MOMENTUM IN THE CORPORATE BOND MARKET: EVIDENCE IN KOREA

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ABSTRACT

The paper studies momentum in Korean corporate bond market. With 1,541,507 observations of daily bond price from July 2004 to January 2016, we observe significant momentum profit across full bond sample and both in IG and NIG subsamples. Our empirical findings reveal that momentum profits were the largest among NIG bonds and with lower graded bonds. We also show that time-varying risk factors (cumulative risk factor return during bond portfolio formation period) does not have strong impact on momentum profits and thus we conclude that momentum profits seems unlikely to be a mere compensation of systematic risks. Lastly, we detect change in momentum profits conditional to business cycles. Momentum profits are larger during the expansion period and smaller during the recessionary period. Finally, we confirm that momentum profitability exists with different formation and holding periods.

BIOGRAPHICAL SKETCH

The author, Hyeik Kim graduated from Ewha Womans University with a bachelor's degree in Business Administration in 2014. She began her masters study in Applied Economics and Management with a concentration in Finance at Cornell University in 2014. During her study at Cornell, she became interested in empirical studies in price momentum.

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TABLE OF CONTENTS

1. Introduction

Momentum has been one of the subjects that intrigued financial economists in the literature of finance as its' existence suggest market anomaly which cannot be explained by asset pricing theory. There has been a series of research on the reasons behind the existence of momentum; whether they are a compensation of risk factors, or whether they are just merely a market's misinterpretation of information, or if they are caused by some microstructural biases in the market (Ball, Kothari, and Shanken 1995; Ball and Kothari 1989; K. Chan 1988; L. K. C. Chan, Hamao, and Lakonishok 1991; Conrad and Kaul 1993; DeLong 1990; Lakonishok, Shleifer, and Vishny 1994).

Streams of studies detected abnormal returns in assets and argued whether this kind of anomalies are due to cognitive biases that investors have or whether it could be explained by macro economic factors. (Jegadeesh and Titman 1993) argues that the phenomenon can be attributed to the fact that investors have cognitive bias; investors tend to underestimate firm specific information and this is what causes momentum in equity prices. This suggested the interrelationship between investor sentiment and asset price questioning the efficient market hypothesis (hereafter, EMH). Later (Barberis, Shleifer, and Vishny 1998) presented in their paper, based on their empirical findings, a model of investor sentiments, or how investors form their beliefs. (Lo 1999) said there are common explanations for the departure of efficient market hypothesis, that investors do not always react with proper rationale to performances and that we could easily detect underestimations or overestimations. On the premise that the stock market overreacts to the news, (Bondt and Thaler 1985) reported that on the basis of the past half century of data, large abnormal returns were earned by following contrarian strategy. It was the first attempt to conduct an empirical test of investor's cognitive biasness towards market information. (Chopra, Lakonishok, and Ritter 1992) also found strong market overreaction especially among

smaller firms. As opposed to the contrarian theory, there also have been extensive studies on momentum theory. (Jegadeesh and Titman 1993) documented the existence of a momentum effect suggesting market underreaction. (Rowenhorst 1997)'s empirical study on 12 European markets found return continuation present in all 12 European countries. (K. Daniel, Hirshleifer, and Subrahmanyam 1998) apart from the general idea that underreaction is causing momentum, maintains that investor's overestimation is causing momentum.

A side from researchers who maintains that the phenomena is due to psychological bias involved among investors, others argue that anomalies are a mere compensation for risk or macroeconomic factors. Although (Fama and French 1993) could not explain the abnormal excess returns existing in the market with their theoretical asset pricing model, some argue that this distortions in price from theory is not against the efficient market hypothesis. (K. Chan 1988) shows that risk adjusted returns of contrarian trading strategy does not exhibit a statistically significant return which shows consistency towards efficient market theory. (Zarowin 1990) argues that those anomalies are just merely manifestation of the size effect. They found out that loser's superior performance over winners weren't due to investor's overreaction but because losers tend to be smaller in size compared to winners. When they controlled for the size, they could only detect losers significantly outperforming winners during Janurary. (Chordia and Shivakumar 2002) also shows that momentum strategies can be attributed by a set of lagged macroeconomic variables and payoffs to momentum disappears as stock returns are adjusted by their predictability based on macroeconomic indicators.

Relatively recently, financial economists also started to examine the presence of momentum in different asset classes other than equity. For example, (Okunev and White 2003)and (Menkhoff et al. 2012) have examined momentum in currency markets. In 2011, Beracha and Skiba studied

residential real estate market and found statistically significant and economically meaningful momentum existing in the market. New trend in recent years is examining the bond market. Very recent study conducted by (Chordia, Goyal, and Shanken 2015) investigates the presence of return anomalies in corporate bond market where they concluded that bond prices are priced efficiently. Vann et al. (2012) found extra return in following momentum strategy inside a government bond.

There also has been research studying the return predictability of corporate bonds in the U.S. and Europe. (Khang and King 2004) found short to intermediate term reversals in investment grade corporate bond returns and could not detect any momentum returns among them. (Gebhardt, Hvidkjaer, and Swaminathan 2005) also found no momentum returns using their investment grade samples. By examining both IG and NIG bonds, (Jostova et al. 2013) confirmed a significant momentum in a comprehensive U.S. corporate bonds in non-investment grade bond samples but could not observe any in IG bonds. They also found that these momentum profits in IG bonds are not a mere compensation for risk factors nor are they manifestation of equity momentum. In this paper, we are going to examine whether there is profitability in Korean corporate bond market by holding momentum strategy. Our objective of the study is to examine momentum profit under various conditions as well as determining systematic risk factors could in the end explain the existence of momentum profit. Like (Jostova et al. 2013), we investigate both investment grade and non-investment grade corporate bonds from July 2004 to January 2016.

First, our finding suggest that we present strong evidence of momentum profitability using a comprehensive sample of investment grade(IG) and noninvestment grade(NIG) Korean corporate bonds. Over the full time period from July 2004 to January 2016, we find momentum returns across different portfolio formation periods and in both NIG and IG bonds. This contradicts (Gebhardt, Hvidkjaer, and Swaminathan 2005; Jostova et al. 2013; Pospisil and Zhang 2010) that

could not find any evidence of momentum return among IG bonds. Second, consistent with (Jostova et al. 2013) and Barth et al.(2015), we conclude that most of the momentum profits are mainly driven by NIG bonds. For the full sample, NIG bonds exhibit 1.6% of momentum profit per month (19.2% a year) when IG bonds only exhibit 0.27% a month (3.24% a year). Third, like (Jostova et al. 2013), it seems unlikely that momentum returns are a compensation for risk factors. Fourth, we found out that macro-economic factors driven momentum profits does not exist except for the limited time when term spread returns goes upward and even for the case the impact isn't statistically significant. Fifth, consistent with (Avramov et al. 2007), we also find an apparent link between momentum profitability and firm credit rating. Especially among extreme winner and loser portfolios, the portion of high credit risk bonds are the highest. 70 % of C graded bonds are in P10 or P1 which is the extreme winner and loser whereas only 23% of AAA graded bonds are in P10 or P1. Overall, 41% of NIG bonds are contained in winners or loser portfolios whereas only 19% of IG bonds are winners or losers. Sixth, we find that momentum profitability is related to business cycles. We find that during the economic expansion period, momentum tend to be larger than during the contraction period. Furthermore, following (Destefano 2004), we divide periods into two sections each and examine the momentum returns in each of the 4 stages (i.e. first expansion stage, second expansion stage, first recession stage, second recession stage). We observe lowest momentum profit during the second stage of recession period across all samples. We detect momentum crashes (Moskowitz et al.(2012), Barroso and Santa-Clara (2015), and Daniel and Moskowitz (2015)) in the second stage of the recession period. This is consistent to (Chordia and Shivakumar 2002) findings that stock momentum strategies have positive and significant returns mainly during expansionary periods. In our findings, momentum returns are negative showing return reversal during the second half of the recession period.

The paper proceeds as follows: Section 2 describes bond data sample and describes statistics of the data. Section 3 explains the main methodology applied. Section 4 analyzes momentum strategies with regard to both unconditional and conditional risk factors, credit risk, and business cycle. Section 5 Concludes.

2. Data description

2.1 Bond databases

Korean bond market has comparably recently started marking the market price of the bonds. Before 1998, when the financial supervisory service started to execute the current bond price valuation systems, bonds were entirely computed by the fixed yield that was promised when a bond is first issued. However, after the 2000, all the bonds including high risk, unrated bonds are calculated based on the fluctuating standard yields by credit rating agencies (i.e. KAP, KIS, NICE, FN, etc). All of the prices that are valued by these entities are quotation based and are clean prices.

The daily time-series data for Korean Corporate bond prices are hand collected from Yonhap Infomax. The database contains a comprehensive set of over the counter bond characteristics including yield to maturity, duration, and credit ratings estimates of four different Korean credit rating agencies (KAP,KIS,NICE)[1]. For more accuracy, we only attain bonds that are straight and has fixed coupon rate. We exclude all the callable, puttable, mortgaged backed, asset backed bonds, bonds with warrents, and bonds part of unit deals to eliminate the possibilities where bond prices may be affected by the premiums or other factors other than fundamental risk factors of the issuing firm. Non-coupon bonds are also excluded because they may have low liquidity and be subject to pricing errors. In addition, baby bonds, individual bonds with face values less than 1 billion KRW,

[1] Papers using this database: Park and Um (2016) , Lim et al (2013), Park and Shin (2014)

are also excluded from the sample. Baby bonds are mainly traded by individual investors (Won and Lee(2007)). In such cases, security companies charge huge commissions to the investors and may affect the interest rate and thus distort the price of bonds (Shin and Kim 2015). Unlike (Gebhardt, Hvidkjaer, and Swaminathan 2005), we include non-investment grade bonds.

The database provides us with daily clean price data. To compute the return of the bond we use month-end price, which is the daily price of the last day of the month. And with this month-end price we compute the return as the following:

$$\gamma_{\text{dirty(it)}} = \frac{\left(\mathrm{P_{i,t}} + \mathrm{AI_{i,t}} + \mathrm{Coupon_{i,t}}\right) - \left(\mathrm{P_{i,t-1}} + \mathrm{AI_{i,t-1}}\right)}{\mathrm{P_{i,t-1}} + \mathrm{AI_{i,t-1}}}, \tag{1}$$

where $\gamma_{i,t}$ is the return of bond i at time t, $P_{i,t}$ is the clean price of bond i at time t, $AI_{i,t}$ is the accrued interest of bond i at time t, and $Coupon_{i,t}$ is any coupon distributed between month t and $t-1$.

2.2 Descriptive statistics

The data set includes 1,541,507 daily bond price observations from July 2004 to January 2016 from 1,378 Korean bonds issued. Our sample contains an average of 412 bonds per month. All the bonds issued have a face value of 10,000 KRW and hold quarterly fixed coupon payment. Table 1 reports summary statistics for our corporate bond sample. Panel A provides characteristics of the full sample covering 51,130 of monthly observations, 48,263 observations for the investment grade sample and 2,867 for non-investment grade sample.

For the credit ratings, we follow (Covitz and Downing 2007) and code each credit ratings into number dummies : AAA =1, AA+ =2, …, D =24. Ratings 1(AAA) through 10(BBB-) are investment grade bonds and 11(BB+) through 24(D) are high risk, non-investment grade junk bonds. All the bonds are rated in the data set and about 92% of bonds are investment grade and on average about 8% are non-investment grade bonds. The mean rating of the full sample is 5.434, 15.73 for NIG, and 4.823 for IG, corresponding to A, CCC, and A+ respectively. The median for all, NIG, and IG sample are 5,12, and 5 respectively. We don't see much difference in modified duration, time to maturity across different credit rating groups. Compared to all and IG bond sample, NIG bond sample have slightly lower durations and maturity. The credit spreads are clearly higher for NIG bonds. The mean(median) of spread for all, NIG and IG samples are 88.22(43), 453.6(281), and 66.52(38.6) respectively. For all of the samples, mean spreads are higher than the median spread indicating right skewedness. This makes sense when we consider 2007-2008 global financial crisis.

Panel B provides the number of bonds available at the end of each year. Number of bonds increases and peaks at 721 and then decreases. Percentage of NIG bonds are the highest during the December of 2005 and then decreases; It slightly went up in 2008 due to the financial crisis when many firms' credit ratings were downgraded.

And finally panel C shows the bond return dispersion of the full bond sample. NIG bonds have the lowest mean but their median is the highest and they are more disperse than IG bonds.

Table 1
Descriptive statistics

Panel A : Bond characteristics

	ALL	**NIG**	**IG**
Bond-month obs	51,130	2867	48,263
Mean rating(1-AAA,24-D)	5.434	15.73	4.823
Median rating	5	12	5
Mod.Duration(mean)	1.68	1.5	1.691
Mod.Duration(median)	1.49	1.35	1.5
Time to maturity (mean, yrs)	3.54	2.78	3.581
Time to maturity (median, yrs)	3	3	3
spread(mean, bp)	88.22	453.6	66.52
spread(median,bp)	43	281	38.6

Panel B : Number of bonds

	ALL	NIG	IG	% NIG
Dec-05	294	20	274	0.07
Dec-06	398	19	379	0.05
Dec-07	501	19	482	0.04
Dec-08	452	21	431	0.05
Dec-09	592	17	575	0.03
Dec-10	721	7	714	0.01
Dec-11	555	25	530	0.05
Dec-12	369	39	330	0.11
Dec-13	147	27	120	0.18
Dec-14	94	18	76	0.19

Panel C : Return dispersion

	Percentiles									
	0.05	0.1	0.25	0.5	0.75	0.9	0.95	mean return	median	SD
ALL	-1.61	-0.85	-0.57	-0.21	0.74	1.11	1.28	0.06	-0.17	1.69
NIG	-2.21	-1.28	-0.56	-0.04	0.85	1.33	1.54	0.01	-0.15	1.69
IG	-1.08	-0.83	-0.56	-0.19	0.77	1.17	1.39	0.07	-0.2	0.96

This table presents descriptive statistics of all the bond month observations used for analyses. The sample includes 1,541,507 daily bond issued by 1,378 companies and covers the period from July 2004 to January 2016. There are on average 412 bonds per month, the numerical ratings increase with credit risk (AAA =1, AA+=2, …, D=24). Ratings higher than 10 (BBB-) are considered non-investment grade bonds and ratings equal or lower to 10 are considered investment grade bonds. Panel B shows number of bonds active during December each year. Panel C presents return dispersion of the bond samples.

3. Methodology

We follow the momentum strategy that was implemented by (Jegadeesh and Titman 1993)and used in (Gebhardt, Hvidkjaer, and Swaminathan 2005; Jostova et al. 2013). With a daily price panel data consisting 1,378 bonds, we use the month–end price for our analysis. Using the month-end price which is yet a clean price, we add up accrued interest into the price and compute the return from it as it is mentioned in our data-description. During month t and t-1, if there was a coupon issued, we also include coupon interests into the price.

To see whether the past winner bonds out-performed the past loser bond, we first divide the bonds into 10 decile portfolios each month. For this we compute the past J month cumulative return (formation period) to rank all the existing bonds in month t in an ascending order based on the return during t-J to t-1. We divide the bonds into 10 deciles which will be the portfolio group from strict winner portfolio(P10) to strict loser portfolio(P1) based on their rankings. After the portfolios are formed each month, we apply the momentum strategy by buying the extreme winner portfolio (P10) and selling the extreme loser portfolio (P1) (Jegedeesh and Titman 1993). We skip a month to avoid price pressure, bid-ask price, and short-term price reversals and hold the portfolios for another K months (holding period) to see if momentum return is present. Momentum returns are calculated as the equal weighted return over all extreme loser (P1) portfolio subtracted from the equal weighted return over all extreme winner (P10) portfolios as it is done in (Jostova et al 2013).

4. Momentum in Korean Corporate Bonds

4.1 Unconditional performance evaluation

Table 2 provides the mean monthly raw returns of momentum with a formation period of 3,6,9, and 12 months and holding period of a month with a month skipped between the formation and holding period.

We find positive and statistically significant momentum profits (P10-P1) for the full time period across both NIG and IG bond samples. Panel A provides a mean monthly returns of momentum strategy. On average momentum profits amount to 0.61% per month (about 7.32% per year) during the full time period (July 2004 to January 2016), 0.3% (3.6% annually) during the first half time period (July 2004 to October 2010) and 0.98% (11.79% annually) during remaining half of the period (November 2010 to January 2016). Compared to the first half time period between, the second half of the time period was slightly more profitable following the momentum strategy. Even though the second half of the period had lower extreme winner returns compared to the first half, they had significantly lower, negative loser returns which made them earn higher momentum returns than the first half. In contrast, the momentum profitability of the first half period mainly stems from the loser portfolio. For all of the time span, strict loser portfolio (P1) earns strictly negative return than the rest of the 9 portfolios. The average return difference between P2 to P10 was 0.2% for the whole period, 0.42% for the first half, and 0.26% for the second half of the period. However, there is a big leap between P1 and P2 (on average, 0.42%). This is almost as much or even higher than the difference throughout P2 to P10. We conclude here that the middle part of the decile portfolios does not have dramatically different returns.

Figure 1 shows the 12 month cumulative moving average of bond momentum profit. As it is evident in table 2, we see increase in momentum profit over time. In figure 1, we see the slope which indicates the 12 month moving average of momentum profit increasing.

Panel B in Table 2 shows the bond portfolio momentum return during the 2007-2008 financial crisis. Interestingly we find that momentum profit tends to shrug during financial crisis period; an average return of -0.25% per month (due to the negative return with J6/K1 strategy). Compared to other time periods, it clearly shows that during the crisis momentum strategy earned less return.

Also, we barely see the monotonous increase in the monthly holding period returns across portfolios. During the crisis, it seems like neither the extreme winner nor the extreme loser earn or lose significantly. The dispersion of returns across portfolios seems to be relatively stable.

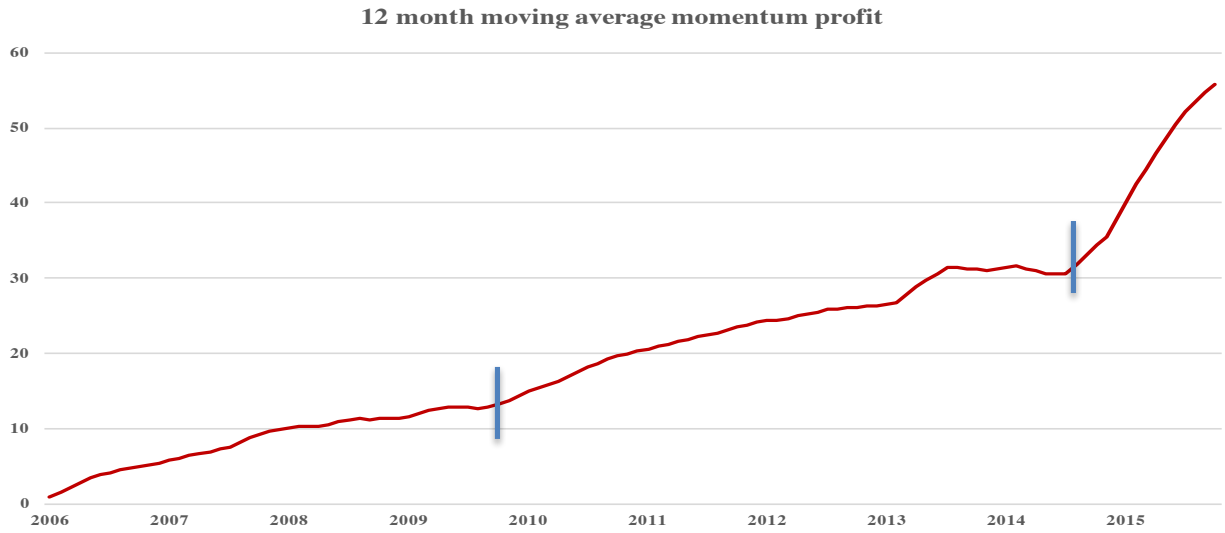

Figure 1
Time-series of momentum profitability
The figure represents the cumulative return of 12-month moving average monthly momentum profit (P10-P1) for all bonds.

(Fama and French 1996) could not explain with its' three factor model the short term return continuation documented by (Jegadeesh and Titman 1993). Table 3 presents the bond risk adjusted returns of the bonds and their momentum profits. This is to examine whether the momentum profits are merely a compensation of the risk factors that exists in bonds. We regress momentum portfolio returns and profits on bond risk factors applied by (Fama and French 1996; Gebhardt, Hvidkjaer, and Swaminathan 2005; Jostova et al. 2013; Khang and King 2004).

Table 2
Mean monthly returns of momentum strategies
Panel A : Bond momentum across time

J	Loser	Decile portfolios								Winner	W-L	t-stat
	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P10-P1	
July 2004 – January 2016												
3	-0.44	-0.02	-0.04	-0.01	0.00	0.02	0.05	0.03	0.11	0.03	0.47	**2.07**
6	-0.48	-0.05	-0.01	-0.02	0.00	0.01	0.04	0.02	0.13	0.14	0.62	**2.73**
9	-0.50	-0.07	0.00	0.02	0.00	0.04	0.03	0.03	0.13	0.20	0.70	**2.26**
12	-0.46	-0.07	0.00	0.01	-0.01	0.02	0.02	0.05	0.12	0.20	0.65	**2.60**
July 2004 - October 2010												
3	-0.03	0.05	-0.02	0.03	0.05	0.07	0.13	0.13	0.18	0.38	0.41	**2.78**
6	0.05	0.06	0.03	0.06	0.05	0.08	0.10	0.13	0.19	0.35	0.30	**2.05**
9	0.10	0.11	0.07	0.09	0.08	0.12	0.14	0.16	0.25	0.32	0.22	1.53
12	0.05	0.12	0.07	0.08	0.08	0.13	0.10	0.17	0.24	0.30	0.25	1.67
November 2010 - January 2016												
3	-0.89	-0.09	-0.07	-0.05	-0.05	-0.02	-0.03	-0.08	0.02	-0.35	0.54	1.18
6	-1.09	-0.18	-0.06	-0.10	-0.03	-0.05	-0.02	-0.10	0.06	-0.10	0.99	**2.16**
9	-1.22	-0.28	-0.08	-0.05	-0.06	-0.03	-0.07	-0.09	0.01	0.04	1.25	1.87
12	-1.09	-0.30	-0.07	-0.05	-0.09	-0.07	-0.04	-0.05	-0.01	0.06	1.15	**2.09**

Panel B : Bond momentum during the financial crisis (December 2007 – April 2009)

J	Loser	Decile portfolios								Winner	W-L	t-stat
	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P10-P1	
December 2007 - April 2009												
3	0.15	0.19	0.15	0.26	0.15	0.17	0.24	0.26	0.23	0.25	0.10	0.22
6	0.41	0.35	0.28	0.26	0.19	0.21	0.20	0.12	0.09	0.11	-0.30	-0.72
9	0.25	0.24	0.17	0.23	0.23	0.31	0.26	0.20	0.17	0.27	0.02	0.04
12	0.15	0.23	0.24	0.28	0.27	0.26	0.22	0.20	0.24	0.32	0.17	0.40

This table presents the monthly performance of momentum strategies in percentage. Each month t, bonds are sorted into decile portfolios P1 to P10 based on their cumulated returns over the portfolio formation period. The first column of the table represents the number of months that has been taken account to compute the cumulated return before the portfolio is formed. Based on the formation periods, above are the monthly returns calculated with a holding period of one month. We skipped one month between the formation and holding period. Panel A contains the bond momentum across different time periods. The first section of the date contains the full sample observation from January 2005 to December 2014. The second and third section covers January 2005 to December 2008 and December 2008 to December 2014. Panel B only shows the bond momentum during 2007-2008 financial crisis

We focus on the time period March 2006 to April 2011 when the bond momentum is the most significant. Using the model that we mentioned in the methodology section, we estimate the alphas from the following model:

$$r_{it} = \alpha_i + \beta' F_t + \varepsilon_{it}, \quad i = 1,2 \ldots., P \;\; t = 1, \ldots, T$$

Where r_{it} is an average monthly excess return of i-th bond at time t, F_t are the bond risk factor variables such as the change in the term spread and the change in the credit spread. Term spreads are calculated as the difference between the ten-year and one-year Treasury yields and credit spreads are calculated as the difference between the BBB corporate yields and AA- corporate yields. Table 3 shows that momentum profits do not compensate for both NIG and IG samples. The strategy alphas for NIG is from 124 bps to 128 bps and 28 bps to 31 bps for IG when the raw momentum profits are 105 bps and 30 bps respectively. For the full sample, the momentum profits were from 32 bps to 35 bps. Compared to the full and IG bond samples, NIG bonds' momentum profit increases pronouncedly when bond risk factors are adjusted. Increase in momentum profit in NIG bond stems from decrease in return in loser portfolio. The highest momentum profits are obtained when momentum returns are regressed on all of the bond risk factors (model 3). Overall, empirical result from the model suggests that momentum profits do not necessarily compensate for the systematic risks. However, the model is not complete to explain the impact of risk factors on each bond returns and as a result it is insufficient to explain what the final impact to momentum profit is. Next section will examine the matter more carefully.

4.1.1 Time–varying portfolio composition and conditional performance.

Even though we could not observe any changes in momentum profit when we follow the risk adjusted model by (Jostova et al. 2013), we still observe some changes in each momentum portfolio returns. Momentum profit did not change because both winner and loser bond return went down with same amount. So we decided to further investigate whether the composition of winner and loser bond portfolios are impacted by the exposure of factor realizations during the bond portfolio formation period and thus how it affects momentum profit. For example, in times when interest rates are low, bond prices will rise and bonds with longer duration generates positive returns thus, placed in winner portfolios. Similarly, during the economy down turn, lower rated bonds, as they are more sensitive to default risk, are more likely to be placed in loser bonds. Before we get into regressions we first plot each winner and loser bond momentum returns and their median duration and median spread over time.

Figure 2 plots median duration and mean spread of winner and loser portfolios throughout time period from 2005-2011. As we can see from the graph, the median duration of winner and loser bonds move in opposite directions. Since duration can also be interpreted as how much bond price fluctuates by the change in interest rate, bonds with longer durations are therefore more sensitive to interest rate risk. From here, we confirm our assumption that interest rate realization each month may affect the composition of winner and loser bonds.

Table 3
Alphas of bond momentum portfolios

		Momentum portfolios											
	Model	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P10-P1	t-stat
ALL	*Raw returns*												
	0	-0.44	-0.02	-0.04	-0.01	0.00	0.02	0.05	0.03	0.11	0.03	0.47	**2.07**
	Momentum portfolio alphas												
	1	0.01	0.03	-0.01	0.04	0.04	0.04	0.07	0.08	0.10	0.33	0.32	**2.38**
	2	-0.01	0.02	-0.02	0.03	0.03	0.03	0.05	0.07	0.09	0.32	0.33	**2.39**
	3	-0.01	0.02	-0.02	0.03	0.04	0.04	0.07	0.08	0.11	0.34	0.35	**2.58**
NIG	*Raw returns*												
	0	-0.51	-0.07	-0.13	0.05	0.10	0.00	0.28	0.32	0.06	0.53	1.05	**2.11**
	Momentum portfolio alphas												
	1	-0.54	-0.04	-0.20	0.09	0.03	-0.08	0.19	0.22	0.10	0.58	1.24	**3.07**
	2	-0.58	-0.04	-0.20	0.08	0.03	-0.08	0.21	0.25	0.08	0.57	1.27	**3.11**
	3	-0.59	-0.03	-0.19	0.08	0.04	-0.07	0.22	0.25	0.10	0.57	1.28	**3.09**
IG	*Raw returns*												
	0	0.05	0.05	0.01	0.05	0.06	0.06	0.08	0.11	0.14	0.35	0.30	**8.19**
	Momentum portfolio alphas												
	1	0.04	0.03	0.00	0.04	0.03	0.04	0.07	0.09	0.11	0.32	0.28	**2.07**
	2	0.02	0.02	-0.01	0.03	0.02	0.03	0.06	0.08	0.09	0.31	0.29	**2.09**
	3	0.02	0.02	-0.01	0.03	0.03	0.04	0.07	0.09	0.11	0.33	0.31	**2.29**

Bond momentum portfolio returns are computed as in Table 2 for all databases from March 2006 to April 2011. Model 0 indicates the raw average return of portfolios to for comparison purposes. We then run a mixed effect regression of these portfolio returns on bond systematic factors.

$$r_{it} = \alpha_i + \beta' F_t + \varepsilon_{it}, \quad i = 1,2,\dots,P \;\; t = 1,2,\dots,T$$

Where r_{it} is an average monthly excess return of i-th bond in at time t. For each model, F is represented by the following factors:

(0) Raw return without risk factors
(1) mTERM
(2) mDEF
(3) mTERM, mDEF

Where $mTERM_t = \frac{\Delta TERM_t}{1+TERM_{t-1}}$, $mDEF_t = \frac{\Delta DEF_t}{1+DEF_{t-1}}$. $TERM_t$ 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 and they were collected from the Bank of Korea economic statistics system. The table shows the estimated alphas and their t-statistics. T-statistics that are bolded indicates that it is significant.

Figure 2 :
This figure shows the mean modified duration of the bonds sorted into the winner and loser portfolio for a three month formation period, applied to the full sample as well as the IG and NIG subsample. Both panels cover the period from April 2005 to December 2011.

For both IG and NIG sample in figure 2, median duration of winner and loser bonds move in a clear opposite direction. This is more prominent among IG bonds compared to NIG bonds. From here we find that compared to NIG bonds, composition of IG bonds is more driven by interest rate risk. Also we observe some time-dependency as well when we plot the median spread of winner and loser bonds. For example, for the full sample, we see that loser bonds have more spread than winner bonds especially during the 2007 – 2008 financial crisis. This is due to the fact that during economic down turn bigger portion of loser bonds consist of NIG bonds which in general have higher yields. Overall, as Barth et al(2015), we also conclude that there must be some time-varying

factor exposures that affect the composition of winner and loser portfolios on the corporate bond market.

So in this section we would further like to investigate whether time-varying factor exposures impact the composition of portfolios and thus affect momentum profits. We follow (Grundy and Martin 2001) and designate each month as up, flat, or down based on the cumulative factor return during the formation period. If the cumulative return is above, within, or below one standard deviation from its mean, it will be characterized as up, flat, and down respectively. This is a split entered version of equation (2) with total of six dummy variables $D_t^{a,b}$. The factor TERM and DEF are denoted by a (T and D), and whether it indicates up, flat, or down is noted by b.

$$r_{i,t} = \alpha_i + \beta_i^{T,up} D_i^{T,up} TERM_t + \beta_i^{T,flat} D_i^{T,flat} TERM_t + \beta_i^{T,down} D_i^{T,down} TERM_t + \beta_i^{D,up} D_i^{D,up} DEF_t + \beta_i^{D,flat} D_i^{D,flat} DEF_t + \beta_i^{D,down} D_i^{D,down} DEF_t + \varepsilon_{i,t}$$

Since we only hold the portfolio for a month, all the exposures to factor loading during the formation periods come from this very formation period and does not overlap.

Table 4 presents the regression result of equation (2). At a glance, we can see that IG bonds have the most significant impact from the term risk exposure during the formation period as we have already observed in figure 2. For the full sample, TERM risk factor exposure seems to be bigger in TERM up months than down months generating positive relation with momentum profit. This is because when TERM goes up, longer duration bonds in winner bond portfolio are highly sensitive to interest rates and thus their returns rise. On the contrary, when interest rates rise, shorter duration bonds are bought which are less sensitive to interest rates and that is why the exposure during the TERM down months is smaller. However, there is no significant impact of

interest rate changes during the formation period to momentum returns among NIG bonds. Although each winner and loser portfolios did have larger exposure during the TERM up months compared to down months, it is statistically insignificant. IG bonds show larger exposure to interest rate changes during TERM up months and it earns more significance than the full sample. Also winner bonds have stronger exposure to interest risk factor during TERM up months for IG bond samples.

During the time when default risk increases, demand for high yield bonds increases which lead yields to increase in general and causes bond price to decrease. This induces DEF factor to have more negative impact to returns towards up months. For the full sample, we only observe this among winner bonds and did not detect relation in loser returns and momentum profits. For NIG bonds, we did not observe any relationship between default risk factors and momentum returns. For IG bond samples, default risk factors did have some negative impact on winner bond samples during up months and a positive impact on loser bond samples during both up and down months. In the end it exhibited a negative impact on momentum profit.

In summary, our empirical findings suggest that exposure to interest rate risk factor in momentum profit is bigger during the TERM up months compared to the down months for all and IG sample. However, we don't see as much interest rate risk impact in NIG bonds. Exposure to default rate risk factor is only significant in winner returns for full sample and both winner and loser returns for IG bonds. Momentum profits are positively impacted during TERM up months but cannot see any relations with DEF factor. Also since the absolute value of coefficients are below 1%, we conclude that risk factor exposures to momentum returns and profit is very minimal even if it exists.

Table 4
The influence of factor realizations during the formation period on factor exposures in the holding period

ALL		Winner	*t-stat*	Loser	*t-stat*	W-L	*t-stat*
	α	0.29	1.46	-0.16	-0.58	-0.14	-0.56
	β_{up}^{T}	0.89	**5.98**	0.4	**1.87**	0.48	1.85
	β_{flat}^{T}	0.26	1.22	0.57	**1.82**	-0.29	-0.76
	β_{down}^{T}	0.40	**4.91**	0.34	**2.85**	0.08	0.57
	β_{up}^{D}	-0.19	**-2.80**	-0.04	-0.42	-0.16	-1.29
	β_{flat}^{D}	-0.10	**-2.26**	-0.1	-1.49	-0.01	-0.14
	β_{down}^{D}	-0.05	-0.64	0.11	1.1	-0.16	-1.29
NIG	α	4.39	0.81	2.07	0.62	1.86	0.52
	β_{up}^{T}	2.27	0.64	2.3	0.87	-0.03	-0.17
	β_{flat}^{T}	-5.02	-0.68	-3.14	-0.69	-1.44	-0.16
	β_{down}^{T}	0.47	0.18	1.59	0.99	-0.93	-0.35
	β_{up}^{D}	-1.26	-0.69	-1.14	-0.93	0.07	0.03
	β_{flat}^{D}	-1.61	-1.29	-1.06	-1.48	-0.31	-0.26
	β_{down}^{D}	-1.08	-0.66	-0.62	-0.56	-0.20	-0.11
IG	α	0.10	1.49	-0.48	**-5.69**	-0.48	**-6.37**
	β_{up}^{T}	0.81	**16.14**	0.04	0.57	0.75	**9.05**
	β_{flat}^{T}	0.08	1.15	0.09	0.93	-0.02	-0.16
	β_{down}^{T}	0.31	**11.17**	-0.01	-0.35	0.31	**6.92**
	β_{up}^{D}	-0.12	**-5.25**	0.16	**5.26**	-0.28	**-7.30**
	β_{flat}^{D}	-0.03	-1.75	0.08	**3.97**	-0.10	**-4.07**
	β_{down}^{D}	0.02	0.98	0.27	**8.44**	-0.24	**-6.13**

This table presents the influence of factor realizations during the formation period on the factor exposures of corporate bond momentum strategies during the holding period, according to Grundy and Martin(2001) for the J3/K1 strategy. Values are given in %. To measure the influence following equation is used :

$$r_{i,t} = \alpha_i + \beta_i^{T,up} D_t^{T,up} TERM_t + \beta_i^{T,flat} D_t^{Tflat} TERM_t + \beta_i^{T,down} D_t^{T,down} TERM_t + \beta_i^{D,up} D_t^{D,up} DEF_t + \beta_i^{D,flat} D_t^{D,flat} DEF_t + \beta_i^{D,down} D_t^{D,down} DEF_t + \varepsilon_{i,t}$$

$r_{i,t}$ is the bond return of portfolio i at time t. $D_t^{a,b}$ is a dummy variable which equals one if the cumulative return of factors TERM and DEF are denoted by a (T or D), during the formation period with a one month skip before holding period, goes up, flat, or down by one standard deviation from the mean and zero otherwise; this is denoted by b. The data covers from July 2004 to January 2016.

4.2 Conditional performace evaluation

4.2.1 Credit risk and bond momentum profitability

Literatures that studied the link between an asset's credit ratings and momentum profit found out that credit rate is one of the factors that affects momentum profit. (Avramov et al. 2007; Lu, Lee, and Yu 2014) found an apparent link between momentum profit and firm credit ratings. (Avramov et al. 2007) found out that the extreme winner and loser portfolios are comprised mainly of high credit risk stocks and that momentum profit is large among low-rated firms, but nonexistent among high-grade firms. (Lu, Lee, and Yu 2014) also concluded that equity momentum strongly depends on credit risks. In this section, we examine whether this relationship also holds for the bond market as well.

Table 4 presents the composition of momentum portfolios over January 2005 to December 2014. Each month, all the bonds are ranked according to their past returns and further divided into 10 decile portfolios. We now see how each of those 10 portfolios are composed by reporting the distribution of individual credit ratings. Columns 2 to 11 shows portion of each individual rating inside each of momentum portfolios. Row average shows the average credit rate for each of the portfolios. Momentum portfolios contain on average about 8% NIG bonds ("Row Average"), and about 92% of IG bonds.

Average credit ratings shows a distinct U-shape across decile portfolios. As expected, extreme winner and extreme losers' average credit ratings are bigger than porfolios in the middle; P1 and P10 have an average rating of 6.37($\approx A$) and 6.89($\approx A-$) respectively while P2- P8 portfolios have an average rating of 5.435 ($\approx A+$).

The last column of table 5 shows the portion of extreme winner and loser bonds inside each of the credit ratings. We find that compared to IG bonds, the percentage of extreme winners and losers inside NIG bonds are higher. On average, 41 % of NIG bonds are placed in extreme winner or loser bonds. While only 19% of IG bonds are placed in extreme winner and loser bonds. It is more prominent if we compare the portion of winner and loser bonds of AA graded bonds and C graded bonds. While only 17 % of AA+ graded bonds are extreme winners and losers, 70% of C graded bonds are placed in extreme portfolios. Interesting thing to note is that IG bonds tend to be placed more in loser bonds than winner bonds where as NIG bonds are more likely to be placed in winner bonds than loser bonds except for D graded bond where 20 % are placed loser and 13% are placed winner. 11% of IG bonds are in P1 when 8% are placed in P10, 18% of NIG bonds are in P1 when 23% are placed in P10.

As it is evident in table 5 that there is a link between credit risk and momentum portfolio composition, we examine conditional momentum strategies in different credit rating settings in table 6. Each month t, we sort the bonds into 5 quintile credit rating groups from Q1 to Q5. Panel A in table 6 presents the momentum portfolios and profit of each of credit rating groups from Q1 to Q5, NIG and IG bonds.

Momentum strategies are highly profitable among NIG bonds and lower rated bonds. For the full time period from July 2004 to January 2016, NIG bond sample earned 1.6% per month while IG bonds earned 0.27% by implementing momentum strategy. During the first half time period from July 2004 to October 2010, there weren't big difference in momentum profit between NIG and IG bond sample. However, looking at the 5 groups, we certainly observe the fact that momentum profit monotonously increased towards Q5 except for a bump in Q2. This pattern is more pronounced during the second half of the

time period from November 2010 to January 2016. While Q1 earned insignificant 0.06% monthly return, Q5 earned 1.22% per month and NIG bond sample in total earned 2.15% monthly return while IG bond sample only earned 0.2%. Unlike (Jostova et al. 2013) we find that IG bonds are also significantly profitable when we apply momentum strategy. This also contradicts to the findings of (Avramov et al. 2007; Gebhardt, Hvidkjaer, and Swaminathan 2005), who couldn't find any significant momentum profits among IG bonds.

Table 5
Composition of momentum portfolios by individual ratings.

	L	Decile portfolio								W			
	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	Row Avg	% P1	% P10
AAA	0.19	0.18	0.16	0.18	0.15	0.15	0.16	0.17	0.18	0.15	0.17	0.14	0.09
AA+	0.07	0.09	0.10	0.11	0.11	0.10	0.09	0.10	0.11	0.08	0.10	0.09	0.08
AA	0.04	0.05	0.05	0.04	0.04	0.04	0.03	0.03	0.02	0.03	0.04	0.13	0.07
AA-	0.09	0.12	0.11	0.11	0.10	0.09	0.10	0.09	0.07	0.08	0.10	0.11	0.08
A+	0.11	0.15	0.15	0.13	0.14	0.15	0.15	0.13	0.12	0.10	0.13	0.10	0.08
A	0.11	0.14	0.14	0.14	0.15	0.15	0.16	0.14	0.13	0.12	0.14	0.10	0.08
A-	0.06	0.08	0.09	0.09	0.11	0.10	0.09	0.08	0.08	0.08	0.09	0.09	0.09
BBB+	0.07	0.07	0.05	0.06	0.06	0.07	0.07	0.07	0.08	0.08	0.07	0.12	0.12
BBB	0.06	0.06	0.06	0.06	0.07	0.06	0.07	0.06	0.07	0.06	0.06	0.12	0.1
BBB-	0.02	0.03	0.03	0.03	0.04	0.04	0.03	0.04	0.03	0.03	0.03	0.09	0.08
BB+	0.04	0.02	0.02	0.02	0.01	0.02	0.02	0.03	0.05	0.06	0.03	0.13	0.18
BB	0.01	0.01	0.01	0.00	0.00	0.01	0.00	0.01	0.02	0.03	0.01	0.16	0.31
BB-	0.02	0.00	0.01	0.00	0.00	0.01	0.01	0.01	0.01	0.03	0.01	0.1	0.34
CCC	0.07	0.02	0.02	0.01	0.01	0.02	0.02	0.03	0.02	0.06	0.03	0.24	0.25
C	0.01	0.00	NA	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.22	0.48
D	0.02	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.20	0.13
NIG	0.16	0.05	0.06	0.04	0.03	0.05	0.06	0.09	0.11	0.20	0.08	0.18	0.23
IG	0.84	0.95	0.94	0.96	0.97	0.95	0.94	0.91	0.89	0.80	0.92	0.11	0.08
Avg rating	6.37	5.17	5.32	5.09	5.27	5.50	5.61	5.72	5.80	6.89	5.67		

This table presents the percentage of bonds in each of the portfolio across credit ratings. Bond momentum portfolio returns are computed as in Table 2 for all databases from July 2004 to January 2016. The column "Row Average" shows the average percentage of each credit ratings 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 three rows represent the composition of NIG, IG bonds and the average ratings for each portfolios.

Bond momentum is unprofitable in Q1 credit rating groups and increases its' profitability towards lower rated bonds. We now try to investigate whether lack of low rated bonds could be the reason behind no momentum profitability. In panel B of table 5, we ran a time-series regressions of monthly momentum profits on the percentage of NIG bonds inside total bond sample each month from July 2004 to December 2011 when

the ratio between NIG and IG bonds are quite consistent inside the full sample to avoid time-trend issue involved in the ratio of NIG bonds over time. We also control for the risk factors as in table 3, time trend and lagged momentum profit. We find strong and significant relationship between momentum profit and the percentage of NIG bonds out of total bond sample each month.

In panel C, we run a time-series of monthly momentum profits on mean credit ratings of extreme winner(P10) plus extreme loser(P1). Here, we also find some significant and positive relationship between momentum profit and sum of credit ratings of extreme bonds.

Overall, our empirical findings indicate that lack of lower rated bonds may partially explain the reason why Q1 bond sample did not attain any momentum profits. Bonds with low rates are more likely to profit applying momentum strategy.

Table 6
Panel A: Bond Momentum and credit risk

Rating Group	Avg rating	Momentum portfolios											
		P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P10-P1	t-stat
July 2004 – January 2016													
Q1	1.21	0.05	0.04	0.03	0.12	0.02	0.01	0.03	0.03	0.07	0.11	0.06	0.85
Q2	3.22	0.00	0.04	0.01	0.00	0.03	0.02	0.06	0.07	0.05	0.34	0.34	**5.29**
Q3	5.13	-0.02	-0.01	-0.01	-0.04	0.04	0.06	0.06	0.07	0.13	0.26	0.28	**5.62**
Q4	6.71	-0.03	-0.02	-0.09	0.00	-0.01	0.02	0.05	0.08	0.13	0.34	0.37	**7.61**
Q5	10.44	-0.81	0.02	0.00	-0.02	0.02	0.01	0.04	0.02	0.08	0.06	0.87	**3.06**
NIG	15.67	-2.15	-0.02	-0.15	-0.24	0.07	0.03	-0.07	-0.15	0.06	-0.46	1.60	**2.32**
IG	4.75	0.02	0.02	-0.01	0.02	0.02	0.02	0.05	0.07	0.09	0.29	0.27	**10.34**
July 2004 – October 2010													
Q1	1.30	0.04	0.05	0.04	0.25	0.06	0.05	0.05	0.06	0.11	0.10	0.06	0.62
Q2	3.70	0.02	0.07	0.08	0.02	0.14	0.07	0.11	0.11	0.05	0.45	0.43	**4.71**
Q3	5.53	-0.01	-0.01	-0.01	0.01	0.11	0.10	0.14	0.14	0.14	0.29	0.31	**4.46**
Q4	7.12	0.04	0.06	-0.06	0.01	-0.04	0.10	0.06	0.14	0.29	0.44	0.40	**6.51**
Q5	10.31	-0.02	0.07	-0.02	-0.03	0.07	0.00	0.04	0.06	0.15	0.50	0.52	**4.32**
NIG	15.68	-0.41	0.11	-0.11	-0.24	0.20	0.13	-0.04	-0.05	0.18	0.29	0.33	1.67
IG	5.14	0.04	0.05	0.01	0.06	0.06	0.06	0.09	0.11	0.15	0.36	0.32	**8.6**
November 2010 – January 2016													
Q1	1.08	0.06	0.02	-0.04	0.00	-0.08	-0.02	0.01	-0.02	0.03	0.16	0.06	0.73
Q2	2.53	-0.05	0.00	-0.06	-0.05	-0.06	-0.04	-0.05	-0.03	0.04	0.07	0.12	1.6
Q3	4.54	-0.03	-0.03	-0.05	-0.07	-0.03	-0.02	0.00	0.03	-0.04	0.24	0.27	**4.11**
Q4	6.12	-0.09	-0.08	-0.03	-0.05	-0.02	-0.08	0.07	-0.01	0.02	0.14	0.23	**2.99**
Q5	10.64	-1.55	-0.10	-0.01	-0.03	-0.03	0.00	-0.02	-0.04	-0.03	-0.32	1.22	**2.3**
NIG	15.67	-3.18	-0.20	-0.22	-0.23	-0.09	-0.07	-0.11	-0.22	-0.03	-1.02	2.15	**1.95**
IG	4.17	-0.02	-0.03	-0.04	-0.04	-0.04	-0.03	0.01	0.00	0.01	0.18	0.20	**5.88**

(Continued)

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

Spec.	Controls	Constant	% NIG	Adj. R^2
1		0.35		0
		(4.38)		
2	Factors	0.27	2.34	6.9
		(1.92)	**(2.24)**	
3	Factors + trend	0.02	2.57	5.9
		(0.17)	**(2.2)**	
4	Factors + lagged P10 - P1	0.24	1.75	4.6
		(1.38)	(0.73)	

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

Spec.	Controls	Constant	Rating[P1+P10]	Adj. R^2
1		1.05		0
		(2.11)		
2	Factors	-3.3	0.13	6.6
		(-2.0)	**(2.74)**	
3	Factors + trend	0.06	0.12	4.8
		0.185	**(2.37)**	
4	Factors + lagged P10 - P1	-3.23	0.13	5.2
		(-1.905)	**(2.55)**	

This table presents the momentum portfolio returns and momentum profits for each rating sorted group. Each month t, all bonds are sorted into 5 quintile groups based on their credit ratings. Within each group, we repeat the momentum analysis described in Table 2. Panel A presents the momentum portfolio returns and momentum profits for each 5 credit rating group. We also divide them into IG or NIG groups; 11 = BB+ or higher (i.e., worse) are considered NIG and the rest are considered IG. 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, lagged bond momentum profits (lagged P10-P1), and the bond and equity factors from Table 3: mTERM, mDEF. Panel B reports the intercept and slope coefficient on the %NIG variable (in %), t -statistics in parentheses, and adjusted R2. 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 (Rating[P1+P10]), a time trend, lagged NIG bond momentum profits (lagged P10-P1), and the bond and equity factors from Table 3: mTERM, mDEF. Panel C reports the intercept and slope coefficient on Rating[P1+P10] (in %), t -statistics in parentheses, and adjusted R2. The sample period for panels A-C is from July 2004 to January 2016.

4.2.2 Corporate bond momentum and the business cycle.

The last section of our paper will examine momentum profitability in different business conditions. (K. D. Daniel and Moskowitz 2013) documents momentum crashes especially during extreme market environments. They argue that even though in "normal" environments momentum profits tend to be positive and statistically significant and economically strong, in times when poor past market condition rebounds, the losers start gaining strong gains and may result momentum crash.

The average momentum returns holding J6/K1 strategy for the full bond sample in panel B in table 2 clearly shows significant momentum crashes. Even though these crashes aren't frequently seen in the market, we can see them especially after market declines during the

recession period, in this case during December of 2007 until April 2009. Therefore, in this section we investigate whether momentum crashes are related to business cycle.

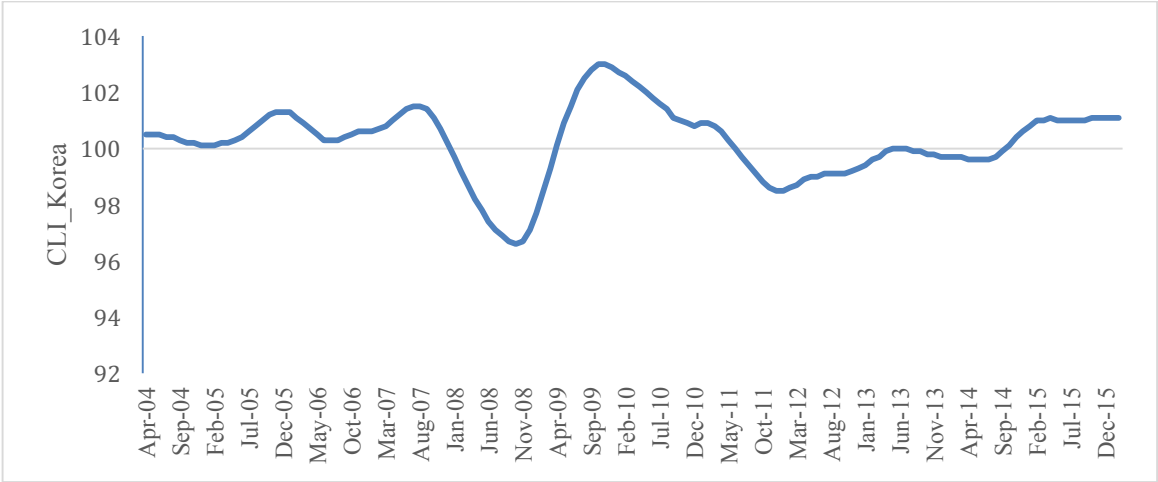

Figure 3
This figure shows the composite leading indicator provided by OECD for Korea. The data covers from April 2004 to December 2015.

Table 7 presents the momentum profitability in recessionary periods and expansionary periods. Each month t is considered recessionary or exansionary according to the composite leading indicator of Korea provided by OECD (Figure 3). If the indicator marks below 100 it is considered as recessionary period and if it marks above 100 it is considered expansionary period. We also include January dummy and non-january dummy.

The results suggest that the momentum strategy earns more profit in expansionary period. We also observe the fact that momentum profits are smaller in Januaries compared to non-January months. As our observations are relatively short and we only have two recessionary and expansionary periods inside that time frame, this cannot completely conclude that momentum profits more in expansionary periods. However since the difference in momentum profits between the two periods is statistically significant 0.44% per month (t stat = 7.28), this may suggest that momentum profits may be related to business cycle.

Table 7
Momentum profits classified by Business Cycles.

Recessionary periods					Expansion periods				
		Overall	Jan	Non -Jan			Overall	Jan	Non -Jan
Jan 08 - Apr 09	W-L	-0.25	-1	-0.2	Aug 06 - Jan 08	W-L	0.26	-0.41	0.34
	t-stat	**-2.49**	**-4.65**	**-1.89**		t-stat	**3.98**	**-2.82**	**5.02**
Jun 11 - May 13	W-L	0.44	0.26	0.45	Apr 09 - Jun 11	W-L	0.77	0.45	0.79
	t-stat	**2.93**	**1.94**	**2.78**		t-stat	**10.26**	**3.64**	**10.26**

This table presents the momentum profitability of J3/K1 strategy in different business cycles following Chordia and Shivakumar (2002). Each month t is considered recession period or expansion period according to the CLI(composite leading indicator) provided by OECD for Korea. If CLI marks above 100, it is considered an expansion period, whereas it if goes below 100 it is denoted as recession period. Each month t, bonds are sorted into decile portfolios P1 to P10 based on their cumulated returns over the portfolio formation period.

In table 8 we present the momentum returns and profits of two significant recessionary and expansionary periods according to figure 3. The two apparent recession and expansion periods are from December 2007 to March 2009 and from April 2009 to May 2011, respectively. We subdivide the sample into NIG and IG bonds to examine how momentum profitability in each sample group is affected by changing business cycle.

Our result in table 8 indicates that statistically significant momentum profits only exists during full and IG sample's expansionary period. Even though momentum profit in NIG bond sample are economically large, that lack statistical significance. During the recessionary period, we document almost no or even negative profits for full and IG bond samples; with J6/K1 strategy full and IG bonds loses significantly by holding momentum strategy. Although NIG bond sample earns some positive and larger momentum profits during the recessionary period compared to full and IG bond samples, they are statistical significance is weak.

(Destefano 2004) separates the recessionary and expansionary period into two different stages and found that stock returns during the early stages of economic expansion (Stage I) are positive and decreases towards zero as the expansion reaches its later phase(Stage II).

He argues that gradual decline in stock returns is in part due to falling expectations for future earnings. In this section, we refine the gridline and divide each recessionary and expansionary time periods into two separate sections (Exp1, Exp2, Rec1, Rec2) following (Destefano 2004) in order to examine how momentum profitability differs in each stage. Exp1 indicates the time period within expansion until the economy reaches the peak and Exp2 is the rest when the economy falls within expansion. Similar, Rec1 denotes the time before economy hits the trough within the recession period and Rec2 is when the economy recovers from the trough.

Table 8
Performance of momentum strategies in different business cycles

		Momentum portfolio											
		P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P10-P1	t-stat
	J	ALL											
Exp	3	0.00	0.01	-0.02	-0.02	-0.03	-0.03	-0.03	0.01	0.02	0.38	0.38	**2.97**
	6	-0.11	-0.05	-0.03	-0.04	-0.02	0.01	0.00	-0.01	0.15	0.50	0.61	**5.21**
	9	-0.02	-0.06	0.00	0.00	-0.09	-0.02	-0.03	-0.04	0.10	0.35	0.37	**3.46**
	12	-0.02	0.00	-0.08	-0.03	-0.05	-0.05	-0.03	-0.01	0.14	0.21	0.23	1.90
Rec	3	0.17	0.20	0.19	0.31	0.21	0.22	0.29	0.33	0.27	0.31	0.13	0.30
	6	0.45	0.38	0.31	0.29	0.23	0.26	0.24	0.18	0.16	0.15	-0.30	-0.70
	9	0.30	0.26	0.19	0.25	0.26	0.35	0.31	0.26	0.23	0.32	0.02	0.04
	12	0.19	0.27	0.27	0.30	0.27	0.31	0.26	0.25	0.30	0.38	0.19	0.42
		NIG											
Exp	3	-1.51	0.06	-0.66	0.13	0.09	-0.14	0.32	0.12	-0.49	0.46	1.97	1.54
	6	-1.17	-0.44	-0.15	0.09	-0.03	-0.90	0.37	0.18	0.48	0.40	1.56	1.22
	9	-2.88	-0.41	-0.22	0.55	-1.40	0.26	0.75	-0.14	0.32	0.39	3.27	1.08
	12	-2.71	-0.53	0.01	0.13	-1.13	0.26	0.06	0.05	0.29	0.62	3.33	1.15
Rec	3	-0.27	-0.10	0.06	0.37	0.22	-0.22	0.26	-0.07	0.40	0.67	0.94	**2.10**
	6	-0.29	0.31	0.16	-0.06	0.26	0.03	0.02	0.32	0.44	0.72	1.01	**2.42**
	9	-0.20	0.25	0.10	0.04	0.57	0.05	0.15	0.28	0.20	0.51	0.71	1.91
	12	-0.35	0.16	0.20	-0.03	-0.03	0.04	0.60	0.40	0.49	0.60	0.96	**2.11**
		IG											
Exp	3	0.04	0.02	0.00	0.00	0.01	0.01	-0.01	0.01	0.05	0.45	0.41	**3.54**
	6	-0.04	-0.06	0.00	-0.05	-0.01	0.00	0.00	0.00	0.14	0.49	0.53	**4.31**
	9	0.05	0.00	0.01	0.03	-0.07	0.00	0.02	0.00	0.15	0.34	0.29	**2.36**
	12	0.04	0.01	0.00	-0.04	-0.04	0.01	0.04	0.05	0.15	0.20	0.17	1.20
Rec	3	0.20	0.18	0.17	0.25	0.16	0.16	0.25	0.28	0.23	0.25	0.05	0.12
	6	0.46	0.36	0.27	0.25	0.21	0.21	0.18	0.12	0.11	0.11	-0.35	-0.81
	9	0.28	0.25	0.18	0.22	0.23	0.30	0.26	0.21	0.18	0.26	-0.02	-0.04
	12	0.17	0.24	0.25	0.24	0.27	0.27	0.23	0.22	0.24	0.32	0.15	0.35

This table presents the momentum profits in the holding periods that are classified into the various expansionary and recessionary periods as determined by Composite Leading Indicator provided by the OECD for Korea. Each month t, bonds are sorted into decile portfolios P1 to P10 based on their cumulated returns over the portfolio formation period. The second column of the table represents the number of months that has been taken account to compute the cumulated return before the portfolio is formed. Based on the formation periods, above are the monthly returns calculated with a holding period of one month. We skipped one month between the formation and holding period. For expansionary period we use samples during April 2009 to May 2011 and for recessionary period we use samples during December 2007 to March 2009.

Table 9 presents the monthly raw momentum profits of 4 different business cycle stages (Exp1, Exp2, Rec1, Rec2). It also presents the risk adjusted momentum profits of each stages. Risk factors are the same as we used in table 3. For the full sample, we observe the highest and statistically significant momentum profit during the second half of the expansion period and the least profitable but not statistically significant during the second half of the recession period. For IG bonds, we observed no difference between Exp1 and Exp2. However, we observe a big difference between the two stages in NIG bond sample; during Exp1, NIG bond sample earns negative momentum profit while in Exp2 the profit turn into positive. Also another interesting thing to note is that there is no significant difference between the two stages within recession period for NIG bond sample while all and IG bond sample exhibit significant difference between the two. This is related to what (K. D. Daniel and Moskowitz 2013) found; as soon as the market turns, the loser portfolio appreciates more than the winner portfolio and momentum crashes. As the second part of recession has passed the trough, loser bonds are appreciating more than winner bonds and thus causing momentum to be negative. This finding is also consistent to what we observed in table 4. There we found that only all and IG bond samples were sensitive to the changes to interest rate risk factor. During the second half of the recessionary period, the term spread return move downwards and thus as it is shown in table 4 it generates less momentum profit compared to the up-ward TERM period. The results are identical even if we risk adjust the factors.

Overall, we observe difference in momentum profits across different stages in business cycle. For the full sample, the difference occurs within each business cycle period. For NIG

bond sample, we find difference in momentum profit within Expansionary period and for IG sample, we observe the difference within the recessionary period.

Table 9
Performance of momentum strategies in different business cycle stages

Monthly raw return													
		ALL				NIG				IG			
		Exp1	Exp2	Rec1	Rec2	Exp1	Exp2	Rec1	Rec2	Exp1	Exp2	Rec1	Rec2
	P10-P1	0.15	0.41	0.31	-0.13	-1.37	1.69	0.63	0.54	0.41	0.40	0.30	-0.21
	t-stat	1.26	**8.41**	**3.53**	-0.86	**-2.82**	1.55	1.55	1.05	**7.47**	**8.53**	**3.24**	-1.35
Risk adjusted return													
		ALL				NIG				IG			
		Exp1	Exp2	Rec1	Rec2	Exp1	Exp2	Rec1	Rec2	Exp1	Exp2	Rec1	Rec2
(1)	P10-P1	0.16	0.40	0.31	-0.14	-1.52	1.83	0.64	0.48	0.42	0.38	0.30	-0.22
	t-stat	1.35	**7.66**	**3.54**	-0.93	**-2.80**	1.56	1.54	0.92	**7.60**	**7.76**	**3.25**	-1.42
(2)	P10-P1	0.18	0.40	0.31	-0.18	-1.39	1.63	0.61	0.47	0.41	0.39	0.30	-0.27
	t-stat	1.44	**7.78**	**3.56**	-1.26	**-2.70**	1.63	1.48	0.97	**7.52**	**7.94**	**3.29**	-1.78
(3)	P10-P2	0.19	0.41	0.31	-0.19	-1.53	1.68	0.61	0.50	0.42	0.40	0.30	-0.28
	t-stat	1.60	**8.00**	**3.59**	-1.29	**-2.70**	1.55	1.44	1.02	**7.67**	**8.16**	**3.34**	-1.81

This table presents the monthly raw return of J3/K1 strategy as well as bond risk factor adjusted returns in different stage of the business cycle. Holding periods that are classified into expansionary and recessionary periods as determined by Composite Leading Indicator provided by the OECD for Korea and then it is subdivided into two equal halves(Exp1, Exp2, Rec1, and Rec2) according to DeStefano(2004).

To compute the risk adjusted return, we run a mixed effect regression of these portfolio returns on bond systematic factors.

$$r_{it} = \alpha_i + \beta' F_t + \varepsilon_{it}\,, \quad i = 1,2,\dots,P \quad t = 1,\dots,T$$

Where r_{it} is an average monthly excess return of i-th bond at time t. For each model, F is represented by the following factors:

(1) mTERM
(2) mDEF
(3) mTERM, mDEF

Where $mTERM_t = \frac{\Delta TERM_t}{1+TERM_{t-1}}$, $mDEF_t = \frac{\Delta DEF_t}{1+DEF_{t-1}}$. $TERM_t$ 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 and they were collected from the Bank of Korea economic statistics system. The table shows the estimated alphas and their t-statistics. T-statistics that are bolded indicates that it is significant.

4.3 Robustness

To check the robustness of our results, we try different length of formation and holding period (J,K= 3,6,9,12). Table 10 presents momentum profits with these different lengths of formation and holding period. We mostly find our result to be consistent with different formation and holding periods setting with statistical significance. Momentum strategy

profits the most when with 9 months of formation period and 6 months of holding period. However, as the formation period and holding period length gets longer, we find that the reversal happens. Especially when we form and hold a bond for a month there is a huge loss of 1.07% per month. This suggests future work to investigate whether there is a cyclical change in momentum with different formation and holding periods.

Table 10
Bond momentum profitability for various formation and holding periods

	Holding period			
Formation period	3 months	6 months	9 months	12 months
3 months	0.15	0.12	0.33	0.34
	(3.88)	**(2.84)**	**(7.95)**	**(7.40)**
6 months	0.01	0.31	0.42	0.23
	(0.11)	**(4.76)**	**(6.43)**	**(3.03)**
9 months	0.33	0.61	0.30	-0.32
	(4.29)	**(7.62)**	**(3.46)**	**-(3.37)**
12 months	0.40	0.37	-0.32	-1.07
	(4.49)	**(3.91)**	**-(3.21)**	**-(9.56)**

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 July 2005 to December 2014.

5. Conclusion

The paper examines momentum profitability by documenting Korean corporate bond market from July 2004 to January 2016 and the results are based on 1,541,507 daily bond price observations, and 1,378 Korean corporate bonds issued. We document a strong and significant momentum profits over both IG and NIG bond samples using J3/K1 strategy (3 months formation period and a month of holding period). We also check that this momentum profit holds for 3,6,9 months of formation and holding periods yet we could not observe momentum with J9/K12, J12/K9, and J12/K12 combination.

Consistent with (Jostova et al. 2013) we observe huge momentum profit stemming from NIG bond sample. On average, NIG bonds earn about 19.2 % of statistically significant return per year while IG bonds only earn 3.24% a year. We also find that lower credit rated bonds tend to earn more profit holding momentum strategy. There actually is a significant positive relationship between the percentage of NIG bonds each month and momentum profit as it is recorded in table 6 panel B. If we look at the descriptive statistics in table 1, we observe more NIG bonds towards the end of time period this partially explains why in table 2, the first half of the time period momentum profits were less than the second half of the period.

We also find that factor realization during the bond portfolio formation period have some impact on the composition of winner and loser portfolio. Even though risk adjusted momentum portfolios also have shown profitability of almost same magnitude as raw momentum profits, each of the time-varying factor realization during bond portfolio formation period have some impacts on momentum returns. Our empirical result found out that for all and IG bond samples, there is some impact of interest rate risk exposure on winner bonds, which we assume will mostly be longer duration bonds that are sensitive to interest rate, and thus positively affect momentum profit during the TERM factor up months. We find some impact of default risk factor exposure during up months for winner and loser bond returns but could not find more negative impact on momentum profits during up months. We conclude that even though there is some risk factor exposure to momentum profit during TERM up months, since it lacks statistical significance it does not have significant impact on momentum returns. Here, we conclude that we do not see any evidence of momentum profits compensating for systematic risk.

We also examine momentum profits in different business cycles. We find that momentum profit maximizes during the second half of the expansionary period and minimizes during the second half of the recessionary period for full and IG bond sample. This is because loser bonds appreciate more after hitting the bottom during recession. This finding is also consistent to what we observed in table 4. There we found that only all and IG bond samples were sensitive to the changes to interest rate risk factor. During the second half of the recessionary period, the term spread return move downwards and thus as it is shown in table 4 it generates less momentum profit compared to the up-ward TERM period. Therefore, we conclude that momentum returns seems unlikely to be factor driven. Also our results are robust across different formation and holding periods.

REFERENCES

Avramov, D, T Chordia, G Jostova, and a Philipov. 2007. "Momentum and Credit Rating 1 Momentum." *The Journal of Finance* 62(5): 2503–20. /citations?view_op=view_citation&continue=/scholar?hl=en&start=20&as_sdt=0,31&scilib=1050&citilm=1&citation_for_view=66ZlWDwAAAAJ:0KyAp5RtaNEC&hl=en&oi=p.

Ball, Ray, and S. P. Kothari. 1989. "Nonstationary Expected Returns. Implications for Tests of Market Efficiency and Serial Correlation in Returns." *Journal of Financial Economics* 25(1): 51–74.

Ball, Ray, S. P. Kothari, and Jay Shanken. 1995. "Problems in Measuring Portfolio Performance An Application to Contrarian Investment Strategies." *Journal of Financial Economics* 38(1): 79–107.

Barberis, Nicholas, Andrei Shleifer, and Robert Vishny. 1998. "A Model of Investor Sentiment." *Journal of Financial Economics* 49(3): 307–43.

Bondt, Werner F M, and Richard Thaler. 1985. "Does the Stock Market Overreact?" *The Journal of finance* 40(3): 793–805.

Chan, Kalok. 1988. "On the Contrarian Investment Strategy." *The Journal of Business* 61(2): 147.

Chan, Louis K C, Yasushi Hamao, and Josef Lakonishok. 1991. "Fundamentals and Stock Returns in Japan." *The Journal of Finance* 46(5): 1739–64.

Chopra, Navin, Josef Lakonishok, and Jay R Ritter. 1992. "Measuring Abnormal Performance: Do Stocks Overreact?" *Journal of financial Economics* 31(2): 235–68.

Chordia, Tarun, Amit Goyal, and Jay A Shanken. 2015. "Cross-Sectional Asset Pricing with Individual Stocks: Betas versus Characteristics." *Available at SSRN 2549578*.

Chordia, Tarun, and Lakshmanan Shivakumar. 2002. "Momentum , Business Cycle , and Time-Varying." LVII(2): 985–1019.

Conrad, Jennifer, and Gautam Kaul. 1993. "Long-Term Market Overreaction or Biases in Computed Returns?" *The Journal of Finance* 48(1): 39–63.

Covitz, Dan, and Chris Downing. 2007. "Liquidity or Credit Risk? The Determinants of Very Short-Term Corporate Yield Spreads." *The Journal of Finance* 62(5): 2303–28.

Daniel, Kent D, and Tobias J Moskowitz. 2013. "Momentum Crashes." *Swiss Finance Institute Research Paper* (13-61): 14–16.

Daniel, Kent, David Hirshleifer, and Avanidhar Subrahmanyam. 1998. "Investor Psychology and Security Market Under-and Overreactions." *the Journal of Finance* 53(6): 1839–85.

DeLong, Mahlon R. 1990. "Primate Models of Movement Disorders of Basal Ganglia Origin." *Trends in neurosciences* 13(7): 281–85.

Destefano, Michael. 2004. "Stock Returns and the Business Cycle." *The Financial Review* 39: 527–47.

Fama, Eugene F, and Kenneth R French. 1996. "Multifactor Explanations of Asset Pricing Anomalies." *The Journal of Finance* LI(1): 55–84.

Fama, Eugene F., and Kenneth R. French. 1993. "Common Risk Factors in the Returns on Stocks and Bonds." *Journal of Financial Economics* 33(1): 3–56.

Gebhardt, William R., Soeren Hvidkjaer, and Bhaskaran Swaminathan. 2005. "Stock and Bond Market Interaction: Does Momentum Spill Over?" *Journal of Financial Economics* 75(3): 651–90.

Grundy, Bruce D, and J Spencer Martin Martin. 2001. "Understanding the Nature of the Risks and the Source of the Rewards to Momentum Investing." *Review of Financial studies* 14(1): 29–78.

Jegadeesh, N, and S Titman. 1993. "Returns to Buying Winners and Selling Losers: Implications for Stock Market Efficiency." *The Journal of Finance* 48(1): 65.

Jostova, Gergana, Stanislava Nikolova, Alexander Philipov, and Christof W Stahel. 2013. "Momentum in Corporate Bond Returns." *Review of Financial Studies*: hht022.

Khang, Kenneth, and Tao-Hsien Dolly King. 2004. "Return Reversals in the Bond Market: Evidence and Causes." *Journal of banking & finance* 28(3): 569–93.

Lakonishok, Josef, Andrei Shleifer, and Robert W Vishny. 1994. "Contrarian Investment, Extrapolation, and Risk." *The journal of finance* 49(5): 1541–78.

Lo, Andrew W. 1999. "The Three P's of Total Risk Management." *Financial Analysts Journal* 55(1): 13–26.

Lu, Su-Lien, Kuo-Jung Lee, and Chia-Chang Yu. 2014. "Momentum Strategy and Credit Risk." *Applied Financial Economics* 24(11): 753–62.

Menkhoff, Lukas, Lucio Sarno, Maik Schmeling, and Andreas Schrimpf. 2012. "Currency Momentum Strategies." *Journal of Financial Economics* 106(3): 660–84.

Okunev, John, and Derek White. 2003. “Do Momentum-Based Strategies Still Work in Foreign Currency Markets?” *Journal of Financial and Quantitative Analysis* 38(02): 425–47.

Pospisil, Libor, and Jing Zhang. 2010. “Momentum and Reversal Effects in Corporate Bond Prices and Credit Cycles.” *The Journal of Fixed Income* 20(2): 101.

Rowenhorst, Geert. 1997. *Local Return Factors and Turnover in Emerging Stock Markets*. Working paper, Yale University.

Shin, Dongheon, and Baeho Kim. 2015. “Liquidity and Credit Risk before and after the Global Financial Crisis: Evidence from the Korean Corporate Bond Market.” *Pacific-Basin Finance Journal* 33: 38–61.

Zarowin, Paul. 1990. “Size, Seasonality, and Stock Market Overreaction.” *Journal of Financial and Quantitative analysis* 25(01): 113–25.