Original Article

Evidence and implications of the predictability of high yield bond returns

Received (in revised form): 6th February 2012

David P. Simon
is the Stanton Professor of Finance at Bentley University. His primary research and teaching interests are option trading strategies and fixed income markets. He was previously employed as an economist at the Federal Reserve Board.

Correspondence: David P. Simon, Department of Finance, Bentley University, Waltham, MA 02452, USA
E-mail: dsimon@bentley.edu

ABSTRACT **This study demonstrates that roughly one quarter to one-third of the monthly returns of the Merrill Lynch High Yield Bond Indexes from September 1988 through June 2009 can be explained by predetermined variables. The study also shows that out of sample forecasts of Sharpe ratios from GARCH models are able to predict favorable and unfavorable times to invest in high yield bonds and would have allowed investors to avoid most of the months in which high yield bonds suffered substantial losses. These out of sample results are robust when applied to Vanguard and Fidelity high yield bond mutual funds. Overall, the results support the case for allocating funds to high yield bonds only when favorable risk-return tradeoffs are forecast, particularly in light of the modest risk adjusted high yield bond returns from passive strategies over the sample period and the recent introduction of high yield bond exchange traded funds that have substantially reduced transactions costs.**

Journal of Derivatives & Hedge Funds (2012) **18,** 141–166. doi:10.1057/jdhf.2012.6;
published online 22 March 2012

Keywords: high yield bonds; fixed income; active portfolio management

INTRODUCTION

The predictability of equity returns has been a major focus of finance research in recent years. Studies, including Campbell (1991) and Ferson and Harvey (1993), have demonstrated the existence of predictability in stock index returns with regressions of monthly stock index returns on predetermined variables typically having R^2s in the low to mid single digits.[1] This evidence has provided the empirical justification for the possibility that statistically driven asset allocation strategies can outperform passive strategies. Along these lines, Kandel and Stambaugh (1996) demonstrate that a predictive model with a seemingly low R^2 of 0.025 is sufficient both to affect the optimal asset allocation decision of a Bayesian investor and to improve investment performance to an economically significant degree.

While several studies have examined the investment performance of high yield bonds, few studies have focused on the predictability of the returns and volatility of high yield bonds and their implications for active investment strategies. Cornell and Green (1991) and Blume *et al* (1991) examine the investment performance of high yield bonds from the late 1970s through the late 1980s and find that high yield bond returns have greater sensitivities than investment grade bond returns to equity returns and lower sensitivities to Treasury bond returns.[2] These studies also find that high yield bonds have lower return volatilities than long-term Treasury bonds, which is attributed largely to the lower duration of high yield bonds owing to their higher coupons.

More recently, Sangvinatsos (2005) finds that two factor models incorporating the equity and debt components of corporate bonds explain a substantial degree of the variation of the contemporaneous returns of investment grade and speculative grade corporate bond index returns from March 1990 to December 2003. Sangvinatsos (2005) also finds that predetermined variables such as dividend yields, default risk proxies and the slope of the yield curve have predictive power for subsequent corporate bond index returns, although he does not examine the implications of these findings for active investment strategies.[3]

The present article uses a GARCH framework to model the monthly returns and risk of Merrill Lynch High Yield Bond Indexes from September 1988 through June 2009 and focuses on the implications of the findings for active investment strategies. The results indicate that the predictability of the monthly BB, B and C rated high yield bond index returns is substantial, with roughly 1/4–1/3 of the monthly variation of returns explained by predetermined market variables. The estimated conditional Sharpe ratios also indicate that expected risk reward ratios vary substantially through time owing both to changing conditional means and changing conditional volatility.

The study then examines the predictive power of out of sample conditional Sharpe ratios for the subsequent monthly returns of the B and C rated high yield bond indexes. The results indicate that out of sample forecasts of risk and return have strong predictive power for subsequent monthly excess returns – when conditional Sharpe ratios are in their highest quartiles, monthly excess returns of B and C rated high yield bond indexes from January 1995 through June 2009 average statistically significant 1.14 and 1.61 per cent, respectively, versus statistically significant −0.95 and −1.65 per cent when conditional Sharpe ratios are in their lowest quartiles. In addition, the subsequent volatility of high yield bond monthly returns is cut in half when out of sample conditional Sharpe ratios are in their highest versus lowest quartiles. As a check on robustness and to guard against the possibility that these results are artifacts of using bond indexes, the out of sample conditional Sharpe ratios estimated for the B rated index are applied to the returns of the Vanguard and Fidelity High Yield Bond open end mutual funds over the same period. The results indicate that the out of sample conditional Sharpe ratios have substantial predictive power for the subsequent returns of these two high yield bond mutual funds.

The article proceeds as follows: The first section provides a preliminary analysis of the data and addresses issues related to the possibility that the predictability of the high yield bond index returns reflects stale prices; the second section describes the methodology used to estimate the conditional means and the conditional volatilities of the monthly returns of the Merrill Lynch High Yield Bond Indexes and shows the results; and the third section discusses the methodology for obtaining out of sample conditional Sharpe ratios and provides evidence about subsequent high yield bond index returns across periods when favorable versus unfavorable risk reward ratios are forecast. The final section discusses the implications of the results in light of the substantial increase in liquidity available in the high yield bond market owing to the recent introduction of high yield bond exchange traded funds.

BACKGROUND ON THE MERRILL LYNCH HIGH YIELD BOND INDEXES

This study examines the returns of the Merrill Lynch BB, B and C rated High Yield Bond Indexes over the sample period from September 1988 through June 2009. These 'cash pay' indexes track the performance of US dollar denominated, below investment grade corporate bonds.[4] To be included in the indexes, bonds must have at least 1 year remaining to maturity and a minimum outstanding value of US$100 million. The indexes are capitalization weighted and are rebalanced monthly. Intra-month cash flows are assumed to be reinvested at the beginning of a 1-month LIBID rate.[5]

Figure 1 shows the yield spreads of the Merrill Lynch BB, B and C rated high yield bond indexes over the comparable duration Merrill Lynch 5–7 year US Treasury index over the sample period from September 1988 through June 2009.[6] The figure shows three periods of sharply elevated spreads. During the real estate

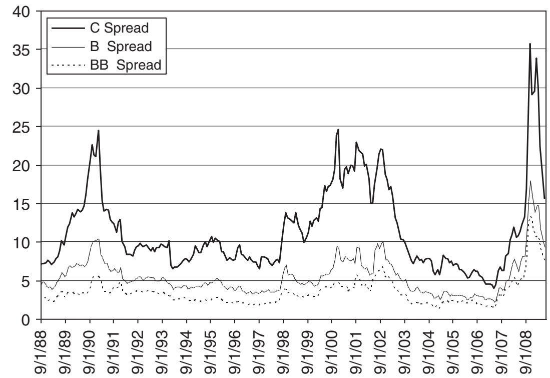

Figure 1: High yield bond spreads over treasuries (September 1988 – June 2009).

crisis and the first Gulf War in the early 1990s, BB and B rated spreads about doubled to 5 and 10 per cent, respectively, and C rated spreads rose from about 7 to 24 per cent. As economic growth resumed and remained stable over much of the rest of the 1990s, spreads returned to their previous low levels of roughly 2–1/4, 4–1/4 and 7 per cent for the BB, B and C rated indexes, before rising sharply back to the high levels seen earlier in the sample period as the Asian crisis unfolded and the technology stock bubble burst. Following the subsequent economic recovery, high yield bond spreads fell to their lowest levels of the sample period in Spring 2007, before rising to levels not seen since the great depression during the ensuing financial panic. From the lows in Spring 2007 to their subsequent highs in October 2008, BB rated spreads rose from 1–1/4 to 13–1/4 per cent, while B rated spreads rose from 2–1/2 to 18 per cent, and C rated spreads rose from 4 to 36 per cent. Subsequently, as financial markets stabilized and extreme risk aversion receded, high yield bond spreads fell substantially with BB, B and C rated spreads reaching 7–1/2 per cent, 9–1/4 per cent and 15–1/2 per cent by the end of June 2009.

Figure 2 provides information about how $100 invested in each of the high yield bond indexes, as well as the Merrill Lynch 5–7 year US Treasury index and the S&P 500 index, would have fared over the sample period. The figure indicates that incurring more default risk over the sample period led to lower returns as $100 invested in the BB , B and C rated indexes grew to $513, $461 and $362, respectively. In light of evidence presented later that shows that volatility and correlation with S&P 500 returns rises as high yield bond ratings decrease, this historical evidence suggests that B and C rated bonds should be preferred over BB rated bonds only on a tactical basis and not on a buy and hold basis. In addition, $100 invested in the 5–7 year Treasury index grew to $460 over the sample period, which about matched the returns of the B rated index.

Even if cumulative returns are examined only through May 2007 when high yield spreads reached their sample period lows, the ordering between the returns on high yield bonds remains unchanged as BB rated bonds continue to return slightly more than B rated bonds, which return more than C rated bonds. However, all three high yield bond indexes now return more than Treasuries.[7] The figure also shows that the returns on the S&P 500 index over the whole sample period outpaced those of the BB index, as $100 invested in the S&P 500 index grew to $559, albeit with much greater swings than those of the high yield bond indexes.

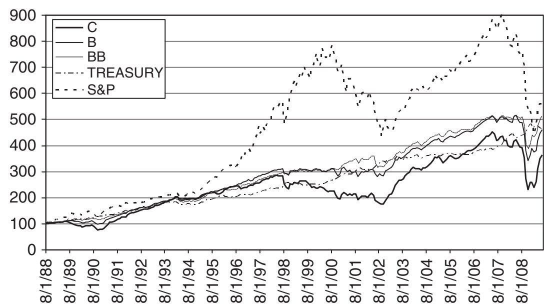

Figure 2: Total accumulated wealth from investing US$100 in high yield bonds, treasuries and the S&P 500 from September 1988 through June 2009.

Table 1 provides further background information on the data that are examined in this study. Consistent with the previous evidence, the table shows that mean monthly high yield bond returns over the sample period from September 1988 through June 2009 are tightly clustered at 0.67, 0.64 and 0.60 per cent for BB, B and C rated bonds, respectively. By contrast, the return volatilities vary substantially – the monthly standard deviation of BB rated bond returns is 1.98 per cent, whereas the monthly standard deviation of B rated bond returns is 2.56 per cent, and the standard deviation of C rated bond returns is twice that of BB rated bond returns at 3.99 per cent. The average monthly gains of high yield bonds outpace those of risk-free returns, as proxied by the return on the 3-month Treasury bill rate, as monthly Treasury bill returns average 0.35 per cent over the sample period.[8] Thus, the unconditional Sharpe ratios of monthly high yield bond index returns are all fairly low and decline from 0.16 to 0.11 to 0.06 from BB to B to C rated bonds.[9] The monthly standard deviation of comparable duration Treasury returns of 142 basis points is substantially lower than that of high yield bond returns. This finding suggests that the seemingly anomalously low volatilities of high yield bond returns reported by Blume *et al* (1991) and Cornell and Green (1991) have not been present in the last few decades.[10] Unconditional Sharpe ratios for S&P 500 index returns are also fairly low over the sample period at 0.10 and the

Table 1: Data summary statistics

	Mean (%) (t-value)	*SD*	*Sharpe ratio*	*Skewness (P-value)*	*Excess kurtosis (P-value)*	*Top/bottom decile*	*Autocorrelation*			
							r (1)	*r (2)*	*r (3)*	*r (4)*
BB rated returns	0.6739 (5.36)	1.98	0.163	−2.43 (0.00)	18.66 (0.00)	2.16/−1.03	0.37	−0.09	−0.06	0.08
B rated returns	0.6442 (3.97)	2.56	0.114	−1.01 (0.00)	8.43 (0.00)	2.59/−1.78	0.33	−0.05	0.01	0.13
C rated returns	0.5964 (2.35)	3.99	0.061	−0.603 (0.00)	7.80 (0.00)	3.82/−3.27	0.43	0.05	0.07	0.14
Treasury returns	0.6159 (6.84)	1.42	0.186	−0.064 (0.68)	0.22 (0.48)	2.47/−1.29	0.15	−0.10	0.04	−0.01
S&P 500 returns	0.77 (2.82)	4.30	0.097	−0.65 (0.00)	1.34 (0.00)	5.89/−4.45	0.07	−0.02	0.07	0.03
Risk free returns	0.3517 (31.48)	0.1763	—	0.025 (0.87)	−0.47 (0.13)	0.60/0.097	0.99	0.98	0.97	0.95
BB rated yield spread	3.36 (29.42)	1.80	—	2.73 (0.00)	10.00 (0.00)	5.19/1.88	0.96	0.89	0.83	0.76
B rated yield spread	5.52 (34.96)	2.49	—	1.87 (0.00)	5.07 (0.00)	8.22/3.08	0.96	0.89	0.83	0.77
C rated yield spread	11.52 (32.32)	5.63	—	1.47 (0.00)	2.32 (0.00)	19.77/6.43	0.96	0.89	0.83	0.76
VIX	19.96 (40.6)	7.77	—	1.76 (0.00)	4.79 (0.00)	28.70/12.07	0.86	0.73	0.66	0.61
ΔVIX	0.03 (0.12)	4.05	—	1.10 (0.00)	6.56 (0.00)	4.51/−3.85	−0.01	−0.22	−0.12	0.01
ΔVIX (Orthogonal)	0.00 (0.00)	3.08	—	0.06 (0.68)	3.86 (0.00)	3.37/−3.16	−0.02	−0.12	−0.07	0.02

This table provides information on the data used in this study. These data include the monthly total returns of the Merrill Lynch BB, B, C rated high yield indexes, the S&P 500 index, the Merrill Lynch 5–7 year Treasury index and the risk free return, which is assumed to be equal to the 3-month Treasury bill coupon equivalent yield divided by 12. The table also shows yield spread of the high yield indexes over the Merrill Lynch 5–7 year Treasury index, the level of the VIX, the monthly change of the VIX and the component of the change of the VIX that is orthogonal to the contemporaneous return on the S&P 500 index. Sharpe ratios are calculated with excess returns over the risk free return. The data begin at the end of September 1988 through the end of June 2009.

standard deviation of 430 basis points is about twice that of the BB and B rated high yield bond indexes.

The table also indicates that high yield bond returns are significantly autocorrelated at the first lag, as are Treasury and S&P returns, although to a smaller extent. The source of the positive autocorrelation of high yield bond returns is important for this study, as it is possible that the positive autocorrelation reflects a delayed updating of the prices of some of the high yield bonds in the indexes in response to new information. This stale pricing could induce the appearance of predictability in high yield bond returns as well as lower return volatilities. Discussions with Merrill Lynch indicate that the bond price quotes used in the index over the last several years are not based on quotes from their traders or based on matrix pricing but rather are taken from the high yield bond pricing service of Financial Times Interactive Data (FTID). FTID does not use matrix pricing in a mechanical sense to price high yield bonds but rather has a large team of evaluators, comprised of former portfolio managers and traders who adjust high yield bond prices on a case by case basis using the TRACE data and buy and sell side input, such as dealer quotes, which they receive on an ongoing basis. An official from Merrill Lynch also stated that they are proactive about the pricing of the high yield bonds in the index and receive emails when market participants believe that the pricing of a bond in the index is unrealistic.

Statistical tests were also run to assess potential problems related to stale pricing. If high yield bond index prices are adjusted slowly in response to new information, one might expect to see higher positive autocorrelation following large magnitude versus small magnitude returns because of more uncertainty in the former case about the change in the values of the underlying bonds, which could lead to partial adjustment in the indexes. In addition, negative high yield bond returns could have proportionally greater effects than equal magnitude positive returns on subsequent returns to the extent that liquidity falls following price declines, which could lead to an increase in the staleness of prices and greater subsequent returns in the same direction.

Unreported regression results indicate no significant differences in the impact on subsequent high yield bond returns across various classifications of sign and magnitude of lagged high yield bond returns.[11] In addition, when high yield bond index returns are regressed on their own first lag in order to correct for the AR(1) component that could owe to stale prices and the residuals from these models are regressed on the lagged values of the variables that are included in the conditional mean equation in the subsequent analysis, the lagged variables enter with statistically significant coefficients for all three ratings categories. Thus, for stale quotes to be a major driver of the predictability of high yield bond index returns, the staleness of high yield bond quotes beyond what would be captured by an AR(1) term would have to increase as a function of the other lagged variables that enter the conditional mean model. Finally, the first order autocorrelation coefficients of the monthly returns of the Vanguard and Fidelity high yield bond mutual funds, which are used subsequently to examine the robustness of the results, are fairly close to those of the high yield bond indexes.[12] To the extent that mutual fund companies have strong incentives to provide accurate prices at which customers can buy and sell open end mutual funds, this finding suggests that stale prices play a limited role in the positive autocorrelation found in the monthly returns of the high yield bond indexes.

The table also provides background information on data used in the subsequent analysis, including high yield bond spreads over comparable duration Treasuries (discussed earlier), the VIX, the monthly change of the VIX and the component of the monthly change of the VIX that is orthogonal to the contemporaneous S&P 500 return. The VIX averages around 20 per cent with the upper and lower deciles of monthly changes ranging from 4.5 to −3.9 percentage points. Orthogonal monthly changes of the VIX are created from the residual of a regression of the change of the VIX on a constant and on the contemporaneous S&P 500 index return. The orthogonal change of the VIX is centered at zero (by construction) and has a standard deviation of 3 percentage points and upper and lower deciles that range from 3.4 per cent to −3.2 per cent.

Overall, a preliminary analysis of the data shows that buy and hold investors were not well compensated for credit risk over the sample period and that high yield bonds did not outperform Treasuries on a risk adjusted basis over the sample period. These results indicate that active high yield bond investment strategies could outperform passive strategies if favorable and unfavorable times to invest in high yield bonds can be determined. This issue is examined in the next section.

THE PREDICTABILITY OF HIGH YIELD BOND RETURNS AND RISK

This section models high yield bond returns in a GARCH framework. The estimated conditional moments from these models are used to construct time varying Sharpe ratios, which are used to assess the variation over time of the conditional risk adjusted performance of high yield bonds. The latter is important as the previous section demonstrates that high yield bonds have not been compelling buy and hold investments over the sample period. A variety of variables were examined in preliminary analyses and the chosen model of conditional returns specifies monthly high yield bond excess returns as a function of lagged own excess returns, lagged equity excess returns, lagged government bond excess returns and lagged VIX changes that are orthogonal to lagged S&P 500 index returns.[13]

Lagged own excess returns are included in the model to allow for delays in the adjustment of high yield bond prices to new information, which could reflect momentum effects stemming from investors chasing or running away from past performance.[14] The lagged S&P 500 index excess return proxies the ‘equity component’ of high yield bond returns.[15] The equity component is grounded theoretically in the Merton model (1974), which models a corporate bond as a composite security comprised of a default free bond and a put option sold on the value of the firm’s assets, where the strike price is the present value of the payments owed to bondholders. As the market capitalization of a firm falls, the value of the firm’s assets decline (holding all else constant). This reduces the value of a corporate bond because the likelihood increases that the bond will be put to investors, in which case investors will receive less than the promised payout. On an economy wide basis, the cash flows received by corporations decrease as the S&P 500 index declines, which increases the probability of default.

The inclusion of government bond excess returns reflects the 'debt' component of high yield bond returns. This component stems from the fact that the interest rate used to discount the expected future cash flows of high yield bonds can be decomposed into a default free rate and a default risk premium. The default free rate reflects the pure time value of money, while the default risk spread is associated with the uncertainty of the cash flows. The debt component of high yield bond returns is proxied by the return of the Merrill Lynch 5–7 year government bond index. This index is chosen because, as shown earlier, its duration is close to that of the Merrill Lynch High Yield Bond Indexes examined in this study.

The final variable in the model is the component of the lagged change of the VIX that is orthogonal to S&P 500 index returns. Campbell and Taksler (2003) show that the expected volatility of equity returns is an important component of the cross section of corporate bond returns. In a time series context, the implied volatility of options on a broad equity index should have predictive power for high yield bond returns because expected higher equity volatility – holding equity values constant – increases the possibility that the value of assets fall to the point where the put option that bond holders are short goes in the money and is exercised by the firm. Thus, within the theoretical framework of the Merton Model, both the level of equity prices and the expected volatility of equity returns affect corporate bond prices.

The model is specified with the component of VIX changes that are orthogonal to contemporaneous S&P 500 index returns entering the model rather than raw VIX changes.[16] The rationale is that because VIX changes are driven by contemporaneous S&P 500 changes, the high correlation between VIX changes and S&P returns makes it difficult to sort out the effects of a change in expected equity market volatility versus the effects of a change in equity values. The high correlation is borne out below, where the results of regressing the monthly change of the VIX on a constant and on the contemporaneous total return of the S&P 500 index over the sample period from September 1988 through June 2009 are shown with t-statistics in parentheses.

$$VIX_t = \underset{(1.50)}{0.003} - \underset{(-13.81)}{0.626} * SPRET_t \quad (1)$$

$$RBAR^2 = 0.433,\ NOBS = 249,\ DW = 2.05,$$

These results demonstrate that a 1 per cent greater monthly S&P 500 index decline is associated with a highly statistically significant 0.63 percentage point contemporaneous VIX increase. Much of the typical increase of the VIX in response to a drop in the S&P 500 index can be attributed to evidence that the actual subsequent volatility of S&P500 index returns increases more for a given magnitude drop than for a given magnitude increase of the index (see Wu (2001), Bekaert and Wu (2000), and Dennis *et al* (2006)). Some of the negative correlation between the change of the VIX and S&P 500 index returns reflects the volatility skew, which is manifested by lower strike price options having higher implied volatilities. As the S&P falls, the VIX is more heavily influenced by lower strike options, which tend to have higher implied volatilities than the previously closer to the money options. In any event, including the orthogonal component of the change of the VIX rather than the change of the VIX facilitates the assessment of the effects of both S&P returns and changes in equity volatility forecasts on future high yield bond returns.

The basic specification for the conditional mean equation is

$$\begin{aligned} HYXRET_t = \beta_0 + \beta_1\, HYXRET_{t-1} \\ + \beta_2\, SPXRET_{t-1} + \beta_3\, GOVXRET_{t-1} \\ + \beta_4\, VIXRES_{t-1} + \varepsilon_t, \end{aligned} \quad (2)$$

where the monthly excess return of the Merrill Lynch BB, B and C rated indexes are regressed on a constant, own lagged monthly excess returns, lagged S&P 500 excess returns, lagged government bond excess returns, and the lagged change of the VIX that is orthogonal to the contemporary S&P 500 return. Excess returns are calculated with the risk free rate proxied by the 3-month coupon equivalent Treasury bill rate converted to a monthly basis.

Conditional volatility initially is specified along the lines of a standard GARCH model that restricts equal magnitude positive and negative innovations to have the same effect on conditional volatility. This assumption is then relaxed and the Glosten *et al* (1993) specification, which allows equal magnitude positive and negative innovations to have different effects on conditional volatility, is used. To the extent that the conditional volatility of high yield bond excess returns is driven by the equity component, the effect of positive and negative innovations on conditional volatility should be asymmetric because several studies, including Wu (2001), Bekaert and Wu (2001), and Dennis *et al* (2006), show that volatility is highly asymmetric in equity markets. On the other hand, the debt component of high yield bond returns should result in an absence of conditional volatility asymmetries to the extent that they are largely absent in US government bond returns.[17]

The general specification of conditional volatility is

$$h_t = \gamma_0 + \gamma_1 h_{t-1} + \gamma_2 \varepsilon^2_{t-1} + \gamma_3 D^{neg} \varepsilon^2_{t-1}, \quad (3)$$

where conditional volatility is a function of a constant, an own lag, the lagged squared standardized residual and a dummy variable times the lagged squared standardized residual, where the dummy variable takes on the value one when the lagged squared standardized residual is negative and zero, otherwise. The GJR but not the symmetric GARCH specification includes the final term. This article uses the quasi-maximum likelihood (QML) approach of Bollerslev and Wooldridge (1992) to estimate the GARCH models where the log-likelihood function from the conditional normal specification is maximized, but the estimated standard errors of the parameter estimates are robust to non-normal error distributions. This allows the usual statistical inferences to be drawn even if the error terms are non-normal.

Table 2 shows the model estimates for the monthly returns of the Merrill Lynch BB, B and C rated high yield bond indexes. The results show that high yield bond returns are persistent with a 1 per cent increase in returns leading to between 0.17 and 0.36 per cent greater returns the next month. The results also indicate that lagged S&P returns have significant predictive power for B and C rated bonds, but not for BB rated bonds. This finding is consistent with the equity component of high yield bond returns being greater for lower rated bonds. For B and C rated bonds, the results indicate that a 1 per cent increase in S&P returns leads to 0.06–0.17 per cent greater high yield bond returns the next month, respectively. The results also indicate that the debt component of high yield bond returns

Table 2: The predictability of monthly high yield bond returns and risk

$$HYXRET_t = \beta_0 + \beta_1\, HYXRET_{t-1} + \beta_2\, SPXRET_{t-1} + \beta_3\, GOVXRET_{t-1} + \beta_4\, VIXRES_{t-1} + \varepsilon_t$$
$$h_t = \gamma_0 + \gamma_1 h_{t-1} + \gamma_2 \varepsilon_{t-1}^2 + \gamma_3\, D^{neg}\, \varepsilon_{t-1}^2$$

	BB rated		*B rated*		*C rated*	
B_0	0.0014	0.0014	0.0027**	0.0020*	0.0022	0.0009
	(1.51)	(1.45)	(2.5)	(1.66)	(1.39)	(0.54)
B_1	0.3321***	0.3285***	0.1742**	0.2314***	0.3578 ***	0.3152***
	(3.45)	(2.98)	(2.15)	(3.24)	(5.20)	(6.49)
B_2	0.0132	0.0101	0.1041**	0.0683**	0.1764***	0.1007**
	(0.46)	(0.34)	(2.85)	(2.21)	(3.86)	(2.41)
B_3	0.1394**	0.1358*	0.2468***	0.2817***	0.2259**	0.2595**
	(2.14)	(1.91)	(2.92)	(3.80)	(2.04)	(2.44)
B_4	−0.0757***	−0.0854***	−0.1844***	−0.1687***	−0.3399***	−0.2330***
	(2.70)	−2.78)	(−6.20)	(−4.74)	(−9.10)	(−4.88)
R^2	0.235	0.235	0.289	0.289	0.314	0.314
Loglikelihood	918.30	918.45	864.54	879.71	766.27	774.21
γ_0	0.0001*	0.0001**	0.00001*	0.000018***	0.00002	0.00002***
	(1.91)	(2.11)	(1.81)	(3.09)	(1.20)	(3.88)
γ_1	0.7908***	0.7982***	0.7906***	0.8350***	0.7777***	0.9514***
	(21.17)	(18.45)	(15.33)	(18.79)	(12.95)	(71.82)
γ_2	0.2274***	0.1518	0.2174***	−0.0580**	0.2503***	−0.1322***
	(4.16)	(1.33)	(3.79)	(−2.49)	(3.13)	(−6.58)
Dγ_3	—	0.1036	—	0.3665***	—	0.3158***
	—	(0.71)	—	(4.71)	—	(7.53)

Mean (*P*-value)	−0.0098	−0.0071	−0.1016	−0.0371	−0.0905	−0.0049
	(0.88)	(0.91)	(0.11)	(0.55)	(0.15)	(0.94)
Skewness (*P*-value)	−1.53	−1.55	−0.8084	−0.7072	−0.6805	−0.6843
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Kurtosis (*P*-value)	4.88	5.034	3.070	2.180	1.980	1.759
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
J-B Statistic (*P*-value)	342.64	361.90	124.43	69.78	59.66	51.35
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
LB (12) (*P*-value)	3.24	3.10	13.27	14.74	10.13	10.38
	(0.72)	(0.99)	(0.35)	(0.99)	(0.60)	(0.58)
LB^2 (12) (*P*-value)	8.75	8.48	4.13	3.47	8.79	6.80
	(0.72)	(0.74)	(0.98)	(0.99)	(0.72)	(0.87)

GARCH models are estimated for the excess returns of the Merrill Lynch BB, B and C rated High Yield Bond Indexes from September 1988 through June 2009. The independent variables in the conditional mean equation are a constant, lagged own excess returns, lagged S&P 500 index excess returns, lagged US government bond excess returns, proxied by the excess return on the Merrill Lynch 5–7 year US Treasury index and lagged changes in the VIX that are orthogonal to contemporaneous S&P 500 index returns. The risk-free rate is proxied by the 3-month coupon equivalent Treasury bill rate. All *t*-values (in parentheses) are based on quasi-maximum likelihood (QML) estimation robust to non-normality in the residuals. LB(x) ($LB^2(x)$) is the Ljung-Box chi-squared statistic for testing the null hypothesis of zero autocorrelation up to lag x in the (squared) standardized residuals. The R^2 shown in the table is from an OLS regression of the conditional mean equation.

⋆, ⋆⋆ and ⋆⋆⋆ represent statistical significance at the 10, 5 and 1 per cent, respectively.

has significant predictive power for all three high yield bond index returns, with 1 per cent higher Treasury returns leading to 0.14–0.28 per cent greater high yield bond index returns the next month.

The lagged change in the component of the VIX that is orthogonal to S&P 500 index returns also has significant predictive power for subsequent high yield bond returns across all of the high yield bond categories. The coefficient estimates indicate that a 1 per cent increase in orthogonalized implied volatility is associated with lower returns the next month of roughly 0.08 per cent for BB rated bonds, 0.18 per cent for B rated bonds and 0.28 per cent for C rated bonds. The significant negative coefficient is consistent with increased implied volatility reflecting an expected greater dispersion of outcomes for the value of the assets of firms, which increases the probability that asset values fall and more firms default on their debt.[18]

To provide a sense of the magnitude of the predictability of high yield bond returns, the table also shows the R^2s of the mean equations. The R^2s demonstrate that the model predicts roughly 23 per cent of the overall variation of monthly excess returns of BB rated bonds and roughly 29 and 31 per cent of the overall variation of monthly excess returns of B and C rated bonds, respectively. Thus, high yield bond index returns exhibit much greater predictability than typically found in equity index returns.

The estimation results also indicate that the volatility of high yield bond returns is well specified by the GARCH framework. Conditional volatility asymmetries are absent for BB rated bonds, but are present for B and C rated bonds. For B and C rated bonds, the conditional volatility asymmetries are stronger than typically found in equities, as larger positive return innovations are associated with statistically significant *decreases* in conditional volatility, whereas larger negative return innovations are associated with statistically significant *increases* in conditional volatility. The coefficient estimates for the B and C rated indexes indicate that 1 per cent higher positive standardized return innovations give rise to 0.06 and 0.13 percentage point conditional volatility decreases, respectively, while 1 per cent greater negative innovations gives rise to 0.31 and 0.18 percentage point conditional volatility increases, respectively. Thus, the presence of conditional volatility asymmetries for the B and C rated high yield bond returns but not for the BB rated high yield bond returns is consistent with the greater equity component in lower rated high yield bonds. Finally, a battery of diagnostic tests indicate that the GARCH models are well specified, as skewness, excess kurtosis and autocorrelation are not present in the standardized residuals and autocorrelation is also absent from the square of the standardized residuals.

Information about the time varying nature of the tradeoff between risk and return can be obtained from the estimated conditional moments. Figures 3a and 3b show the conditional means, the conditional volatilities and the conditional Sharpe ratios for the B rated high yield bond index using the GJR model. The figures indicate that conditional moments vary substantially over the sample period, with expected returns ranging over most of the sample between roughly 2 per cent and −1–1/2 per cent, but with wider swings in 2008 and 2009. Conditional volatility tends to hover between 1 and 2 per cent range during much

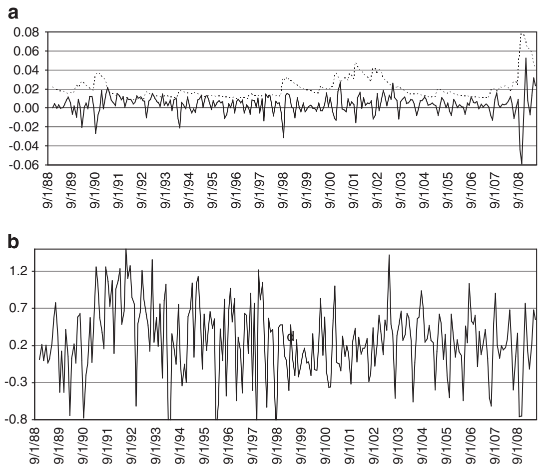

Figure 3: (**a**) Conditional means (solid line) and volatilities (dashed line) estimated from a GJR GARCH model of Merrill Lynch B rated high yield bond returns; (**b**) Conditional Sharpe ratios estimated from a GJR GARCH model of Merrill Lynch B rated high yield bond returns.

of the period but spikes to ever-higher peaks during the early 1990s, the early 2000s and in 2008, reaching almost 8 per cent. Conditional Sharpe ratios vary from 1–1/2 to −3/4 per cent and exhibit fairly jagged behavior during the sample period.

The extreme variation of expected returns and expected risk adjusted returns over the sample period, as well as the modest excess returns over the entire sample period for buy and hold high yield bond investors shown in Table 1, raises the possibility that high yield bond investors could benefit from overweighting or underweighting high yield bonds depending on forecasts of their risk reward tradeoff. The study next examines the performance of high yield bonds conditional on out of sample forecasts of the risk reward tradeoff.

THE PREDICTIVE POWER OF OUT OF SAMPLE CONDITIONAL SHARPE RATIO FORECASTS

The finding in the previous section that high yield bond returns are highly predictable suggests the possibility but does not indicate that this information could have been used for investment strategies over the sample period. The usual caveat that relationships revealed over the course of a sample period might not have been known until the end is especially germane here in light of the extreme events and volatility toward the end of the sample period.

This section examines whether the predictability uncovered in the previous section could have been used in real time during the sample period by constructing out of sample 1-month ahead forecasts of Sharpe ratios and then comparing subsequent high yield bond returns across periods when risk reward tradeoffs are expected to be favorable and unfavorable. Out of sample conditional Sharpe ratios are constructed as follows: The GARCH models presented in the previous section of the article are estimated first from the beginning of the sample period in September 1988 through December 1994 and the parameter estimates along with data from 1995 are used to construct out of sample conditional means, volatilities and Sharpe ratios for each month of 1995. The models are then re-estimated with another year of data and out of sample conditional moments and Sharpe ratios are obtained for the next year. This process is repeated to obtain out of sample monthly conditional moments and Sharpe ratios from January 1995 through June 2009.

A two step procedure for model selection for each estimation period is used. In the first step, a GJR model with all of the variables that are included in the conditional mean equation in the previous section is estimated. If the asymmetric conditional volatility term is statistically significant for a particular sub-period, it remains in the equation, otherwise conditional volatility is specified as a symmetric GARCH process. With conditional volatility specified, the GARCH models are estimated for each sub-period first with all of the variables included in the conditional mean equation from the previous section in the model. These models specify monthly high yield bond excess returns as a function of lagged own returns, lagged S&P excess returns, lagged government bond excess returns (proxied by the Merrill Lynch 5–7 year US government bond index) and lagged changes of the VIX that are orthogonal to S&P 500 returns.[19] The GARCH models are then re-estimated with various combinations of these variables included in the conditional mean equation.[20] The Akaike and Schwarz Information Criteria are used to select the specification that ultimately is used for each sub-period. When the two model selection procedures disagree, the variable in question is kept in the model only if it is statistically significant at the 10 per cent level.[21]

The predictive power of the out of sample forecasts of the Sharpe ratios for the BB index are not shown in the subsequent analysis because the only variable significantly entering the conditional mean equation until well into the sample period is the lagged own return. In addition, the parameter estimates in the conditional volatility equation typically are not statistically significant and conditional volatility is not well specified by a GARCH process until the latter part of the sample period is included in the estimation period. By contrast, all of the variables in the conditional mean equations for the B and C rated indexes shown in equation 2 either significantly enter the models right away or during the early part of the out of sample estimation period. In addition, the conditional volatilities of B and C rated high yield index returns are reasonably well estimated as GARCH processes over the early parts of the out of sample period.

Actual subsequent monthly excess returns of B and C rated high yield bonds are partitioned on the basis of out of sample Sharpe ratio forecasts. If high yield bond risk and returns are predictable, subsequent high yield bond returns should be favorable when conditional Sharpe ratios are high and unfavorable when conditional Sharpe ratios are low. Conditional Sharpe ratios are considered to be high when they are in their top quartiles over the period from January 1995 through June 2009. The cutoff for the top quartiles of Sharpe ratios are 0.59 and 0.48 for the B and C rated high yield bond indexes, respectively. Likewise, conditional Sharpe ratios are considered to be low when they are in their lower quartiles, which correspond to 0.05 and −0.10 for the B and C rated indexes, respectively. Although investors did not know the distribution of conditional Sharpe ratios over the period from January 1995 through June 2009 until the end of the sample period, the results can be interpreted as indicating the subsequent actual excess returns when risk adjusted excess returns are forecast to be attractive and when risk adjusted excess returns are expected to be negligible and hence unattractive.

Table 3 provides the conditional means, the conditional volatilities and conditional Sharpe ratios from the out of sample GARCH models and the subsequent monthly excess returns of the Merrill Lynch B and C rated high yield bond indexes when the conditional Sharpe ratios are in their highest and lowest quartiles as well as

Table 3: The predictive power of out of sample conditional Sharpe ratio forecasts for the monthly excess returns of B and C rated high yield bonds from January 1995 through June 2009

	Conditional mean forecasts	*Conditional volatility forecasts*	*Conditional Sharpe ratio forecasts*	*Subsequent excess returns when Sharpe ratio is in top quartile*	*Subsequent excess returns when Sharpe ratio is in bottom quartile*	*Subsequent excess returns when Sharpe ratio is in middle 2 quartiles*
B rated bond index						
Mean	0.452***	1.83***	0.304***	1.136**	−0.950***	0.370
NOBS	174	174	174	44	44	86
SD	0.965***	1.17***	0.508	1.85	3.29	2.68
Sharpe ratio	—	—	—	0.61	−0.29	0.14
Skewness	−0.939***	2.99***	−0.138	1.52***	−2.34***	0.32
Kurtosis	9.95***	9.75***	2.09***	4.23***	7.43***	4.08***
High	5.06	7.83	2.25	6.93	4.26	10.77
Top $\frac{1}{4}$	0.91	1.72	0.59	1.26	0.82	1.31
Bot $\frac{1}{4}$	0.08	1.25	0.05	0.304	−1.35	−0.73
Low	−5.03	0.87	−1.57	−3.49	−14.66	−0.87
C rated bond index						
Mean	0.423***	2.97	0.166	1.61**	−1.65***	0.304
NOBS	174	174	174	44	44	86
SD	2.08	1.81	0.591	2.83	5.57	3.92
Sharpe ratio	—	—	—	0.57	−0.30	0.08

Table 3 *continued*

	Conditional mean forecasts	*Conditional volatility forecasts*	*Conditional Sharpe ratio forecasts*	*Subsequent excess returns when Sharpe ratio is in top quartile*	*Subsequent excess returns when Sharpe ratio is in bottom quartile*	*Subsequent excess returns when Sharpe ratio is in middle 2 quartiles*
Skewness	0.06⋆⋆⋆	0.06⋆⋆⋆	−1.18⋆⋆⋆	1.85⋆⋆⋆	−1.22⋆⋆⋆	0.91⋆⋆⋆
Kurtosis	9.81⋆⋆⋆	9.81⋆⋆⋆	3.92⋆⋆⋆	5.65	4.95	7.07⋆⋆⋆
High	10.57	12.44	1.56	12.42	12.06	19.52
Top $\frac{1}{4}$	1.20	3.47	0.48	2.89	0.83	1.91
Bot $\frac{1}{4}$	−0.29	1.99	−0.10	0.032	−3.33	−1.09
Low	−10.52	1.28	−2.63	−3.45	−22.78	−10.77

The conditional means, volatilities and Sharpe ratios for the monthly returns of the Merrill Lynch B and C rated high yield bond indexes are formed from out of sample GARCH models. Models initially are estimated from September 1988 through December 1994 and then successively with an additional year of data through the end of the 2008. Conditional moments of high yield bond excess returns for each year beginning in 1995 are formed using the observations for that year and the parameter estimates based on data from September 1988 through the beginning of that year. The GARCH models allow for conditional volatility asymmetries for each estimation period when they are present. The conditional means are specified generally as the excess high yield bond return on an own lag, lagged S&P returns, the lagged Merrill Lynch 5–7 year Treasury bond index return, the lagged changed of the VIX that is orthogonal to the lagged S&P 500 return. The specification chosen for subperiods are based on the Akiake and Schwarz Information Critieria. When these model selection procedures disagree, the variable in question is omitted from the model if it is not statistically significant at the 10 per cent level. Significance levels for subsequent monthly excess returns are based on the fractiles from 10 000 artificial excess returns series created by randomly drawing from the excess return series from January 1995 through June 2009.

⋆⋆ and ⋆⋆⋆ represent statistical significance at the 10, 5, 1 per cent, respectively.

their middle two quartiles over the period from January 1995 through June 2009. For the subsequent monthly excess returns, the table provides data on the mean, standard deviation, skewness, kurtosis, ex-post Sharpe ratios as well as the maximum and minimum values and the highest and lowest quartiles of returns. Because the subsequent excess returns are not normally distributed, the statistical significance of returns is determined by bootstrapping. The bootstrapping experiments involve creating 10 000 artificial data sets by randomly drawing 44 observations – the number of observations when conditional Sharpe ratios are deemed high or low – from the monthly excess returns from January 1995 through June 2009 and determining significance levels from the fractiles of the means of the monthly excess returns of the 10 000 artificial data sets.[22]

The table shows that the out of sample conditional mean forecasts of the B and C rated monthly excess returns average 0.45 and 0.42 per cent, respectively, while their conditional volatilities average 1.83 per cent and 2.97 per cent, respectively. Combining these two conditional moments, the estimates indicate that the means of the conditional Sharpe ratios are a statistically significant 0.30 for the B rated index and a statistically insignificant 0.16 for the C rated index. These findings indicate that the ex-ante conditional risk adjusted returns for B rated bonds have been more attractive than C rated bonds on average over the past 15 years, consistent with the ex-post returns shown in Table 1.

More importantly, out of sample conditional Sharpe ratios vary substantially and have significant predictive power for subsequent high yield bond excess returns. When conditional Sharpe ratios are in their upper quartiles, subsequent average monthly excess returns are 1.14 per cent for B rated bonds and 1.61 per cent for C rated bonds. Bootstrapping experiments indicate that these returns are statistically significant at the 5 per cent levels. By contrast, when conditional Sharpe ratios are in their lowest quartiles, subsequent monthly excess returns average −0.95 and −1.65 per cent for B and C rated bonds, which bootstrapping results indicate are statistically significant at the 1 per cent levels. The average ex-post Sharpe ratios swing from 0.61 to −0.29 for B rated bonds when out of sample conditional Sharpe ratios are in their highest versus lowest quartiles, while the average ex-post Sharpe ratios for C rated bonds swing from 0.57 to −0.30. When conditional Sharpe ratios for the subsequent excess returns are in their middle two quartiles, monthly excess returns are statistically insignificant and average 0.37 and 0.30 per cent for B and C rated bonds, respectively.

In addition, investing in high yield bonds only when risk-return tradeoffs are forecast to be favorable would have allowed investors to avoid the several severe selloffs that occurred over the sample period. When conditional Sharpe ratios are in their highest quartiles, the largest negative subsequent excess returns are −3–1/2 per cent for both indexes and the cutoff for the bottom quartile of actual subsequent monthly excess returns are 0.30 and 0.03 per cent for the B and C rated indexes, respectively.[23] Along these lines, the table also indicates that the distribution of subsequent monthly excess returns for both B and C rated bonds are significantly favorably skewed when conditional Sharpe ratios are in their top quartile and are significantly negatively skewed when conditional Sharpe ratios are in their lowest quartiles.

The subsequent strong performance and the manageable losses when out of sample conditional Sharpe ratios are attractive does not stem solely from avoiding exposure to high yield bonds when conditional volatility forecasts are high. As can be inferred from Table 3, the variation of the conditional Sharpe ratios owes about equally to variation in conditional means and conditional volatility, as their standard deviations are similar.[24] Unreported results show that when subsequent excess returns are partitioned solely on the basis of out of sample conditional excess returns being in their top and bottom quartiles, the results are similar to those shown in Table 3. Excess returns for B and C rated high yield bonds are a statistically significant 1.42 and 1.98 per cent, respectively, when conditional returns are in their highest quartiles and are a statistically significant −0.95 and −1.82 per cent, respectively, when conditional excess returns are in their lowest quartiles.

A possible concern in interpreting the results in Table 3 is that the predictability of high yield bond index returns could be an artifact of the illiquidity of some of the underlying high yield bonds in the indexes. Although these issues were addressed earlier, further evidence can be gleaned from examining how the same strategies would have performed on high yield bond open end mutual funds, where issues related to the staleness of prices should be substantially mitigated. This stems from the obligation to calculate the net asset value (NAV) at which investors can buy or sell mutual funds at the end of each day, which provides strong incentives to quote NAVs accurately on a daily basis and certainly on a monthly basis. To the extent that open end high yield bond mutual fund NAVs are not affected by stale prices, the finding that out of sample forecasts of Sharpe ratios for the high yield bond indexes have predictive power for subsequent high yield bond mutual fund returns would suggest that the predictive power found in high yield bond index returns does not owe to stale prices.

The next step is to examine whether the out of sample conditional Sharpe ratios estimated for the Merrill Lynch High Yield Bond Indexes would have been useful for predicting high yield bond open end mutual fund returns. For this purpose, the returns of two large high yield bond mutual funds are examined – the Vanguard High Yield Corporate Fund (ticker symbol VWEHX) and the Fidelity High Income Fund (ticker symbol SPXIX).[25] The Vanguard High Yield Corporate Fund has an R^2 of 0.97 with its benchmark – the Barclays Capital US Corporate High Yield Bond Index – which suggests that it is not very actively managed.[26] The Fidelity High Income Fund also has a fairly high R^2 of 0.93 against its benchmark, which is the Merrill Lynch US High Yield Master II Constrained Index. The prospectus indicates that the Fidelity High Income Fund 'normally' invests in securities rated Ba by Moody's.[27] It is important to note that Vanguard and Fidelity both impose a 1 per cent fee on frequent trading of their high yield bond funds.[28] Thus, finding that out of sample conditional Sharpe ratios have predictive power for these mutual fund returns would not imply that successful trading strategies could have been employed during the sample period. Instead, it would suggest that the predictability of high yield bond index returns is robust and does not owe to issues related to the construction of the indexes.

Table 4 shows information concerning the monthly returns of the Vanguard High Yield Corporate Fund and the Fidelity High Income

Table 4: The predictive power of out of sample conditional Sharpe ratios of the Merrill Lynch B rated high yield bond index for the excess monthly returns of the vanguard high yield corporate bond mutual fund and the fidelity high income mutual fund from January 1995 through June 2009

	Excess returns for all observations	*Excess returns when the out of sample Sharpe ratio for the B rated index is in its top quartile*	*Excess returns when the out of sample Sharpe ratio for the B rated index is in its bottom quartile*	*Excess returns when the out of sample Sharpe ratio for the B rated index is in its two middle quartiles*
Vanguard corporate high yield bond mutual fund				
Mean	0.18	0 0.95***	−0.81***	0.29
NOBS	174	44	44	86
SD	2.29	1.45	2.89	2.12
Sharpe ratio	0.08	0.66	−0.28	0.14
Skewness	−1.64***	0.93**	−3.26***	0.66**
Kurtosis	13.53***	3.21***	14.69***	4.13***
High	8.48	5.60	2.16	8.48
Top $\frac{1}{4}$	1.14	1.41	0.74	1.16
Bot $\frac{1}{4}$	−0.58	0.17	−1.27	−0.68
Low	−15.40	−3.04	−15.41	−6.20
Fidelity high income fund				
Mean	0.21	1.09**	−1.07***	0.41
NOBS	174	44	44	86
SD	2.92	2.00	3.67	2.68
Sharpe ratio	0.07	0.55	−0.29	0.15
Skewness	−1.24***	1.21***	−2.05**	−0.02
Kurtosis	6.59***	49.50***	5.03***	3.31***

Table 4 *continued*

	Excess returns for all observations	*Excess returns when the out of sample Sharpe ratio for the B rated index is in its top quartile*	*Excess returns when the out of sample Sharpe ratio for the B rated index is in its bottom quartile*	*Excess returns when the out of sample Sharpe ratio for the B rated index is in its two middle quartiles*
High	10.30	8.48	3.39	10.30
Top $\frac{1}{4}$	1.34	1.64	0.91	1.34
Bot $\frac{1}{4}$	−0.64	0.093	−1.51	−0.59
Low	−15.14	−4.19	−15.14	−7.79

The conditional means, volatilities and Sharpe ratios for the monthly returns of the Merrill Lynch B rated high yield bond indexes are formed from out of sample GARCH models. Models initially are estimated from September 1988 through December 1994 and then successively with an additional year of data through the end of the 2008. Conditional moments of high yield bond excess returns for each year beginning in 1995 are formed using the observations for the current year and the parameter estimates based on data from September 1988 through the beginning of that year. The GARCH models allow for conditional volatility asymmetries for each estimation period when they are present. The conditional means are specified generally as the excess high yield bond return on an own lag, lagged S&P returns, the lagged Merrill Lynch 5–7 year Treasury bond index return, the lagged changed of the VIX that is orthogonal to the lagged S&P 500 return. The particular specification chosen for particular subperiods are based on the Akiake and Schwarz Information Critieria. When these model selection procedures disagree, the variable in question is omitted from the model if it is not statistically significant at the 10. Significance levels for subsequent excess returns of the high yield bond mutual funds are based on the fractiles from 10 000 artificial excess returns series created by randomly drawing from each of the high yield bond mutual fund excess return series from January 1995 through June 2009.

⋆⋆ and ⋆⋆⋆ represent statistical significance at the 10, 5, 1 per cent, respectively.

Fund for the whole period and when out of sample forecasts of Sharpe ratio of the Merrill Lynch B rated high yield bond index are in their highest quartile, lowest quartile and in middle two quartiles from January 1995 through June 2009. The out of sample conditional Sharpe ratios from the B rated index rather than from the C rated index are chosen to partition the subsequent returns of the two mutual funds because the risk-return profiles of the funds, as shown in the table, are more similar to that of the Merrill Lynch B rated index.[29] For the same 'out of sample' period examined earlier from January 1995 through June 2009, the standard deviations of the monthly excess returns of the Vanguard and Fidelity high yield funds are 2.29 and 2.92 per cent, respectively, which are close to those of the B rated index. The Vanguard and Fidelity high yield bond funds also have statistically insignificant average monthly excess returns of 0.18 and 0.21 per cent, respectively.

The table also shows that subsequent actual excess returns vary substantially depending on the forecasts of risk reward tradeoffs of the Merrill Lynch B rated index. Bootstrapped significance levels again are used owing to the non-normality of the distribution of the subsequent excess return distributions.[30] Vanguard mean monthly excess returns are a statistically significant 0.95 per cent (at the 1 per cent level) versus a statistically significant −0.81 per cent (at the 1 per cent level) when out of sample conditional Sharpe ratios for the Merrill Lynch B rated index are in their highest versus lowest quartiles. Likewise, the Fidelity high yield fund provides statistically significant mean excess returns (at the 5 per cent level) of 1.09 versus −1.07 per cent (at the 1 per cent level) when out of sample conditional Sharpe ratios for the Merrill Lynch B rated index are in their highest versus lowest quartiles. Consistent with the earlier results with the indexes, the standard deviations of returns are about twice their level when out of sample conditional Sharpe ratios are in their bottom quartile versus their highest quartile and again skewness goes from being significantly positive to significantly negative when conditional Sharpe ratios are high rather than low. Once more, using conditional Sharpe ratios as a tool for allocating to these mutual funds would have allowed investors to avoid most of the months of extreme negative returns from January 1995 through June 2009, as the largest subsequent monthly losses when Sharpe ratios are in their highest quartiles are −3.0 and −4.2 per cent for the Vanguard and Fidelity funds, respectively.[31] Overall, the results demonstrate that out of sample conditional Sharpe ratios estimated for the returns of the Merrill Lynch B rated high yield bond index have predictive power for subsequent returns of the high yield bond mutual funds. These results suggest that this predictive power is robust and is not driven by stale index values.

CONCLUSION

This study estimates GARCH models of the excess returns of high yield bond indexes and finds that conditional returns are highly predictable. Roughly one quarter to one-third of the variation of high yield bond index returns are explained by own lags, lagged S&P 500 returns, lagged Treasury bond returns and the lagged change of the VIX that is orthogonal to S&P 500 returns. The results also indicate that the conditional volatilities of B and C rated, but not BB rated, high yield bond index returns are highly asymmetric, consistent with the greater importance of the equity component of debt for lower rated high yield bonds. The estimates also show that the conditional Sharpe ratios vary substantially over the sample period, which in light of the modest risk adjusted returns of high yield bonds over the sample period suggests a role for active strategies.

The study then examines the forecasting power of out of sample conditional Sharpe ratios for subsequent monthly returns and finds that favorable times to invest in high yield bonds could have been identified in real time during the sample period. When out of sample conditional Sharpe ratios are in their highest quartiles, subsequent monthly excess returns of B and C rated bonds average statistically significant 1.1 to 1.6 per cent, respectively. Likewise, when out of sample conditional Sharpe ratios are in their lowest quartiles, subsequent monthly excess returns of B and C rated bonds average statistically significant −0.95 and −1.65 per cent, respectively. In addition, the lowest monthly returns for these indices when out of sample conditional Sharpe ratios are in their highest quartile are only −3–1/2 per cent and thus investors would have avoided the months of extreme carnage in the high yield bond market over the sample period. As a check on robustness, the study examines whether the out of sample conditional Sharpe ratios constructed for the B rated index also have predictive power for the subsequent returns of two large high yield open end mutual funds and the results are very similar. Thus, the predictability of high yield bond returns extends to mutual funds and does not appear to owe to stale index values.

There is little doubt that transactions costs would have overwhelmed the potential gains from active trading strategies in high yield bonds over the sample period. Nevertheless, the predictability of high yield bond returns demonstrated in this study could be used by longer term institutional and retail investors to fine-tune entry and exit strategies. In addition, the introduction of high yield bond exchange traded funds such as the iShares iBoxx High Yield Corporate Bond Fund and the SPDR Barclays Capital High Yield Fund has dramatically reduced transactions costs in the high yield bond market and suggests that timing strategies based on the predictability of high yield bond returns could be promising for more active traders.

ACKNOWLEDGEMENTS

The author thanks Bentley University for a summer research grant and Mark Goldblatt of Merrill Lynch and Robert Haddad of Financial Times Interactive Data for helpful conversations on issues related to the construction of the Merrill Lynch High Yield Bond Indexes. The usual disclaimer applies.

NOTES

1. For example, Campbell (1991) reports an R^2 of 0.024 from regressions from 1952–1988 of the monthly continuously compounded real return to the value-weighted NYSE on its own lagged return, the dividend-price ratio and the 1-month bill minus its past 12-month average. Ferson and Harvey (1993) report an adjusted R^2 of 0.06 from regressions from 1970–1989 of monthly US equity returns on a constant, a January dummy variable, lagged excess returns of the MSCI world index over 30-day US Treasury bill yields, the dividend yield over the past 12 months on the MSCI world equity index, the lagged difference between

the 90-day Eurodollar rate and the 3-month Treasury bill rate, the lagged difference between the US 10-year Treasury note yield and the US 3-month Treasury bill yield and the lagged US 30-day Treasury bill yield.

2. The finding of a substantial equity component in high yield bond returns is confirmed over a more recent period from 1986 through 2000 by Reilly and Wright (2001).
3. Sangvinatsos' (2005) regressions of BA and B rated corporate bond index returns on the variables described above result in adjusted R^2s of 0.09 and 0.19 percent, although only the dividend yield variable significantly enters the models.
4. By contrast, PIK bonds or 'payment in kind' bonds pay coupons comprised of additional bonds rather than cash.
5. At the end of June 2009, the market values of the BB, B and C rated indexes were $289 billion, $188 billion and $289 billion, while the corresponding number of issues was 750, 547 and 507, respectively.
6. Over the sample period the Macauley durations of the BB, B and C rated Merrill Lynch High Yield Bond Indexes averaged 5.7, 5.1 and 4.3, respectively, versus an average Macauley duration of 4.9 for the 5–7 year Merrill Lynch US Treasury Bond Index.
7. At the end of May 2007, $100 invested in BB, B and C rated bonds had grown to $515, $512, and $450, respectively, while $100 invested in Treasuries had grown to $383.
8. The risk free return is calculated by dividing the 3-month Treasury bill coupon equivalent rate by 12.
9. These findings are consistent with Kozhemiakin (2007), who shows that ex post Sharpe ratios from 1985 to 2005 fall from BB to B to CCC rated bonds.
10. These authors attribute the lower volatility of high yield bond returns relative to long-term Treasury returns to the shorter duration of high yield bonds owing to their higher coupons and their call features. Part of the difference may owe to the use of comparable duration Treasuries in the present article.
11. A variety of specifications were examined where high yield bond returns were regressed on lagged high yield bond returns and separate interactive dummy variables for negative and large negative and large positive lagged high yield bond returns. Various thresholds from the highest quartiles to the highest deciles of positive and negative high yield bond returns were examined and none of these variables entered the model significantly.
12. The first order autocorrelation coefficients for the Vanguard and Fidelity high yield mutual funds are 0.29 and 0.28 percent, respectively, compared to a range from 0.33 to 0.43 for the high yield bond indexes. It is important to note that Fidelity and Vanguard were not involved in the controversy related to some mutual fund companies allowing favored customers to buy and sell international equity funds at stale prices.
13. Variables similar to those included by Sangvinatsos (2005) in regressions of high yield bond returns on predetermined variables such as the slope of the yield curve, high yield spreads over Treasuries and the

dividend yield on the S&P 500 index did not significantly enter the models estimated in the present study.

14. Anecdotal and statistical evidence concerning the possibility that stale pricing is driving the positive autocorrelation of the high yield bond index returns is discussed in the previous section.
15. The results are fairly similar when the monthly returns of the Russell 2000 index are used instead of the S&P 500 index although the results using the latter are more robust.
16. This study uses the most recent version of the VIX that was introduced in 2003 and calculated back to January 1990. For the earlier part of the sample period, the version of the VIX that was created in 1993 and calculated back to January 1986 is used.
17. Hunter and Simon (2005) demonstrate that conditional volatility asymmetries are absent in US 10-year Treasury note returns from 1992 to 2002.
18. When the lagged raw change of the VIX is included in the model, it frequently enters significantly but its inclusion in some cases causes the lagged S&P return to be insignificant owing to the endogeneity of the VIX with respect to S&P returns that was discussed earlier. Later when out of sample conditional mean returns are estimated, the results are far more stable with the orthogonalized lagged VIX change included rather than the raw VIX change.
19. The component of the change of the VIX that is orthogonal to the contemporaneous S&P 500 return is also obtained from out of sample estimates.
20. The lagged orthogonalized change of the VIX always enters sub-periods significantly and is thus the most robust predictor of subsequent high yield bond excess returns.
21. The models again are estimated using the Bollerslev and Wooldridge (1992) QML approach.
22. The 1 per cent and 5 per cent upper fractiles for the B and C rated bond excess returns are 1.16 and 0.90 per cent and 1.65 and 1.20 per cent, respectively. The 1 per cent and 5 per cent lower fractiles for the B and C rated bond excess returns are −0.78 and −0.48 per cent and −1.41 and −0.92 per cent, respectively.
23. For the out of sample forecast period of 174 months from January 1995 though June 2009, the B rated index had 11 months of losses greater than 3–1/2 per cent with average losses of 6–1/2 per cent during these months, while the C rated index had 20 months of losses greater than 3–1/2 per cent with average losses of 6.6 per cent during these months.
24. For example, the standard deviations of the conditional mean forecast and the conditional volatility forecast of the subsequent returns of the B rated index shown in Table 3 are 0.97 and 1.17 per cent, respectively.
25. It was reported earlier that the monthly returns of both of these funds are strongly positively autocorrelated at the first lag with first order autocorrelation coefficients of around 0.29 and 0.28, which are fairly close to the 0.33 first order autocorrelation coefficient for the Merrill Lynch B rated index.
26. The Vanguard High Yield Corporate Fund was initiated in December 1978 and

is currently managed by Wellington Management. At the end of 2008, the fund had net assets of $7.8 billion, held 257 issues with an average duration of 4 years, and had 42 per cent of the portfolio invested in B rated corporate bonds and 10 per cent invested in bonds rated below B. In addition, the fund had a very low expense ratio of 0.025 per cent.

27. The Fidelity High Income Fund at the end of 2008 had net assets of $6.6 billion across 288 holdings. The fund had 28 per cent of its holdings in BB rated bonds, 45 per cent in B rated bonds and 14 per cent in bond rated below B. The average maturity of the holdings was 5.3 years.
28. Vanguard imposes a 1 per cent penalty if its high yield bond fund is held less than 1 year, while Fidelity imposes the same penalty if its high yield bond fund is held less than 90 days.
29. Also, the holdings of the two funds are closer those of the Merrill Lynch B rated index than the C rated index, with the Vanguard and Fidelity funds having 42 per cent and 45 per cent of their holdings invested in B rated bonds at the end of 2008. Nevertheless the results are little changed if the conditional estimates of the C rated model are used.
30. The bootstrap experiments involve creating 10 000 artificial data sets by drawing 44 observations randomly from the monthly excess returns of each high yield mutual fund from January 1995 through June 2009. The 1 and 5 per cent upper fractiles for the Vanguard fund monthly returns are 0.93 and 0.71 per cent, respectively, and for the Fidelity fund monthly returns are 1.17 and 0.89 per cent, respectively. The corresponding lower 1 and 5 per cent fractiles are −0.70 and −0.42 per cent, respectively, and −0.89 and −0.52 per cent, respectively.
31. The Vanguard high yield fund had monthly losses greater than 3 per cent in 8 months with average losses of 6.1 per cent in those months. The Fidelity high yield fund had monthly losses greater than 4.2 per cent in 8 months with average losses of 8.8 per cent in those months.

REFERENCES

Bekaert, G. and Wu, G. (2000) Asymmetric volatility and risk in equity markets. *Review of Financial Studies* 13(1): 1–42.

Blume, M., Keim, D. and Patel, S. (1991) Returns and the volatility of low-grade bonds. *Journal of Finance* 46(1): 49–74.

Bollerslev, T. and Wooldridge, J. (1992) Quasi-maximum likelihood estimation inference in dynamic models with time-varying covariances. *Econometric Reviews* 11(2): 143–172.

Campbell, J. (1991) A variance decomposition for stock returns. *Economic Journal* 101(405): 157–179.

Campbell, J. and Taksler, G. (2003) Equity volatility and corporate bond yields. *Journal of Finance* 58(6): 2321–2349.

Cornell, B. and Green, K. (1991) The investment performance of low-grade bond funds. *Journal of Finance* 46(1): 29–48.

Dennis, P., Mayhew, S. and Stivers, C. (2006) Stock returns, implied volatility innovations, and the asymmetric volatility phenomenon. *Journal of Financial and Quantitative Analysis* 41(2): 381–406.

Ferson, W. and Harvey, C. (1993) The risk and predictability of international equity returns. *The Review of Financial Studies* 6(3): 527–566.

Glosten, L., Jagannathan, R. and Runkle, D. (1993) On the relationship between the expected value and the volatility of the nominal excess returns on stocks. *Journal of Finance* 48(5): 1779–1801.

Hunter, D. and Simon, D. (2005) A conditional assessment of the relationships between the major world bond markets. *European Financial Management* 11(4): 463–482.

Kandel, S. and Stambaugh, R. (1996) On the predictability of stock returns: An asset-allocation perspective. *Journal of Finance* 51(2): 385–424.

Kozhemiakin, A. (2007) The risk premium of corporate bonds. *Journal of Portfolio Management*, 33(2): 101–109.

Merton, R. (1974) On the pricing of corporate debt: The risk structure of interest rates. *Journal of Finance* 29(2): 449–470.

Reilly, F. and Wright, D. (2001) Unique risk-return characteristics of high-yield bonds. *Journal of Fixed Income* 11(2): 65–82.

Sangvinatsos, A. (2005) Explanatory and predictive analysis of corporate bond indices returns. Available at SSRN: http://ssrn.com/abstract=891641.

Wu, G. (2001) The determinants of asymmetric volatility. *Review of Financial Studies* 14(3): 837–859.