-0.78]	-0.021	[-1.05]	0.097	[1.72] *	0.026	[0.46]
Default Spread (*t*+1)	-0.041	[-0.65]	-0.090	[-3.14] ***	-0.012	[-0.38]	-0.063	[-1.26]	0.007	[0.08]	0.049	[0.43]
Default Spread (*t*+2)	0.072	[0.96]	0.027	[0.67]	-0.008	[-0.18]	-0.048	[-0.80]	0.239	[1.98] **	0.168	[1.40]
Term Spread (*t*+1)	-0.150	[-1.26]	-0.031	[-0.54]	0.066	[0.91]	0.096	[0.91]	0.109	[0.92]	0.259	[1.61]
Term Spread (*t*+2)	0.060	[0.68]	-0.025	[-0.46]	-0.053	[-0.89]	-0.150	[-1.80] *	0.090	[0.58]	0.030	[0.18]
Fixed Income Value Factor (*t*+1)	-0.107	[-1.42]	-0.005	[-0.12]	-0.008	[-0.17]	-0.023	[-0.31]	-0.020	[-0.19]	0.087	[0.76]
Fixed Income Value Factor (*t*+2)	-0.069	[-0.93]	-0.029	[-0.65]	0.012	[0.27]	0.087	[1.45]	-0.037	[-0.40]	0.031	[0.29]
Fixed Income Momentum Factor (*t*+1)	-0.027	[-0.39]	0.027	[0.68]	-0.035	[-1.01]	-0.068	[-1.39]	-0.200	[-2.16] **	-0.173	[-1.73] *
Fixed Income Momentum Factor (*t*+2)	-0.162	[-2.62] ***	-0.048	[-1.28]	0.018	[0.40]	0.018	[0.29]	-0.055	[-0.55]	0.107	[0.99]
Excess Return U.S. Treasury Bonds Intermediate Maturity (*t*+1)	-0.052	[-0.43]	0.039	[0.60]	0.076	[1.14]	0.115	[1.17]	-0.162	[-0.95]	-0.110	[-0.60]
Excess Return U.S. Treasury Bonds Intermediate Maturity (*t*+2)	0.074	[0.57]	0.097	[1.18]	0.071	[0.81]	0.067	[0.60]	0.222	[1.17]	0.147	[0.80]
Excess Return U.S. Treasury Bonds Long Maturity (*t*+1)	0.265	[2.33] **	0.044	[0.85]	-0.029	[-0.42]	-0.074	[-0.73]	-0.047	[-0.43]	-0.311	[-2.12] **
Excess Return U.S. Treasury Bonds Long Maturity (*t*+2)	-0.024	[-0.27]	0.025	[0.50]	0.049	[0.99]	0.116	[1.58]	0.058	[0.43]	0.082	[0.52]
Excess Return U.S. Corporate Bonds Investment Grade (*t*+1)	0.645	[5.34] ***	0.581	[9.61] ***	0.479	[8.20] ***	0.505	[6.32] ***	0.401	[2.32] **	-0.244	[-1.28]
Excess Return U.S. Corporate Bonds Investment Grade (*t*+2)	-0.020	[-0.15]	-0.078	[-1.16]	-0.060	[-0.69]	-0.015	[-0.13]	-0.434	[-2.30] **	-0.414	[-2.15] **
Excess Return U.S. Corporate Bonds High Yield (*t*+1)	0.041	[0.82]	0.089	[3.14] ***	0.111	[4.20] ***	0.208	[5.09] ***	0.519	[8.72] ***	0.478	[6.36] ***
Excess Return U.S. Corporate Bonds High Yield (*t*+2)	-0.110	[-1.96] *	0.010	[0.40]	0.071	[2.05] **	0.118	[2.61] **	0.121	[2.09] **	0.231	[3.00] ***
R-Squared	0.88		0.94		0.94		0.92		0.88		0.79	
Observations	184		184		184		184		184		184	

(continued)

Table 4: Factor Model Time Series Regressions (continued)

Panel B: Value-weighted Portfolios

	Q1 (low BBM)		Q2		Q3		Q4		Q5 (high BBM)		Q5-Q1	
	Coef	*t*-stat	Coef	*t*-stat	Coef	*t*-stat	Coef	*t*-stat	Coef	*t*-stat	Coef	*t*-stat
Intercept	0.038	[0.69]	0.078	[2.55] **	0.121	[2.94] ***	0.103	[2.03] **	0.217	[3.57] ***	0.179	[2.41] **
Excess Return on Market Portfolio (*t*+1)	-0.029	[-0.57]	0.003	[0.10]	-0.024	[-0.67]	-0.025	[-0.63]	-0.094	[-1.30]	-0.065	[-0.79]
Excess Return on Market Portfolio (*t*+2)	0.049	[0.77]	-0.066	[-1.75] *	-0.036	[-0.96]	-0.078	[-1.58]	-0.069	[-1.11]	-0.118	[-1.36]
SMB (*t*+1)	0.011	[0.48]	0.009	[0.62]	0.010	[0.69]	0.020	[1.20]	0.025	[0.88]	0.014	[0.45]
SMB (*t*+2)	-0.018	[-0.64]	-0.018	[-1.15]	-0.011	[-0.80]	0.000	[-0.01]	-0.015	[-0.50]	0.003	[0.08]
HML (*t*+1)	-0.010	[-0.43]	-0.021	[-1.34]	-0.041	[-2.13] **	-0.045	[-1.89] *	-0.088	[-2.83] ***	-0.078	[-2.21] **
HML (*t*+2)	-0.024	[-0.86]	-0.030	[-1.67] *	-0.039	[-1.69] *	-0.027	[-1.01]	-0.063	[-1.77] *	-0.039	[-0.88]
CMA (*t*+1)	-0.092	[-1.91] *	-0.018	[-0.67]	0.048	[1.30]	0.066	[1.52]	0.038	[0.65]	0.131	[1.82] *
CMA (*t*+2)	-0.035	[-0.78]	-0.020	[-0.69]	0.017	[0.73]	0.069	[2.20] **	0.159	[2.07] **	0.193	[2.24] **
RMW (*t*+1)	-0.037	[-1.01]	-0.007	[-0.33]	0.016	[0.78]	0.036	[1.50]	0.082	[1.84] *	0.119	[2.24] **
RMW (*t*+2)	0.026	[0.75]	-0.031	[-1.33]	-0.028	[-1.29]	-0.033	[-1.21]	-0.120	[-2.41] **	-0.146	[-2.49] **
Momentum (*t*+1)	0.030	[1.73] *	0.015	[1.28]	0.017	[1.25]	0.021	[1.43]	0.050	[2.24] **	0.020	[0.70]
Momentum (*t*+2)	0.009	[0.47]	-0.002	[-0.18]	-0.007	[-0.65]	-0.012	[-0.85]	0.009	[0.40]	0.000	[-0.02]
Short-term Reversal (*t*+1)	-0.020	[-0.87]	0.016	[1.39]	0.008	[0.56]	0.005	[0.29]	-0.005	[-0.22]	0.015	[0.52]
Short-term Reversal (*t*+2)	-0.026	[-1.17]	-0.011	[-0.94]	0.003	[0.22]	-0.007	[-0.39]	-0.009	[-0.36]	0.017	[0.61]
Long-term Reversal (*t*+1)	0.106	[2.92] ***	0.042	[2.36] **	0.034	[1.86] *	0.008	[0.30]	0.062	[1.38]	-0.043	[-0.87]
Long-term Reversal (*t*+2)	-0.004	[-0.14]	-0.004	[-0.16]	0.003	[0.17]	-0.028	[-1.22]	-0.081	[-1.93] *	-0.077	[-1.58]

(continued)

Table 4: Factor Model Time Series Regressions (continued)

Panel B: Value-weighted Portfolios (continued)

	Q1 (low BBM)		Q2		Q3		Q4		Q5 (high BBM)		Q5-Q1	
	Coef	*t*-stat	Coef	*t*-stat	Coef	*t*-stat	Coef	*t*-stat	Coef	*t*-stat	Coef	*t*-stat
Excess Stock Return Bond Book/Market Quintile 1 (*t*+1)	0.112	[1.24]	0.001	[0.01]	0.016	[0.29]	-0.042	[-0.67]	0.045	[0.45]	-0.067	[-0.56]
Excess Stock Return Bond Book/Market Quintile 1 (*t*+2)	-0.067	[-0.75]	0.034	[0.70]	0.040	[0.79]	0.030	[0.49]	-0.035	[-0.36]	0.032	[0.28]
Excess Stock Return Bond Book/Market Quintile 2 (*t*+1)	0.028	[0.26]	0.084	[1.59]	-0.064	[-0.90]	-0.060	[-0.73]	-0.191	[-1.44]	-0.219	[-1.31]
Excess Stock Return Bond Book/Market Quintile 2 (*t*+2)	0.150	[1.31]	0.040	[0.65]	0.002	[0.04]	-0.037	[-0.46]	0.025	[0.15]	-0.125	[-0.75]
Excess Stock Return Bond Book/Market Quintile 3 (*t*+1)	-0.074	[-0.66]	-0.007	[-0.11]	0.080	[1.30]	0.061	[0.95]	0.080	[0.76]	0.154	[1.09]
Excess Stock Return Bond Book/Market Quintile 3 (*t*+2)	-0.020	[-0.25]	-0.028	[-0.54]	-0.086	[-1.79] *	-0.037	[-0.61]	0.075	[0.66]	0.095	[0.80]
Excess Stock Return Bond Book/Market Quintile 4 (*t*+1)	-0.027	[-0.30]	-0.084	[-1.63]	-0.042	[-0.83]	0.005	[0.08]	-0.094	[-0.87]	-0.068	[-0.46]
Excess Stock Return Bond Book/Market Quintile 4 (*t*+2)	-0.128	[-1.66] *	-0.016	[-0.32]	0.023	[0.51]	0.084	[1.29]	-0.127	[-1.44]	0.001	[0.01]
Excess Stock Return Bond Book/Market Quintile 5 (*t*+1)	0.015	[0.41]	0.005	[0.29]	0.009	[0.53]	0.029	[1.22]	0.218	[5.78] ***	0.203	[3.61] ***
Excess Stock Return Bond Book/Market Quintile 5 (*t*+2)	0.075	[2.60] **	0.035	[2.10] **	0.010	[0.73]	-0.021	[-1.23]	0.093	[1.74] *	0.018	[0.29]
Default Spread (*t*+1)	0.077	[1.06]	-0.054	[-1.73] *	0.059	[1.38]	0.082	[1.31]	0.102	[1.27]	0.025	[0.24]
Default Spread (*t*+2)	0.086	[1.06]	0.035	[0.80]	-0.044	[-0.94]	-0.118	[-1.81] *	0.123	[1.21]	0.037	[0.33]
Term Spread (*t*+1)	0.011	[0.07]	-0.016	[-0.21]	0.098	[1.17]	0.194	[1.78] *	0.211	[1.29]	0.201	[0.82]
Term Spread (*t*+2)	0.015	[0.15]	-0.034	[-0.50]	-0.129	[-1.74] *	-0.263	[-2.77] ***	-0.019	[-0.14]	-0.034	[-0.19]
Fixed Income Value Factor (*t*+1)	-0.139	[-1.57]	0.006	[0.12]	-0.032	[-0.69]	0.002	[0.03]	-0.077	[-1.00]	0.062	[0.59]
Fixed Income Value Factor (*t*+2)	-0.078	[-1.03]	-0.072	[-1.54]	0.034	[0.72]	0.080	[1.29]	0.030	[0.29]	0.108	[0.91]
Fixed Income Momentum Factor (*t*+1)	0.024	[0.31]	0.058	[1.43]	-0.070	[-1.81] *	-0.052	[-1.07]	-0.128	[-1.67] *	-0.152	[-1.53]
Fixed Income Momentum Factor (*t*+2)	-0.173	[-2.47] **	-0.084	[-2.01] **	0.022	[0.47]	0.001	[0.01]	-0.132	[-1.32]	0.041	[0.40]
Excess Return U.S. Treasury Bonds Intermediate Maturity (*t*+1)	-0.046	[-0.33]	0.063	[0.91]	0.101	[1.26]	0.198	[2.11] **	0.038	[0.21]	0.084	[0.39]
Excess Return U.S. Treasury Bonds Intermediate Maturity (*t*+2)	0.114	[0.85]	0.084	[0.87]	0.000	[0.01]	0.043	[0.37]	0.222	[1.33]	0.108	[0.58]
Excess Return U.S. Treasury Bonds Long Maturity (*t*+1)	0.181	[1.25]	0.045	[0.67]	-0.025	[-0.32]	-0.123	[-1.24]	-0.083	[-0.56]	-0.265	[-1.17]
Excess Return U.S. Treasury Bonds Long Maturity (*t*+2)	0.004	[0.04]	0.019	[0.32]	0.100	[1.79] *	0.167	[2.25] **	0.069	[0.56]	0.065	[0.41]
Excess Return U.S. Corporate Bonds Investment Grade (*t*+1)	0.635	[4.91] ***	0.665	[10.30] ***	0.531	[7.05] ***	0.491	[5.21] ***	0.319	[2.05] **	-0.316	[-1.79] *
Excess Return U.S. Corporate Bonds Investment Grade (*t*+2)	-0.006	[-0.04]	-0.048	[-0.63]	-0.008	[-0.09]	0.078	[0.59]	-0.218	[-1.30]	-0.212	[-1.04]
Excess Return U.S. Corporate Bonds High Yield (*t*+1)	0.055	[0.88]	0.071	[2.18] **	0.092	[2.55] **	0.163	[3.75] ***	0.550	[7.37] ***	0.495	[5.36] ***
Excess Return U.S. Corporate Bonds High Yield (*t*+2)	-0.167	[-2.57] **	-0.024	[-0.90]	0.092	[2.39] **	0.130	[2.18] **	0.080	[1.25]	0.247	[2.69] ***
R-Squared	0.89		0.94		0.95		0.94		0.93		0.82	
Observations	184		184		184		184		184		184	

Table 5: Default Risk

The table shows average coefficients and test statistics from Fama and MacBeth (1973) regressions of monthly bond returns on bond and stock characteristics with interaction variables for bonds with high default risk. Across different specifications, returns are regressed against end-of-prior-month values for bond book-to-market, bond yield to maturity, bond value, bond age, bond maturity, bond bid-ask spreads, lagged bond returns, bond momentum, bond credit rating, nearness to default, equity market beta, equity book-to-market, equity market capitalization, equity short-term reversal, equity momentum, equity long-term reversal, accruals, standardized unexpected earnings (SUE), gross profitability, and earnings yield. The table employs quintile dummies for the characteristics as regressors except for bond book-to-market in even-numbered specifications, which employ the normal score of bond book-to-market. Each month's quintiles are determined from sorts of firms with non-missing values for all characteristics. Size (market capitalization) quintiles are based on NYSE breakpoints. The regressions include dummy variables for Quintiles 2, 3, 4, and 5 of each characteristic, but the table displays only the coefficients of the quintile dummy with the largest amount of the characteristic (Q5) for brevity. All regressions include the fifth quintile dummy for nearness to default (Panel A) or for bond credit rating (Panel B), as well as interactions of these indicator variables with the fifth quintile dummy for bond book-to-market and the normal score of bond book-to-market, respectively. Additional controls are the number of outstanding bonds of a firm, the percentage of bond market capitalization of a firm that trade in a month, and the number of days from the beginning and end of the month of bond price data used to calculate the bond return. All regressions include industry dummy variables based on the 38 Fama and French industry classifications. The table also shows the average number of observations and average adjusted R-Squared. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% level, respectively. The return sample period is February 2003 to May 2018. All variables are defined in Appendix A.

Panel A: Interaction with Nearness to Default

	(1)			(2)			(3)			(4)			(5)			(6)			(7)			(8)		
	Coef	*t*-stat		Coef	*t*-stat		Coef	*t*-stat		Coef	*t*-stat		Coef	*t*-stat		Coef	*t*-stat		Coef	*t*-stat		Coef	*t*-stat	
Bond Book/Market Q5 * Nearness to Default Q5	-0.143	[-1.03]					-0.137	[-0.97]					-0.160	[-1.20]					-0.154	[-1.17]				
Bond Book/Market (normal score) * Nearness to Default Q5				0.126	[1.33]					0.132	[1.39]					0.077	[0.87]					0.101	[1.13]	
Bond Book/Market Q5	0.428	[4.09]	***				0.428	[4.03]	***				0.242	[4.38]	***				0.274	[4.44]	***			
Bond Book/Market (normal score)				0.112	[3.16]	***				0.115	[3.17]	***				0.074	[3.26]	***				0.085	[3.70]	***
Nearness to Default Q5	0.175	[1.56]		-0.006	[-0.07]		0.185	[1.56]		-0.009	[-0.11]		0.136	[1.25]		-0.076	[-1.25]		0.178	[1.35]		0.017	[0.15]	
Observations	993			993			993			993			992			992			992			992		
Adj. R-Squared	0.13			0.13			0.13			0.13			0.24			0.24			0.27			0.27		
Bond Characteristic Controls (see Table 3)	No			No			No			No			Yes			Yes			Yes			Yes		
Stock Characteristic Controls (see Table 3)	No			No			No			No			No			No			Yes			Yes		
Market Microstructure Controls (see Table 3)	No			No			Yes			Yes			Yes			Yes			Yes			Yes		
Industry Controls	Yes			Yes			Yes			Yes			Yes			Yes			Yes			Yes		

(continued)

Table 5: Default Risk (continued)

Panel B: Interaction with Bond Credit Rating

	(1)		(2)		(3)		(4)		(5)		(6)		(7)		(8)	
	Coef	*t*-stat	Coef	*t*-stat	Coef	*t*-stat	Coef	*t*-stat	Coef	*t*-stat	Coef	*t*-stat	Coef	*t*-stat	Coef	*t*-stat
Bond Book/Market Q5 * Bond Rating Q5	0.066	[0.43]			0.080	[0.52]			0.009	[0.06]			0.103	[0.64]		
Bond Book/Market (normal score) * Bond Rating Q5			0.125	[1.20]			0.126	[1.21]			0.087	[0.86]			0.119	[1.25]
Bond Book/Market Q5	0.408	[3.86] ***			0.410	[3.82] ***			0.221	[4.06] ***			0.240	[3.95] ***		
Bond Book/Market (normal score)			0.109	[3.07] ***			0.111	[3.09] ***			0.068	[3.19] ***			0.076	[3.47] ***
Bond Rating Q5	-0.085	[-0.78]	-0.017	[-0.18]	-0.073	[-0.66]	-0.008	[-0.08]	-0.181	[-1.94] *	-0.220	[-2.24] **	-0.187	[-1.85] *	-0.202	[-1.84] *
Observations	992		992		992		992		992		992		992		992	
Adj. R-Squared	0.13		0.13		0.14		0.14		0.24		0.25		0.27		0.28	
Bond Characteristic Controls (see Table 3)	No		No		No		No		Yes		Yes		Yes		Yes	
Stock Characteristic Controls (see Table 3)	No		No		No		No		No		No		Yes		Yes	
Market Microstructure Controls (see Table 3)	No		No		Yes		Yes		Yes		Yes		Yes		Yes	
Industry Controls	Yes		Yes		Yes		Yes		Yes		Yes		Yes		Yes	

Table 6: Treasury Bonds

The table shows results from Fama-MacBeth (1973) regressions of monthly Treasury bond returns on Treasury bond characteristics. Treasury bond returns are regressed on book-to-market, yield to maturity, market value, age, time to maturity, bid-ask spreads, lagged returns, cumulative returns from $t-6$ to $t-1$ of Treasury bonds. The regressions include dummy variables for Quintiles 2, 3, 4, and 5 of each characteristic, but the table displays only the coefficients of the quintile dummy with the largest amount of the characteristic (Q5) for brevity. The table also shows the average number of observations and average adjusted R-Squared. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% level, respectively.

	(1)			(2)			(3)			(4)			(5)		
	Coef	*t*-stat		Coef	*t*-stat		Coef	*t*-stat		Coef	*t*-stat		Coef	*t*-stat	
Panel A. 1961.7-2018.5															
Bond Book/Market Q5	-0.069	[-1.30]		0.054	[0.81]								-0.016	[-0.64]	
Bond Yield Q5							0.274	[3.37]	***	0.138	[3.05]	***	0.134	[3.10]	***
Bond Value Q5				-0.010	[-0.21]					-0.009	[-0.47]		0.000	[-0.03]	
Bond Age Q5				-0.060	[-2.20]	**				-0.009	[-0.43]		-0.019	[-0.88]	
Bond Maturity Q5				0.130	[1.77]	*				-0.015	[-0.34]		-0.028	[-0.67]	
Bond Bid/Ask Spread Q5				-0.016	[-0.22]					0.006	[0.25]		0.036	[1.87]	*
Bond Reversal Q5				-0.041	[-1.10]					-0.069	[-2.30]	**	-0.082	[-2.80]	***
Bond Momentum Q5				-0.028	[-0.71]					-0.023	[-1.10]		-0.02	[-1.10]	
Intercept	0.577	[9.00]	***	0.544	[8.46]	***	0.379	[9.64]	***	0.427	[9.22]	***	0.503	[10.10]	***
Observations	144			144			144			144			144		
Adj. R-Squared	0.28			0.77			0.58			0.76			0.76		
Panel B. 1961.7-2003.1															
Bond Book/Market Q5	-0.050	[-0.89]		0.097	[1.05]								0.036	[0.84]	
Bond Yield Q5							0.210	[2.46]	**	0.159	[3.03]	***	0.178	[3.53]	***
Bond Value Q5				-0.013	[-0.20]					-0.005	[-0.19]		-0.004	[-0.16]	
Bond Age Q5				-0.057	[-1.70]	*				0.002	[0.08]		-0.017	[-0.67]	
Bond Maturity Q5				0.073	[0.95]					0.003	[0.05]		-0.019	[-0.34]	
Bond Bid/Ask Spread Q5				-0.05	[-0.54]					0.005	[0.15]		0.048	[2.12]	**
Bond Reversal Q5				-0.036	[-0.83]					-0.069	[-2.00]	**	-0.112	[-3.10]	***
Bond Momentum Q5				-0.047	[-0.90]					-0.040	[-1.50]		-0.026	[-1.10]	
Intercept	0.635	[9.44]	***	0.657	[7.83]	***	0.472	[9.02]	***	0.504	[8.45]	***	0.615	[9.75]	***
Observations	117			117			117			117			117		
Adj. R-Squared	0.28			0.73			0.52			0.72			0.71		
Panel C. 2003.2-2018.5															
Bond Book/Market Q5	-0.123	[-1.10]		-0.044	[-0.91]								-0.041	[-0.85]	
Bond Yield Q5							0.447	[2.30]	**	-0.011	[-0.18]		-0.051	[-0.70]	
Bond Value Q5				-0.009	[-0.56]					-0.011	[-0.82]		-0.012	[-0.75]	
Bond Age Q5				-0.074	[-1.40]					-0.040	[-0.94]		-0.064	[-1.30]	
Bond Maturity Q5				0.274	[1.60]					-0.076	[-1.30]		-0.050	[-0.91]	
Bond Bid/Ask Spread Q5				0.037	[0.88]					0.021	[0.68]		0.035	[0.80]	
Bond Reversal Q5				-0.039	[-0.61]					-0.043	[-0.73]		-0.029	[-0.50]	
Bond Momentum Q5				0.017	[0.48]					0.010	[0.31]		0.017	[0.55]	
Intercept	0.418	[2.74]	***	0.24	[3.56]	***	0.125	[5.13]	***	0.216	[3.91]	***	0.223	[3.42]	***
Observations	216			216			216			216			216		
Adj. R-Squared	0.30			0.87			0.74			0.87			0.88		

Table 7: Factor Model Time Series Regressions with Bond HML Factor

The table shows estimates and *t*-statistics from time series regressions of monthly portfolio returns (in excess of 1-month USD LIBOR) on a risk model augmented with a high-minus-low factor based on bond book-to-market (BBM). Bonds are sorted each month into quintiles based on bond book-to-market and combined into equal-weighted portfolios. The table reports regression statistics separately for each of the five portfolios, Q1–Q5, and for the corresponding times-series of return spreads between the highest book-to-market (Q5) and lowest book-to-market (Q1) bond quintiles. To form the Bond HML factor, each month, we divide bonds into one of 6 categories based on bond size (aggregate market value outstanding) and bond book-to-market. For the 3 categories in the larger of the two bond sizes (bottom, middle, and top third of month-*t* bond book-to-market), we compute the spread in the month *t* + 1 value-weighted bond returns (based on bond market capitalization) between the top and bottom third bond book-to-market bonds. We then repeat the exercise for the firm in the smaller of the two bond sizes. We then average the two value-weighted return spreads and include the average as the Bond HML factor. Other factors in the risk model are, as in are the excess return on the market portfolio, SMB (small minus big), HML (high minus low), CMA (conservative minus aggressive), RMW (robust minus weak), Momentum, Short-term Reversal, and Long-term Reversal, obtained from the Kenneth French data library (http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html). The model also includes the average stock return (in excess of the risk-free rate) of the firms in the bond book-to-market quintile. Furthermore, the model includes the Default Spread and the Term Spread, obtained from Amit Goyal's website (http://www.hec.unil.ch/agoyal/), the fixed income value strategy returns and the fixed income momentum strategy returns, obtained from Toby Moskowitz's website (https://faculty.som.yale.edu/tobymoskowitz/research/data/), as well as the returns on the Bloomberg Barclays U.S. Treasury Intermediate Index, U.S. Long-Term Treasury Index, U.S. Corporate Investment Grade Index, and the U.S. Corporate High-Yield Index, all in excess of the risk-free rate. All risk models include one lead of each factor. Standard errors are estimated using the Newey West (1987) procedure. For brevity, the table only displays coefficients and *t*-statistics for the regression intercept and the Bond HML factors. The table also shows the number of observations and R-Squared. *, **, and *** indicate significance at the 10%, 5%, and 1% level, respectively. The return sample period is February 2003 to May 2018. All variables are defined in Appendix A.

	Q1 (low BBM)			Q2			Q3			Q4			Q5 (high BBM)			Q5-Q1 (high - low BBM)		
	Coef	*t*-stat		Coef	*t*-stat		Coef	*t*-stat		Coef	*t*-stat		Coef	*t*-stat		Coef	*t*-stat	
Intercept	0.155	[3.47]	***	0.156	[5.43]	***	0.174	[4.78]	***	0.138	[2.83]	***	0.276	[4.39]	***	0.121	[2.65]	***
Bond HML Factor (*t*+1)	-0.504	[-6.51]	***	-0.165	[-3.49]	***	0.023	[0.42]		0.162	[2.11]	**	0.645	[5.64]	***	1.149	[13.63]	***
Bond HML Factor (*t*+2)	0.014	[0.23]		-0.022	[-0.57]		-0.008	[-0.18]		0.033	[0.40]		0.215	[1.45]		0.201	[1.52]	
R-Squared	0.91			0.95			0.94			0.92			0.91			0.90		
Observations	184			184			184			184			184			184		
21 Pairs of Factors (see Table 4A)	Yes			Yes			Yes			Yes			Yes			Yes		

Table 8: Bond Mispricing and Bond Book-to-Market

The table shows average coefficients and test statistics from Fama and MacBeth (1973) regressions of monthly bond returns on bond and stock characteristics. Across different specifications, returns are regressed against end-of-prior-month values for bond book-to-market, bond mispricing, bond yield to maturity, bond value, bond age, bond maturity, bond bid-ask spreads, lagged bond returns, bond momentum, bond credit rating, nearness to default, equity market beta, equity book-to-market, equity market capitalization, equity short-term reversal, equity momentum, equity long-term reversal, accruals, standardized unexpected earnings (SUE), gross profitability, and earnings yield. The table employs quintile dummies for the characteristics as regressors. Each month's quintiles are determined from sorts of firms with non-missing values for all characteristics. Size (market capitalization) quintiles are based on NYSE breakpoints. The regressions include dummy variables for Quintiles 2, 3, 4, and 5 of each characteristic but the table displays only the coefficients of the quintile dummy with the largest amount of the characteristic (Q5) on bond book-to-market and bond mispricing for brevity. Additional controls are the number of out-standing bonds of a firm, the percentage of bond market capitalization of a firm that trade in a month, and the number of days from the beginning and end of the month of bond price data used to calculate the bond return. All regressions include industry dummy variables based on the 38 Fama and French industry classifications. The table also shows the average number of observations and average adjusted R-Squared. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% level, respectively. The return sample period is February 2003 to May 2018. All variables are defined in Appendix A.

	(1)			(2)		
	Coef	t-stat		Coef	t-stat	
Bond Book/Market Q5	0.266	[3.79]	***	0.219	[3.28]	***
Bond Mispricing Q5				0.202	[2.24]	**
Observations	839			839		
Adj. R-Squared	0.30			0.30		
Bond Characteristic Controls (see Table 3)	Yes			Yes		
Stock Characteristic Controls (see Table 3)	Yes			Yes		
Market Microstructure Controls (see Table 3)	Yes			Yes		
Industry Controls	Yes			Yes		

Table 9: Sample of All Corporate Bonds

The table shows results for regressions using the sample of all bonds including junior bonds and bonds with embedded options. Panel A shows average coefficients and test statistics from Fama and MacBeth (1973) regressions of monthly bond returns on bond and stock characteristics for the same regression specifications as in Table 3. Across different specifications, returns are regressed against end-of-prior-month values for bond book-to-market, bond yield to maturity, bond value, bond age, bond maturity, bond bid-ask spreads, lagged bond returns, bond momentum, bond credit rating, nearness to default, equity market beta, equity book-to-market, equity market capitalization, equity short-term reversal, equity momentum, equity long-term reversal, accruals, standardized unexpected earnings (SUE), gross profitability, and earnings yield. The panel employs quintile dummies for the characteristics as regressors except for bond book-to-market in even-numbered specifications, which employ the normal score of bond book-to-market. Each month's quintiles are determined from sorts of firms with non-missing values for all characteristics. Size (market capitalization) quintiles are based on NYSE breakpoints. The regressions include dummy variables for Quintiles 2, 3, 4, and 5 of each characteristic, but the panel displays only the coefficients of the quintile dummy with the largest amount of book-to-market (Q5) or the normal score of bond book-to-market for brevity. Additional controls are the number of outstanding bonds of a firm, the percentage of bond market capitalization of a firm that trade in a month, and the number of days from the beginning and end of the month of bond price data used to calculate the bond return. All regressions include industry dummy variables based on the 38 Fama and French industry classifications. The panel also shows the average number of observations and average adjusted R-squared. Panel B shows intercepts, slope coefficients, and *t*-statistics from time series regressions of monthly portfolio returns (in excess of 1-month USD LIBOR) on twenty-one pairs of factors. Bonds are sorted each month into quintiles based on bond book-to-market (BBM) and combined into equal-weighted portfolios. The panel reports regression statistics separately for each of the five portfolios, Q1–Q5, and for the return spreads between the highest bond book-to-market (Q5) and lowest bond book-to-market (Q1) quintiles. Regressors for the factor model are the excess return on the market portfolio, SMB (small minus big), HML (high minus low), CMA (conservative minus aggressive), RMW (robust minus weak), Momentum, Short-term Reversal, and Long-term Reversal, obtained from the Kenneth French data library (http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html). The model also includes the equal-weighted average stock return (in excess of the risk-free rate) of the firms in the bond book-to-market quintile. Furthermore, the model includes the Default Spread and the Term Spread, obtained from Amit Goyal's website (http://www.hec.unil.ch/agoyal/), the fixed income value strategy returns and the fixed income momentum strategy returns, obtained from Toby Moskowitz's website (https://faculty.som.yale.edu/tobymoskowitz/research/data/), as well as the returns on the Bloomberg Barclays U.S. Treasury Intermediate Index, U.S. Long-Term Treasury Index, U.S. Corporate Investment Grade Index, and the U.S. Corporate High-Yield Index, all in excess of the risk-free rate. All risk models include one lead of each factor. Standard errors are estimated using the Newey West (1987) procedure. For brevity, the panel only displays coefficients and *t*-statistics for the regression intercept. The panel also shows the number of observations and R-squared. Panel C shows estimates and *t*-statistics from time series regressions of monthly portfolio returns (in excess of 1-month USD LIBOR) on a risk model augmented with a high-minus-low factor based on bond book-to-market (BBM). To form the Bond HML factor, each month, we divide bonds into one of 6 categories based on bond size (aggregate market value outstanding) and bond book-to-market. For the 3 categories in the larger of the two bond sizes (bottom, middle, and top third of month-t bond book-to-market), we compute the spread in the month $t + 1$ value-weighted bond returns (based on bond market capitalization) between the top and bottom third bond book-to-market bonds. We then repeat the exercise for the firm in the smaller of the two bond sizes. We then average the two value-weighted return spreads and include the average as the Bond HML factor. All regressions also include the 21 factor pairs from Panel B. For brevity, the panel only displays coefficients and *t*-statistics for the regression intercept and the Bond HML factors. Standard errors are estimated using the Newey West (1987) procedure. The panel also shows the number of observations and R-Squared. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% level, respectively. The return sample period is February 2003 to May 2018. All variables are defined in Appendix A.

(continued)

Table 9: Sample of All Corporate Bonds (continued)

Panel A: Fama-MacBeth Cross-Sectional Regressions

	(1)		(2)		(3)		(4)		(5)		(6)		(7)		(8)	
	Coef	*t*-stat	Coef	*t*-stat	Coef	*t*-stat	Coef	*t*-stat	Coef	*t*-stat	Coef	*t*-stat	Coef	*t*-stat	Coef	*t*-stat
Bond Book/Market Q5	0.594	[4.57] ***			0.592	[4.56] ***			0.309	[4.14] ***			0.368	[5.02] ***		
Bond Book/Market (normal score)			0.199	[4.06] ***			0.197	[4.02] ***			0.126	[3.15] ***			0.148	[4.06] ***
Observations	1,179		1,179		1,179		1,179		1,171		1,171		1,171		1,171	
Adj. R-Squared	0.10		0.09		0.10		0.10		0.21		0.21		0.24		0.24	
Bond Characteristic Controls (see Table 3)	No		No		No		No		Yes		Yes		Yes		Yes	
Stock Characteristic Controls (see Table 3)	No		No		No		No		No		No		Yes		Yes	
Market Microstructure Controls (see Table 3)	No		No		Yes		Yes		Yes		Yes		Yes		Yes	
Industry Controls	Yes		Yes		Yes		Yes		Yes		Yes		Yes		Yes	

Panel B: Factor Model Time-Series Regressions

	Q1 (low BBM)		Q2		Q3		Q4		Q5 (high BBM)		Q5-Q1 (high - low BBM)	
	Coef	*t*-stat	Coef	*t*-stat	Coef	*t*-stat	Coef	*t*-stat	Coef	*t*-stat	Coef	*t*-stat
Intercept	0.079	[1.83] *	0.198	[7.71] ***	0.263	[7.65] ***	0.391	[6.54] ***	0.526	[6.23] ***	0.447	[4.82] ***
R-Squared	0.90		0.95		0.92		0.84		0.88		0.77	
Observations	184		184		184		184		184		184	
21 Pairs of Factors (see Table 4A)	Yes		Yes		Yes		Yes		Yes		Yes	

Panel C: Factor Model Time-Series Regressions with Bond HML Factor

	Q1 (low BBM)		Q2		Q3		Q4		Q5 (high BBM)		Q5-Q1 (high - low BBM)	
	Coef	*t*-stat	Coef	*t*-stat	Coef	*t*-stat	Coef	*t*-stat	Coef	*t*-stat	Coef	*t*-stat
Intercept	0.122	[2.85] ***	0.204	[7.56] ***	0.244	[7.02] ***	0.351	[6.06] ***	0.371	[5.80] ***	0.250	[4.30] ***
Bond HML Factor (*t*+1)	-0.293	[-4.68] ***	-0.092	[-2.49] **	0.106	[2.13] **	0.258	[3.73] ***	1.046	[14.64] ***	1.339	[17.98] ***
Bond HML Factor (*t*+2)	0.007	[0.17]	0.034	[1.00]	0.012	[0.19]	0.006	[0.07]	-0.014	[-0.22]	-0.021	[-0.35]
R-Squared	0.92		0.95		0.93		0.85		0.96		0.95	
Observations	184		184		184		184		184		184	
21 Pairs of Factors (see Table 4A)	Yes		Yes		Yes		Yes		Yes		Yes	

Table 10: Buy-and-Hold Returns

The table shows intercepts from time series regressions of monthly bond portfolio returns on twenty-one factor pairs. The regression also includes one lead of each factor. Following Jegadeesh and Titman (1993, 2001), the table measures the monthly performance of a portfolio held for 12 months with the following non-overlapping returns methodology: Bonds are sorted each month into 12 sets of quintiles based on bond book-to-market (BBM) that is delayed from 0 to 11 months and combined into equal-weighted portfolios within the same signal delay cohort. The monthly return that is used in the regression equally weights the twelve portfolios that belong to the same quintile. The table reports regression statistics separately for each of the five portfolios, Q1-Q5, and for the corresponding times-series of return spreads between the highest bond book-to-market (Q5) and lowest bond book-to-market (Q1) quintiles. Regressors for the factor model are the excess return on the market portfolio, SMB (small minus big), HML (high minus low), CMA (conservative minus aggressive), RMW (robust minus weak), Momentum, Short-term Reversal, and Long-term Reversal, obtained from the Kenneth French data library (http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html). The model also includes the equal-weighted average stock return (in excess of the risk-free rate) of the firms in the bond book-to-market quintile. Furthermore, the model includes the Default Spread and the Term Spread, obtained from Amit Goyal's website (http://www.hec.unil.ch/agoyal/), the fixed income value strategy returns and the fixed income momentum strategy returns, obtained from Toby Moskowitz's website (https://faculty.som.yale.edu/tobymoskowitz/research/data/), as well as the returns on the Bloomberg Barclays U.S. Treasury Intermediate Index, U.S. Long-Term Treasury Index, U.S. Corporate Investment Grade Index, and the U.S. Corporate High-Yield Index, all in excess of the risk-free rate. All risk models include one lead of each factor. Standard errors are estimated using the Newey West (1987) procedure. *, **, and *** indicate significance at the 10%, 5%, and 1% level, respectively. The return sample period is February 2003 to May 2018. All variables are defined in Appendix A.

	Q1 (low BBM)			**Q2**			**Q3**			**Q4**			**Q5 (high BBM)**			**Q5-Q1 (high - low BBM)**	
	Coef	*t*-stat		Coef	*t*-stat		Coef	*t*-stat		Coef	*t*-stat		Coef	*t*-stat		Coef	*t*-stat
Alpha 21-factor model	0.158	[2.87]	***	0.148	[4.85]	***	0.143	[4.47]	***	0.173	[4.94]	***	0.251	[4.69]	***	0.093	[1.44]

Table 11: Turnover and Transaction Costs

The table shows monthly one-way turnover, transaction costs as well as gross and net performance of the long-short investment strategy based on bond book-to-market with monthly rebalancing. Results are reported separately for the returns of the portfolios of the lowest bond book-to-market bonds (Q1), the highest bond book-to-market bonds (Q5) and the spread portfolio (Q5-Q1). The first column reproduces the 21-factor alphas from Table 4 Panel A. The second column reports one-way turnover (in percent per month). Columns 3-6 report the average transaction costs based on two-way turnover and transaction cost adjusted (net) performance as the intercept of a regression of quintile portfolio returns (in excess of 1-month USD LIBOR) minus monthly transaction costs on the 21-factor pairs. Standard errors are estimated using the Newey West (1987) procedure. Daily average bid and ask prices are computed by taking the average of all dealer buy and dealer sell transactions for all bonds in a quintile. We then take the average of daily bids and asks in a month separately for bids and asks, and compute monthly bid-ask spreads. We assign these quintile-level half spreads to bonds that join the quintile, and calculate transaction costs as in Eq. (4). As shown in the column headings, the bid-ask spreads are calculated alternatively for all transactions in TRACE (All) and transactions with volume at least 100,000 U.S. dollars (Institutions). The return sample period is February 2003 to May 2018.

			All				Institutions			
Portfolio	Alpha	One-Way Turnover	Transaction Costs	Net Performance	*t*-stat		Transaction Costs	Net Performance	*t*-stat	
Q1	0.117	13%	0.094	0.207	[3.66]	***	0.050	0.173	[3.07]	***
Q5	0.366	18%	0.439	-0.127	[-1.58]		0.151	0.197	[2.64]	***
Q5-Q1	0.249	31%	0.533	-0.333	[-3.73]	***	0.201	0.024	[0.29]	

Appendix A: Variable Definitions

The table shows the definitions of the main variables used in the paper.

Variable	Definition	Source
Bond Variables		
Bond Book/Market	Face value of a bond divided its market value	TRACE, Mergent FISD
Bond Mispricing	-1 * Residual/ Market Value of Total Liabilities of firm	
Bond Yield	Yield to maturity (%)	TRACE, Mergent FISD
Bond Value	Market value of bond	TRACE, Mergent FISD
Bond Face Value	Face value of bond	Mergent FISD
Bond Age	Years elapsed since issuance	Mergent FISD
Bond Maturity	Remaining time to maturity (in years)	Mergent FISD
Bond Bid/Ask Spread	Bid/Ask spread of bond. Daily spreads are computed as the difference between average dealer sells and average dealer buys, scaled by the average of buys and sells in the day. We use dealer-to-customer trades only. Monthly spread is the average of daily spreads in month t.	TRACE
Bond Reversal	Returns of bond in month t	TRACE, Mergent FISD
Bond Momentum	Six-month returns over month $t-6$ to $t-1$, computed using the beginning of the month price in $t-6$ and the end of the month price in $t-1$.	TRACE, Mergent FISD
Bond Rating	Rating of bond expressed in numerical values from AAA (1) to D (22). Credit rating is from S&P when available, and from Moody's when S&P's rating is not available.	Mergent FISD
Number of Bonds t+1	Number of outstanding bonds of firm in calendar month $t+1$	Mergent FISD
Percent of Bond Market Capitalization Traded in t+1	Percentage of the market values of bonds of a firm that trade in calendar month $t+1$ as a fraction of the market value of bonds with signals in month t	Mergent FISD
Number of Days from Beginning of Month t+1	Difference in calendar days between the date of first transaction in month $t+1$ and the first trading date of month $t+1$.	TRACE
Number of Days from End of Month t+1	Difference in calendar days (in absolute values) between the last trading date of month $t+1$ and the date for month $t+1$ end-of-month transaction.	TRACE
Bond Book/Market Factor Beta	Exposure of quintile portfolio to bond book/market factor in time-series regression	
Investment Grade	Dummy variable which equals one if bond's credit rating is BBB- or above.	Mergent FISD
Non-Investment Grade	Dummy variable which equals one if bond's credit rating is BB+ or below.	Mergent FISD
Offering Price	Price at which bond is initially sold to investors.	Mergent FISD
Bond Market Factors		
Default Spread	Monthly Default Return Spread (DEF) (difference between long-term corporate bond and long-term government bond returns)	Amit Goyal website
Term Spread	Monthly Term Spread (TERM) (difference between the long-term government bond return and the one-month Treasury bill rate)	Amit Goyal website
Fixed Income Value Factor	The value factor on government bonds proposed by Asness, Moskowitz and Pedersen (2013), where value is measured using 5-year changes in 10-year yields.	AQR/Toby Moskowitz website
Fixed Income Momentum Factor	The momentum factor on government bonds proposed by Asness, Moskowitz and Pedersen (2013).	AQR/Toby Moskowitz website
Excess Return U.S. Treasury Bonds Intermediate Maturity	Excess return on the subindex of the U.S. Treasury Index, focusing on securities with less than ten years to maturity, excluding Treasury bills.	DataStream
Excess Return U.S. Treasury Bonds Long Maturity	Excess return on the subindex of the U.S. Treasury Index, focusing on securities with ten years or more to maturity.	DataStream
Excess Return U.S. Corporate Bonds Investment Grade	Excess return on the index for investment grade, fixed-rate, taxable corporate bonds, including U.S. dollar-denominated securities publicly issued by U.S. and non-U.S. industrial, utility and financial issuers.	DataStream
Excess Return U.S. Corporate Bonds High Yield	Excess return on the index for U.S. dollar-denominated, high-yield, fixed-rate corporate securities. Securities are classified as high-yield if the middle rating of Moody's, Fitch and S&P is Ba1/BB+/BB+ or below. The middle rating is the credit rating assigned by Bloomberg when there is disagreement among rating agencies. When three rating agencies provide a rating, then the middle rating is the one provided by two of them. If two agencies provide a rating, then the middle rating is the lower rating of the two.	DataStream
Equity Market Factors		
Excess Return on Market Portfolio	Monthly market index return net of risk-free rate (Mkt_RF)	Ken French website
SMB	Monthly Small Minus Big (SMB) portfolio return (size factor)	Ken French website
HML	Monthly High Minus Low (HML) portfolio return (value factor)	Ken French website
CMA	Monthly Conservative Minus Aggressive (CMA) portfolio return (investment factor)	Ken French website
RMW	Monthly Robust Minus Weak (RMW) portfolio return (profitability factor)	Ken French website
Momentum	Monthly Momentum (Mom) portfolio return	Ken French website
Short-term Reversal	Monthly Short-term Reversal (ST_Rev) portfolio return	Ken French website
Long-term Reversal	Monthly Long-term Reversal (LT_Rev) portfolio return	Ken French website
Excess Stock Return Bond Book/Market Quintile 1	Monthly excess return on stocks of bonds in bond book/market quintile 1	
Excess Stock Return Bond Book/Market Quintile 2	Monthly excess return on stocks of bonds in bond book/market quintile 2	
Excess Stock Return Bond Book/Market Quintile 3	Monthly excess return on stocks of bonds in bond book/market quintile 3	
Excess Stock Return Bond Book/Market Quintile 4	Monthly excess return on stocks of bonds in bond book/market quintile 4	
Excess Stock Return Bond Book/Market Quintile 5	Monthly excess return on stocks of bonds in bond book/market quintile 5	

(continued)

Appendix A: Variable Definitions (continued)

Variable	Definition	Source
Equity/Firm Variables		
Equity Mispricing	-1 * Residual/ Market Capitalization (Bartram and Grinblatt 2018, 2020)	
Beta	Annual Market Beta	CRSP
Market Capitalization	Stock Market Capitalization of Common Stock, calculated as product of Share Price (PRC) * Number of Shares Outstanding (SHROUT)	CRSP
Book/Market	(Book Equity (CEQQH) + Deferred Taxes Balance Sheet (TXKITCQH))/Market Capitalization	CRSP, Compustat
Short-term Reversal	Return in prior month	CRSP
Momentum	Return in prior year excluding prior month	CRSP
Long-term Reversal	Return in prior five years excluding prior year	CRSP
Accruals	Accruals = [NOA(t)-NOA(t-1)]/NOA(t-1), where NOA(t) = Operating Assets (t) - Operating Liabilities (t). Operating Assets is calculated as total assets (ATQH) less cash and short-term investments (CHEQH). Operating liabilities is calculated as total assets (ATQH) less total debt (DLCQH and DLTTQH) less book value of total common and preferred equity (CEQQH and PSTKQH) less minority interest (MIBTQH) (Richardson et al., 2001, p. 22)	Compustat
SUE	Quarterly earnings surprise based on a rolling seasonal random walk model (Livnat and Mendenhall, 2006, page 185)	Compustat
Gross Profitability	(Revenue (SALEQH) - Cost of Goods Sold (COGSQH))/Total Assets (ATQH) (Novy-Marx 2013)	Compustat
Earnings Yield	Earnings/Price (Penman, Richardson, Riggoni, and Tuna, 2014)	Compustat
Nearness to Default	Negative of Distance to default of firm over the one-year horizon (Schaefer and Strebulaev, 2008)	CRSP, Compustat
Market Value of Total Liabilities	Total Liabilities (LTQH) - Face Value of Bonds + Market Value of Bonds	Compustat, TRACE
Firm-level Fundamentals for BG Signal		
ATQH	Assets - Total - Quarterly	Compustat
DVPQH	Dividends - Preferred/Preference - Quarterly	Compustat
SALEQH	Sales/Turnover (Net) - Quarterly	Compustat
SEQQH	Stockholders Equity - Total - Quarterly	Compustat
IBQH	Income Before Extraordinary Items - Quarterly	Compustat
NIQH	Net Income (Loss) - Quarterly	Compustat
XIDOQH	Extraordinary Items and Discontinued Operations - Quarterly	Compustat
IBADJQH	Income Before Extraordinary Items - Adjusted for Common Stock Equivalents - Quarterl	Compustat
IBCOMQH	Income Before Extraordinary Items - Available for Common - Quarterly	Compustat
ICAPTQH	Invested Capital - Total - Quarterly	Compustat
TEQQH	Stockholders Equity - Total - Quarterly	Compustat
PSTKRQH	Preferred/Preference Stock - Redeemable - Quarterly	Compustat
PPENTQH	Property Plant and Equipment - Total (Net) - Quarterly	Compustat
CEQQH	Common/Ordinary Equity - Total - Quarterly	Compustat
PSTKQH	Preferred/Preference Stock (Capital) - Total - Quarterly	Compustat
DLTTQH	Long-Term Debt - Total - Quarterly	Compustat
PIQH	Pretax Income - Quarterly	Compustat
TXTQH	Income Taxes - Total - Quarterly	Compustat
NOPIQH	Nonoperating Income (Expense) - Quarterly	Compustat
AOQH	Assets - Other - Total - Quarterly	Compustat
LTQH	Liabilities - Total - Quarterly	Compustat
DOQH	Discontinued Operations - Quarterly	Compustat
LOQH	Liabilities - Other - Total - Quarterly	Compustat
CHEQH	Cash and Short-Term Investments - Quarterly	Compustat
ACOQH	Current Assets - Other - Total - Quarterly	Compustat
DVQH	Cash Dividends (Cash Flow) - Quarterly	Compustat
LCOQH	Current Liabilities - Other - Total - Quarterly	Compustat
APQH	Accounts Payable - Quarterly	Compustat