Momentum in Corporate Bond Returns

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This paper documents significant momentum in a comprehensive sample of 81,491 U.S. corporate bonds with both transaction and dealer-quote data from 1973 to 2011. Momentum is driven by noninvestment grade (NIG) bonds. Momentum profits have increased over time, along with the growth of this segment. From 1991 to 2011, they average 59 basis points (bps) per month across all bonds and 192 bps in NIG bonds. NIG bonds issued by private firms earn even higher profits (282 bps). Momentum profits do not appear to compensate for risk or persist as a result of trading frictions. Bond momentum is not just a manifestation of equity momentum. (*JEL* G10, G12, G14)

Momentum has been documented in U.S. and international equities, currencies, commodities, sovereign bonds, and residential real estate.[1] Yet, for the \$9.7 trillion U.S. corporate bond market,[2] Gebhardt, Hvidkjaer, and Swaminathan

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[1] See Jegadeesh and Titman (1993), Rouwenhorst (1998), Chan, Hameed, and Tong (2000), Okunev and White (2003), Miffre and Rallis (2007), Gorton, Hayashi, and Rouwenhorst (2008), Asness, Moskowitz, and Pedersen (2013), and Beracha and Skiba (2011).

[2] As of December 2010. Source: Board of Governors of the Federal Reserve System, Flow of Funds. The size of the U.S. equity market as of that date is \$18.8 trillion. Over 1997–2006, U.S. firms raised \$1.5 trillion through

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(GHS; 2005b) find no evidence of momentum using a sample of investment grade bonds.

This paper contributes to the literature with a number of new findings. First, we present strong evidence of momentum profitability using a comprehensive sample of investment grade (IG) and noninvestment grade (NIG) U.S. corporate bonds. Second, we find that bond momentum profits are driven by NIG bonds, consistent with findings on equity momentum.[3] In 2010, NIG bonds represent 25% of the amount issued and 39% of trading volume.[4] Third, momentum profits are much higher among NIG bonds of private firms, although public-firm NIG bonds also generate significant momentum profits. Fourth, although there is some momentum spillover from equities to both IG and NIG bonds, in NIG bonds there are large and significant bond-specific momentum effects.

Our sample combines 3.75 million dealer-quote (from Lehman, DataStream, and Bloomberg) and transaction (from TRACE and FISD) bond-month observations on 81,491 U.S. corporate bonds (8,159 per month on average) by 9,709 issuers from January 1973 to June 2011. Over this period, past six-month bond winners outperform losers by 37 basis points (bps) per month (t-value of 3.90) over a six-month holding period.[5]

Momentum profits are concentrated in NIG bonds, among which the momentum strategy generates 121 bps per month. The strategy is not profitable among IG bonds.[6] High-yield bonds have a large impact on momentum profits in the overall sample, because they overpopulate the winner and loser portfolios. To illustrate, 75% (70%) [67%] of bonds rated D (C) [CC] appear among winners or losers versus 12% of bonds rated A+.

Momentum profits have increased over time, both in the overall sample and among NIG bonds. Momentum profits in the overall sample have increased with the growth of the NIG bond segment. In the period 1973–1990, only 10% of bonds are NIG versus 22% over 1991-2011. Over 1991–2011, the momentum strategy yields 59 bps per month across all bonds and 192 bps among NIG bonds. In the period 1973–1990, momentum profits are absent in the overall sample but are significant at 44 bps in NIG bonds. The link between overall momentum profits and the availability of NIG bonds is supported by a time-series regression and persists after controlling for time-series effects.

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common stock and $4.6 trillion through corporate debt issuance, suggesting that corporate bonds have become an important venue for firms to raise funds (Bessembinder and Maxwell 2008).

3 Avramov et al. (2007) find equity momentum only in NIG firms.

4 In the fourth quarter of 2010, the NIG share of daily volume in TRACE was 39% with $7.46 billion NIG bonds traded daily (FINRA TRACE FactBook 2010, Tables C24 and C25). In 2010, issuance of IG (NIG) corporate bonds amounts to $799 ($264) billion (SIFMA). In the past decade, there have been about 4,500 new issues of NIG bonds with a total amount outstanding of $1.5 trillion (Bloomberg). In our sample, 4,031 firms have had NIG bonds at some point during the sample period.

5 Bond momentum is also significant for formation and holding periods of three, nine, and twelve months.

6 GHS find a small reversal of 12 bps in IG bonds, but this reversal is present only in long-term IG bonds. GHS study IG bonds with seven or more years to maturity.

The increase in momentum profits among NIG bonds is due to the worsening credit risk of winners and losers. Further analysis shows that momentum profits are higher when the credit risk of the bonds in the momentum strategy is higher. From the first to the second part of the period, the average rating of NIG bond losers deteriorates by two notches from B+ to B− and from B to B− for NIG winners.

Momentum persists after adjusting for bond-level credit and interest-rate risk. Bond momentum is also robust to adjusting for systematic risk using bond and equity factors:[7] the momentum strategy alpha is larger than raw momentum profits. Finally, momentum profits withstand survivorship concerns and adjusting for microstructure noise.

Bond momentum profits come primarily from winners.[8] For example, consider the worst-rated bond quintile, Q5, where momentum is profitable. When returns are adjusted for duration, age, amount outstanding, and credit risk, momentum winners earn 98 bps per month more than otherwise similar bonds. Losers earn 47 bps less. More than two-thirds of the characteristics-adjusted momentum profits of 145 bps are due to winners.

Although both equity and bond momentum are driven by NIG firms, bond momentum is not just a manifestation of equity momentum, as indicated by a series of tests. First, implementing the momentum strategy based on stock-adjusted bond returns still produces significant momentum profits in NIG bonds. Second, the time-series correlation between equity and bond momentum profits in public firms is 0.34, whereas the correlation between private- and public-firm bond momentum is 0.81. Third, equity momentum explains about 20% of the magnitude of the raw bond momentum profits of their corresponding firms. Fourth, only 22% (27%) of the firms that are bond winners (losers) are also stock winners (losers). The remaining 78% (73%) populate other equity momentum portfolios, with 10% (8%) appearing among stock losers (winners). Fifth, a 5×5 independent sort on past equity and past bond returns reveals that, alhtough some momentum spills over from equities to both IG and NIG bonds, there are large and significant bond-specific momentum effects in NIG bonds. Finally, cross-sectional regressions of future six-month bond returns reveal that, among NIG bonds, the predictive power of past six-month bond returns is multiple times higher than that of past six-month equity returns.

The above results indicate that stocks and bonds can evolve differently. Even though they depend on the same underlying firm fundamentals, the impact of corporate events could differ across stocks and bonds, and even be opposite when there are wealth transfers between equity- and bondholders (e.g., dividend cuts, debt reduction, equity issuance, etc.).

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[7] For example, the Fama and French (1993) factors, the equity momentum factor of Carhart (1997), and the term and default bond factors.

[8] Avramov et al. (2007) find that equity momentum is driven by losers.

Momentum profitability is strongest among private-firm NIG bonds, a substantial segment of our sample, where the momentum strategy yields 282 bps per month over 1991–2011. These profits are mainly due to the large returns of high credit risk winners. Yet, we find no pattern in their characteristics that could explain such high returns. They have similar rating, duration, amount outstanding, trade size, and lower return volatility than high credit risk bond losers.

Bond momentum profitability is unlikely due to transaction costs or trading frictions. Momentum is profitable in both quote- and trade-based data. Moreover, high credit risk bonds, which drive momentum profits, tend to have higher turnover, larger trade sizes, and lower effective transaction costs than low credit risk bonds. Bonds in the worst-rated quintile, Q5, are four times more likely to trade than bonds in the best-rated quintile, Q1. The average trade size of Q5 bonds is twice that of Q1 bonds, which lowers effective transaction costs despite the adverse impact of higher credit risk.[9] Transaction costs represent only 23% of gross momentum profits in NIG bonds and 16% in private-firm NIG bonds.

Our findings challenge a number of potential explanations of momentum explored in the equity literature. We find no evidence that momentum profits compensate for systematic or bond-specific risk. Neither lack of trading nor transaction costs appear to be responsible for the persistence of bond momentum. Market opaqueness does not seem a likely explanation either, because the improved bond market transparency brought on by TRACE in 2002 coincides with an increase in bond momentum profits.

However, our evidence leaves the possibility that information frictions related to the gradual diffusion of information, as in Hong and Stein (1999), could explain the persistence of bond momentum. Momentum profits are strongest among private-firm bonds, where company-specific information is likely to diffuse more gradually, and among NIG bonds, where information may be harder to interpret.

1. Data

Our corporate bond sample is compiled from five databases: the Lehman Brothers Fixed Income Database (Lehman), DataStream, Bloomberg, TRACE, and Mergent's Fixed Income Securities Database/National Association of Insurance Commissioners Database (FISD). To the best of our knowledge, our sample has the largest cross-section and longest time-series of U.S. corporate bonds used in an empirical study. It includes 3.75 million bond-month return observations from January 1973 to June 2011 from 81,491 U.S. bonds issued by 9,709 firms. Our sample contains an average of 8,159 bonds per month.

[9] We estimate transaction costs from TRACE data following Edwards, Harris, and Piwowar (2007). We confirm that transaction costs increase with credit risk for a fixed trade size, but decrease with trade size.

1.1 Bond databases

The Lehman database reports information on U.S. bonds from January 1973 to March 1998. We extract monthly returns and ratings for all corporate fixed-coupon bonds that are not convertible, puttable, mortgage backed or asset backed. Although most prices in Lehman reflect dealer quotes, some are "matrix" prices derived from price quotes of bonds with similar characteristics. Like GHS, we use both quote and matrix prices and similarly find that results are similar when matrix prices are excluded. Unlike them, we do not exclude high-yield bonds.

From DataStream we extract all bonds from January 1990 to June 2011,[10] excluding non-U.S. dollar denominated bonds, bonds with unusual coupons (e.g., step-up, increasing-rate, pay-in-kind, and split-coupons), mortgage backed or asset backed bonds, convertible bonds, bonds with warrants, and bonds part of unit deals. We extract the monthly total return index, from which returns are computed. From Bloomberg, we collect U.S. fixed-coupon nonconvertible bond month-end prices and coupons, from which returns are calculated.

The above three databases provide prices based on dealer quotes, which may fail to reveal infrequent trading or stale prices—important considerations for implementing a trading strategy. This is why we incorporate two strictly trade-based databases, FISD and TRACE.

Our first trade-based data source is Mergent's FISD/NAIC. The FISD portion of the database contains a comprehensive set of bond characteristics. The NAIC portion contains prices for all trades in public corporate bonds made by insurance companies since 1994. Insurers are required to file quarterly reports with the National Association of Insurance Commissioners (NAIC) with information on which bonds were traded, in which quantities, and on what date. We collect bond prices from February 1994 to December 2010 (the latest available), excluding non-U.S. dollar denominated bonds, and bonds that are convertible, mortgage- or asset-backed, pay-in-kind, or part of a unit deal.

Introduced in July 2002, TRACE provides information on secondary market transactions in publicly traded TRACE-eligible securities, such as investment grade, high-yield, and convertible corporate bonds. By February 2005, TRACE covers more than 99% of the OTC activity in U.S. corporate bonds.[11] We eliminate preferred shares, non-U.S. dollar denominated bonds, bonds with unusual coupons, bonds with warrants, bonds that are mortgage backed or asset backed, convertible, or part of unit deals. We collect prices from July 2002 to March 2011 (the latest available). We follow the data cleaning procedure in

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10 Extensive discussions with the DataStream support team about the source of their data confirmed that most U.S. corporate bond prices are dealer quotes reported by market-makers. These data are further augmented with trading prices for traded bonds. Like Lehman, DataStream provides no indication of whether a price is based on a quote or a trade. Unlike DataStream, Lehman also contains identifiable matrix prices. DataStream starts extensive coverage on individual bond returns in 1990.

11 See the FINRA news release www.finra.org/Newsroom/NewsReleases/2005/P013274.

Bessembinder et al. (2009) and eliminate canceled, corrected, and commission trades.[12]

The overlap between databases is low—88% of bond-month return observations are single-database observations—largely because Lehman spans the first eighteen years of our sample as the only available source. About 11% of the observations come from exactly two databases. The biggest overlap is between DataStream and TRACE—8.5% of the observations. We use this overlap later in the paper to assess data consistency. Less than 1% of all observations come from 3 or 4 sources. When there are returns for the same bond-month available from multiple sources, we take the first available return in the following sequence: TRACE, FISD, Lehman, DataStream, and Bloomberg. This sequence gives precedence to trade-based returns.

Although quote-based databases provide month-end prices and returns, trade-based databases provide intraday clean prices. To compute monthly returns for TRACE and FISD, we first compute daily prices as the trade-size weighted average of intraday prices.[13] The month-end price is the last available daily price from the last five trading days of the month.[14] Using this month-end price, we compute monthly returns as:

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

where $r_{i,t}$ is bond i's month-t return, $P_{i,t}$ is its price at month-end t, $AI_{i,t}$ is its accrued interest at month-end t, and $Coupon_{i,t}$ is any coupon paid between month-ends t-1 and t.[15]

Bond credit ratings are obtained from Standard and Poor's *RatingXpress*, which provides instrument-specific ratings starting in 1969. We collect all available bond ratings from January 1973 to June 2011. From all databases, we also collect issue date, maturity date, amount outstanding, and duration. We eliminate observations that are obvious data entry errors, for example, those with negative prices, with maturity dates prior to issuance or trade dates, etc.

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12 Our results are robust to using alternative cleaning procedures as in Dick-Nielsen (2009).

13 This approach is consistent with findings in Bessembinder et al. (2009) that a daily price based on trade-size weighted intraday prices is less noisy than the last price of the day.

14 Using the last price within the last five trading days of the month instead of that on the last day helps increase the number of non-missing monthly observations. If there are no trades in the last five trading days, the month-end price is missing for that month. Our conclusions are robust to extending/contracting this month-end window. More evidence on trading frequency is presented later in the paper.

15 Computing accrued interest requires the bond's coupon size, coupon frequency, and day count convention. If the coupon frequency is missing, we assume it is semiannual. If the day count convention is missing, we assume it is 30/360. Our findings are similar if we limit our sample to observations that have all of the above information.

1.2 Descriptive statistics

Table 1 reports summary statistics for our corporate bond sample, which contains 3,753,328 bond-month return observations.[16] The mean (median) monthly return is 0.71% (0.60%). The mean (median) duration, age, and amount outstanding are 6.12 (5.94) years, 80.74 (55) months, and \$232.83 (\$100) millions, respectively.

We convert the S&P ratings from *RatingXpress* into a numeric scale from 1 to 22: 1 = AAA, 2 = AA+, 3 = AA, …, 20 = CC, 21 = C, and 22 = D. Ratings 1 through 10 (AAA through BBB−) are investment grade. The mean (median) bond rating in our sample is 7.15 (6), corresponding to A− (A). Ratings are available for 89.06% of bond-month observations. Of the rated bonds, 81.67% are investment grade and 18.33% are noninvestment grade.

The average ratings in Lehman, DataStream, Bloomberg, TRACE, and FISD are 6.33, 8.02, 6.36, 8.50, and 6.27, respectively. DataStream and TRACE, which cover the later period, contain the most NIG bonds, 24.43% and 27.65%, respectively. Lehman, the main data source for the earlier period, has fewer NIG bonds (12.13%). The average bond age in DataStream, Bloomberg, and TRACE, is similar—64.11, 58.19, and 53.27 months, respectively. Lehman contains older bonds (104.04 months), whereas FISD contains the youngest (34.32 months).[17] FISD has the largest amount outstanding, consistent with evidence by Alexander, Edwards, and Ferri (2000) that insurance companies trade larger bond issues. Duration is similar across databases, averaging about six years. Monthly returns in Lehman, DataStream, Bloomberg, TRACE, and FISD average 0.79%, 0.66%, 0.64%, 0.61%, and 0.44%, respectively. They are similar, except for FISD, which has the lowest returns—FISD covers primarily IG bonds in the later period, when interest rates are lower, whereas Lehman covers the earlier period, when interest rates are higher.

To check consistency across quote- and trade-based returns, Panel B of Table 1 compares returns from DataStream and TRACE over their common bond-month observations—320,977 observations from 11,036 bonds. The mean, median, standard deviation, and return percentiles are quite similar across the two databases. This is especially comforting considering that justifiable differences could have resulted from TRACE returns being based on the last price within the last five trading days of the month, whereas DataStream returns are based on the price quote on the last day of the month.

[16] To ensure that the results are not driven by outliers, we have eliminated return observations above the 99.5th percentile (returns above 30% per month). The results are robust to alternative cutoffs.

[17] This could be due to the fact that Lehman contains mostly IG bonds, which tend to have longer maturity (verified in unreported results). Although FISD also contains mostly IG bonds, it is based on insurance companies' trades. Alexander, Edwards, and Ferri (2000) argue that insurance companies mostly trade bonds within two years of issuance, after which, these bonds are absorbed into inactive portfolios.

Table 1
Descriptive statistics

Panel A: All available observations

	All databases	Lehman	DataStream	Bloomberg	TRACE	FISD
Period covered	1973–2011	1973–1998	1990–2011	1987–2008	2002–2011	1994–2010
Bond-month observations	3,753,328	1,712,705	1,763,919	150,205	489,192	85,989
Return - mean (%/month)	0.71	0.79	0.66	0.64	0.61	0.44
Return - median (%/month)	0.60	0.74	0.53	0.67	0.49	0.40
S&P rating - mean	7.15	6.33	8.02	6.36	8.50	6.27
S&P rating - median	6.00	6.00	7.00	6.00	8.00	6.00
% rated	89.06	97.22	84.72	83.61	86.31	81.54
% of rated that are IG	81.67	87.87	75.57	95.17	72.35	86.72
% of rated that are NIG	18.33	12.13	24.43	4.83	27.65	13.28
Duration - mean (years)	6.12	6.27	6.01	5.95	5.41	5.82
Duration - median (years)	5.94	6.38	5.37	5.63	4.60	5.08
% obs with duration	75.69	100.00	55.35	52.91	92.01	88.14
Age - mean (months)	80.74	104.04	64.11	58.19	53.27	34.32
Age - median (months)	55.00	70.00	52.00	51.00	42.00	23.00
% obs with age	96.50	98.38	94.69	93.63	99.96	99.78
Amt outst. - mean ($ millions)	232.83	98.31	353.71	241.92	450.15	1,114.65
Amt outst. - median ($ millions)	100.00	50.00	200.00	100.00	300.00	675.00
% obs with amt out.	96.86	99.69	94.68	92.73	99.52	80.60

Panel B: DataStream and TRACE compared over common bond-month observations

Database source	Mean return	Median return	SD	Return percentiles							
				1st	5th	10th	25th	75th	90th	95th	99th
DataStream	0.59	0.48	5.05	−14.68	−3.90	−1.90	−0.27	1.49	3.40	5.57	14.81
TRACE	0.60	0.48	5.17	−15.68	−4.55	−2.45	−0.55	1.75	3.97	6.43	16.31

The sample includes 81,491 U.S. corporate bonds issued by 9,709 companies and covers the period from January 1973 to June 2011. There are on average 8,159 individual bonds per month issued by an average of 1,878 companies. The numerical ratings increase with credit risk, that is 1 = AAA, 2 = AA+, 3 = AA, 4 = AA−, …, 19 = CCC−, 20 = CC, 21 = C, and 22 = D. Ratings 11 = BB+ or higher (worse) are considered noninvestment grade (NIG). Ratings 10 = BBB− or lower (better) are investment grade (IG). Observations on duration, age, and amount outstanding are truncated at the 99th percentile. Panel B compares returns in DataStream and TRACE over 320,977 bond-month observations (11,036 bonds in total), for which both databases have returns.

2. Momentum in U.S. Corporate Bonds

Our momentum strategy follows Jegadeesh and Titman (1993). Specifically, each month t, bonds are sorted into decile portfolios, P1 to P10, based on their cumulative returns over months $t-6$ to $t-1$ (formation period). The momentum strategy is long the winner portfolio, P10, and short the loser portfolio, P1. The portfolios are held over months $t+1$ to $t+6$ (holding period). Following the equity momentum literature, we skip one month between the formation and holding periods to avoid potential biases from bid-ask bounce and short-term price reversal. Portfolio returns are equally weighted across their constituent bonds. The overall momentum strategy month-t return is the equally weighted average month-t return of strategies implemented in the prior month and strategies formed up to six months earlier. This allows for standard statistical inference based on nonoverlapping returns.

Our main analysis of bond momentum is based on individual bond returns, rather than on firm-level average bond returns.[18] The bond-level analysis allows for a readily implementable and less costly trading strategy. Nevertheless, we implement the bond momentum strategy at the firm level later in the paper and find that the two methods produce similar conclusions.

2.1 Bond momentum profitability

Table 2 summarizes momentum profits in U.S. corporate bonds. Considering the full sample, momentum profits amount to 37 bps per month (t-stat of 3.90). Losers, P1, earn 53 bps, while winners, P10, generate 90 bps. Rated bonds produce identical momentum profits.

Figure 1 reveals that momentum profits are close to zero in the first part of the sample, but become significantly positive in the second part and steadily and substantially increase towards the end. Panel A of Table 2 shows that, from 1973 to 1990, the bond momentum strategy earns an insignificant 11 (10) bps per month among all (rated) bonds.

In contrast, the bond momentum strategy earns a strongly significant 59 bps per month (t-value of 4.30) over 1991–2011. The monthly holding period returns increase almost monotonically from P1 (32 bps) to P10 (91 bps). The biggest jump occurs between P9 and P10—from 64 to 91 bps—and the second biggest between P1 and P2—from 32 to 53 bps—suggesting that extreme past returns are strongly predictive of future returns. The P10-P9 and P2-P1 return differentials are statistically significant (unreported results).

To address concerns that momentum could result from dealers smoothing quotes through time without actual trades taking place, in Panel B of Table 2 we examine momentum profits separately for trade-based (TRACE and FISD) and quote-based (Lehman, DataStream, and Bloomberg) subsamples over their common period from February 1994 to March 2011. The bond momentum

[18] GHS aggregate bond returns at the company level before implementing the momentum strategy.

Table 2
Bond momentum

Panel A: Bond momentum across time

	Momentum portfolios (P1 = losers, P10 = winners)											
	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P10 - P1	t-stat
					January 1973–June 2011							
All databases	0.53	0.66	0.68	0.70	0.70	0.70	0.72	0.73	0.76	0.90	0.37	(**3.90**)
All rated	0.58	0.67	0.69	0.70	0.70	0.71	0.72	0.74	0.77	0.95	0.37	(**3.79**)
					January 1973–December 1990							
All databases	0.79	0.77	0.78	0.81	0.82	0.83	0.85	0.87	0.88	0.89	0.11	(0.76)
All rated	0.78	0.77	0.78	0.81	0.81	0.82	0.85	0.87	0.88	0.88	0.10	(0.75)
					January 1991–June 2011							
All databases	0.32	0.53	0.56	0.57	0.56	0.56	0.57	0.58	0.64	0.91	0.59	(**4.30**)
All rated	0.41	0.55	0.58	0.57	0.58	0.58	0.58	0.59	0.65	1.01	0.60	(**4.23**)

Panel B: Bond momentum across databases from February 1994 to March 2011

	Momentum portfolios (P1 = losers, P10 = winners)											
	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P10 - P1	t-stat
All databases	0.45	0.55	0.59	0.59	0.58	0.58	0.58	0.60	0.66	1.02	0.57	(**3.69**)
All rated	0.48	0.57	0.60	0.59	0.60	0.59	0.59	0.61	0.67	1.07	0.59	(**3.68**)
Quote-based databases	0.49	0.57	0.60	0.59	0.58	0.57	0.58	0.59	0.66	1.01	0.52	(**3.58**)
Quote-based rated	0.54	0.59	0.61	0.60	0.59	0.59	0.58	0.60	0.66	1.08	0.53	(**3.63**)
Trade-based databases	0.02	0.34	0.44	0.49	0.49	0.47	0.51	0.53	0.54	0.65	0.63	(**2.28**)
Trade-based rated	−0.01	0.30	0.48	0.51	0.51	0.53	0.47	0.55	0.57	0.65	0.66	(**2.14**)

Panel C: Returns in quote- and trade-based databases over their common bond-month observations from February 1994 to March 2011

	Momentum portfolios (P1 = losers, P10 = winners)									
	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10
Quote-based databases	0.12	0.46	0.48	0.47	0.51	0.52	0.50	0.57	0.55	0.60
Trade-based databases	0.13	0.40	0.49	0.47	0.45	0.49	0.49	0.53	0.50	0.58

Each month t, bonds are sorted into decile portfolios P1 to P10 based on their cumulative returns over months $t-6$ to $t-1$ (formation period). The momentum strategy is long the winner portfolio, P10, and short the loser portfolio, P1. These positions are held over a six-month holding period ($t+1$ through $t+6$, i.e., after a one-month lag). Portfolio returns are equally weighted across their constituent bonds. The overall strategy portfolio month-t return is the equally weighted average month-t return of strategies implemented in the prior month and strategies formed up to six months earlier. The table presents the average monthly returns of the momentum portfolios, P1 to P10, as well as the momentum strategy profits (P10-P1) during the holding period. The t-statistics of the P10-P1 returns are in parentheses in the last column. The databases included are Lehman, DataStream, and Bloomberg (quote-based) and TRACE and FISD (trade-based). Panel A presents results for all databases for the overall period (January 1973–June 2011), as well as the first (1973–1990) and second (1991–2011) parts. Panel B compares momentum profits in all, quote-based, and trade-based datasets over their common period of coverage of February 1994 to March 2011. Panel C reports average momentum portfolio returns from quote- and trade-based data over their common bond-month observations—an average of 1,025 bonds per month.

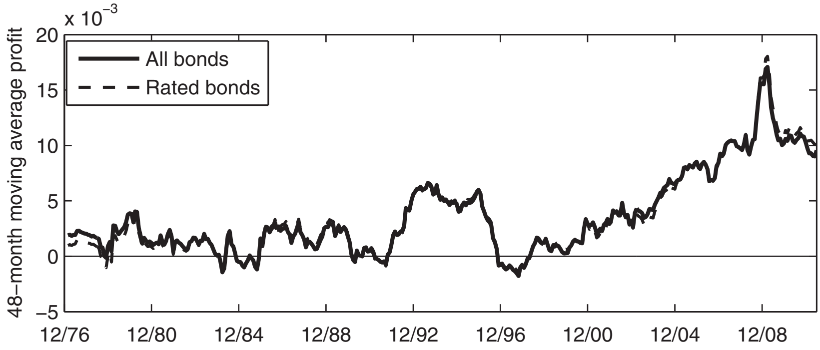

Figure 1
Time-series of momentum profitability
The figure presents the 48-month moving average monthly momentum profit (P10-P1) for all bonds (solid line) as well as for only rated bonds (dashed line). The momentum strategy uses bonds from all databases: Lehman, DataStream, Bloomberg, FISD, and TRACE. The sample period is from January 1973 to June 2011.

strategy based on transaction data produces profits of 63 bps per month (t-value of 2.28). Momentum strategies based on dealer quotes earn 52 bps (t-value of 3.58). Furthermore, rated bonds that trade generate momentum profits of 66 bps compared to 53 bps for rated bonds in the dealer-quote database. These results imply that quote-smoothing or lack of trading are unlikely to explain bond momentum.

Although momentum profits are similar in trade- and quote-based data, winner and loser returns differ. Holding period returns are generally smaller in the trade-based sample, but this difference is more pronounced in the extreme momentum portfolios. Holding period returns based on quotes (trades) are 49 (2) bps in P1 and 101 (65) bps in P10. To check whether these differences are due to data inconsistencies, we form momentum portfolios using only bond-months that appear in both types of databases (an average of 1,025 observations per month) and report their holding period returns over their common bond-months in Panel C. Holding period returns in quote- and trade-based data are quite similar.[19] This suggests that winners trade less than losers, which we later confirm using TRACE data.

In Table 3, we examine whether bond momentum profits compensate for systematic risk. We regress momentum portfolio returns on bond and equity risk factors, found to be priced in the cross-section of bond returns (e.g., Fama and French 1989, 1993; Gebhardt, Hvidkjaer, and Swaminathan 2005a). We focus on 1991–2011, when bond momentum is significant. Using ordinary least squares (OLS) regression with Newey-West adjusted standard errors, we

19 Panel B of Table 1 compares returns in DataStream and TRACE; here, we compare holding period returns of the momentum strategy in quote- and trade-based data.

Table 3
Alphas of bond momentum portfolios

	Momentum portfolios (P1 = losers, P10 = winners)											
Model	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P10 - P1	t-stat
	Momentum portfolio returns											
0	0.32	0.53	0.56	0.57	0.56	0.56	0.57	0.58	0.64	0.91	0.59	(**4.30**)
	Momentum portfolio alphas											
1	0.05	0.27	0.30	0.30	0.30	0.30	0.30	0.32	0.37	0.65	0.59	(**4.32**)
2	0.05	0.26	0.29	0.30	0.29	0.29	0.30	0.31	0.37	0.64	0.60	(**4.62**)
3	0.05	0.26	0.30	0.30	0.30	0.30	0.30	0.31	0.37	0.64	0.60	(**4.63**)
4	−0.20	0.17	0.24	0.26	0.26	0.27	0.27	0.27	0.31	0.52	0.72	(**5.11**)
5	−0.17	0.18	0.23	0.25	0.24	0.24	0.24	0.24	0.28	0.48	0.65	(**4.47**)
6	−0.16	0.20	0.25	0.27	0.27	0.28	0.28	0.29	0.33	0.54	0.70	(**5.16**)
7	−0.11	0.23	0.27	0.28	0.27	0.27	0.27	0.28	0.31	0.52	0.62	(**4.44**)
8	−0.11	0.23	0.27	0.28	0.27	0.27	0.27	0.27	0.31	0.52	0.63	(**4.44**)
9	−0.37	−0.01	0.07	0.10	0.10	0.09	0.09	0.09	0.12	0.33	0.70	(**5.04**)

Bond momentum portfolio returns are computed as in Table 2 for all databases from January 1991 to June 2011. Model 0 presents the average raw portfolio returns for easy comparison. We then run time-series regressions of these portfolio excess returns on systematic factors:

$$r_{p,t}=\alpha_p+\boldsymbol{\beta}'_p\boldsymbol{F}_t+e_{p,t},$$

where $r_{p,t}=R_{p,t}-R_{rf,t}$ is the momentum portfolio excess return over the risk-free rate or the momentum strategy return $r_{p,t}=R_{P10,t}-R_{P1,t}$. $\boldsymbol{F}_t$ is a vector of factors. The coefficients are estimated using OLS with Newey-West-adjusted standard errors. For each model, $\boldsymbol{F}$ is represented by the following factors:

(1) *mTERM*
(2) *mDEF*
(3) *mTERM, mDEF*
(4) *MKT, SMB, HML*
(5) *MKT, SMB, HML, MOM*
(6) *mTERM, mDEF, MKT, SMB, HML*
(7) *mTERM, mDEF, MKT, SMB, HML, MOM*
(8) *ΔTERM, ΔDEF, MKT, SMB, HML, MOM*
(9) *rTERM, rDEF, MKT, SMB, HML, MOM*

where MKT, SMB, HML, and MOM are the returns on the market, size, and book-to-market factors of Fama and French (1993), and momentum factor of Carhart (1997), respectively. $\Delta TERM_t=(TERM_t-TERM_{t-1})$ and $\Delta DEF_t=(DEF_t-DEF_{t-1})$, $mTERM_t=\Delta TERM_t/(1+TERM_{t-1})$, $mDEF_t=\Delta DEF_t/(1+DEF_{t-1})$, $rTERM_t=rSBTSY10_t-R_{rf,t}$, and $rDEF_t=rSBC3B_t-rSBTSY10_t$. $TERM_t$ is the difference between ten-year and one-year Treasury yields, and DEF_t is the difference between BBB and AAA-rated corporate bond yields, both at the end of month t. *rSBTSY10* is the return on long-term government bonds based on the SBTSY10 index (a ten-year constant maturity price index) from Bloomberg. *rSBC3B* is the return on BBB-rated corporate bonds based on the SBC3B index from Bloomberg. The table shows the estimated alphas (with their associated t-statistics in parentheses).

estimate alphas from the following model:

$$r_{p,t}=\alpha_p+\boldsymbol{\beta}'_p\boldsymbol{F}_t+e_{p,t}, \tag{2}$$

where $r_{p,t}=R_{p,t}-R_{rf,t}$ is the momentum portfolio excess return over the risk-free rate or the momentum profit $r_{p,t}=R_{P10,t}-R_{P1,t}$. $\boldsymbol{F}_t$ contains combinations of equity factors such as the MKT, SMB, and HML factors of Fama and French (1993), the momentum factor of Carhart (1997), and bond factors such as the change in the term spread (difference between ten-year and one-year Treasury yields) and the change in the default spread (difference between BBB and AAA corporate yields). We also use return-based bond factors. Specifically, the term spread factor is the difference between the monthly return on ten-year government bonds and the one-month risk-free rate. The default spread factor is the difference between the monthly returns on BBB-rated corporate bonds and ten-year Treasury notes.

Table 3 suggests that momentum profits do not compensate for systematic risk. The strategy alphas range from 59 to 72 bps, compared with raw momentum profits of 59 bps.[20]

2.2 Credit risk and bond momentum profitability

Avramov et al. (2007) show that equity momentum is strong among NIG firms but nonexistent among IG firms. In this section, we show that a similar pattern exists for bond momentum.

We examine the composition of momentum portfolios over 1991–2011 in Table 4. Each month, decile momentum portfolios are formed across all bonds, regardless of rating. Then, for each momentum portfolio, we report the distribution of its constituent bonds across the IG, NIG, and unrated categories and across individual ratings.[21]

Momentum portfolios contain on average 18.01% NIG bonds ("Row Average"), but these bonds disproportionately populate P1 (29.06%) and P10 (45.59%).[22] The winner and loser portfolios contain 41.45% of all NIG bonds, more than twice the proportion implied by a uniform distribution. Conversely, only 15.03% of IG bonds are among the winners and losers.

Refining the rating grid, we compute for each portfolio the bond frequency distribution across individual ratings. Better-rated bonds overpopulate the middle portfolios. The worse a bond's credit rating, the more likely it is to appear among winners or losers. Of bonds rated D (C) [CC], 74.83% (69.86%) [67.08%] end up in P1 or P10 and affect the momentum strategy, compared with 11.61% of bonds rated A+.

The last part of Table 4 shows a distinct U-shape across the average ratings of the momentum portfolios—P1 and P10 have the highest credit risk with an average rating of 8.59 ($\approx$ BBB) and 10.53 ($\approx$ BB+), respectively. P2–P8 portfolios have ratings of A or A$-$.

Following the above evidence of a link between credit risk and momentum portfolio composition, we implement conditional momentum strategies in rating-based subsamples. Specifically, each month t, bonds are sorted into quintiles (Q1 to Q5), or split into IG and NIG, based on prior-month rating.

[20] Momentum profits have significant exposure only to $mDEF$, MKT, and MOM (unreported results). Although all momentum portfolios have negative $mDEF$ betas with an inverted U-shape across P1 to P10, the default beta of the momentum strategy is positive—losers do worse than winners when the default premium widens. The MKT beta is negative, even though all momentum portfolios have positive MKT betas (with a U-shape pattern)—in equity market downturns P1 does worse than P10. The MOM beta is small at 0.09.

[21] Bonds are classified into rating classes based on their credit rating at the time portfolios are formed.

[22] Avramov et al. (2007) find similar patterns for equity momentum portfolios.

Table 4
Composition of momentum portfolios

	Momentum portfolios (P1 = losers, P10 = winners)										Row average	% in P1 or P10
	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10		
Composition of momentum portfolios by rating category												
IG	67.45	87.00	88.58	88.78	88.28	87.77	86.10	80.99	72.52	52.84	80.03	15.03
NIG	29.06	10.45	9.24	9.29	10.01	10.70	12.49	17.47	25.79	45.59	18.01	41.45
Unrated	3.49	2.55	2.17	1.93	1.71	1.53	1.41	1.54	1.69	1.57	1.96	25.80
Composition of momentum portfolios by individual ratings												
AAA	15.15	16.08	15.31	13.93	13.64	12.69	12.07	10.66	10.39	11.48	13.14	20.27
AA+	1.31	1.89	1.88	1.83	1.84	1.90	1.92	1.63	1.27	1.23	1.67	15.25
AA	2.88	3.90	3.98	3.96	3.59	3.46	3.50	3.17	2.72	1.69	3.29	13.90
AA-	4.27	6.60	6.94	6.75	6.72	6.47	5.82	5.35	4.44	2.54	5.59	12.17
A+	6.74	10.40	10.81	10.98	10.91	10.24	10.03	9.59	7.38	3.81	9.09	11.61
A	10.40	15.57	16.24	16.79	16.44	16.61	15.84	14.37	12.53	7.47	14.23	12.56
A-	6.69	9.37	10.14	10.54	10.44	10.64	10.64	9.85	8.50	5.01	9.18	12.74
BBB+	6.48	9.13	9.02	9.62	9.53	9.85	9.75	9.42	8.48	5.27	8.66	13.57
BBB	7.63	8.98	9.21	9.28	9.95	10.32	10.56	10.23	9.50	6.35	9.20	15.20
BBB-	5.89	5.08	5.05	5.10	5.21	5.58	5.96	6.72	7.31	7.99	5.99	23.18
BB+	3.72	1.99	1.88	1.85	1.84	2.06	2.33	2.98	3.69	4.72	2.71	31.17
BB	3.28	1.47	1.23	1.23	1.25	1.33	1.55	2.19	2.71	4.13	2.04	36.40
BB-	2.31	1.33	1.28	1.29	1.43	1.51	1.73	2.53	3.27	3.77	2.05	29.75
B+	2.79	1.34	1.18	1.28	1.42	1.49	1.76	2.42	3.57	5.10	2.23	35.30
B	3.02	1.51	1.37	1.36	1.51	1.62	1.91	2.81	4.46	6.85	2.64	37.34
B-	3.25	1.22	1.07	1.02	1.19	1.29	1.53	2.17	3.69	5.84	2.23	40.84
CCC+	2.11	0.63	0.51	0.48	0.54	0.57	0.69	0.94	1.71	3.56	1.17	48.35
CCC	1.33	0.27	0.20	0.20	0.22	0.26	0.28	0.47	0.86	2.06	0.61	55.21
CCC-	0.89	0.12	0.10	0.09	0.10	0.10	0.13	0.21	0.38	1.25	0.34	63.65
CC	0.69	0.08	0.06	0.06	0.06	0.06	0.07	0.09	0.20	0.70	0.21	67.08
C	0.58	0.06	0.05	0.06	0.05	0.03	0.04	0.06	0.10	0.48	0.15	69.86
D	5.09	0.43	0.33	0.37	0.40	0.37	0.45	0.61	1.14	7.13	1.63	74.83
Average rating per momentum portfolio												
Letter	BBB	A	A	A	A–	A–	A–	A–	BBB+	BB+		
Numeric	8.59	6.38	6.31	6.40	6.52	6.66	6.87	7.41	8.25	10.53		

Each month t, all bonds (rated and unrated) with returns for months $t-6$ to $t-1$ (formation period) are sorted into decile portfolios based on their cumulative return during the formation period. The first three rows show, for each decile portfolio, the percentage of bonds that are rated investment-grade (IG), noninvestment grade (NIG), or unrated. The middle part of the table presents, for each momentum portfolio, the percentage of bonds in a particular credit rating. The column "Row Average" averages this percentage across the ten momentum portfolios (each row). The last column represents the percentage of bonds of a particular rating that appear in the extreme portfolios (P1 or P10), relative to the total for all momentum portfolios (sum of each row: P1 to P10). The last part of the table presents the average (numeric and letter) rating of the constituents of each momentum portfolio. The sample period is from January 1991 to June 2011.

Within each rating group, bonds are further sorted into momentum deciles based on their cumulative past six-month ($t-6:t-1$) returns. Bonds remain in their rating group throughout the holding period ($t+1:t+6$), even if their rating changes. Panel A of Table 5 presents the average monthly holding period returns and momentum profits within these rating groups.

Momentum strategies are highly profitable among NIG bonds. NIG bonds yield momentum profits of 121 bps per month (t-value of 8.14) over 1973–2011 and 192 bps per month (t-value of 8.72) over 1991–2011. Unconditional momentum strategies based on all bonds generate 37 bps and 59 bps over the same periods (Panel A of Table 2). Momentum is not profitable among IG bonds. This result parallels what Avramov et al. (2007) document for equity momentum. It is also consistent with the absence of momentum in GHS, who limit their analysis to IG bonds.

Refining the rating grid, we find that momentum is profitable only in the worst-rated bond quintile (Q5), earning highly significant 103 bps per month

Table 5
Bond momentum and credit risk

Panel A: Bond momentum by rating groups

Rating group	Average rating	Momentum portfolios (P1 = losers, P10 = winners) P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P10 - P1	t-stat
						January 1973–June 2011							
IG	5.49	0.69	0.67	0.68	0.69	0.70	0.70	0.71	0.72	0.74	0.79	0.10	(1.13)
NIG	14.31	0.29	0.59	0.64	0.76	0.80	0.80	0.83	0.83	0.93	1.50	1.21	(**8.14**)
Q1	2.30	0.68	0.68	0.66	0.67	0.67	0.67	0.69	0.70	0.71	0.74	0.07	(0.70)
Q2	4.46	0.64	0.64	0.66	0.68	0.68	0.69	0.70	0.71	0.72	0.76	0.12	(1.41)
Q3	6.32	0.66	0.67	0.68	0.70	0.71	0.71	0.71	0.72	0.73	0.77	0.10	(1.25)
Q4	8.01	0.70	0.70	0.70	0.72	0.73	0.74	0.75	0.77	0.78	0.83	0.13	(1.38)
Q5	12.40	0.41	0.54	0.73	0.76	0.79	0.80	0.82	0.85	0.90	1.44	1.03	(**7.42**)
						January 1973–December 1990							
IG	5.27	0.78	0.76	0.78	0.81	0.81	0.83	0.85	0.87	0.88	0.87	0.09	(0.63)
NIG	13.86	0.56	0.78	0.83	0.87	0.94	0.91	0.89	0.90	0.98	1.00	0.44	(**2.27**)
Q1	2.38	0.72	0.73	0.76	0.79	0.79	0.80	0.83	0.84	0.85	0.84	0.12	(0.79)
Q2	3.90	0.75	0.74	0.77	0.79	0.80	0.82	0.84	0.85	0.86	0.85	0.10	(0.75)
Q3	5.83	0.76	0.76	0.78	0.80	0.81	0.82	0.83	0.85	0.87	0.85	0.09	(0.67)
Q4	6.97	0.81	0.79	0.80	0.81	0.81	0.84	0.86	0.88	0.89	0.86	0.05	(0.42)
Q5	10.93	0.77	0.88	0.89	0.88	0.90	0.92	0.92	0.95	0.94	0.98	0.21	(1.22)
						January 1991–June 2011							
IG	5.68	0.59	0.56	0.57	0.57	0.56	0.56	0.56	0.56	0.58	0.69	0.10	(0.91)
NIG	14.67	-0.04	0.32	0.43	0.62	0.64	0.66	0.75	0.73	0.85	1.88	1.92	(**8.72**)
Q1	2.22	0.61	0.62	0.55	0.54	0.53	0.52	0.53	0.53	0.56	0.62	0.01	(0.07)
Q2	4.93	0.51	0.53	0.55	0.55	0.55	0.54	0.54	0.55	0.57	0.64	0.13	(1.19)
Q3	6.76	0.56	0.56	0.57	0.58	0.59	0.57	0.56	0.57	0.58	0.66	0.11	(0.98)
Q4	8.91	0.57	0.60	0.59	0.62	0.62	0.62	0.63	0.63	0.66	0.77	0.20	(1.41)
Q5	13.68	0.16	0.23	0.58	0.64	0.68	0.69	0.71	0.76	0.85	1.87	1.71	(**8.03**)

Panel B: Regression of bond momentum profits on the availability of NIG bonds

Spec.	Controls	Constant	% NIG	Adj. R^2
1		0.37		0.00
		(**3.79**)		
2	Factors	0.33		1.50
		(**3.27**)		
3		−0.33	4.72	2.59
		(−1.53)	(**3.59**)	
4	Factors	−0.43	5.07	4.53
		(−**1.97**)	(**3.87**)	
5	Factors+trend	−0.43	5.29	4.32
		(−1.93)	(**2.40**)	
6	Factors+lagged P10-P1	−0.37	4.08	8.81
		(−1.71)	(**3.13**)	
7	Factors+year dummies	−1.54	10.55	4.40
		(−1.25)	(**2.16**)	

(*continued*)

Table 5
Continued

Panel C: Regression of NIG bond momentum profits on the average rating of NIG winners and losers

Spec.	Controls	Constant	$\text{Rating}_{[P1+P10]}$	Adj. R^2
1		1.21 (**8.14**)		0.00
2	Factors	1.22 (**8.00**)		4.53
3		−10.56 (**−6.83**)	0.37 (**7.64**)	11.37
4	Factors	−10.07 (**−6.60**)	0.36 (**7.43**)	14.97
5	Factors+trend	−7.83 (**−4.79**)	0.25 (**4.54**)	17.12
6	Factors+lagged P10-P1	−7.82 (**−4.64**)	0.25 (**4.41**)	16.95
7	Factors+year dummies	−8.84 (**−3.01**)	0.36 (**4.02**)	17.39

Panel D: Regression of bond momentum profits on the availability of NIG bonds and the rating-attributed NIG momentum profits (fitted value from specification 3 in Panel C)

Spec.	Controls	Constant	% NIG	Rating-attributed NIG profits	Adj. R^2
3		−0.09 (−0.52)	3.08 (**2.96**)	42.48 (**16.58**)	39.65
4	Factors	−0.16 (−0.93)	3.30 (**3.16**)	42.45 (**16.15**)	39.97
5	Factors+trend	−0.13 (−0.71)	5.36 (**3.07**)	42.76 (**16.23**)	40.13
6	Factors+lagged P10-P1	−0.13 (−0.72)	2.67 (**2.55**)	41.25 (**15.82**)	41.90
7	Factors+year dummies	−1.31 (−1.34)	7.43 (**1.99**)	43.32 (**16.07**)	40.56

Each month t, all bonds are sorted into investment grade (IG) and noninvestment grade (NIG) groups, as well as rating quintile groups, based on their month $t-1$ rating. Within each group, we repeat the momentum analysis described in Table 2. Panel A presents the momentum portfolio returns and momentum profits for each rating-sorted group. The second column provides the time-series average of the cross-sectional mean rating for the particular rating group. The numerical ratings increase with credit risk, that is 1 = AAA, …, 22 = D. Ratings 11 = BB+ or higher (i.e., worse) are considered noninvestment grade (NIG). In Panel B, we run time-series regressions of monthly bond momentum profits (P10-P1) on combinations of a constant, the percentage of bonds in the sample that are NIG (%NIG, i.e., the number of NIG bonds divided by the total number of rated bonds in each month of the sample), a time trend, year dummies, lagged bond momentum profits (lagged P10-P1), and the bond and equity factors from Table 3: $mTERM$, $mDEF$, MKT, SMB, HML, and MOM. Panel B reports the intercept and slope coefficient on the %NIG variable (in %), t-statistics in parentheses, and adjusted R^2. In Panel C, we run time-series regressions of monthly NIG bond momentum profits (P10-P1) on combinations of a constant, the average rating of NIG bond winners plus the average rating of NIG bond losers ($\text{Rating}_{[P1+P10]}$), a time trend, year dummies, lagged NIG bond momentum profits (lagged P10-P1), and the bond and equity factors from Table 3: $mTERM$, $mDEF$, Mkt, SMB, HML, and MOM. Panel C reports the intercept and slope coefficient on $\text{Rating}_{[P1+P10]}$ (in %), t-statistics in parentheses, and adjusted R^2. In Panel D, we repeat the regressions from Panel B but also including the NIG momentum profits attributed to credit risk (Rating-Attributed NIG Profits, i.e., the fitted value from specification 3 in Panel C). Panel D reports the intercept and slope coefficients on %NIG and Rating-Attributed NIG Profits (both in %), as well as t-statistics (in parentheses) and adjusted R^2. The year dummies in panels B-D take the value of one over two nonoverlapping consecutive years. The sample period for panels B-D is from January 1973 to June 2011.

over 1973–2011 and 171 bps over 1991–2011.[23] Q1-Q4 earn no momentum profits and have an IG average rating.

[23] Although in Q5 the P10-P1 momentum profits are highest, the P10-P2, P9-P1, and P9-P2 return differences are also economically and statistically significant at the 1% level (unreported results). We also find that momentum profits weighted by the amount outstanding are slightly higher than the equally weighted ones at 105 (179) bps per month over the 1973–2011 (1991–2011) period. Our conclusions are also similar if we fix the rating

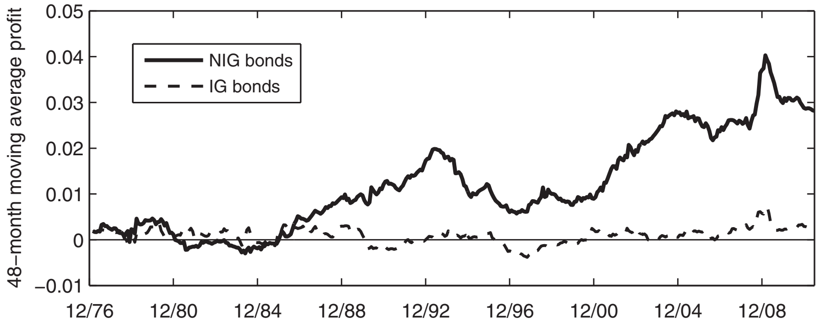

Figure 2
Time-series of momentum profitability in investment and noninvestment grade bonds
The figure presents the 48-month moving average monthly momentum profit (P10-P1) for noninvestment grade (NIG) bonds (solid line) as well as investment grade (IG) bonds (dashed line). The momentum strategy uses bonds from all databases: Lehman, DataStream, Bloomberg, FISD, and TRACE. The sample period is from January 1973 to June 2011.

Bond momentum is unprofitable in all credit-rating quintiles over 1973-1990. The average rating of Q5 over this period is 10.93 (just at the NIG cutoff of 11), but 13.68 over 1991–2011. Over 1973–1990, only 10% of bonds are NIG, compared with 22.20% over 1991–2011. We explore whether this lack of low-rated bonds explains the lack of momentum profits in the overall sample.

We find a strong link between momentum profitability and the availability of NIG bonds. In Panel B of Table 5 we run time-series regressions of monthly momentum profits (P10-P1) on the percentage of NIG bonds (%NIG) in each month from January 1973 to June 2011. In some specifications, we control for bond and equity factors (Model 7 in Table 3). The coefficient on %NIG is always significantly positive. To ensure that %NIG does not simply proxy for a time trend in momentum profits, we include a time trend in specification 5. The time trend is insignificant, and the %NIG coefficient and the R^2 remain almost unchanged. The %NIG variable remains significant when year dummies or lagged momentum profits are included in the regression.[24] Hence, the scarcity of NIG bonds likely explains the lack of bond momentum over 1973–1990 in the overall sample.

Momentum profits among NIG bonds have also increased over time. NIG bonds yield momentum profits of 44 bps (t-value of 2.27) over 1973–1990—still significant, though lower than the NIG bond momentum profits of 192 bps per month over the 1991–2011 period (see Table 5, Panel A). Figure 2 displays the times-series of the 48-month moving average momentum profits among IG and NIG bonds. Momentum profits from IG bonds are consistently around

thresholds throughout the sample. Because of the shifting composition of our bond sample, fixed thresholds, however, result in very imbalanced rating groups.

24 We report results using "two-year" dummies, which take the value of one over two nonoverlapping consecutive years. Including one-year dummies results in a close to singular covariance matrix.

zero throughout the sample period. In contrast, there is a steady increase in momentum profitability of NIG bonds.

The increase in momentum profits among NIG bonds could be attributed to the increase in the credit risk of NIG bonds in the momentum strategy. Panel A of Table 5 shows that the average rating of NIG bonds deteriorates from 13.86 ($\approx$ B+) in the first half to 14.67 ($\approx$ B) in the second half. More importantly, in unreported results, we find that the average rating of NIG bond winners and losers (the momentum strategy constituents) deteriorates even more—by almost two notches for losers (from 14.48 [B+] to 16.22 [B-]) and over one notch for winners (from 15.40 [B] to 16.49 [B-]). To confirm the link between the worsening credit rating of NIG bond winners and losers and the increase in NIG momentum profits, we run time-series regressions of monthly NIG bond momentum profits (P10-P1) on the average rating of NIG bond winners plus the average rating of NIG bond losers ($\text{Rating}_{[P1+P10]}$) in Panel C of Table 5. We control for time effects, as well as bond and equity factors. These tests show that the worse the credit rating of NIG bond winners and losers, the higher the NIG momentum profits.

Finally, we examine the combined effect of the increased availability and credit risk of NIG bonds on the momentum profits in the overall sample. Because NIG bond availability and credit risk are highly correlated ($\approx$0.80), the regression coefficients on %NIG in Panel B of Table 5 may incorporate the effect of both. To assess their individual contributions and address their high correlation, we regress overall momentum profits on %NIG and the NIG momentum profits attributed to credit risk (i.e., the fitted value from specification 3 in Panel C of Table 5). Panel D of Table 5 shows that both these effects are significant and robust to all controls. In sum, the increased presence and credit risk of NIG bonds underlies the increase in overall momentum profits observed in Figure 1.

2.3 Further robustness checks

Corporate bond momentum is robust to adjusting for firm-level interest rate risk, illiquidity proxies, and credit risk and does not appear to be driven by microstructure noise or survivorship bias. Neither is it database-specific—it persists after excluding any one database.

To control for interest rate risk, we duration adjust each bond return by subtracting the average monthly return of the duration decile to which the bond belongs. We then use duration-adjusted returns to compute holding period returns. Table 6 shows that duration-adjusted momentum profits in Q5 are 134 bps per month, and are insignificant in Q1 to Q4. Bond momentum and its link to credit risk appear robust to interest rate risk.

Similarly, we test if bond momentum and its link to credit risk are robust to illiquidity, in light of the documented liquidity effects on asset returns and

Table 6
Bond momentum based on characteristic-adjusted returns

Rating quintile	Momentum portfolios (P1 = losers, P10 = winners)											
	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P10 - P1	t-stat
	Duration-adjusted returns											
Q1	−0.03	−0.03	−0.04	−0.02	−0.02	−0.02	−0.02	−0.04	−0.02	0.05	0.09	(0.92)
Q2	−0.02	−0.08	−0.08	−0.07	−0.04	−0.04	−0.05	−0.05	−0.02	0.02	0.04	(0.31)
Q3	−0.03	−0.03	−0.01	−0.01	−0.01	−0.01	−0.01	−0.01	0.01	0.05	0.08	(0.79)
Q4	−0.05	0.03	0.02	0.01	0.02	−0.00	0.01	0.02	0.04	0.16	0.21	(1.51)
Q5	−0.34	−0.19	0.07	0.11	0.08	0.08	0.06	0.08	0.13	1.00	1.34	(**6.26**)
	Age-adjusted returns											
Q1	0.01	0.03	−0.04	−0.04	−0.06	−0.06	−0.06	−0.06	−0.03	0.04	0.02	(0.22)
Q2	−0.07	−0.06	−0.05	−0.05	−0.06	−0.06	−0.07	−0.05	−0.04	0.04	0.11	(1.05)
Q3	−0.04	−0.04	−0.03	−0.03	−0.02	−0.04	−0.05	−0.05	−0.04	0.04	0.08	(0.78)
Q4	−0.03	−0.00	−0.01	0.01	0.01	0.01	0.02	0.02	0.04	0.15	0.18	(1.34)
Q5	−0.43	−0.35	−0.02	0.05	0.09	0.10	0.12	0.15	0.24	1.22	1.65	(**8.01**)
	Amount-outstanding-adjusted returns											
Q1	0.04	0.03	−0.05	−0.06	−0.07	−0.07	−0.06	−0.08	−0.03	0.03	−0.01	(−0.08)
Q2	−0.08	−0.07	−0.05	−0.05	−0.05	−0.05	−0.05	−0.05	−0.03	0.04	0.12	(1.14)
Q3	−0.04	−0.04	−0.03	−0.02	−0.01	−0.02	−0.03	−0.04	−0.02	0.07	0.11	(1.03)
Q4	−0.02	0.00	−0.01	0.02	0.02	0.02	0.03	0.04	0.06	0.17	0.19	(1.38)
Q5	−0.43	−0.36	−0.02	0.04	0.08	0.09	0.11	0.15	0.24	1.26	1.69	(**8.09**)
	Credit-risk-adjusted returns											
Q1	0.05	0.05	−0.01	−0.03	−0.02	−0.03	−0.03	−0.03	0.00	0.07	0.02	(0.20)
Q2	−0.05	−0.03	−0.02	−0.02	−0.02	−0.03	−0.03	−0.02	0.00	0.09	0.13	(1.25)
Q3	−0.03	−0.03	−0.02	−0.02	−0.01	−0.02	−0.03	−0.03	−0.01	0.07	0.10	(0.96)
Q4	−0.06	−0.04	−0.05	−0.02	−0.02	−0.02	−0.01	−0.01	0.00	0.11	0.17	(1.32)
Q5	−0.50	−0.41	−0.14	−0.09	−0.07	−0.05	−0.03	0.01	0.09	1.09	1.58	(**7.92**)
	Returns adjusted for all above characteristics											
Q1	−0.02	−0.00	−0.01	0.00	0.00	−0.01	0.00	−0.01	0.02	−0.01	0.02	(0.23)
Q2	−0.03	−0.07	−0.06	−0.05	−0.03	−0.03	−0.04	−0.05	−0.06	−0.02	0.00	(0.02)
Q3	−0.05	−0.03	−0.01	−0.02	−0.01	−0.01	−0.02	−0.02	−0.03	0.00	0.05	(0.51)
Q4	−0.06	0.02	0.00	0.00	0.03	0.01	0.02	0.02	0.03	0.14	0.20	(1.52)
Q5	−0.47	−0.29	0.01	0.06	0.04	0.05	0.04	0.05	0.09	0.98	1.45	(**6.87**)

Each month, characteristic-adjusted returns are computed by subtracting from each monthly bond return the average monthly return of the characteristic decile to which the bond belongs. Bond momentum profits are then computed as in Table 5 using characteristic-adjusted, rather than raw returns, to calculate portfolio holding period returns. The different subpanels present results after adjusting for bond duration, age, amount outstanding, or credit rating. In the last subpanel, bond returns are characteristic-adjusted simultaneously for duration, age, amount outstanding, and credit rating. The adjustment is done by running monthly cross-sectional regressions of bond returns on these characteristics and taking the residuals as the characteristics-adjusted returns. These characteristics-adjusted returns are used to compute holding period returns reported in the last subpanel. All characteristics (except for rating) are truncated at the 99th percentile to limit the impact of outliers on the results. The sample period is from January 1991 to June 2011.

equity momentum.[25] As in Chen, Lesmond, and Wei (2007), we use age and amount outstanding as liquidity proxies. Age- (amount outstanding-) adjusted profits are only significant in Q5 at 165 (169) bps (Table 6). As an additional test, each month we group bonds based on a 3×3 independent sort on rating and an illiquidity proxy (amount outstanding or age). Within each group, we implement

[25] See, among others, Amihud and Mendelson (1986), Lee and Swaminathan (2000), Pastor and Stambaugh (2003), Korajczyk and Sadka (2004), Acharya and Pedersen (2005), and Chen, Lesmond, and Wei (2007).

the momentum strategy by further sorting bonds into decile portfolios based on past six-month returns as in Table 2. Bond momentum is only significant in the highest credit risk group in all illiquidity terciles (unreported results). We also compare trade- and quote-based momentum profits by rating quintiles over their common period from February 1994 to March 2011. Q5 momentum profits are 187 (180) [117] bps in all (quote-based) [trade-based] data. Momentum profits in Q1 to Q4 are all insignificant (unreported results).

We next test whether momentum profits are due to the higher returns earned by worst-rated bonds. We control for credit risk by subtracting from each bond return the monthly return of the credit rating decile to which that bond belongs. The credit-risk-adjusted momentum profits in Q5 are 158 bps (Table 6). In unreported results, we also credit-risk-adjust returns using a finer grid: twenty credit risk groups rather than deciles, and individual ratings. Even with the finest grid, momentum profits remain significant in Q5. Recognizing that ratings may be sticky and not fully capture the variations in credit risk, we compare the credit risk of Q5 winners and losers using Altman (1968) Z-scores and Ohlson (1980) O-scores from Compustat and credit spreads from DataStream (unreported results). Based on all three measures, Q5 winners appear to have lower credit risk than Q5 losers. We also compare future rating changes of Q5 winners and losers. We find that over 6, 12, and 24 months following portfolio formation, Q5 winners are more likely to be upgraded, whereas Q5 losers are more likely to be downgraded. Overall, the higher returns of Q5 winners relative to Q5 losers do not appear to compensate for credit risk.

Finally, we adjust bond returns for multiple characteristics through monthly cross-sectional regressions of bond returns on duration, age, amount outstanding, and rating.[26] The regression residuals constitute characteristics-adjusted returns used to compute holding period returns. The characteristics-adjusted momentum profits are 145 bps in Q5 (Table 6).

Bond momentum profitability comes primarily from winners. Consider the worst-rated quintile, Q5, where momentum is profitable. Based on characteristics-adjusted returns, momentum winners earn 98 bps per month more than otherwise similar bonds. Losers earn 47 bps less. More than two-thirds of the characteristics-adjusted momentum profits of 145 bps are due to winners. In contrast, Avramov et al. (2007) find that equity momentum profits are largely attributable to losers.

We also check whether momentum profits are sensitive to downgrades or upgrades. Hand, Holthausen, and Leftwich (1992) and Dichev and Piotroski (2001) show that downgrades have a substantial impact on bond and stock returns. Avramov et al. (2013) find that equity momentum derives its profitability from periods around issuer downgrades. In contrast, we find that bond momentum profits remain unchanged after we exclude bond-month

26 All characteristics (except rating) are truncated at the 99th percentile to limit the impact of outliers.

Table 7
Bond momentum profitability for various formation and holding periods

	Holding period			
Formation period	3 months	6 months	9 months	12 months
3 months	0.71 (**5.40**)	0.56 (**5.57**)	0.54 (**5.47**)	0.47 (**4.94**)
6 months	0.65 (**4.48**)	0.59 (**4.30**)	0.53 (**3.88**)	0.43 (**3.33**)
9 months	0.71 (**4.43**)	0.58 (**3.74**)	0.48 (**3.11**)	0.35 (**2.52**)
12 months	0.62 (**3.71**)	0.49 (**3.00**)	0.35 (**2.28**)	0.24 (1.77)

We repeat the analysis in Table 2 for various combinations of formation and holding periods, including all databases in our sample. Each row represents the average monthly holding period returns on the momentum strategy (P10-P1) for a different length of the formation period and each column a different holding period. The sample period is from January 1991 to June 2011.

observations from twelve months prior to twelve months after a rating change (unreported results).

This paper focuses on a momentum strategy based on formation and holding periods of six months. Table 7 shows that, over 1991–2011, momentum profits are also significant at 71 (59) [48] {24} bps per month over formation and holding periods of 3 (6) [9] {12} months. The shorter holding periods generate higher momentum for all formation periods.

We recognize that using matrix prices can be problematic, because they can induce serial correlation and lead to spurious momentum. This issue is specific to the three quote databases, of which only Lehman unambiguously identifies matrix prices. Excluding matrix prices has little effect (less than 3 bps) on momentum profits (unreported results).

Although the concern of matrix prices is irrelevant for transaction data, the two transaction databases come with their own issue—the possibility of bias due to microstructure noise. Asparouhova, Bessembinder, and Kalcheva (2010) suggest that characteristic-sorted portfolio returns may be biased if the characteristic is correlated with microstructure noise. The authors correct for such bias by weighing portfolio returns by gross past returns. Asparouhova, Bessembinder, and Kalcheva (2013) show that this correction produces even higher momentum for equities. Using their approach, we recompute momentum profits and find that the microstructure-noise-corrected profits differ only by a few basis points. For example, momentum profits in all bonds over 1991–2011 decrease from 59 bps to 58 bps.

Conceivably, some bonds disappear during the holding period because they default—a more likely scenario for riskier bonds. This could pose a problem because we have no record of recovery rates and no "delisting" returns as in the Center for Research in Security Prices (CRSP). To assess the extent of this issue, we count the number of bonds that are in each momentum portfolio in month $t+1$ and $t+6$. We find that 91% (92%) of the bonds that enter P1 (P10) in month $t+1$ remain in the portfolio through $t+6$. The fact that retention rates are this similar for P1 and P10 suggests that survivorship is not likely to be driving momentum profitability.

3. Bond Momentum and Equity Momentum

Bond momentum is generated by high-yield bonds. Previous research shows that (1) equity momentum is also concentrated among high credit risk firms and (2) high-yield bonds behave like equities.[27] Is then bond momentum simply a manifestation of equity momentum?

The evidence in Table 8 suggests otherwise. First, bond momentum profits are larger among companies that do not have publicly traded equity. For those that have, implementing the momentum strategy based on stock-adjusted bond returns still produces significant momentum profits in NIG bonds. Second, the time-series correlation between equity and bond momentum profits is low. Third, equity momentum explains about 20% of the magnitude of the raw bond momentum profits of their corresponding firms. Fourth, the overlap between public-firm bond and equity momentum portfolio constituents is low. Finally, independent sorts and cross-sectional regressions reveal that, although there is some momentum spillover from equities to both IG and NIG bonds, a larger portion of the momentum profits in NIG bonds are bond specific.

We split our sample into bonds of public and of private firms.[28] Panel A of Table 8 shows that private-firm bonds are major contributors to momentum profits. Specifically, over 1973–2010, momentum profits among private- (public-) firm bonds are 63 (16) bps per month with a t-statistic of 5.44 (1.83) and are based on a monthly average of 3,355 (3,724) bonds. Over 1991-2010, private- (public-) firm bonds earn momentum profits of 107 (21) bps with a t-statistic of 5.83 (1.83), based on a monthly average of 4,024 (4,977) bonds.

NIG bonds of private (public) firms generate momentum profits of 163 (83) bps per month over 1973–2010 and 282 (115) bps over 1991–2010. Momentum is insignificant in IG bonds of both public and private firms. Although the average rating of private- and public-firm bonds is similar (6.67 vs. 6.79), 20.55% of private-firm bonds are NIG versus 16.31% of public firms.

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[27] See for (1) Avramov et al. (2007) and for (2) Cornell and Green (1991), Blume, Keim, and Patel (1991), Kwan (1996), Avramov, Jostova, and Philipov (2007), among others.

[28] We categorize a firm as public if, in a particular month, it has traded equity in CRSP and private if it does not. We match bond cusips to their equity cusips using several methods. First, we perform six-digit cusip matches across bonds and stocks in CRSP. Then we check if the remaining unmatched bond cusips are associated with gvkeys in the S&P *RatingsXpress* database and if these gvkeys have matches with CRSP cusips. Finally, we apply Bloomberg bond and equity matching tools to the remaining unmatched bond cusips. The existence of an equity cusip indicates that the issuing firm has been public at some point. We recognize that a large number of firms with an equity cusip are not listed on CRSP during our sample period, either because they are currently not public or they are currently not exchange-traded. In either case, we have no equity return data that allow us to study the bond-equity momentum interaction, so we focus on public firms with CRSP returns. However, we have checked that bonds of firms that have an equity cusip, but are not listed on CRSP have similar momentum profits as firms with no equity cusip, suggesting that non-CRSP firm bonds behave more like private-firm bonds than like bonds of exchange-traded public firms.

Table 8
Bond momentum and equity momentum

Panel A: Bond-level momentum in private and public firms (in % per month)

	1973–2010			1991–2010		
Sample	Private	Public	Public stock-adj.	Private	Public	Public stock-adj.
Obs/month	3,355	3,724	3,724	4,024	4,977	4,977
% rated	89.06	93.31	93.31	81.88	89.28	89.28
			Momentum profits (P10–P1 in % per month)			
All	0.63	0.16	0.13	1.07	0.21	0.17
	(**5.44**)	(1.83)	(1.66)	(**5.83**)	(1.83)	(1.62)
Rated	0.67	0.14	0.12	1.15	0.21	0.16
	(**5.53**)	(1.66)	(1.46)	(**5.94**)	(1.75)	(1.52)
IG	0.13	0.07	0.05	0.14	0.08	0.03
	(1.35)	(0.85)	(0.61)	(1.04)	(0.71)	(0.35)
NIG	1.63	0.83	0.73	2.82	1.15	1.02
	(**8.54**)	(**5.13**)	(**4.75**)	(**9.74**)	(**4.45**)	(**4.15**)
Q1	0.07	0.05	0.06	-0.02	0.01	0.03
	(0.65)	(0.61)	(0.78)	(-0.13)	(0.14)	(0.37)
Q2	0.16	0.11	0.10	0.21	0.12	0.10
	(1.63)	(1.22)	(1.24)	(1.47)	(1.00)	(1.02)
Q3	0.09	0.10	0.07	0.09	0.10	0.05
	(1.04)	(1.23)	(0.91)	(0.77)	(0.92)	(0.51)
Q4	0.33	0.07	0.02	0.57	0.07	−0.01
	(**2.13**)	(0.87)	(0.27)	(**2.06**)	(0.59)	(−0.14)
Q5	1.74	0.35	0.27	3.04	0.46	0.36
	(**9.37**)	(**2.85**)	(**2.42**)	(**10.83**)	(**2.44**)	(**2.06**)
			Momentum losers (P1 in % per month)			
All	0.50	0.66	−0.02	0.26	0.54	−0.00
Rated	0.47	0.67	−0.01	0.20	0.55	0.00
IG	0.68	0.70	−0.00	0.57	0.60	0.02
NIG	0.26	0.19	−0.39	−0.20	−0.13	−0.53
Q1	0.70	0.67	−0.04	0.68	0.59	−0.00
Q2	0.61	0.63	−0.08	0.46	0.51	−0.08
Q3	0.69	0.65	−0.05	0.60	0.54	−0.03
Q4	0.51	0.73	0.03	0.22	0.66	0.09
Q5	0.23	0.58	−0.05	−0.15	0.49	−0.00
			Momentum winners (P10 in % per month)			
All	1.13	0.81	0.11	1.33	0.75	0.17
Rated	1.14	0.81	0.10	1.35	0.76	0.17
IG	0.81	0.77	0.05	0.71	0.68	0.06
NIG	1.89	1.01	0.34	2.62	1.02	0.48
Q1	0.78	0.72	0.02	0.66	0.60	0.03
Q2	0.77	0.74	0.01	0.67	0.62	0.02
Q3	0.78	0.75	0.02	0.69	0.64	0.02
Q4	0.84	0.80	0.06	0.79	0.73	0.08
Q5	1.97	0.93	0.22	2.89	0.95	0.36
			Average credit rating			
Rated	6.67	6.79	6.79	7.20	7.48	7.48
Q1	1.89	2.85	2.85	1.51	3.14	3.14
Q2	3.82	4.75	4.75	3.66	5.58	5.58
Q3	6.04	6.51	6.51	6.23	7.17	7.17
Q4	8.15	7.92	7.92	8.97	8.84	8.84
Q5	13.30	11.46	11.46	15.15	12.47	12.47

(*continued*)

Table 8
Continued

Panel B: Firm-level bond momentum in private and public firms (in % per month)

Sample	1973–2010 Private	Public	Public stock-adj.	Stocks	1991–2010 Private	Public	Public stock-adj.	Stocks
Obs/month	989	707	707	707	1,237	845	845	845
% rated	84.41	95.16	95.16	95.16	77.09	94.87	94.87	94.87
				Momentum profits (P10–P1)				
All	1.08	0.38	0.30	1.27	1.83	0.46	0.33	1.16
	(**9.75**)	(**4.34**)	(**3.92**)	(**4.06**)	(**10.87**)	(**3.87**)	(**3.38**)	(**2.24**)
Rated	1.17	0.34	0.27	1.18	2.06	0.45	0.33	1.07
	(**9.85**)	(**4.06**)	(**3.65**)	(**3.77**)	(**11.09**)	(**3.76**)	(**3.31**)	(**2.03**)
IG	0.23	0.07	0.04	0.35	0.35	0.08	0.03	0.21
	(**2.97**)	(1.12)	(0.69)	(1.51)	(**3.25**)	(1.04)	(0.48)	(0.54)
NIG	2.03	1.08	0.90	2.88	3.53	1.23	0.96	3.34
	(**10.92**)	(**6.31**)	(**5.86**)	(**5.51**)	(**12.38**)	(**4.84**)	(**4.46**)	(**3.89**)
Q1	0.20	0.06	0.06	0.22	0.30	0.07	0.06	0.22
	(**2.59**)	(0.98)	(1.02)	(0.92)	(**2.81**)	(0.96)	(0.92)	(0.53)
Q2	0.29	0.06	0.01	0.36	0.45	0.06	-0.01	0.19
	(**3.37**)	(0.88)	(0.22)	(1.39)	(**3.56**)	(0.68)	(-0.11)	(0.44)
Q3	2.23	0.87	0.72	2.47	3.96	1.08	0.84	2.77
	(**12.13**)	(**6.71**)	(**6.37**)	(**5.33**)	(**13.77**)	(**5.69**)	(**5.39**)	(**3.53**)
				Momentum losers (P1)				
All	0.42	0.48	−0.14	0.32	0.21	0.40	−0.09	0.35
Rated	0.40	0.52	−0.11	0.41	0.14	0.43	−0.07	0.44
IG	0.61	0.70	−0.02	1.04	0.47	0.60	−0.02	1.03
NIG	0.38	−0.03	−0.52	−0.75	0.06	−0.11	−0.42	−1.08
Q1	0.59	0.68	−0.06	0.99	0.46	0.59	−0.07	0.91
Q2	0.60	0.71	0.01	1.10	0.47	0.63	0.02	1.19
Q3	0.32	0.16	−0.36	−0.57	0.10	0.13	−0.22	−0.88
				Momentum winners (P10)				
All	1.51	0.86	0.16	1.60	2.04	0.86	0.24	1.50
Rated	1.57	0.86	0.16	1.59	2.19	0.88	0.26	1.51
IG	0.83	0.77	0.02	1.39	0.82	0.69	0.01	1.24
NIG	2.41	1.07	0.40	2.12	3.59	1.16	0.57	2.24
Q1	0.80	0.74	−0.00	1.21	0.76	0.66	−0.00	1.12
Q2	0.89	0.77	0.02	1.46	0.92	0.69	0.02	1.38
Q3	2.55	1.03	0.36	1.89	4.05	1.21	0.62	1.89
				Average credit rating				
Rated	8.49	8.42	8.42	8.42	9.75	9.55	9.55	9.55
Q1	3.55	4.63	4.63	4.63	4.01	5.79	5.79	5.79
Q2	7.80	7.75	7.75	7.75	9.04	8.95	8.95	8.95
Q3	14.13	12.61	12.61	12.61	16.16	13.91	13.91	13.91

Panel C: Momentum in NIG bonds based on stock-adjusted returns

	Momentum portfolios (P1 = losers, P10 = winners)											
Returns used	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P10 - P1	*t*-stat
Raw returns	−0.13	0.24	0.62	0.65	0.70	0.73	0.70	0.69	0.68	1.02	1.15	(**4.45**)
Stock-adjusted returns	0.07	0.42	0.60	0.64	0.64	0.70	0.68	0.63	0.69	0.69	0.62	(**2.67**)
FP=Raw,HP=Stock-adjusted	0.07	0.24	0.61	0.64	0.67	0.68	0.64	0.61	0.61	0.88	0.81	(**3.49**)
FP=Stock-adjusted, HP=Raw	0.06	0.47	0.63	0.68	0.66	0.76	0.74	0.65	0.71	0.66	0.60	(**2.51**)

(*continued*)

Table 8
Continued

Panel D: Time-series correlations between bond and stock momentum profitability (1973–2010)

	Bond momentum				Stock momentum Firm-level Stocks
	Bond-level		Firm-level		
	Private	Public	Private	Public	
Bond momentum					
Bond-level					
Private	1.00	0.81	0.83	0.72	0.24
Public	0.81	1.00	0.64	0.84	0.34
Firm-level					
Private	0.83	0.64	1.00	0.68	0.19
Public	0.72	0.84	0.68	1.00	0.35
Stock momentum					
Stocks	0.24	0.34	0.19	0.35	1.00

Panel E: Bond momentum profitability attributed to stock momentum profitability (in % per month)

	1973–2010						1991–2010					
	Total P10-P1	Bond-specific α_{P10-P1}	Stock-driven P10-P1	% of P10-P1 driven by stock mom	Stock mom beta	Adj. R^2	Total P10-P1	Bond-specific α_{P10-P1}	Stock-driven P10-P1	% of P10-P1 driven by stock mom	Stock mom beta	Adj. R^2
Public firms (firm-level bond momentum)												
All	0.38	0.26	0.12	32.34	0.10	11.78	0.46	0.36	0.10	22.97	0.09	15.41
	(**4.34**)	(**3.07**)	(**4.06**)		(**7.74**)		(**3.87**)	(**3.21**)	(**2.24**)		(**6.51**)	
Q3	0.87	0.66	0.21	24.43	0.09	9.34	1.08	0.86	0.22	19.96	0.08	10.16
	(**6.71**)	(**5.17**)	(**5.33**)		(**6.77**)		(**5.69**)	(**4.69**)	(**3.53**)		(**5.10**)	
Private firms (firm-level bond momentum)												
All	1.08	1.00	0.08	7.80	0.07	3.30	1.83	1.76	0.07	3.64	0.06	2.69
	(**9.75**)	(**8.97**)	(**4.06**)		(**4.00**)		(**10.87**)	(**10.50**)	(**2.24**)		(**2.70**)	
Q3	2.23	2.12	0.12	5.34	0.05	1.27	3.96	3.89	0.07	1.70	0.02	-0.00
	(**12.13**)	(**11.21**)	(**5.33**)		(**2.57**)		(**13.77**)	(**13.18**)	(**3.53**)		(1.00)	

Panel F: Overlap between bond and stock firm-level momentum portfolios (1973–2010)

	Momentum portfolios based on past six-month stocks returns									
	PS1	PS2	PS3	PS4	PS5	PS6	PS7	PS8	PS9	SP10
All firms										
% of firms in P1$_{Bonds}$ that appear in	27.10	12.93	9.54	8.40	7.61	7.53	6.67	6.27	6.37	7.59
% of firms in P10$_{Bonds}$ that appear in	10.48	8.09	7.49	7.07	7.26	7.72	8.36	9.46	12.68	21.51
Q3 firms										
% of firms in P1$_{Bonds}$ that appear in	31.60	14.95	10.64	7.74	6.88	6.90	5.78	4.96	4.61	5.93
% of firms in P10$_{Bonds}$ that appear in	8.34	7.38	7.28	7.59	7.43	8.59	8.73	10.50	13.56	21.87

(*continued*)

Table 8
Continued

Panel G: Monthly bond holding period returns in 5×5 independently sorted portfolios based on past six-month bond returns and past six-month stock returns

Stock quintile	P1	P2	P3	P4	P5	P5 - P1	t-stat
			January 1973–December 1990				
			IG bonds				
PS1	0.68	0.73	0.74	0.76	0.75	0.07	(0.77)
PS2	0.77	0.76	0.78	0.80	0.83	0.06	(0.65)
PS3	0.77	0.76	0.79	0.82	0.83	0.06	(0.72)
PS4	0.79	0.78	0.81	0.85	0.86	0.07	(0.82)
PS5	0.82	0.80	0.82	0.86	0.88	0.07	(0.93)
PS5-PS1	0.14	0.07	0.08	0.10	0.14		
	(**3.14**)	(**2.83**)	(**3.49**)	(**3.64**)	(**3.73**)		
			January 1991–December 2010				
			IG bonds				
PS1	0.53	0.52	0.53	0.56	0.62	0.08	(0.82)
PS2	0.63	0.59	0.58	0.58	0.66	0.03	(0.43)
PS3	0.65	0.61	0.60	0.60	0.65	-0.01	(-0.14)
PS4	0.62	0.61	0.61	0.61	0.69	0.07	(1.25)
PS5	0.66	0.66	0.64	0.64	0.69	0.03	(0.55)
PS5-PS1	0.12	0.13	0.11	0.09	0.07		
	(1.62)	(**4.30**)	(**4.41**)	(**3.89**)	(**2.62**)		
			NIG bonds				
PS1	−0.15	0.53	0.50	0.86	1.26	1.41	(**4.60**)
PS2	0.49	0.70	0.63	0.68	0.99	0.51	(**2.45**)
PS3	0.70	0.84	0.75	0.71	1.08	0.38	(**3.19**)
PS4	0.77	0.84	0.81	0.83	0.92	0.16	(1.70)
PS5	0.83	0.78	0.87	0.83	1.06	0.23	(**1.98**)
PS5-PS1	0.99	0.26	0.37	−0.03	−0.19		
	(0.98)	(**2.06**)	(**3.89**)	(−0.16)	(−1.21)		

Panel H: Cross-sectional regressions of six-month bond returns $r^B_{t+1:t+6}$ (1991–2010)

Specification	Intercept	$r^B_{t-6:t-1}$	$r^S_{t-6:t-1}$	$r^S_{t+1:t+6}$	Rating$_t$	Adj. R^2
			NIG bonds of public firms			
1	2.67	21.88				10.01
	(**5.09**)	(**7.19**)				
2	3.04		3.43			2.36
	(**6.01**)		(**5.19**)			
3	2.87	19.58	2.27			11.58
	(**5.52**)	(**6.35**)	(**3.98**)			
4	3.74		1.84	10.94		11.68
	(**11.41**)		(**3.99**)	(**13.52**)		
5	3.40	18.47	0.90	10.58		20.23
	(**8.96**)	(**6.32**)	(**2.00**)	(**14.00**)		
6	3.77	17.05	0.82	10.30	-0.11	22.27
	(**8.88**)	(**5.93**)	(**1.98**)	(**13.93**)	(-1.27)	
7	0.23				0.24	5.10
	(0.16)				(**2.30**)	

(*continued*)

Table 8
Continued

Specification	Intercept	$r^B_{t-6:t-1}$	$r^S_{t-6:t-1}$	$r^S_{t+1:t+6}$	Rating_t	Adj. R^2
			IG bonds of public firms			
1	3.84	−1.24				9.49
	(**10.91**)	(−0.36)				
2	3.49		0.62			0.78
	(**10.30**)		(**2.53**)			
3	3.81	−1.73	0.82			10.14
	(**10.77**)	(−0.51)	(**4.43**)			
4	3.54		0.47	3.00		3.10
	(**10.56**)		(**2.24**)	(**8.01**)		
5	3.81	−1.50	0.58	2.98		12.47
	(**11.08**)	(-0.44)	(**2.71**)	(**8.30**)		
6	4.16	−2.34	0.66	2.85	0.06	14.16
	(**9.58**)	(−0.70)	(**3.85**)	(**8.23**)	(1.45)	
7	2.97				0.14	2.36
	(**8.51**)				(**3.22**)	

We estimate bond momentum as in Table 2 for bonds of private and public firms. A firm is defined as public if it has publicly traded equity with returns in CRSP. In Panel A, the analysis is performed at the bond level and in Panel B at the firm level. Monthly firm-level bond returns and ratings are equally weighted averages across all available bond returns. In Panel A, NIG refers to bond ratings of BB+ or worse and in Panel B to an average firm rating of 10.5 (between BBB− and BB+) or worse. Panel B also reports stock momentum profits over firm-month observations for which bond returns are available. In the column "Public Stock-Adj.", bond momentum profits of public firms are adjusted by subtracting the average monthly bond return of the stock return decile to which the bond belongs in that month from each bond-month return. Panel A uses rating quintiles (Q1-Q5), and Panel B uses rating terciles (Q1-Q3). Panel C focuses on public-firm NIG bonds over the 1991–2010 period. We run time-series regressions of monthly bond returns on a constant and the firm's contemporaneous monthly stock returns. The intercept and residuals represent stock-adjusted bond returns. We restrict the sample to bonds with at least twelve months of bond and stock returns. The first row shows raw momentum profits (as in Panel A). Momentum profits are computed using stock-adjusted bond returns, both in the formation and holding periods (second row), by sorting on raw bond returns in the formation period, but using stock-adjusted bond returns in the holding period (third row), sorting on stock-adjusted bond returns in the formation period, but using raw bond returns in the holding period (fourth row). Panel D reports the time-series correlations between the monthly momentum profits, P10-P1, of the various stock and bond samples of Panels A and B. In Panel E, we run time-series regressions of firm-level bond momentum profits on a constant and stock momentum profits. Q3 bond momentum are regressed on Q3 stock momentum of the same Q3 firms. The first column reports the raw bond momentum profits, P10-P1 (see Panel B). The second column reports the bond-specific momentum profit, α_{P10-P1}, which is the intercept in the above regressions. The third column reports the stock-driven bond momentum, and is the average stock momentum profit multiplied by the slope coefficient. The fourth column presents the percentage of bond momentum profitability that is explained by stock momentum profitability and is computed by dividing the stock-driven bond momentum profitability in the preceding column by the total bond momentum profits P10-P1 in the first column. The last two columns report the stock momentum beta of the bond momentum strategy and the adjusted R^2. In Panel F, we form portfolios based on independent sorts on past six-month firm-level bond returns and on past six-month stock returns, and report the percentage of firms in the extreme bond-sorted momentum portfolios that also appear in each stock-sorted momentum portfolio. In Panel G, we form portfolios based on an independent 5×5 sort on past six-months equity (PS1-PS5) and bond (P1-P5) firm-level returns. Panel G reports the average monthly firm-level bond return over the six-month holding period, as well as the PS5-P1 and P5-P1 differentials. In Panel H, we run monthly Fama-MacBeth cross-sectional regressions of six-month bond returns ($r^B_{t+1:t+6}$) on combinations of lagged six-month bond returns ($r^B_{t-6:t-1}$), contemporaneous ($r^S_{t+1:t+6}$) and lagged ($r^S_{t-6:t-1}$) six-month stock returns, and lagged bond numeric ratings:

$$r^B_{i,t+1:t+6}=c_{0,t}+c_{1,t}\,r^B_{i,t-6:t-1}+c_{2,t}\,r^S_{i,t-6:t-1}+c_{3,t}\,r^S_{i,t+1:t+6}+c_{4,t}\,Rating_{i,t}+e_{i,t},$$

Panel H reports the time-series averages of the cross-sectional regression coefficients with Newey and West (1987)-adjusted heteroscedastic-serial consistent t-statistics and average adjusted R^2. The sample period is January 1991 to December 2010. t-statistics are reported in parentheses (and are bold if significant at the 5% level).

Conditioning on rating quintiles, private-firm bonds in the worst-rated quintile, Q5, generate momentum profits of 304 bps per month, almost all (289 bps) attributable to winners. Even Q4 private-firm bonds earn significant profits of 57 bps. Among public-firm bonds, momentum is only profitable in Q5, where it generates 46 bps. Although in Q5, private-firm bond losers earn lower returns than public-firm bond losers (-15 vs. 49 bps), private-firm winners earn much higher returns than public-firm winners (289 vs. 95 bps).

Panel B of Table 8 shows that bond momentum profits are higher at the firm level than at the bond level.[29] Over the full period, private firms generate bond momentum profits of 108 bps (Panel B), whereas their bonds individually generate 63 bps (Panel A). Public firms generate bond momentum profits of 38 bps (t-value of 4.34), more than twice the profits generated by their bonds individually. Just as with individual bonds, worst-rated firms earn the highest momentum profits. Because bond aggregation by firms reduces the number of observations, we condition on rating terciles rather than quintiles. Firm-level bond momentum strategies for public firms perform well only in the worst-rated tercile, earning 87 bps (108 bps in 1991–2010). Profits among private firms are significant across the board but much lower in Q1 and Q2 than in Q3. For example, from 1991 to 2010, monthly Q1 (Q2) [Q3] profits are 30 (45) [396] bps. Bond momentum strategies are more profitable at the firm-level than at the bond-level because the proportion of high credit risk firms in the sample is larger than the proportion of high credit risk bonds. High credit risk firms usually have fewer bonds (verified in unreported results), which increases these firms' weight in the momentum strategies. As a result, average credit ratings are worse at the firm level.

As a first way to control for the impact of equity returns on public-firm bond momentum, we "stock adjust" individual bond returns (Panel A) and firm-level bond returns (Panel B) by subtracting each month the average monthly return of bonds in the stock return decile to which the bond belongs. Columns "Public Stock-Adj." in Panels A and B report holding period returns based on these stock-adjusted returns. This stock adjustment reduces bond momentum profits in individual NIG bonds from 83 to 73 bps over 1973–2010, and from 115 to 102 bps over 1991–2010. At the firm level, NIG momentum profits are reduced from 108 bps to 90 bps over 1973–2010, and from 123 to 96 bps over 1991–2010. Over 1991–2010, momentum profits are 353 bps in private-firm NIG bonds, comparable to the 334 bps profits of NIG stocks.

As a second way to control for the impact of equity momentum on public-firm bond momentum, for each bond with at least twelve months of bond and stock returns, we run a time-series regression of monthly bond returns on a

[29] We compute firm-level bond returns and ratings by equally weighting across all bonds of a firm. Public- (private-) firm bonds are grouped by issuer using their matched equity cusip (the first six digits of their cusip). We then form momentum portfolios using firm-level bond returns.

constant and the firm's contemporaneous monthly stock returns. The stock-adjusted bond returns are the intercept and residuals from these time-series regressions. We then repeat the momentum analysis with stock-adjusted bond returns, focusing on public-firm NIG bonds over the 1991–2010 period. Panel C of Table 8 presents the results. The raw momentum returns from these bonds are presented in the first row for easy comparison (they are the same as in Panel A). Public-firm NIG bond momentum is indeed larger based on raw returns at 115 bps per month. However, using stock-adjusted bond returns in both formation and holding periods still produces economically and statistically significant momentum profits of 62 bps (t-value of 2.67) per month. Sorting on raw bond returns in the formation period, but computing stock-adjusted bond returns in the holding period produces momentum profits of 81 bps (t-value of 3.49, third row). Sorting on stock-adjusted bond returns, produces raw bond momentum profits of 60 bps (t-value of 2.51) in the holding period (fourth row). Although past equity returns provide some information for future bond returns, there appears to be significant bond-driven momentum effects that are not explained by equity momentum.

We further analyze the bond-stock momentum interaction by examining the time-series correlation between aggregate bond and stock momentum profits in Panel D of Table 8.[30] The highest correlations are between private bond-level and firm-level bond momentum (0.83) and public bond-level and firm-level bond momentum (0.84). The next highest correlations are between public- and private-firm bond momentum at the bond level (0.81) and at the firm level (0.68). In contrast, the correlations of stock momentum with public- and private-firm bond momentum are much lower, ranging from 0.19 to 0.35. Unreported results indicate that the correlation of stock momentum with NIG bond momentum is not higher. Figure 3 illustrates the relatively low time-series correlation between equity and bond momentum.

To assess the economic magnitude of the bond-stock momentum interaction, we regress aggregate firm-level bond momentum profits on aggregate stock momentum profits (see Panel E of Table 8). The adjusted R^2 ranges from zero to 15.41%. The stock momentum betas of bond momentum profits, although mostly significant, are very small—in the 0.02–0.10 range. Over 1973–2010, the bond-specific momentum alpha (regression intercept) among public firms is 26 bps (t-value of 3.07); the stock momentum contribution towards bond momentum profits is 12 bps (computed as the product of the regression beta and the average stock momentum profit). For the worst-rated tercile of public firms, alpha is 66 bps, whereas the stock contribution is 21 bps. Overall, the stock contribution varies between 11 and 22 bps. In relative terms, equity momentum contributes 32.34% (24.43%) of bond momentum profits in the sample of all (worst-rated) public firms over the full period. In 1991–2010, this contribution

[30] We calculate stock momentum profits using equity returns only for firms in our bond sample.

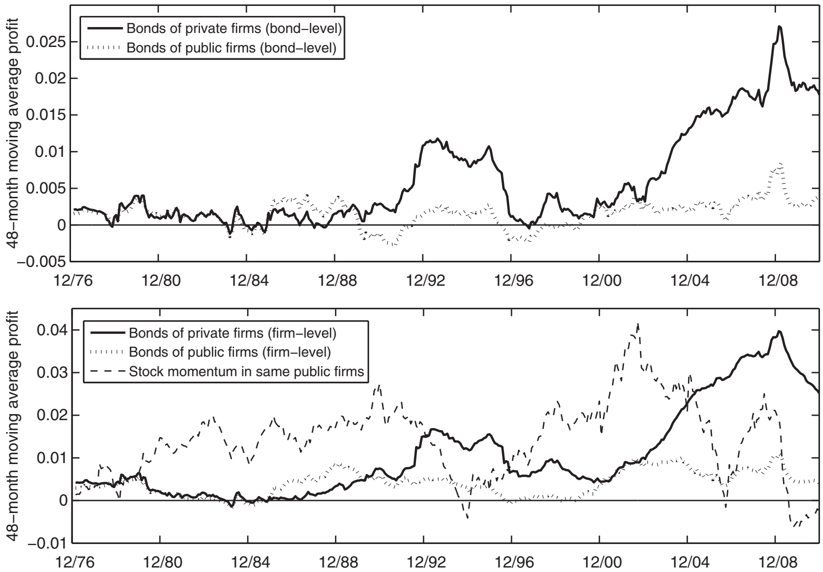

Figure 3
Bond and stock momentum profitability
The top plot presents the 48-month moving average momentum profit (P10-P1) for bonds of private firms (solid line) and bonds of public firms (dotted line). The momentum portfolios in the top plot are formed at the bond level. The bottom plot compares the 48-month moving average momentum profit (P10-P1) of bonds of private firms (solid line) and bonds of public firms (dotted line) with the momentum profits of the stocks of the same firms over the same firm-month observations (plus marker line). The analysis in the bottom plot is based on firm-level sorts. The sample period is January 1973 to December 2010. All strategies are based on six-month formation and holding periods.

is 22.97% (19.96%). Stock momentum has almost no contribution toward bond momentum profits of private firms—its contribution ranges from 1.70% to 7.80%.

Panel F of Table 8 shows that the company overlap between portfolios sorted on past bond and past stock returns is small. Specifically, we sort public firms based on an independent 10-by-10 sort on past six-month firm-level bond returns (P1 to P10) and past six-month equity returns (PS1 to PS10). We then track the distribution of bond winners (P10) and losers (P1) across stock momentum portfolios (PS1 to PS10). The largest overlap occurs between bond and equity losers, where 27.10% of bond losers (in P1) are also stock losers (in PS1). Only 21.51% of the firms that are bond winners (in P10) are also stock winners (in PS10). Surprisingly, 10.48% (7.59%) of the firms that are bond winners (losers) are at the same time stock losers (winners). In fact, firms that are bond losers, P1, or bond winners, P10, appear in all ten stock momentum portfolios. Even among Q3 firms, where bond and stock momentum are most profitable, the overlap between bond and stock momentum portfolios does not exceed 31.60% (again for bond and stock losers). Also noteworthy is that bond losers do not monotonically decrease their representation from PS1 to PS10.

There are more bond losers among stock winners, PS10, than there are in PS9, PS8, or PS7.

As a direct test of the momentum spillover from equities to bonds, each month we sort public firms into twenty-five portfolios based on a 5×5 independent sort on past six-month firm-level bond returns, $r^B_{t-6:t-1}$, and on past six-month stock returns, $r^S_{t-6:t-1}$. For each of the twenty-five portfolios, Panel G of Table 8 presents average monthly bond returns over the six-month holding period, $t+1:t+6$. Consistent with GHS, we find small but statistically significant momentum spillover from equities to IG bonds ranging between 7 and 14 bps per month over 1973–1990.[31] While small, this spillover is significant in all past bond-return quintiles (P1 to P5). However, bond momentum is insignificant in all past equity-return quintiles (PS1 to PS5), consistent with our earlier findings of absence of momentum in IG bonds. To confirm that these results are not period-driven, we reexamine IG bonds over 1991–2010. The results are similar, except that spillover disappears in past bond losers.

Focusing on NIG firms over 1991–2010, the results change dramatically.[32] We find momentum spillover from equities to NIG bonds in two of the past bond-return quintiles, P2 and P3, but not among bond winners and losers. Bond momentum, P5-P1, on the other hand, is present in all past equity-return quintiles. In particular, bond momentum profits are 141 bps per month (t-value of 4.60) among stock losers, PS1. They are 51 bps (t-value of 2.45), 38 bps (t-value of 3.19), 16 bps (t-value of 1.70), and 23 bps (t-value of 1.98) in past stock-return quintiles PS2, PS3, PS4, and PS5, respectively. Bond momentum profits differ across equity momentum portfolios, suggesting some interaction between bond and equity momentum. However, there are large and significant bond-driven momentum profits that are not the result of equity momentum, especially among stock losers.

We reassess the bond-equity momentum interaction through cross-sectional regressions. Specifically, we run monthly Fama-MacBeth regressions of six-month bond returns ($r^B_{t+1:t+6}$) on various combinations of lagged six-month bond returns ($r^B_{t-6:t-1}$), contemporaneous ($r^S_{t+1:t+6}$) and lagged ($r^S_{t-6:t-1}$) six-month stock returns, and lagged numeric bond ratings ($Rating_{i,t}$):

$$r^B_{i,t+1:t+6} = c_{0,t} + c_{1,t}\, r^B_{i,t-6:t-1} + c_{2,t}\, r^S_{i,t-6:t-1} + c_{3,t}\, r^S_{i,t+1:t+6} + c_{4,t}\, Rating_{i,t} + e_{i,t} \tag{3}$$

Panel H reports the time-series averages of the cross-sectional regression coefficients ($\times 100$), their Newey and West (1987) adjusted t-statistics, and average adjusted R^2. We focus on public-firm bonds over the 1991–2010 period.

The cross-sectional regression results confirm our conclusions based on portfolio sorts. Among NIG bonds, past bond returns significantly predict future bond returns (spec. 1). Past equity returns also significantly predict future bond

[31] Results are similar over the 1973–1996 GHS period, for which GHS find momentum spillover of 11 bps.

[32] There are not enough NIG bonds in the first part of the period for a 5×5 sort with only NIG firms.

returns (spec. 2), but the regression coefficients are seven times smaller, and the adjusted R^2 falls from 10.01% with past bond returns to 2.36% with past stock returns. When both past equity and past bond returns are included (spec. 3), both are significant, but the bond contribution (coefficient times average returns, $c_1 \times \overline{r^B}_{t-6:t-1}$) is more than five times larger than the equity contribution ($c_2 \times \overline{r^S}_{t-6:t-1}$). In economic terms, a 1% increase in past equity returns leads to 2.27 bps higher future bond returns, whereas the same increase in past bond returns leads to 19.58 bps higher future bond returns. Adding past equity returns to past bond returns increases the average cross-sectional explanatory power from 10.01% to 11.58%. Even after controlling for contemporaneous equity returns, past equity and bond returns continue to predict future bond returns, and a 1% increase in past six-month equity (bond) returns leads to 0.90 (18.47) bps higher future six-month bond returns (spec. 5). Although worse credit ratings typically lead to higher bond returns (spec. 7), controlling for past bond and equity returns and contemporaneous equity returns makes the rating variable insignificant in cross-sectional regressions (spec. 6).

In contrast, among IG bonds, past bond returns fail to predict future bond returns in all regression specifications. As in GHS, we find evidence of momentum spillover from equities to IG bonds. Past equity returns significantly predict future bond returns. The regression coefficients are, however, multiple times smaller than in NIG bonds. IG bond returns are also significantly related to contemporaneous equity returns. A 1% increase in equity returns leads to approximately 3 bps higher IG bond returns and 11 bps higher NIG bond returns.

Overall, the results in Table 8 suggest that bond momentum is not just a manifestation of equity momentum. Although there is some momentum spillover from stocks to bonds, a large proportion of bond momentum profits appear to be bond specific. Indeed, some natural interaction between bond and stock returns is expected because information about an issuer affects the value of both its debt and equity. Often this information is about the value of the issuer's assets, which results in positive correlation between bond and stock returns (Kwan 1996). In fact, in our analysis we observe that up to 30% of bond-loser firms are also stock losers. However, we also observe firms whose bonds are winners, but whose stocks are losers, or vice versa. This is consistent with findings in the corporate finance literature that some events have an asymmetric effects on the firm's debt and equity value, because they result in a transfer of wealth from bondholders to stockholders, or vice versa. Examples of these include mergers and acquisitions, sales of assets to repay debt, leverage buyouts, spinoffs, seasoned equity offerings, dividend-payment changes, and increased hedge fund activism.[33]

[33] See Warga and Welch (1993), Brown, James, and Mooradian (1994), Dhillon and Johnson (1994), Eberhart and Siddique (2002), Maxwell and Rao (2003), Billett, King, and Mauer (2004), Elliott, Prevost, and Rao (2009), Billett, Jiang, and Lie (2010), and Klein and Zur (2011).

The potential for wealth transfer is largest among financially distressed firms (which dominate the momentum strategy) because high credit risk bonds are more sensitive to firm-level information. Indeed, we observe such wealth-transfer corporate events in a random sample of NIG bond winners that are simultaneously stock losers. We use Lexis-Nexis to identify news about these issuers within the six-month formation period. We find that almost all of these issuers underwent major corporate changes that resulted in wealth transfer from stockholders to bondholders. For instance, in 2005–2006 General Motors (GM) sold a majority stake in General Motors Acceptance Corp. (GMAC; GM's finance unit), its entire stake in Fuji Heavy Industries, and its shares of Suzuki. It cut dividends in half to compensate for large operating losses, which reduced GM's dividend yield from 8.6% to 4.3%, about equivalent to the yield on a two-year government bond. According to analysts, the dividend yield had been a key reason to buy the stock. These events put GM among NIG bond winners and among stock losers.

4. Characteristics of Bond Momentum Portfolios

So far we have shown that momentum profits are concentrated among NIG bonds and are largest among NIG bonds issued by private firms. In this section, we examine whether any bond or stock characteristics set the bond momentum portfolios apart. We focus on the 1991-2010 period when momentum profitability is strongest. Panel A of Table 9 presents bond characteristics for P1 through P10 by rating quintile, separately for public and private firms. The table reveals several noteworthy points.

First, momentum profits do not appear to compensate for credit risk. Among private firms, the average rating of Q5 winners (losers) is 17.34 (16.50) or CCC+. In public firms, it is 13.83 (13.65) or B+. While private-firm winners may earn higher returns than public-firm winners (Table 8, Panel A) because of their higher credit risk, credit risk cannot explain why private-firm losers earn less than the better-rated public-firm losers.

Second, momentum profitability does not seem correlated with measures of overall bond risk. Q5 bonds have lower duration than Q1-Q4 bonds, and private-firm bonds have lower duration than public-firm bonds. In fact, Q5 private-firm bond winners and losers have the lowest duration of all momentum portfolios, yet their momentum profits are the largest. Higher credit risk momentum portfolios have higher return volatility, and private-firm momentum portfolios are more volatile than those of public firms. Yet, Q5 winners tend to be less volatile than Q5 losers in both private and public firms, again pointing to a disconnect between momentum profitability and overall risk. Moreover, private-firm bond momentum portfolios have higher average amount outstanding than public-firm ones, yet they generate higher momentum profits.

Among high credit risk bonds, very few of a firm's bonds appear in the same momentum portfolio. For example, although we find that private firms have

Table 9
Characteristics of momentum portfolios

Panel A: Bond characteristics of bond momentum portfolios (1991–2010)

Rating quintile	Momentum portfolios (P1 = losers, P10 = winners)									
	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10
					Rating					
					Bonds of private firms					
Q1	1.43	1.48	1.54	1.55	1.57	1.58	1.59	1.55	1.47	1.34
Q2	3.75	3.71	3.65	3.59	3.63	3.64	3.62	3.68	3.65	3.72
Q3	6.18	6.18	6.22	6.21	6.22	6.22	6.24	6.24	6.26	6.31
Q4	9.09	8.84	8.84	8.82	8.82	8.86	8.92	9.07	9.16	9.25
Q5	16.50	14.83	14.41	14.13	14.24	14.39	14.63	14.92	15.83	17.34
					Bonds of public firms					
Q1	3.24	3.14	3.08	3.05	3.02	3.04	3.09	3.21	3.28	3.25
Q2	5.64	5.60	5.58	5.55	5.54	5.56	5.57	5.57	5.60	5.62
Q3	7.16	7.16	7.15	7.17	7.17	7.17	7.18	7.19	7.17	7.19
Q4	8.84	8.78	8.77	8.76	8.77	8.77	8.80	8.86	8.94	9.06
Q5	13.83	12.12	12.03	11.97	12.04	12.09	12.13	12.29	12.58	13.65
					Duration (in years)					
					Bonds of private firms					
Q1	7.23	6.11	5.74	5.90	6.12	6.21	6.37	6.78	7.52	10.25
Q2	6.36	5.77	5.36	5.43	5.45	5.45	5.84	6.24	6.79	8.71
Q3	6.70	5.90	5.57	5.35	5.37	5.50	5.78	6.34	7.31	8.60
Q4	6.39	5.46	5.23	5.28	5.34	5.43	5.71	6.09	6.72	7.45
Q5	3.43	4.23	4.17	4.34	4.33	4.33	4.47	4.50	4.30	3.47
					Bonds of public firms					
Q1	7.27	6.03	5.69	5.59	5.82	6.01	6.36	6.76	7.77	9.69
Q2	6.91	6.36	6.07	5.96	5.94	6.04	6.29	6.80	7.56	8.79
Q3	6.78	6.39	6.28	6.15	6.12	6.24	6.36	6.73	7.47	8.46
Q4	6.63	6.11	5.99	5.97	6.04	6.08	6.22	6.64	7.22	8.00
Q5	5.08	5.33	5.26	5.21	5.22	5.37	5.59	5.88	6.17	5.98
					Portfolio volatility (standard deviation of monthly portfolio returns in %)					
					Bonds of private firms					
Q1	2.10	1.80	1.56	1.38	1.31	1.27	1.36	1.51	1.79	2.27
Q2	2.42	1.65	1.41	1.18	1.16	1.11	1.18	1.26	1.46	1.68
Q3	2.15	1.53	1.31	1.19	1.09	1.13	1.20	1.28	1.41	1.63
Q4	4.63	2.73	1.69	1.29	1.26	1.11	1.11	1.14	1.29	1.66
Q5	4.19	3.53	3.18	1.80	1.72	1.23	1.29	1.32	1.76	2.73
					Bonds of public firms					
Q1	1.53	1.21	1.15	1.14	1.15	1.21	1.22	1.28	1.40	1.64
Q2	2.18	1.68	1.52	1.35	1.34	1.35	1.34	1.39	1.49	1.72
Q3	2.16	1.57	1.44	1.40	1.34	1.37	1.38	1.40	1.48	1.64
Q4	2.38	1.76	1.54	1.42	1.39	1.37	1.36	1.38	1.46	1.71
Q5	3.66	2.23	1.68	1.38	1.05	0.99	1.02	1.10	1.27	1.80
					Amount outstanding (in $ millions)					
					Bonds of private firms					
Q1	474	625	650	648	507	534	565	641	611	575
Q2	313	397	452	447	363	395	443	459	407	393
Q3	287	282	281	274	284	280	283	281	284	282
Q4	283	271	265	268	264	256	255	253	253	295
Q5	292	291	286	278	281	268	276	276	313	318
					Bonds of public firms					
Q1	384	404	360	324	305	313	305	319	315	317
Q2	237	240	239	237	235	237	237	228	218	211
Q3	234	211	203	207	206	210	208	207	209	219
Q4	223	202	196	188	191	194	195	193	198	205
Q5	232	215	211	209	207	210	207	208	213	225

(*continued*)

Table 9
Continued

Rating quintile	Momentum portfolios (P1 = losers, P10 = winners) P1	P2	P3	P4	P5	P6	P7	P8	P9	P10
					Number of firms per portfolio					
					Bonds of private firms					
Q1	30	33	34	34	33	33	32	30	27	26
Q2	54	55	55	56	55	55	54	53	51	52
Q3	53	58	59	60	60	61	58	59	56	55
Q4	42	48	53	57	56	57	57	55	53	48
Q5	49	52	57	59	58	60	58	56	52	53
					Bonds of public firms					
Q1	36	36	36	35	36	36	36	36	36	34
Q2	56	62	64	64	65	64	64	63	60	57
Q3	73	81	84	86	87	88	87	85	81	77
Q4	60	69	73	75	76	77	76	73	68	62
Q5	62	72	76	77	77	78	77	75	70	63
					Number of bonds per firm					
					Bonds of private firms					
Q1	3.11	2.90	2.79	2.78	2.83	2.85	2.93	3.11	3.50	3.61
Q2	2.46	2.41	2.40	2.38	2.40	2.42	2.44	2.49	2.61	2.54
Q3	1.99	1.91	1.86	1.83	1.80	1.81	1.84	1.86	1.93	1.97
Q4	2.27	2.02	1.79	1.71	1.70	1.70	1.68	1.74	1.82	1.99
Q5	1.48	1.41	1.32	1.26	1.26	1.24	1.27	1.32	1.41	1.40
					Bonds of public firms					
Q1	3.13	3.12	3.14	3.21	3.16	3.11	3.16	3.15	3.16	3.31
Q2	2.51	2.28	2.21	2.20	2.18	2.20	2.18	2.23	2.33	2.48
Q3	2.07	1.85	1.78	1.75	1.72	1.72	1.73	1.78	1.85	1.96
Q4	2.03	1.77	1.69	1.63	1.60	1.60	1.61	1.67	1.78	1.97
Q5	1.73	1.50	1.42	1.41	1.40	1.39	1.40	1.44	1.55	1.71
Panel B: Stock characteristics of public-firm bond momentum portfolios (1991–2010)										
					Price (in \$)					
Q1	48.30	47.12	46.30	46.04	46.86	47.15	47.22	46.88	47.93	49.13
Q2	45.25	45.09	44.74	44.56	44.69	44.90	45.35	45.39	45.53	46.02
Q3	38.68	39.85	40.88	41.33	41.21	41.15	41.34	41.26	41.20	40.59
Q4	32.53	34.52	34.86	35.50	35.84	35.69	36.28	35.62	34.81	33.60
Q5	19.27	25.44	26.70	26.78	27.16	26.85	26.17	25.60	24.49	21.86
					Shares outstanding (in millions of shares)					
Q1	833	820	794	791	805	781	786	787	795	782
Q2	599	576	561	567	577	569	570	558	536	573
Q3	418	361	333	328	321	326	317	327	344	360
Q4	280	246	231	220	221	218	223	227	234	251
Q5	219	193	187	176	176	170	174	184	207	221
					Firm size (market capitalization in \$ billions)					
Q1	39.40	37.47	36.29	36.45	37.54	36.88	37.06	36.67	36.36	36.34
Q2	28.28	27.42	26.38	26.35	27.27	27.49	27.87	27.32	27.17	28.15
Q3	16.34	15.26	14.52	14.72	14.63	14.74	14.52	15.19	16.01	16.32
Q4	7.59	7.50	7.43	7.27	7.29	7.22	7.48	7.30	7.18	7.28
Q5	3.61	3.97	4.28	4.05	4.24	4.22	4.12	4.19	4.44	4.23
					Monthly turnover (% of shares traded over shares outstanding)					
Q1	11.33	10.83	10.63	10.64	10.52	10.71	10.58	10.28	10.35	10.72
Q2	13.34	11.86	11.35	11.11	11.10	11.09	10.88	10.90	10.97	11.49
Q3	13.70	11.65	11.47	11.30	11.06	10.97	11.09	11.11	11.37	12.07
Q4	14.85	12.78	12.24	12.13	12.00	11.78	11.99	12.27	12.43	13.21
Q5	18.76	15.50	14.77	14.69	14.62	14.57	14.60	14.75	15.16	17.56

Bond momentum portfolios are formed at the bond-level within rating quintiles, separately for private and public firms, as in Panel A of Table 8. Panel A (B) presents the time-series average of the cross-sectional mean bond (stock) characteristic per bond momentum portfolios in private- and public-firm bonds (public-firm bonds). All characteristics are measured at the end of the formation period. All characteristics (except for rating) are truncated at the 99th percentile to limit the impact of outliers. The portfolios' return volatility is the standard deviation of portfolio returns across all sample months.

on average 3.39 bonds, only 1.40 (1.48) of these appear among Q5 winners (losers). As a general pattern, the higher the credit risk, the fewer of a firm's issues appear in the same bond momentum portfolios.

Panel B of Table 9 reports equity characteristics of the momentum portfolios of public-firm bonds. The public-firm bonds generating momentum profits are issued by firms whose equity is smaller but more actively traded. The average market capitalization of Q1 bond issuers is $37 billion compared to $4 billion for Q5 bond issuers. Q5 winners and losers are issued by companies with the largest number of shares outstanding relative to other Q5 portfolios. Issuers of Q5 bond winners and losers are the most actively traded.

5. Trading Activity and Transaction Costs

Equity market evidence reveals that momentum profits are concentrated in the least liquid stocks (Avramov et al. 2013) and that profits may not survive trading costs (Korajczyk and Sadka 2004). We examine whether trading frictions explain why momentum profits persist among NIG bonds but are absent among IG bonds. TRACE evidence suggests that this is not the case: The high credit risk bonds driving momentum are more likely to trade, trade in larger lots, and trade at a lower effective cost than better-rated bonds.

Panel A of Table 10 presents trade intensity, number of trades per bond, and trade size across the bond momentum portfolios. We examine these after October 2004, when TRACE reporting becomes mandatory. Trade intensity is measured as the proportion of bonds in a momentum portfolio for which trades are reported to TRACE in a given month, averaged across the sample months. High credit risk bonds are significantly more likely to trade than low credit risk bonds. Over 2004–2010, on average 20% (8%) of Q1 private-firm bond losers (winners) trade versus 60% (33%) in Q5. Among public-firm bonds, 17% (12%) of Q1 losers (winners) trade versus 74% (63%) in Q5. Over 2009–2010, trading in Q5 private- (public-) firm bond winners intensifies to 59% (72%). Q5 losers trade more than Q5 winners over 2004-2010, which could explain the lower trade-based momentum portfolios returns observed earlier in the paper. Still, Q5 winners' trade intensity is similar to that of other Q5 portfolios, and is higher than that of better-rated ones. Over 2009–2010, however, Q5 winners trade more than Q5 losers and are in fact among the bonds most likely to trade.

Among bonds that trade, Q5 winners and losers have more trades than other Q5 bonds or better-rated winners and losers. Higher credit risk issues have higher average trade size, especially in private firms—Q5 private-firm losers (winners) average $450 ($435) thousand per trade over 2004–2010—compared to $288 ($89) for Q1.[34] In fact, Q5 private-firm winners and losers trade in some of the largest lots.

[34] TRACE reports trades of IG (NIG) bonds above $5 ($1) million as $5 ($1) trades. This method biases the average trade size of IG bonds upward relative to NIG bonds. To control for this bias, we consider all trades in both IG and NIG bonds above $1 million as $1 million trades.

Table 10
Trading activity and transaction costs across momentum portfolios

Panel A: Trading activity across momentum portfolios based on TRACE data

Quintile	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10
				Trade intensity: % of portfolio bonds with trades in TRACE (2004–2010)						
				Bonds of private firms						
Q1	0.20	0.13	0.09	0.09	0.08	0.08	0.07	0.06	0.07	0.08
Q2	0.32	0.29	0.27	0.25	0.27	0.27	0.27	0.29	0.27	0.23
Q3	0.45	0.40	0.40	0.40	0.40	0.40	0.41	0.37	0.36	0.30
Q4	0.51	0.51	0.46	0.43	0.43	0.38	0.36	0.35	0.36	0.41
Q5	0.60	0.51	0.42	0.36	0.31	0.29	0.34	0.40	0.42	0.33
				Bonds of public firms						
Q1	0.17	0.15	0.14	0.12	0.12	0.12	0.12	0.13	0.15	0.12
Q2	0.45	0.43	0.40	0.38	0.38	0.38	0.37	0.36	0.35	0.35
Q3	0.49	0.44	0.43	0.42	0.42	0.43	0.42	0.43	0.42	0.40
Q4	0.56	0.56	0.53	0.53	0.54	0.53	0.52	0.47	0.39	0.40
Q5	0.74	0.65	0.63	0.62	0.54	0.47	0.45	0.47	0.54	0.63
				Trade intensity: % of portfolio bonds with trades in TRACE (2009–2010)						
				Bonds of private firms						
Q1	0.11	0.09	0.06	0.07	0.07	0.05	0.03	0.02	0.01	0.01
Q2	0.31	0.31	0.30	0.33	0.39	0.40	0.41	0.41	0.41	0.35
Q3	0.37	0.42	0.43	0.44	0.45	0.44	0.46	0.43	0.45	0.46
Q4	0.38	0.40	0.38	0.41	0.47	0.45	0.46	0.46	0.44	0.44
Q5	0.44	0.40	0.38	0.47	0.52	0.51	0.56	0.61	0.67	0.59
				Bonds of public firms						
Q1	0.19	0.18	0.16	0.16	0.18	0.19	0.22	0.22	0.22	0.14
Q2	0.42	0.44	0.43	0.44	0.44	0.40	0.40	0.40	0.40	0.42
Q3	0.47	0.45	0.44	0.47	0.47	0.48	0.46	0.48	0.50	0.47
Q4	0.42	0.45	0.45	0.47	0.48	0.47	0.46	0.41	0.37	0.32
Q5	0.65	0.58	0.63	0.75	0.79	0.81	0.77	0.74	0.71	0.72
				Number of trades per bond per month (2004–2010)						
				Bonds of private firms						
Q1	73	127	240	234	203	155	97	67	69	36
Q2	41	54	71	78	85	85	95	88	52	35
Q3	39	49	50	56	59	62	60	59	58	41
Q4	95	75	66	64	62	59	55	54	48	56
Q5	73	53	55	59	62	56	57	53	61	63
				Bonds of public firms						
Q1	65	110	131	116	118	133	126	131	93	59
Q2	56	75	92	103	112	111	108	100	87	50
Q3	51	51	54	62	61	63	66	63	58	54
Q4	62	41	43	52	48	52	55	53	53	84
Q5	93	59	54	56	56	52	53	56	58	68
				Trade size (in $1,000) (2004–2010)						
				Bonds of private firms						
Q1	288	215	195	196	146	124	147	128	122	89
Q2	248	244	221	204	188	183	182	176	187	168
Q3	294	275	259	239	238	239	239	238	240	246
Q4	267	266	277	275	284	291	270	275	284	283
Q5	450	435	449	443	438	421	405	407	407	435
				Bonds of public firms						
Q1	257	225	210	200	191	184	202	190	191	161
Q2	249	251	221	204	191	188	171	182	193	179
Q3	287	267	259	243	240	244	244	250	248	249
Q4	310	317	310	303	305	301	302	311	296	310
Q5	401	379	384	387	378	370	369	363	376	372

(*continued*)

Table 10
Continued

Panel B: Transaction costs as in Edwards, Harris, and Piwowar (2007) based on 2009–2010 TRACE data

Sample	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	Average
					Transaction cost estimates (in %)						
IG	0.49	0.39	0.39	0.45	0.50	0.53	0.61	0.66	0.81	0.95	0.72
NIG	0.53	0.40	0.35	0.37	0.41	0.45	0.55	0.64	0.72	0.83	0.68
Private IG	0.49	0.40	0.37	0.40	0.44	0.51	0.61	0.70	0.75	0.91	0.56
Private NIG	0.62	0.37	0.32	0.39	0.40	0.47	0.61	0.65	0.77	0.82	0.54
Public IG	0.48	0.39	0.43	0.48	0.53	0.55	0.61	0.68	0.84	0.98	0.60
Public NIG	0.48	0.40	0.38	0.38	0.43	0.46	0.50	0.58	0.71	0.82	0.51
					Bonds of private firms						
Q1	0.80	0.79	0.63	0.35	0.44	0.71	0.78	0.75	0.81	1.27	0.73
Q2	0.45	0.38	0.39	0.40	0.44	0.52	0.63	0.71	0.79	0.95	0.57
Q3	0.54	0.43	0.41	0.42	0.51	0.58	0.64	0.73	0.82	0.99	0.61
Q4	0.47	0.33	0.37	0.45	0.44	0.54	0.54	0.66	0.69	0.76	0.52
Q5	0.54	0.44	0.30	0.38	0.44	0.49	0.50	0.69	0.79	0.78	0.53
					Bonds of public firms						
Q1	0.38	0.26	0.26	0.28	0.32	0.38	0.43	0.55	0.70	0.92	0.45
Q2	0.47	0.41	0.40	0.47	0.48	0.57	0.63	0.76	0.86	1.00	0.61
Q3	0.58	0.47	0.55	0.55	0.57	0.61	0.63	0.73	0.83	0.95	0.65
Q4	0.50	0.45	0.50	0.59	0.65	0.70	0.73	0.80	0.87	1.03	0.68
Q5	0.45	0.43	0.45	0.44	0.51	0.55	0.63	0.71	0.82	0.85	0.58
					Average trade size (in $1,000) over which transaction costs were estimated						
IG	191	185	165	153	147	139	136	137	137	138	153
NIG	322	309	327	338	335	332	298	256	248	264	303
Private IG	189	192	162	149	140	133	123	120	135	140	148
Private NIG	341	357	340	346	344	329	260	232	243	266	306
Public IG	196	182	164	152	153	148	144	140	138	134	155
Public NIG	302	298	316	333	329	330	315	295	279	290	309
					Bonds of private firms						
Q1	154	73	73	73	48	67	52	105	64	65	77
Q2	194	186	132	121	104	105	83	81	80	98	118
Q3	174	178	154	157	132	139	130	128	136	141	147
Q4	264	244	231	214	207	215	197	215	211	202	220
Q5	359	346	374	378	335	332	254	218	266	314	317
					Bonds of public firms						
Q1	234	229	201	162	151	132	141	130	122	109	161
Q2	184	160	141	132	127	116	104	94	96	99	125
Q3	175	159	151	140	146	150	146	144	143	153	151
Q4	216	209	189	177	193	180	192	200	187	214	196
Q5	264	249	282	299	291	284	267	248	231	231	265

Panel C: Most profitable bond momentum samples net of transaction costs (%)

	1-mo gross profit (%)	6-mo gross profit (%)	Transaction costs (%)	6-mo net profit (%)	(Trans. costs)/ (Gross profit)
Private Q5	3.04	19.68	2.64	17.05	0.13
Private NIG	2.82	18.16	2.88	15.28	0.16
NIG	1.92	12.09	2.74	9.35	0.23
Public NIG	1.15	7.10	2.60	4.50	0.37
Private Q4	0.57	3.47	2.47	1.00	0.71
Public Q5	0.46	2.79	2.60	0.19	0.93

Bond momentum portfolios are formed at the bond-level within rating quintiles, separately for private and public firms, as in Panel A of Table 8. Panel A reports the trade intensity, measured as the percentage of bonds that have trades reported in TRACE over that month, averaged across the sample months. For the bonds that trade, we report the average number of trades per month and the average size of the trade in that month, averaged across the sample months. These measures are examined over two periods: (1) the period after October 2004, when TRACE reporting becomes mandatory, and (2) over January 2009 to December 2010, for which we are able to estimate transaction costs (reported in Panel B). Transaction costs are calculated following Edwards, Harris, and Piwowar (2007) using TRACE transaction data. Panel B also reports the average trade size over which transaction costs are estimated. Panel C examines the momentum profitability net of transaction costs for the subsamples in which momentum is profitable.

Panel B of Table 10 reports transaction cost estimates based on the methodology of Edwards, Harris, and Piwowar (EHP; 2007) (see Appendix). To estimate costs, we use TRACE data from January 2009 to December 2010 because a key input, a flag for buyer- or seller-initiated trades, is publicly available for most bonds only over that period.[35] For each bond in every year, we estimate a cost function and calculate monthly *effective* transaction costs by evaluating the estimated function at the bond's monthly average trade size. This allows us to compute more representative transaction cost estimates that are based on actual trade sizes rather than on stylized fixed levels. We then calculate a cross-sectionally weighted monthly average for each momentum portfolio. The table reports the time-series averages of these cross-sectional means.

Effective transaction costs for high credit risk bonds are slightly lower than those for low credit risk bonds, because the latter generally trade in significantly larger sizes. As in EHP, we find that transaction costs increase in credit risk for a fixed trade size, but decrease in trade size for any credit risk level (unreported results). NIG bonds have lower *effective* transaction costs because the cost-reducing effect of trade size dominates the cost-increasing effect of credit risk. For example, in order of credit risk, Q1/IG/NIG/Q5 bonds of private firms average 73/56/54/53 bps in transaction costs at corresponding average trade sizes of $77/148/306/317 thousands.[36] Although trade intensities are generally higher in 2009–2010 (Panel A) relative to the 2004–2010 sample, trade sizes are on average lower (Panel B) during 2009–2010. Given the negative relation between transaction costs and trade size, the transaction costs during the financial crisis are likely higher than those in prior years. Hence, our estimates are likely conservative.

Winners trade at higher effective cost than losers because they trade in smaller sizes over 2009–2010. However, over 2004–2010, the trade size of winners is closer to that of losers and much larger in general (Panel A), suggesting that effective transaction costs of high credit risk winners are lower. Moreover, high credit risk winners trade at lower effective cost than other winners.

We conduct several robustness tests to ensure that neither our methodology nor our trade-by-trade TRACE cleaning procedure materially affect our cost estimates. First, we estimate several alternative cost functions from EHP; second, we evaluate the estimated EHP baseline cost functions at actual trade-by-trade transaction sizes, instead of at the monthly average trade sizes; third, we exclude trades below $100,000 when calculating the monthly average trade sizes; and fourth, we use an alternative initial cleaning procedure for TRACE as proposed by Dick-Nielsen (2009). The cost estimates from these alternatives are

[35] EHP estimate transaction costs over January 2003–January 2005 using a nonpublic version of TRACE.

[36] Panel B reports the average trade size over the trades that had available all inputs needed to estimate transaction costs. The average trade size over all trade observations for 2009–2010 are very similar.

consistent with the transaction cost estimates reported in Panel B (unreported results).

Momentum profits in high credit risk bonds survive transaction costs by a wide margin. Panel C of Table 10 summarizes gross and net momentum profits for key subsamples. The first column reports the monthly gross momentum profits over 1991–2010. The second column reports the cumulative profit from the six-month holding period, that is $r_{6\text{-}mo} = (1 + r_{1\text{-}mo})^6 - 1$. The third column shows round-trip transaction costs. To implement the momentum strategy, we need to buy the P10 bonds and sell them after six months and sell the P1 bonds and buy them back in six months.[37] The last two columns report the net six-month momentum profit and the proportion of gross momentum profits spent on transaction costs.

Recall from Panel A of Table 8 that momentum profits in Q5 private-firm bonds are 3.04% per month, which constitutes a cumulative six-month gross profit of 19.68%. The total transaction costs to implement the momentum strategy in Q5 private firms over the six-month period are 2.64% = 2(0.54 + 0.78).[38] This translates into 17.05% (= 19.68% − 2.64%) six-month net momentum profits. Transaction costs represent 13% of gross momentum profits for Q5 private-firm bonds. Transaction costs are only 16% of gross momentum profits in private-firm NIG bonds. They are 23% in all NIG bonds and 37% in public-firm NIG bonds. In Q4 private-firm and Q5 public-firm bonds, where profits are much lower, transaction costs are 71% and 93% of profits, respectively.

6. Discussion

Our evidence suggests that it is unlikely that bond momentum profits compensate for systematic or bond-specific risk. Momentum alphas relative to bond and equity risk factors are similar or higher than raw momentum profits. Although momentum profits are concentrated among high-yield bonds, they do not compensate for credit risk: High credit risk winners and losers have almost identical ratings, and profits persist after a battery of credit risk adjustments. Bond winners also face similar interest rate risk as bond losers, and their returns are less volatile.

The persistence of bond momentum profits is also unlikely to be explained away by trading frictions. The high credit risk bonds driving momentum trade more, in larger trade sizes, and at lower effective transaction costs than other bonds. In fact, transaction costs are only a small fraction of the momentum

[37] This total cost is conservative as it assumes 100% turnover in P1 and P10. Yet, if a strategy includes some of the P10 (P1) bonds of the strategy six months prior, we will not have to sell (buy) and buy (sell) them again as part of the new strategy. In unreported results, we find that of the NIG bonds appearing in P1 (P10), 19% (28%) appear in the same momentum portfolio after six months.

[38] The alternative transaction costs methods described above produce similar estimates. For example, alternative round-trip costs for Q5 private-firm bonds range from 2.12% to 3.40%.

profits that these bonds generate. Short-selling costs, on the other hand, are more difficult to observe than transaction costs. Although it is conceivable that high short-selling costs may account for the persistence of abnormal returns from the short side of the strategy, they cannot explain the high returns and alphas of bond winners, which contribute more toward momentum profits.

We also find no evidence that bond market opaqueness explains momentum profitability. The introduction of TRACE in July 2002 substantially increased transparency in what used to be a very opaque dealer market for U.S. corporate bonds (e.g., Edwards, Harris, and Piwowar 2007). Yet, Figure 1 shows that this higher transparency did little to abate bond momentum profitability. In addition, examining momentum profits among traded bonds (those in TRACE) in the period of highest bond market transparency (after July 2002), we find (in unreported results) that momentum profitability and its link to high credit risk bonds have significantly increased. Moreover, because both private- and public-firm bonds and both high and low credit risk bonds trade in the same dealer markets, with the same market transparency, market opaqueness would not explain why momentum is most pronounced in high credit risk private-firm bonds.[39]

Although our evidence challenges many potential explanations, it leaves the possibility that information frictions related to the gradual diffusion of private information, as in Hong and Stein (HS; 1999), could explain the persistence of bond momentum. Momentum profits are strongest among private-firm bonds, where company-specific information is likely to diffuse more gradually. Moreover, HS argue that even public information may diffuse gradually if it is hard to interpret, a more likely scenario for NIG bonds, where momentum profits are concentrated. Gradual information diffusion is a key assumption in HS, where it results in short-term momentum and long-term reversal. Specifically, as momentum traders attempt to profit from the slow diffusion of information, the initial price movement in the direction of fundamentals continues and results in momentum.[40] As more momentum traders chase this strategy, prices are pushed beyond fundamental values and momentum gives way to reversal with a possible dampened oscillation of prices toward the new fundamental values (see Figure 1 in HS). Our findings are broadly consistent with this prediction of the HS model. Although we observe no significant overall reversal over the two- to five-year period following portfolio formation, we observe negative returns in the second year.[41]

[39] Evidence for equity markets by Ang, Shtauber, and Tetlock (2013) also reveals very small momentum profits in opaque OTC markets, whereas momentum profits in transparent exchange equity markets are large.

[40] Although HS assume that investors are "boundedly rational" because they condition on a limited set of information, they rationally interpret the information they have. Moreover, HS show that their main conclusions are robust to relaxing most assumptions, including that of bounded rationality, as long as these "smart" investors have a finite risk tolerance.

[41] These negative returns are not as large as the momentum profits in the first year, hence the lack of overall reversal.

7. Conclusions

This paper documents strong evidence of momentum profitability in U.S. corporate bonds. From 1991 to 2011, past six-month winners outperform losers by 59 bps per month over a six-month holding period. Momentum is also profitable for formation and holding periods of 3, 9, and 12 months. Results are based on 81,491 investment grade and high-yield bonds of 9,709 public and private issuers, or 3.75 million bond-month quote- and trade-based observations.

Momentum is generated by NIG bonds, a sizable, growing, and active segment of the $9.7 trillion U.S. corporate bond market. Momentum profits are 192 bps per month in NIG bonds and are nonexistent in IG bonds. This explains the lack of momentum in the overall sample over 1973–1990, when NIG bonds are scarce. High-yield bonds represent 22% of our 1991–2011 sample, yet their impact on overall momentum is large because they concentrate in the winner and loser portfolios. Momentum profitability is much stronger in NIG bonds issued by private firms than in NIG bonds of public firms.

Although both equity and bond momentum are driven by NIG firms, bond momentum is not just a manifestation of equity momentum. Only a portion of public-firm bond momentum profits are due to their firm's equity momentum, and there is small overlap between firms sorted on equity and bond momentum. In fact, public-firm bond momentum is much more correlated with private-firm bond momentum than with equity momentum. Although there is momentum spillover from equities to both IG and NIG bonds, among NIG bonds bond-specific momentum effects are larger and more significant.

Trading frictions do not seem to explain the persistence of bond momentum. Momentum is profitable in both quote- and trade-based data and higher credit risk bonds tend to trade more, in larger trade sizes, and at lower cost. Transaction costs account for 16% (37%) of NIG private-firm (public-firm) bond momentum profits. Bond momentum is also robust to adjustments for bond-level interest rate risk, credit risk, and microstructure noise, as well as equity and bond systematic risk.

Appendix

A.1 Transaction cost function and estimation

We use trade information from TRACE and estimate transaction costs following the methodology developed by Harris and Piwowar (2006) and further expanded by Edwards, Harris, and Piwowar (EHP; 2007). Since prior to 2009 the public version of TRACE generally lacks information on the trade side indicator, our sample covers bond trades reported to TRACE from January 2009 to December 2010. Following EHP, we eliminate trades that were subsequently corrected or deleted. Furthermore, we clean the data by applying price filters that identify and eliminate data errors based on deviations from median prices and price reversals. Our final sample contains 13,333,546 trades. We augment the sample with monthly duration and credit-rating information obtained from Lehman, DataStream, Bloomberg, TRACE, and FISD.

EHP's model assumes that the price of a trade is equal to the "true value" plus or minus a price concession depending on whether the trade was buyer- or seller-initiated. Using EHP's functional form, we specify the absolute value of the price concession for a customer trade, that is the transaction cost, as

$$c(S)=c_0+c_1\frac{1}{S}+c_2\log S+c_3 S+c_4 S^2, \tag{A1}$$

where S is the dollar size of the trade. Using trade-by-trade data from TRACE, we estimate (A1) for each bond and year using iterated weighted least squares.[42] Let $\hat{c}=[\hat{c}_0 \quad \hat{c}_1 \quad \hat{c}_2 \quad \hat{c}_3]'$ be the vector of estimated coefficients for a specific bond, $\hat{\Sigma}_c$, the corresponding covariance matrix of the estimates, and

$$D(S)=\left[1 \quad \frac{1}{S} \quad \log S \quad S \quad S^2\right]. \tag{A2}$$

Then for a given trade size S, an estimate of the effective half-spread can be obtained as

$$\hat{c}(S)=D(S)\hat{c} \tag{A3}$$

and the error variance of the estimate as

$$\mathrm{Var}(\hat{c}(S))=D(S)\hat{\Sigma}_c D(S)' \tag{A4}$$

Using observed monthly average trading volumes for each bond and a bond's corresponding annual estimates of $\hat{c}$ and $\hat{\Sigma}_c$, we calculate monthly bond-specific transaction costs. Based on the bond's momentum classification in a particular month, we assign the transaction cost estimate to the corresponding momentum portfolio and compute the average transaction cost for each momentum portfolio. Specifically, we first calculate each month the weighted-average transaction cost within each portfolio, where the weights are given by the inverse of the cost estimate error variances (A4), and then compute the time-series average of the portfolio transaction costs across all months in 2009 and 2010.

Although the transaction costs presented in Panel C of Table 10 are based on actual trade sizes, we also calculate the average transaction costs for each momentum portfolio using various hypothetical fixed trading sizes. In unreported results, we find that transaction costs decrease with trade size and increase with credit risk, consistent with findings by EHP.

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[42] See EHP for specific details about the econometric model and estimation procedures.

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