An Analysis of Passive and Active Bond Mutual Fund Performance

Michael J. Kiffel

Surya Prabhakar, Co-Author
Professor Edward Tower, Faculty Advisor
Professor Grace Kim, Seminar Advisor

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Abstract

The literature on the performance differential between passively and actively managed equity mutual funds is thorough: passively managed funds generally outperform their active counterparts except in the rare presence of highly-skilled managers. However, there exists limited academic research regarding fixed income mutual funds. This study utilizes the Fama-French bond risk factors, *TERM* and *DEF*, in a dual-step multivariate linear regression analysis to determine this performance differential between passively and actively managed bond mutual funds. The funds are comprised of either corporate or government bonds, spanning three categorizations of average maturities. Overall, it is determined that passively managed bond funds offer higher net returns than those offered by actively managed funds. Additionally, the regressions demonstrated that *DEF* possesses a high degree of predictive power and statistical significance.

JEL Classification: C55; G10; G11

Keywords: Mutual Funds, Fama-French Asset Pricing Model, Passive and Active Management, Fixed Income

Table of Contents

Introduction

A financial investment is an asset that an investor deposits money into with the intent that the value of the respective asset will appreciate over time, resulting in a larger sum of money in the future. The motivation behind financial investing is relatively intuitive and is rooted in economic theory: in general, people desire the accumulation of resources. Financial investing is a means to that end. The three most common asset classes available to investors are equities, bonds (fixed income instruments), and cash equivalents. Modern Portfolio Theory assumes that investors are inherently risk averse and will therefore prefer the least risky asset (or portfolio of assets) given a specific expected return. Along these lines, a financial investor will only be willing to take on additional risk if compensated with higher expected returns. While Modern Portfolio Theory assumes that this trade-off between expected return and risk will be the same for all financial investors, the risk aversion characteristics will vary by investor. Therefore, a set of financial investors will evaluate the trade-off profile differently based upon their risk tolerances.

Harry Markowitz was the famous American economist who initially developed Modern Portfolio Theory. In his paper titled "Portfolio Selection," Markowitz offered keen insights into how financial investors should select portfolios given the two aforementioned parameters: expected return and risk. As Markowitz noted, the common rule in investing is to diversify and maximize expected return. This strategy is ostensibly supported by the law of large numbers which "will insure that the actual yield of the portfolio will be almost the same as the expected yield" (Markowitz, 1952, p. 79). This strategy assumes that there is a portfolio that exists which offers the maximum expected return and minimum variance. Markowitz (1952) advanced portfolio theory by asserting that the law of large numbers cannot apply to a portfolio of

securities in this manner due to the fact that "the returns from securities are too intercorrelated" and as a result, "diversification cannot eliminate all variance" (p. 79). Building off of these findings, he proposed the expected returns-variance of returns *(E-V)* rule, which states that an investor should select a portfolio on the efficient frontier, meaning a portfolio with "minimum *V* for given *E* or more and maximum *E* for given *V* or less" (Markowitz, 1952, p. 82).

This thesis seeks to analyze mutual funds as these "portfolios," with specific regard to bond mutual funds. Since the advent of mutual funds, the debate surrounding active versus passive management has been explored in great detail, but primarily with regard to equity funds. Comparatively, very little research has been conducted on the performance differential between actively and passively managed bond funds. The most common explanation for this is that there is less variation in the returns of bond funds in comparison with equity funds. As a result, there is less interest despite the size of the asset class. With respect to the management style, the basic premise here is that passively managed funds seek to create a portfolio allocation that is the same as a specific index. On the other hand, active management requires the use of portfolio managers who seek to outperform a specific index and generate alpha. As a result of these services offered by portfolio managers, actively managed funds charge higher expense ratios than those charged by passively managed funds.

The objective of this thesis is to determine whether passively managed bond mutual funds or actively managed bond mutual funds are superior for a financial investor's portfolio. In other words, this study will determine whether an actively or passively managed bond mutual fund offers a higher expected return given a specified level of risk. For clarification, this paper does not seek to determine the optimal weightings of assets within an asset class or the optimal portfolio allocation across asset classes. Rather, it seeks to determine the optimal bond mutual

fund given the parameters offered by Modern Portfolio Theory. The answer to this question is of great practical utility to financial investors, naturally, who seek maximum capital appreciation over time. Additionally, this study is of interest to academic researchers as well since the findings will shed light on how a bond's risk profile can be quantified and how such risk factors can be explained in the context of expected returns.

The following sections of this thesis will first aim to identify bond risk factors that capture the common variation in the expected returns of bonds by reviewing the relevant literature on the topic. Once these risk factors are established, they will be calculated for a variety of actively and passively managed bond mutual funds across multiple fund styles (corporate and government) and maturities. From this point, statistical analyses will be performed in order to determine the explanatory power of the bond risk factors in explaining the variation in bond fund returns. This paper will conclude with a discussion of the study's findings, including interpretations of the data and potential next steps in order to enhance the contribution to the existing literature.

Literature Review

In the context of Modern Portfolio Theory, existing literature supports the notion that mutual funds can be utilized as portfolios for selection. In his paper titled "An Analytic Derivation of the Efficient Portfolio Frontier," Robert Merton proposed his Mutual Fund Theorem. As the basis of his theorem, Merton (1972) posited the following:

> Given *m* assets, there are two portfolios (mutual funds) constructed from these *m* assets, such that all risk-averse individuals, who choose their portfolios so as to maximize utility functions dependent only on the mean and variance of their portfolios, will be indifferent in choosing between portfolios from among the original *m* assets or from these two funds. (p. 1858)

The mathematical proof of this theorem is outside the scope of this paper, but the theoretical basis of the theorem is essential in analyzing the performance of different bond mutual funds.

With regard to bond funds, there has been a sizable amount of research to determine which economic variables impact bond performance. In Eugene Fama and Kenneth French's paper titled "Common Risk Factors in the Returns of Stocks and Bonds," the two economists developed two bond risk factors: *TERM* and *DEF*. Mathematically, *TERM* is the difference between the long-term (20-year) government bond yield and the one-month Treasury bill yield measured at the end of the previous month. As the economists reasoned, the bill rate is intended to proxy for the general level of expected returns on bonds, so that *TERM "*proxies for the deviation of long-term bond returns from expected returns due to shifts in interest rates" (Fama & French, 1993, p. 7). *DEF*, on the other hand, was developed as a proxy for shifts in economic conditions that influence the likelihood of default for corporate bonds. In addition to the credit ratings published by rating agencies, interest-coverage ratios, which explain how much money a

company generates in order to cover the interest payments on its debt, and capitalization ratios, which explain how much interest-bearing debt a company carries in relation to the value of its assets, are traditional metrics for assessing default risk. For example, a low interest-coverage ratio and/or a high capitalization ratio can signal an increased likelihood for default. Mathematically, *DEF* is the difference between the return on the market portfolio of long-term corporate bonds and the long-term government bond return. In short, *TERM* and *DEF* are essential variables in analyzing the common variation in bond returns.

Similarly, in their paper titled "Fundamental Economic Variables, Expected Returns, and Bond Fund Performance," Elton, Gruber, and Blake developed relative pricing models that were successful in explaining expected returns in the bond market. The economic variables that they used in their model included "market returns, default risk, term risk, unexpected changes in inflation, and unexpected changes in a measure of economic performance" (Elton et al., 1995, p. 1233). The authors later explained that the "unexpected changes in a measure of economic performance" referred to an unexpected change in the forecast of real Gross National Product (GNP). Elton et al. also recognized the relatively little attention given to bond returns in comparison to equity returns, despite the fact that the bond market is several times larger than the equity market. The authors noted that most relative pricing models utilize unanticipated changes in economic variables as factors that influence bond returns (Elton et al., 1995). The contribution of this paper to the existing literature was that it demonstrated, by comparing pricing models that contained the fundamental expectational variables to models that did not contain the variables, that the "addition of the fundamental variables leads to a large improvement in the explanation of expected returns" (Elton et al., 1995, p. 1229). The significance of this paper in combination with the Fama-French paper for this thesis is that both papers establish the importance of fundamental

economic variables to not only analyze the common variation in bond fund returns, but also forecast bond performance in different economic environments.

With regard to actual performance, passive versus active management has been studied in detail with equity funds. In their paper titled "Allocating between Active and Passive Management," Sorensen, Miller, and Samak (1998) explored the question of active versus passive equity management by providing a framework for analyzing the "trade-off that faces the typical large pension plan in choosing between the mix of active and passive strategies" (p. 19). The authors concluded that during bear market years, active manages will likely "declare victory," and during bull market years, "indexers will make the triumphant boasts" (Sorensen et al., 1998, p.29). However, they note that this trend is directly dependent on the skill-level of the portfolio manager and therefore assume that the active manager in such a scenario is highly-skilled. More generally, the authors deduced that "the optimal allocation to indexing declines as skill increases" (Sorensen et al., 1998, p. 18).

In his paper titled "The Arithmetic of Active Management," William Sharpe offers a more nuanced approach than the framework offered by Sorensen et al. Sharpe asserts that "after costs, the return on the average actively managed dollar will be less than the return on the average passively managed dollar" because before costs "the return on the average actively managed dollar will equal the return on the average passively managed dollar" (Sharpe, 1991, p. 7). Sharpe (1991) contends that the returns before costs are equivalent because the "market return must equal a weighted average of the returns on the passive and active segments of the market" (p. 7). The author continues by offering potential reasons for contradictory data such as the fact that "summary statistics for active managers may not truly represent the performance of the average actively managed dollar" (Sharpe, 1991, p. 8). This is merely one example of

improper measurement. Sharpe does note, in conjunction with Sorensen et al.'s conclusions, that it is possible for an active manager to outperform its passive counterpart, but this scenario is not the norm.

An empirical demonstration of Sharpe's findings was demonstrated in Nalla and Tower's paper titled "Vanguard's Index Funds vs. Vanguard's Managed Funds: A Nine Style Box and Fama-French Multi-Variable Regression Approach." In this paper, Nalla and Tower selected a variety of Vanguard active and passive equity mutual funds and then regressed the three stock risk factors (market capitalization, book-to-market equity, and market-risk premium) against the monthly returns of each fund. This yielded regression coefficients for each stock's risk factor, relating the risk factors to the individual funds' monthly returns. Nalla and Tower proceeded by introducing dummy variables for managed and index funds, and then regressed the annual continuously compounded returns of each fund against the coefficients of the stock risk factors and the dummy variable. This process yielded results that demonstrated that Vanguard's small-cap and mid-cap index funds outperformed Vanguard's actively managed mutual funds of the same size (Nalla & Tower, 2017). This methodology is very well-suited for this thesis' methodology in analyzing the performance of actively and passively managed bond mutual funds.

A more generalized understanding of active versus passive equity fund performance is offered by Kenneth French in his paper titled "Presidential Address: The Cost of Active Investing." French set out to discover what society spends to actively invest in the U.S. stock market and compared it to a hypothetical scenario where everyone followed a passive investing strategy. He estimated that the actual cost of investing (the fees paid for mutual funds, investment management costs paid by institutions, fees paid to hedge funds and funds of funds,

and transaction costs paid by traders) was 0.82% of the value of the NYSE, Amex, and NASDAQ in 1980 and 0.75% in 2006; similarly, he estimated that the cost of passively investing was only 0.18% of the aggregate market capitalization in 1980 and 0.09% in 2006 (French, 2008). By calculating the average difference between 1980-2006, French (2008) determined that "if there is no net transfer between a passive market portfolio and other investors, the average annual return on the passive portfolio is 67 basis points higher than the value-weighted average of all investors' returns" (p. 1561). A limitation of this study was that French did not comment on the general economic environment of the period he studied. This may be a function of the substantial size of the data set he analyzed. Over the course of the 26 years, the U.S. market experienced both bull and bear markets, but the overwhelming trend was positive. Despite this limitation, these results unequivocally demonstrate the general superiority of passive equity funds over their active counterparts. In fact, toward the end of the paper French (2008) posed the question, "Why do active investors continue to play a negative sum game?" (p. 1541). He posited that there is a "general misperception" regarding investment opportunities and that overconfidence may be the reason investors are willing to incur the extra fees of active strategies (French, 2008, p. 1562).

Now that the performance of equity funds has been explored, Blake, Elton, and Gruber published a paper titled "The Performance of Bond Mutual Funds" that focused on the actual performance of bond funds. This paper demonstrated that active bond funds underperform their relevant indexes post-expenses (Blake, Elton, & Gruber, 1993). Using the return on the 30-day Treasury bill from Ibbotson and Associates and various government/investment-grade corporate bond indexes from Lehman Brothers, the economists concluded, based upon their samples, that a percentage-point increase in expense leads to a percentage-point decrease in returns (Blake et al.,

1993). They demonstrated this by regressing the funds' alphas on their respective expense ratios. While this relationship may seem self-evident, the results are actually surprising in the sense that if one were to assume that an active manager underperforms an index before expenses due to poor skill, there should be a larger percentage decrease in returns (>1%). Despite these findings, the economists noted that their paper had no predictability power for forecasting bond returns and the economic variables that may influence such returns.

Huang and Wang published a paper titled "Timing Ability of Government Bond Fund Managers: Evidence from Portfolio Holdings" that offered findings that were more nuanced than those in the paper by Blake et al. It is important to note that Huang and Wang's study focused exclusively on government bond funds. Huang and Wang (2014) concluded that, on average, "government bond fund managers possess significant and positive market timing ability at the one-month horizon, based on a bootstrapping approach to statistical inference" (p. 2091). This finding is significant as it demonstrates that there are active strategies, such as market timing, that can positively influence a fund's returns. However, the authors did not conduct any analysis on passively managed index funds, thereby eliminating the potential for comparison between passive and active government bond funds. Additionally, Huang and Wang explained why they chose to focus solely on Treasury security holdings of government bond funds. Their rationale is centered around two primary realizations: (1) managers of such funds are "primarily concerned with interest rate risk, since these funds hold mainly Treasury securities" and (2) since the returns of individual Treasuries are highly correlated, "the main mechanism by which government bond fund managers can deliver superior performance is to engage in market timing rather than asset selection activities" (Huang & Wang, 2014, p. 2092). This thesis will employ a

similar methodology with respect to government bond funds, as will be discussed in the data section of this paper.

On the other hand, Cici and Gibson published a paper titled "The Performance of Corporate Bond Mutual Funds: Evidence Based on Security-Level Holdings" that supported Blake et al.'s finding: active bond funds underperform their relevant indexes post-expenses. Cici and Gibson's paper was the first to examine bond fund performance using holdings of individual corporate bond issues. The authors broke down corporate bond fund returns into six components: i) bond-selection ability, ii) characteristic-timing ability, iii) average style, iv) transaction costs, v) management fees, and vi) net return gap (Cici & Gibson, 2012). The first three components "sum to a fund's holdings returns on its corporate bond portfolio" and the last three components explain "the difference between a fund's holdings return and its reported return, called the return gap" (Cici & Gibson, 2012, p. 160). After a thorough analysis of 746 corporate bond funds, Cici and Gibson (2012) concluded the following:

> …We do not find evidence consistent with bond fund managers, on average, being able to select corporate bonds that outperform other bonds with similar characteristics. We find neutral to weakly positive evidence of ability to time corporate bond characteristics. Overall results show that the costs of active management on average appear larger than the benefits. (p. 159)

This finding is significant as it reinforces similar findings of other economists cited in this paper like Blake et al. (1993), Nalla and Tower (2017), and French (2008).

Based on the aforementioned literature and its contributions to the overall study of bond performance and variation, it is clear that economists have studied several economic variables that influence bond fund performance, such as term risk and default risk. These fundamental

variables can help explain why bond funds perform in the manner that they do. Additionally, it has been shown for both equity funds and bond funds that actively managed funds generally underperform their respective indexes or passively managed funds, but primarily with regard to alpha, expense ratios, and the Fama-French stock risk factors. Despite this common finding, there is literature that slightly contradicts this generalization by offering a more nuanced approach, such as Sorensen et al. (1998) and Huang and Wang (2014). However, these papers either make assumptions outside the scope of this paper, offer overly specific conclusions, or do not directly compare passive and active funds. For example, Sorensen et al. (1998) concluded that as the skill of the active manager increases, the amount allocated to passive funds should decrease. This conclusion does not factor into account the reality that most active managers underperform their respective indexes, indicating that there is a dearth of active managers that fit the mold that they propose.

This thesis is a clear addition to the literature on bond returns and advances the body of work on bond fund performance. There has not been a study on actively managed versus passively managed bond mutual fund performance with respect to risk factors that capture the common variation in bond returns. The analysis of Nalla and Tower's methodology provides this study with a very structured path for the analysis of passively and actively managed bond mutual fund performance. Undergoing this process will shed light on how the difference in performance between actively and passively managed bond mutual funds can be explained through bond risk factors.

Theoretical Framework

The theory of portfolio selection, formally known as Modern Portfolio Theory, is based on the mean-variance criterion developed by Harry Markowitz, as previously discussed. Modern Portfolio Theory states that an investor should select an optimal portfolio from a set of efficient portfolios. Essentially, an investor should seek the highest expected return given a specified variance of return. In addition to Modern Portfolio Theory, there are multiple significant factors that influence portfolio selection and portfolio returns. The first such factor Is portfolio turnover – the total amount of new securities purchased or the amount of securities sold (whichever is less) over a particular period, divided by the total net asset value of the fund. In his paper titled "Portfolio Revision: A Turnover-Constrained Approach," Schreiner (1980) offered a new approach to revising portfolios which "limits turnover of securities to a designated maximum rate" (p. 73). Based on his analysis, Schreiner (1980) determined that "moderate turnover rates are associated with the most favorable performance" (p. 72). More specifically, at 25% maximum turnover, the geometric mean return and the reward to variability ratio are at their respective maximums (Schreiner, 1980).

A fund's management and past performance are two more important factors with regard to portfolio selection and returns. In his paper titled "Is Money Smart? A Study of Mutual Fund Investors' Fund Selection Ability," Zheng (1999) concluded that funds that receive more money "subsequently perform significantly better than those that lose money" (p. 931). He posited that this phenomenon can largely be explained by the strategy of betting on winners. This indicates that a fund's past performance can influence its future performance, even if the effect on performance is short-lived. With regard to a fund's management, in their paper titled "Are Some Mutual Fund Managers Better Than Others? Cross-Sectional Patterns in Behavior and

Performance," Chevalier and Ellison (1999) deduced that managers who attended higher-SAT undergraduate institutions have "systematically higher risk-adjusted excess returns" (p. 875). These findings are relevant to a financial investor seeking to select a portfolio.

The relationship between fund size and expenses is another factor that influences the return of a fund. In their paper titled "The Persistence of Risk-Adjusted Mutual Fund Performance," Elton, Gruber, and Blake (1996) describe how an increase in the expense ratio would negatively impact post-expense performance and "therefore reduce subsequent growth in assets" (p. 153). As a result, if there is a high correlation between asset growth and performance, a successful active manager might increase manager revenue more by not raising the expense ratio, allowing for higher asset growth (Elton et al., 1996). The economists concluded that on average, "managers of successful funds increase their total revenues by having the sizes of their funds increase, not by increasing expenses" (Elton et al., 1996, p. 156). This finding suggests that an investor should seek portfolios with high levels of asset growth, as the manager is incentivized to not increase the fees.

In the same vein as expenses, taxes are of extreme relevance to portfolio selection as well. In his paper titled, "Portfolio Selection in a Lognormal Securities Market," Ahsan explained how different taxes influence an investor's demand for a particular kind of asset. For example, in portfolios with one safe asset and one or many risky assets, an increase in the proportional tax rate on investment returns increases the demand for risky assets (Ahsan, 1978). In order for the investor to restore his/her income, he/she will try to take on more risk in the hopes of recouping the loss. In portfolios with two risky assets, "an increase in the proportional tax on portfolio returns causes a shift towards the high expected return (high-risk) asset from the asset with a lower expected return (low-risk)" (Ahsan, 1978, p. 117). Similarly, in portfolios with

two risky assets and no safe asset, an increase in the lump-sum tax results in a shift towards the high-risk asset from the low-risk asset (Ahsan, 1978). Knowing the effects of taxation is crucial for understanding how such parameters influence the risk level of an asset/portfolio selected for investment.

The final factor that comprises the theoretical framework for this paper is liquidity. In his paper titled "Portfolio Selection with Stochastic Cash Demand," Chen analyzed portfolio selection with respect to cash demand and symmetric transfer costs. If the transfer costs of liquidating the risky assets are the same as those of the risk-free asset, then "an investor constructs his optimal portfolio to fit his personal stochastic cash demand" (Chen, 1977, p. 205). Chen (1977) defined a "liquidity-preferred" asset as an asset that is likely to have a higher return when the investor's cash demand is high; a "liquidity-neutral" asset is an asset whose return is independent of cash demand; a "liquidity-averse" asset is an asset whose return is negatively correlated with cash demand (p. 205). Chen (1977) concluded that "the investor's demand for a risky asset is greater the more liquidity-preferred is the asset" and "the investor's demand for a liquidity-preferred asset increases as the variability of the cash demand increases" (p. 206). The implications of this liquidity/return tradeoff are invaluable to understanding how investors select assets/portfolios. The basic premise here is that interest rates on short-term securities are lower because investors are sacrificing less liquidity in comparison to investing in longer-term securities; therefore, liquid assets yield a lower return than do otherwise comparable illiquid assets.

Methodology

There are relatively few bond mutual funds due to less variation in the defining characteristics of bond funds as compared to equity mutual funds. While equity funds can vary in sector focus, size, growth profiles, etc., bonds funds are generally categorized as either "government," "corporate," or a hybrid of the two, depending on what type of bonds comprise the fund. In order to maintain an apples-to-apples consistency, hybrid bond funds will not be analyzed in this thesis. Additionally, only government bond funds comprised of Treasury bonds will be analyzed in this paper; no government bond funds consisting of municipal bonds will be utilized. This is especially important in order to ensure consistency with respect to tax treatments. Bond funds are further compartmentalized into either short-term, intermediate-term, or long-term bond funds based on the average maturities of the bonds within the fund. For example, the Vanguard Short-Term Government Bond Fund Index Admiral Shares (VSBSX) is comprised 100% of U.S. government bonds with an average maturity of 2.0 years. VSBSX is an example of a bond mutual fund in the short-term government bond category. In comparison to equity funds, bond funds have much fewer characteristics for differentiation. With respect to the data's limitations, the reality of survivorship bias skews the data in the sense that we are only able to analyze the funds that are currently alive. The funds that were shut down for poor performance or otherwise cannot be analyzed due to the disappearance of their data, so this qualification should be noted.

For this thesis, actively and passively managed bond mutual funds will be selected from the largest mutual fund companies by assets under management – namely, Vanguard, BlackRock, Fidelity, Dimensional Fund Advisors, and T. Rowe Price. The largest mutual funds by AUM offer the entire spectrum of government and corporate bond funds. 20 bond mutual

funds will be analyzed over the course of approximately 7 years in order to have a sizable data set that accounts for economic fluctuation. There are database limitations associated with this study, such as funds missing data for some variables and time periods. Therefore, it is difficult to study performance for more than a 5-10 year period. The collected data will consist of the annualized monthly returns of each fund over the time period and the expense ratio of each fund. The Bloomberg U.S. Corporate Bond Index 10+ Years (BUSC 10) will be utilized as the corporate bond index for the CB term (return on a proxy for the market portfolio of corporate bonds) to calculate *DEF*. Utilizing this data, we will regress the two bond risk factors against the annualized monthly returns of each fund over the time period. This will yield regression coefficients for each risk factor in relation to the monthly returns of each mutual fund. From this point, we will incorporate a dummy variable for actively managed funds and then run a second regression of the annual continuously compounded return of each fund against the bond risk factor coefficients and the dummy variable.

Data

As previously mentioned, our methodology consists of a dual-step multivariate linear regression process. The first set of regressions was carried out in order to calculate the relationship that the independent variables *TERM* and *DEF* have with the dependent variable of annualized monthly returns for each individual mutual fund. In carrying out this regression, the initial step is to calculate the values of *TERM* and *DEF* for each month in the seven-year time period of analysis. *TERM* is defined as long-term government bond yield (LTG = 20-year Treasury bond yield) minus the risk-free rate (RF = one-month Treasury bill yield). *DEF* is equal to the yield on a market portfolio of corporate bonds (CB = Bloomberg USD Corporate Bond (BUSC) Index) minus the 20-year Treasury bond yield. Each of these values is calculated using ex-ante yields rather than ex-post returns to reflect current market values. In addition, for each time point, we recorded the (annualized) percentage return that the fund achieved relative to the previous month. Finally, we regressed *TERM* and *DEF* against the annualized returns to find the relationship that *TERM* and *DEF* have on the returns of each bond fund. For the purpose of illustration, a snapshot of the data for the Vanguard Short-Term Government Bond Fund Index Admiral Shares (VSBSX) is shown in Exhibit 1 on the following page.

Exhibit 1 - VSBSX Return Data and TERM/DEF Calculation							
Date	Adj. Closing Price	**Annualized Monthly Returns (%)**	20-Year Treasury Yield [LTG]	One-Month Treasury Yield [RF]	Yield on Market Portfolio of Corporate Bonds [CB]	**TERM = LTG-RF**	**DEF = CB-LTG**
4/1/2017	20.26	0.00	2.88	0.74	4.53	2.14	1.65
3/1/2017	20.26	0.89	2.83	0.40	4.45	2.43	1.62
2/1/2017	20.25	0.41	2.90	0.50	4.57	2.40	1.67
1/3/2017	20.24	1.84	2.91	0.44	4.52	2.47	1.61
12/1/2016	20.21	0.65	2.86	0.38	4.64	2.48	1.78
11/1/2016	20.20	(5.60)	2.36	0.20	4.25	2.16	1.89
10/3/2016	20.29	(0.41)	2.10	0.20	4.08	1.90	1.98
9/1/2016	20.30	0.59	2.02	0.26	4.00	1.76	1.98
8/1/2016	20.29	(2.06)	1.92	0.19	4.03	1.73	2.11
7/1/2016	20.32	(0.94)	2.01	0.20	4.22	1.81	2.21
6/1/2016	20.34	7.37	2.37	0.27	4.50	2.10	2.13
5/2/2016	20.21	(1.53)	2.38	0.16	4.46	2.22	2.08
4/1/2016	20.24	0.18	2.34	0.18	4.64	2.16	2.30
3/1/2016	20.24	1.94	2.23	0.23	4.99	2.00	2.76
2/1/2016	20.20	1.30	2.49	0.22	5.09	2.27	2.60
1/4/2016	20.18	7.05	2.78	0.14	5.06	2.64	2.28
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9/1/2010	19.48	1.96	3.12	0.16	5.26	2.96	2.14
8/2/2010	19.45	1.90	3.59	0.14	5.62	3.45	2.03
7/1/2010	19.42	3.21	3.61	0.17	5.75	3.44	2.14
6/1/2010	19.37	5.67	3.94	0.15	6.03	3.79	2.09
5/3/2010	19.28	4.37	4.22	0.14	5.90	4.08	1.68
4/1/2010	19.21	2.40	4.41	0.15	6.18	4.26	1.77
3/1/2010	19.17	(2.39)	4.24	0.09	6.13	4.15	1.89
2/1/2010	19.21	0.60	4.20	0.02	6.08	4.18	1.88

Linearly regressing *TERM* and *DEF* against Annualized Monthly Returns gives regression coefficients of 1.00 for *TERM* and 0.82 for *DEF*, which will subsequently be used in the second part of the dual-step regression process.

The second step of the process involves compiling the continuously compounded returns (both pre-expense and post-expense) as well as the *TERM* and *DEF* regression coefficients for each fund. Furthermore, each fund is assigned a dummy variable – 0 if the fund is passively managed, and 1 if is actively managed. Assigning these variables allows us to determine the effect of active vs. passive management on after-expense returns during the final multivariate regression. The final data table with all of these values is shown in Exhibit 2 on the following page.

Exhibit 2 - Government and Corporate Bond Mutual Fund Data (2010-2017)

(Consists of 20 bond funds, including calculations for *TERM*/*DEF*)

Factor Loads for Individual Index and Managed Funds								
			Fund Ticker	Seven Year Annual Return Continuously Compounded (before expenses)	Seven Year Annual Return Continuously Compounded (after expenses)	TERM	DEF	Managed Dummy
Government	**Short-Term**	**1**	VSBSX	0.73	0.66	1.00	0.82	0
		2	VFISX	0.92	0.72	1.45	1.45	1
		3	FSBIX	1.13	0.97	2.15	1.93	0
		4	FFXSX	1.29	0.84	2.21	1.54	1
	Intermediate-	**5**	VSIGX	2.77	2.70	6.14	5.12	0
	Term	**6**	VFITX	2.77	2.57	6.23	5.45	1
		7	FIBIX	3.32	3.16	7.76	6.05	0
		8	FSTGX	1.98	1.53	3.63	2.95	1
		9	PBDIX	4.70	4.40	4.30	6.09	0
		10	DFIGX	3.14	3.02	5.94	5.17	0
		11	PNIGX	2.81	2.36	4.51	1.99	1
	Long-Term	**12**	VLGSX	5.59	5.52	15.85	10.54	0
		13	VUSTX	5.67	5.47	16.58	11.11	1
Corporate	**Short-Term**	**14**	VFSTX	2.46	2.26	1.44	5.41	1
		15	VSCSX	2.93	2.86	2.08	6.87	0
	Intermediate-	**16**	VFICX	4.81	4.61	5.62	13.38	1
	Term	**17**	VICSX	5.39	5.32	5.06	14.91	0
		18	VBTLX	3.73	3.68	4.77	6.50	0
	Long-Term	**19**	VWESX	7.13	6.91	12.12	24.06	1
		20	VLTCX	6.97	6.90	9.71	26.52	0

After gathering all of these data points, we run a multivariate linear regression of the coefficients of *TERM* and *DEF* and the Managed Dummy against the dependent variable, the post-expense continuously compounded annual returns for all of the funds.

Results

The results of the multivariate linear regression are shown below. We ran separate regressions for the government bond mutual funds and the corporate bond mutual funds to more coherently analyze how active management impacts returns in both of these fund types. In each case, we also ran the regressions with pre-expense returns and then post-expense returns to differentiate between the impact of active management on gross returns and net returns.

EXHIBIT 3 - SUMMARY OUTPUT FOR GOVERNMENT BOND FUNDS (BEFORE EXPENSES)

Regression Statistics	
Multiple R	0.95
R Square	0.89
Adjusted R Square	0.86
Standard Error	0.63
Observations	13

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	3	30.01	10.0	25.1	0.000104
Residual	9	3.58	0.40		
Total	12	33.59			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 90.0%*	*Upper 90.0%*
Intercept	0.55	0.41	1.35	0.21	-0.37	1.47	-0.20	1.29
TERM	-0.07	0.13	-0.54	0.60	-0.38	0.23	-0.32	0.17
DEF	0.58	0.20	2.86	0.02	0.12	1.04	0.21	0.95
Managed Dummy	**0.09**	0.38	0.22	0.83	-0.78	0.96	-0.62	0.79

EXHIBIT 4 - SUMMARY OUTPUT FOR GOVERNMENT BOND FUNDS (AFTER EXPENSES)

Regression Statistics	
Multiple R	0.96
R Square	**0.92**
Adjusted R Square	0.89
Standard Error	0.55
Observations	13

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	3	32.01	10.67	34.66	2.84E-05
Residual	9	2.77	0.31		
Total	12	34.78			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 90.0%*	*Upper 90.0%*
Intercept	0.38	0.36	1.05	0.32	-0.43	1.18	-0.28	1.03
TERM	-0.06	0.12	-0.49	0.64	-0.32	0.21	-0.27	0.16
DEF	0.57	0.18	3.18	0.01	0.16	0.97	0.24	0.89
Managed Dummy	**-0.11**	0.34	-0.32	0.75	-0.87	0.66	-0.73	0.51

These results are based on actual bond fund data from 2010-2017. The regressions for the government bond funds (before and after expenses) demonstrate that the model fits the data well, as shown by the R-square values of 0.89 and 0.92, respectively. Looking at the coefficients, the pre-expense regression yielded a managed dummy coefficient of 0.09, indicating that actively managed government bond funds outperform index bond funds by 0.09% on a gross basis (not taking into account expenses). However, once expenses are taken into consideration, actively managed government bond funds underperform by 0.11% annually, as indicated by the -0.11 managed dummy coefficient in the post-expense regression.

Some interesting conclusions can be gleaned from this analysis – namely, it appears that active managers do, indeed, have skill in outperforming the market. However, the hefty fees charged by active managers, which are significantly in excess of those charged by index funds, result in underperformance on a net return basis.

Below, the same multivariate regression was run for our selected group of corporate bond funds.

EXHIBIT 5 - SUMMARY OUTPUT FOR CORPORATE BOND FUNDS (BEFORE EXPENSES)

Regression Statistics	
Multiple R	0.99
R Square	**0.97**
Adjusted R Square	0.94
Standard Error	0.45
Observations	7

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	3	20.04	6.68	33.6	0.008253
Residual	3	0.60	0.20		
Total	6	20.64			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 90.0%*	*Upper 90.0%*
Intercept	1.93	0.37	5.23	0.01	0.75	3.10	1.06	2.79
TERM	0.21	0.13	1.60	0.21	-0.20	0.61	-0.10	0.51
DEF	0.13	0.06	2.19	0.12	-0.06	0.31	-0.01	0.26
Managed Dummy	**-0.23**	0.35	-0.66	0.56	-1.36	0.89	-1.07	0.60

EXHIBIT 6 - SUMMARY OUTPUT FOR CORPORATE BOND FUNDS (AFTER EXPENSES)

Regression Statistics	
Multiple R	0.99
R Square	**0.97**
Adjusted R Square	0.94
Standard Error	0.45
Observations	7

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	3	19.92	6.64	33.2	0.0084
Residual	3	0.60	0.20		
Total	6	20.52			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 90.0%*	*Upper 90.0%*
Intercept	1.87	0.37	5.07	0.01	0.70	3.05	1.00	2.74
TERM	0.21	0.13	1.61	0.21	-0.20	0.62	-0.10	0.51
DEF	0.12	0.06	2.16	0.12	-0.06	0.31	-0.01	0.26
Managed Dummy	**-0.37**	0.35	1.06	0.37	-1.50	0.75	-1.21	0.46

Again, these multivariate linear regressions for corporate bond funds demonstrate that the model fits the data well, as shown by the R-square values of 0.97. In the case involving corporate bond mutual funds, we see that even on a pre-expense (gross return) basis, actively managed funds underperform by 0.23% annually. After taking expenses into account, actively managed funds underperform by 0.37% annually, which over a period of 10 years would result in nearly 5% of total fund underperformance. While this figure may seem relatively low, consider the sheer size of the mutual fund market – with trillions of dollars flowing into mutual funds, active management causes tens of billions of dollars of lost investment value.

An issue that we encountered with the managed dummy coefficients was high p-values during the regressions, indicating low statistical power. We believe this was a result of our low number of observations (N=13 for government and N=7 for corporate) due to the limited public data available for fixed income mutual funds. We believe that if researchers are able to expand the data set in future research by adding data from more bond mutual funds, these p-values would decrease. Further specifics of this data set expansion will be discussed in the conclusion section of this paper.

Another finding stemming from our regression results is the predictive power of the Fama-French *DEF* variable. As a reminder, *DEF* is defined as the spread of the yield of a market portfolio of corporate bonds over the short term minus the long-term Treasury yield. In the government bond regressions, *DEF* had a p-value of 0.02 and 0.01 (before and after expenses, respectively), indicating significance at the 98% and 99% confidence levels. Similarly, *DEF* had a p-value of 0.12 in both the regressions of corporate bond funds before and after expenses were taken into account. This confirms Fama and French's 1993 prediction that *DEF* is highly accurate in predicting bond returns, and it appears to hold true even 25 years later.

Conclusion

This study sought to ascertain the effect of active management on gross and net returns for bond mutual funds in the United States. By utilizing the Fama-French bond risk factors, *TERM* and *DEF*, we determined that active managers of both corporate and government bond funds underperform their passive counterparts after expenses are accounted for. Actively managed funds consisting of corporate bonds lagged by 0.37% annually, and actively managed government bond funds underperformed by 0.11%. Interestingly, we noticed that active managers of government funds outperform passively managed government funds by 0.09% annually before expenses are deducted, but the higher expense ratios associated with active management result in underperformance on a net basis. However, active managers of corporate bond funds still produced lower gross returns than passively managed corporate bond funds. However, these findings are not statistically significant as evidenced by the relatively high p-values calculated in the multivariate linear regressions.

On the other hand, a statistically significant finding of this study is that *DEF*, one of the two Fama-French bond risk factors, is an excellent predictor of both government and corporate bond mutual fund returns. This finding makes economic sense, as corporate yields are more volatile than government yields. In times of economic downturn, for example, CB will increase due to the increase in corporate bond yields. Since LTG is less volatile than CB, it will vary less. Therefore, *DEF* as a whole will increase, enabling corporate bond funds to achieve higher returns since the yields on corporate bonds increased. For this reason, *DEF* is positively correlated with bond mutual fund returns.

Regarding extensions of this study, producing statistically significant results is a top priority. The number of observations in this thesis is relatively small, which could explain why

the p-values in the multivariate linear regressions are high. Increasing the number of bond mutual funds will enhance the study. Specifically, having more data points for short-term, intermediate-term, and long-term bond funds for both government and corporate bundles will allow for a more accurate and focused analysis. In the current study, we did not have enough observations to separate the regressions by average maturity; rather, all of the government bond funds (and, separately, the corporate bond funds) were lumped together in the regression. Gaining access to more bond mutual fund data would provide more insight into whether there is a statistically significant performance differential between passively and actively managed bond mutual funds.

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