Selection and Timing Skill in Bond Mutual Fund Returns:
Evidence from Bootstrap Simulations

Lifa Huang[a], Wayne Y. Lee[b], and Craig G. Rennie[c]

ABSTRACT

Bootstrap simulations of monthly returns of U.S. open-end actively-managed domestic bond mutual funds between 1999 and 2016 show benchmark adjusted returns that more than cover costs. Over this horizon, the top performing half of bond funds generate significant positive precision-adjusted alpha on returns net of expenses. Similar results hold for government and corporate bond funds, and across bond funds stratified by assets under management (AUM). We find bond fund managers to be more proficient at selection than timing. For the top performing half of bond funds, selection always contributes to performance. Economic value from selection is greatest for large bond funds with AUM>$750M at 40.8bps on AUM, and for government and bond funds is 19.0 bps and 18.2 bps. For the top performing half of bond funds and large bond funds, timing detracts from performance. However, timing contributes to performance for government and corporate bond funds and is the source of outperformance over 3-year horizons.

December 30, 2018

JEL classification: G1; G11

Keywords: bond market; stock market; financial market; security markets; investment decisions; mutual funds; risk analysis; risk return; return attribution; α; beta; active investment; performance prediction.

[a]Lifa Huang, LHuang@walton.uark.edu, 479-790-9693, Sam M. Walton College of Business, University of Arkansas, WCOB 343, Fayetteville, AR 72701, USA.
[b]Wayne Y. Lee, WLee@walton.uark.edu, 479-575-3944, Sam M. Walton College of Business, University of Arkansas, WCOB 343, Fayetteville, AR 72701, USA.
[c]Craig G. Rennie, crennie@walton.uark.edu, 501-819-2561, Sam M. Walton College of Business, University of Arkansas, WCOB 343, Fayetteville, AR 72701, USA.

Selection and Timing Skill in Bond Mutual Fund Returns:
Evidence from Bootstrap Simulations

I. Introduction

Bond mutual fund managers have greater opportunities to add value through security selection and/or market timing than equity mutual fund managers.[1] In contrast to equity markets, bond markets are larger in size, include securities with issue-specific terms and embedded options, and predominantly trade over-the-counter with lower liquidity. Government bonds vary in duration and convexity, and corporate bonds in credit risk. Further, portfolio adjustments to changing expectations about future interest rates and yield spreads can be timed. In our view, the bond market offers the best chance of observing whether mutual fund managers possess skill.

In fixed income markets, actively managed bond mutual funds are foremost. From the *CRSP* Mutual Fund Database, total net assets in actively managed bond funds increased over the 1999 to 2016 period of our analysis at a 35% compounded annual growth rate, compared to 23% for index bond mutual funds over the period 2003 to 2016.[2] The entry of index bond mutual funds slowed the growth rate of total net assets in actively managed bond funds to 11%. At the end of 2016, 76% of the $1.71 trillion total net assets in bond mutual funds are actively managed.

Existing evidence on actively managed bond mutual funds suggests managers do not generate risk-adjusted returns sufficient to cover costs. Blake et al. (1993) and Elton et al. (1995) find U.S. bond mutual funds on average generate negative risk-adjusted performance net of expenses. For the period 1986 to 2000, Ferson et al. (2006) report actively managed government bond mutual funds tend to underperform passive indexes. Negative excess returns largely disappear, however, when adjustments for risk are made using a stochastic term structure.

[1]For example, at the end of 2016, U.S. bond market debt was $39.4 trillion (The Securities Industry and Financial Markets Association (SIFMA) estimates outstanding U.S. bond market debt at the end of 2016 as: Municipal $3.8 trillion; Treasury $13.9 trillion; Mortgage Related $8.9 trillion; Corporate $8.5 trillion; Federal Agencies $2.0 trillion; Money Market $0.9 trillion; and Asset Backed $1.3 trillion. http://www.sifma.org/research/statistics.aspx), compared to U.S. stock market capitalization of $26.0 trillion (http://www.visualcapitalist.com/all-of-the-worlds-stock-exchanges-by-size/). There are an estimated 150,000 individual U.S. debt securities (Xtrakter's CUPID database), compared to only 19,000 U.S. stocks of which only about 4,333 are actively traded (World Federation of Exchanges; J.P. Morgan). Fewer analysts follow bonds than stocks, bond ratings tend to be infrequently updated or not rated at all, and many bonds are illiquid, especially when placed under Rule 144A.

[2]The first 26 index bond funds reported in the CRSP Mutual Funds Database commenced in 2003.

Kosowski et al. (2006) make a compelling argument that cross-sections of mutual fund alphas will exhibit considerable heterogeneity largely due to differences in the risk-taking behavior of fund managers. Parametric tests tend to bias against finding outperformance. Correcting for the precision of alpha is important when there is uncertainty about true alpha. Moreover, a bootstrap approach that examines precision-adjusted alpha across funds and explicitly controls for "luck" without the imposition of an ex ante statistical distribution, can uncover the elusive "skill" in active management.

Finding outperformance is also contingent on identifying a benchmark model that accounts for all common variation in mutual fund returns across funds and over time. Because benchmark models can fail to capture all the common variation in fund returns, a joint sampling of fund and explanatory factor returns will address potential correlations in alpha as well as any correlated heteroskedasticities in benchmark residual errors and factor returns. Returns are bootstrapped across periods in Fama and French (2010) rather than by individual funds in Kosowski et al. (2006).[3]

Our study draws extensively on the bootstrap approach detailed in Fama and French (2010) to investigate whether bond mutual fund managers possess selection and/or timing skill. We employ a sample of 571 consolidated U.S. open-end actively managed domestic bond mutual funds with monthly returns covering the period January 1999 to December 2016.[4] Data are obtained from the *CRSP* Survivor-Bias Free Mutual Fund Database and Morningstar Direct. The Fama and French (1993) 5-factor bond returns model, and a Chen et al. (2010) motivated 12-factor bond returns model that includes additional factors to account for timing and conditioning on public information, are used to estimate actual and simulated precision-adjusted alpha on gross and net returns. This framework allows us to assess the combined effects of selection and timing skill on bond mutual fund performance from the 5-factor model, selection from the 12-factor model, and timing from the difference.

We address five distinct but related questions. Do actively managed bond mutual funds generate

[3]See Fama and French (2010, p.1925 and p.1939). Kosowski et al. (2006) introduce a potential bias by simulating funds rather than months. Fama and French (2010) recognize that independent bootstraps across periods will not capture autocorrelations in fund and factor returns and time-varying factor return betas.

[4]Our sample starts January 1999 because we consolidate bonds using the *CRSP* Survivorship-Free Mutual Funds database variable CRSP_CL_GRP. This variable is only available starting August 1998.

a positive average precision-adjusted alpha on returns net of expenses? To what extent are precision-adjusted alpha on net returns attributable to selection or timing? How do assets under management (AUM), asset specialization either in government or corporate bonds, average duration of government bond funds, and average credit rating of corporate bond funds, affect precision-adjusted alpha? Is the precision-adjusted performance of active bond mutual fund management robust to short-run (3-year) horizons? Lastly, what is the economic value created or destroyed from active bond mutual fund management?

Comparing percentile-sorted actual against bootstrapped precision-adjusted alpha, we show that: (*i*) bond mutual fund managers possess skill, not just luck; (*ii*) their skills can be attributed to selection and/or timing; and (*iii*) the cumulative economic value (EV) from selection and timing is substantive. The top performing half of our bond mutual fund sample generate significant positive precision-adjusted alpha on returns net of expenses. Similar results hold for government and corporate bond mutual funds, and across bond mutual funds stratified by AUM. For government bond mutual funds, outperformance is most evident in short (0-5 year) average duration funds, and for corporate bond mutual funds, in BBB average credit rating funds.

We find the distribution of actual precision-adjusted alphas to be non-normal and fat tailed. Moreover, parametric tests tend to bias against finding outperformance. A negative precision-adjusted alpha is more likely to indicate statistical significance, whereas a positive precision-adjusted alpha is less likely to indicate statistical significance. Importantly, we show that our inferences from bootstrap simulations are sufficiently robust to uncertainty about true alpha to be reliable.

For short-term 3-year horizons, we find significant positive precision-adjusted alphas in the 5-factor benchmark model for the top performing 10% of all actively managed bond funds, across bond funds stratified by AUM, and government and corporate bond funds. However, in the 12-factor benchmark model, precision-adjusted alpha in the top performing 10% of funds is either insignificant or negative. In the short-run, timing is the source of outperformance.

Finally, we estimate EV from active management over the sample period. We use the annualized median standard error of actual alpha and the difference between actual and average simulated precision-adjusted alpha to compute annualized excess alpha on AUM at each percentile. Overall, selection is a significant source of positive EV. For the top performing half of funds, EV from selection is greatest for large bond funds with AUM>$750M at 40.8 bps on AUM. EV from selection for the top performing half of government and corporate bond funds is 19.0 bps and 18.2 bps. For the top performing 5% of funds, EV from selection is again highest on bond funds with AUM>$750M at 59.8 bps. Compared to the top performing half, EV from selection for the top performing 5% of government and corporate bond funds is 3.3 bps lower and 3.0 bps higher, respectively.

In contrast, timing detracts from performance for large bond funds. EV from timing for the top performing half and top 5% of large funds are -22.5 bps and -34.2 bps. However, timing contributes to performance among government and corporate bond funds. For the top performing half of funds, EV from timing is highest at 18.8 bps for corporate bond funds, and lowest at 6.1 bps for government bond funds. For the top performing 5% of government and corporate bond funds, EV from timing are 21.0 bps and 22.3 bps.

The literature on bond mutual fund performance is surprisingly sparse. Our study is closest to Chen et al. (2010), but with differences. Our focus is on selection as well as timing skills of actively managed domestic bond mutual fund returns rather than just timing. We exclude specialized bond mutual funds where idiosyncratic factors like collateral, taxes, inflation, and foreign exchange rates could apply. Our sample period spans a more recent though shorter 1999 to 2016 period, compared to their 1962 to 2007 study. We use the Fama-French (1993) 5-factor model to describe the common variation in returns across all bond mutual funds rather than assign bond mutual funds to style specific benchmarks. Of the nine Chen et al. (2010) factors – short interest rate, term slope, curvature, credit spread, mortgage spread, liquidity spread, U.S. dollar, equity values, and equity volatility - we eliminate short interest rate (captured in three of five Fama-French (1993) factors) as well as mortgage spread and U.S. dollar (we have no mortgage or international bond funds). Of the remaining six factors, term slope and credit spread correspond to the term and default factors in the Fama-French (1993) 5-factor model. We consider the four remaining timing factors and their interactions with the Fama-French (1993) 5-factors for trading or changes in portfolio holdings associated with better information about forward looking conditions and issue-specific changes in credit risk or supply-demand imbalances. Additionally, squares of variables were used to proxy for non-linearities in bond mutual fund returns, although these were ultimately eliminated in the model selection process. We use all bond return factors collectively rather than as separate individual factors to determine a single best parsimonious 12-factor model. To do so, given our large number of potential regressors, we implement a LAR LASSO (Tibshirani, 1996; and Efron et al., 2004) procedure. This model constrains coefficients, shrinks select coefficients toward to zero, and continues coefficient shrinkage to reduce standard error in coefficient estimates. Finally, rather than bootstrap residual returns as in Chen et al. (2010), we bootstrap simulated returns across months following Fama and French (2010), addressing cross-correlations in returns when the model does not capture all common variation. In this process, we provide strong evidence that, even net of costs, bond mutual fund managers exhibit "investment" selection and timing ability more likely to be related to selectivity than timing.[5]

Using the Morningstar Mutual Funds Database, a second related study by Cici et al. (2012) examines quarterly holdings of domestic, fixed-coupon, non-convertible corporate bonds by 746 corporate bond mutual funds over the period 1995 to 2007. For this select set of corporate bonds with traded prices, time-series of monthly returns over the sample period are used to compute the attribution of quarterly holdings returns to selection, timing, and style.[6] At the fund level, quarterly holdings return is the sum of the value-weighted returns from selection, timing, and style. Over the

[5]In Chen et al. (2010), bond mutual funds are assigned to one of seven benchmarks based on a fund's declared style; nine timing related bond return factors are considered separately; piece-wise linear functions of bond return factors are used to capture non-linearities in bond mutual fund returns; mimicking portfolios are used to replicate the non-linearities in bond mutual fund returns; and simulated portfolio returns are generated by bootstrapping residual errors on demeaned bond mutual fund returns. Chen et al. (2010, Table 6, p. 85) find 14% to 22% of bond mutual funds have returns net of expenses above the zero value achieved by half of bond mutual funds. For the bottom 5% of bond mutual funds, 73% to 81% have less negative returns net of expenses; for the upper 5% of bond mutual funds, 1% to 5% have more positive returns net of expenses. Controlling for non-linearities, there is some evidence that bond mutual fund managers exhibit "investment" (selection and timing) ability that is more likely to be related to selectivity than timing.

[6]Return attribution uses the algebraic identity:

$$w_{b,t-1}R_{b,t} \equiv w_{b,t-1}\left(R_{b,t} - R_t^{P_{b,t-1}}\right) + \left(w_{b,t-1}R_t^{P_{b,t-1}} - w_{b,t-5}R_t^{P_{b,t-5}}\right) + w_{b,t-5}R_t^{P_{b,t-5}}$$

where $w_{b,t-1}$ and $w_{b,t-5}$ represent the value of a domestic, fixed-coupon, non-convertible bond b as a percentage of the total value of domestic, fixed-coupon, non-convertible bonds at quarter-end $t-1$ and year prior quarter-end $t-5$, $R_{b,t}$ is the buy-and-hold return on the domestic, fixed-coupon, non-convertible bond b over quarter t, and $R_t^{P_{b,t-5}}$ is the buy-and-hold return over quarter t on one of 35 benchmark credit rating-duration sorted portfolios of domestic, fixed-coupon, non-convertible bonds that has an average credit rating and duration closest to domestic fixed-coupon, non-convertible bond b.

sample period, the combined contribution of selection and timing to annualized quarterly holdings returns are notably small in magnitude and suggest quarterly changes in holdings are relatively few. Annualized quarterly returns of 6.64% and 8.01% on prior year holdings of investment and speculative grade bonds are attributable to style.[7] For investment grade bonds, selection contributes 27 bps to annualized quarterly holdings returns. For speculative grade bonds, selection and timing contribute -47 bps and 49 bps to annualized quarterly holdings returns. Considering that quarterly holdings returns reflect short-term returns on trading in over-the-counter markets dominated by institutions who are sophisticated and well-informed, these findings are unsurprising (Cici et al. p.161-162).

Our study focuses on the longer-term total returns from all fund holdings rather than shorter-term returns restricted to traded fund holdings of domestic, fixed-coupon, non-convertible bonds. Nonetheless, our results corroborate the Cici et al. (2012) finding that active management is more important for investment grade than speculative grade corporate bond funds. When our sample of corporate bond mutual funds is stratified by average credit rating and corporate bond mutual funds with no credit ratings are excluded, only investment grade rated corporate bond mutual funds exhibit significant positive precision-adjusted alphas on returns net of expenses. From timing for AA rated corporate bond mutual funds, and from both selection and timing for BBB rated corporate bond mutual funds.

II. Sample Selection and Benchmark Returns

A. Sample

Our sample of U.S. open-end actively managed domestic bond mutual fund monthly returns is drawn from the *CRSP* Survivor-Bias-Free Mutual Fund Database. This database provides monthly returns on all types of open-end mutual funds, including bond funds, starting December 1961. To be included in our study, we consolidate different classes of the same fund by CRSP Mutual Fund αDatabase variable CRSP_CL_GRP. This variable is only available from August 1998, and data are

---

[7]The return gap, which is difference between a fund's reported returns and its quarterly holdings returns, reflects the return from investments in securities other than fixed-coupon, non-convertible bonds. Reported fund holdings in Table 1 (p. 165) show sizeable investments in domestic and foreign government, foreign corporate, municipal, convertible, and asset-backed bonds as well as common and preferred stock.

available through December 2016. We start our study with January 1999, and end December 2016, because our primary tests use returns over the entire sample period of 216 months, and our secondary tests rely on returns over non-overlapping 3-year calendar windows. We combine mutual fund-month observations with more than one share class into a single consolidated mutual fund-month observation, like Kosowski et al. (2006) and French (2008). For each fund, we estimate consolidated fund returns by summing value-weighted (VW) returns of each share-class, whether load, no-load, or institutional, where value-weights are based on the proportion of each share-class to total net assets at month start.

The CRSP Survivor-Bias Free Mutual Fund Database monthly returns data item starts with the product of Net Asset Value at month t (NAV_t) times an adjustment factor ($cumfact_t$). The adjustment factor accounts for reinvested dividends and/or splits. It also sets the first observation to a value of 1. CRSP then divides the product by NAV_{t-1} and subtracts 1. The CRSP monthly returns data item is therefore net of management expense and 12b fees. This is what we mean by monthly net returns. Similarly, we define monthly gross returns as monthly net returns minus the ratio of the annual expense ratio divided by 12.[8]

The *CRSP* Style Code combines mutual fund data at four levels of increasing granularity. Relevant *CRSP* Style Codes include: at Level 1, Fixed Income (I); at Level 2, Fixed Income Corporate (IC), and Fixed Income Government (IG); at Level 3, Fixed Income Corporate Quality (ICQ), Fixed Income Corporate Duration (ICD), and Fixed Income Government Duration (IGD); and at Level 4, Fixed Income Corporate Quality High Quality (ICQH), Fixed Income Corporate Quality Medium Quality (ICQM), Fixed Income Corporate Quality High Yield (ICQY), Fixed Income Corporate Duration Short (ICDS), Fixed Income Corporate Duration Intermediate (ICDI), Fixed Income Government Duration Short (IGDS), and Fixed Income Government Duration Intermediate (IGDI).

We exclude Fixed Income Municipal (IU), Fixed Income Government TIPS (IGT), Fixed

[8] Trading costs associated with investing in individual actively managed bond mutual funds, including front and rear loads actually incurred, are not included in our analysis owing to potential error, bias, and lack of reporting. Appendix A of Fama and French (2010) uses passively managed benchmarks with similar styles to those of actively managed equity funds to check estimated differences associated with trading costs and find such differences negligible. We assume the same for actively managed bond mutual funds.

Income Money Market (IM), Fixed Income Foreign (IF) funds, Mixed Fixed Income and Equity (M), and Other Mortgage-Backed (OM) mutual funds. We do so because factors other than those typically used to explain variation in the cross-section of bond returns, such as collateral, taxes, inflation, foreign exchange rates, and other determinants of bond returns, likely apply to such funds. We also exclude indexed bond mutual funds because our focus is on actively managed mutual bond funds. Our sample retains mutual funds that fit *CRSP* Style Codes Bonds (I), Corporate Bonds (IC), Government Bonds (IG), Investment Grade Corporate Bonds (ICQH), and High Yield Corporate Bonds (ICQY).

We construct our sample using an approach that mitigates potential mutual fund incubation bias, i.e. too many funds with short histories. As in Fama and French (2010), we delete funds with AUM less than $5 million in 2006 dollars. We require each fund to have at least 12 observations throughout the sample period with observations from at least 5 different years because we employ a 12-factor model to capture timing in bond fund returns. We stratify funds by AUM into discrete categories: small ($5-$250 million AUM), mid-size ($250-$750 million AUM), and large (AUM>$750 million), where AUM is always expressed in 2006 dollars.

We merge *CRSP* Mutual Funds and Morningstar Direct data to obtain additional information on benchmarks. Average effective duration is a proxy for maturity used in prior literature, and average credit rating, a proxy for credit default risk. Unlike prior literature, we do not drop observations for government bond funds with missing average duration or corporate bond funds with missing average credit rating. These funds account for about one third of our sample and could be systematically different from others in their use of derivatives to hedge interest rate or default risk.[9]

B. *Summary Statistics*

Table 1 shows the number of observations and data coverage of the sample. Our requirement that there be at least 12 observations and 5 years of data reduces the total number of potential bond mutual funds by about 36% overall, or 32% for government bond funds and 42% for corporate bond funds. Although the total overall number of funds at the beginning and end of the sample period is

[9]Morningstar Direct states missing average fund duration and credit rating data are attributable to fund reporting. Whether or not funds report this information for a given period is voluntary on the part of the fund manager.

almost unchanged (316 and 319), there is an 18% rise in the number of government bond funds and 24% decline in the number of corporate bond funds. Average AUM increased about 61% over the 18-year sample period, from $671 million to $1.081 billion (in 2006 dollars). Differences between VW and equal weight (EW) returns indicate gross and net returns are lower for large funds across the entire sample, as well as for government and corporate bond funds.

<Insert Table 1 here.>

Summary statistics on monthly gross and net returns across all funds, government and corporate, are reported in Table 2 Panel A. As expected, mean (median) returns and standard deviations are higher for corporate than government bond mutual funds, government bond mutual funds with longer average duration, and corporate bond mutual funds with lower average credit rating.

Differences between mean and median returns suggest bond mutual fund returns are positively skewed across the sample. Returns on government bond mutual funds are also positively skewed but returns on intermediate (5-10 year) and long (10-30 year) average effective duration government bond funds are negatively skewed. Returns on corporate bond mutual funds are negatively skewed for all but the highest investment grade (AAA) average credit rated corporate bond mutual funds, which are positively skewed.

<Insert Table 2 here.>

C. Benchmark Returns

To examine whether actively managed bond mutual funds create significant total precision-adjusted alpha on a returns net of expenses basis from selection and timing, we first employ the Fama-French (1993) 5-factor bond returns model. Summary statistics and a correlation matrix for factors for this model are reported in Table 2 Panel B. Observe that *MKTRF*, the difference between monthly value-weighted *CRSP* returns and lagged one-month T-Bill rates, is strongly correlated with the other four factors. As in Fama and French (1993), we use *RMO*, the orthogonal projection of *MKTRF* on the other factors, as our proxy for excess market return.

$$R_{i,t} - RF_t = a_i + b_i RMO_t + s_i SMB_t + h_i HML_t + m_i TERM_t + d_i DEF_t + \varepsilon_{i,t} \qquad (1)$$

In (1), *R* denotes monthly bond fund returns, and *RF* is the one-month T-Bill rate. *MKTRF*, *SMB*, *HML* proxy for the risk factors in equity returns. In integrated securities markets, these risk factors should also affect bond returns. *MKTRF* is the value-weighted *CRSP* monthly return minus lagged one-month T-Bill rate. *SMB* is the difference in monthly returns between stocks with market capitalization above and below the NYSE median. *HML* is the difference in monthly returns between stocks with book-to-market equity ratios in the top and bottom 30% of the NYSE. *RMO* is the orthogonal linear projection of *MKTRF* on *SMB* and *HML*, as well as *TERM* and *DEF*.

TERM and *DEF* proxy for economic shocks to term structure and default risk that affect discount rates. *TERM* is the difference in monthly returns between long-term treasuries and the one-month lag T-Bill rate. *DEF* is the difference in monthly returns between corporate and long-term treasury bonds.

We make use of the following factors proposed in Chen et al. (2010) to account for timing in bond mutual fund returns: (*i*) market liquidity, *MKTLIQ*; (*ii*) equity volatility, *EQVOL*; and (*iii*) price-to-dividend ratio, *PRC/DIV*. *MKTLIQ* and *EQVOL* proxy for economic shocks to discount rates from changes in liquidity and equity risks. *PRC/DIV* proxies for economic shocks to cash flow and dividends. *MKTLIQ*, is the difference between 3-month non-financial commercial paper rates and 3-month Treasury yields. *EQVOL* is the one-month lag demeaned *CBOE* implied volatility index (VIX-OEX). *PRC/DIV* is an equity market valuation factor measured as the one-month lag demeaned price/dividend ratio for the *CRSP* value-weighted index.

Timing variables are demeaned and lagged values interacted with *TERM* and *DEF*. Coefficients on interaction terms reflect the effect on expected returns from predictive values of demeaned timing variables used to forecast following month *TERM* and *DEF*. In addition to timing, we consider potential non-linearities in returns using squared terms for *TERM*, *DEF*, and timing variables. However, non-linearities in returns turn out to be unimportant in forming our benchmark model to evaluate precision-adjusted alpha from selection.

To identify the best and most parsimonious model given our large number of potential regressors, we implement a LAR LASSO (Tibshirani, 1996; and Efron et al., 2004) procedure. This model constrains coefficients, shrinks select coefficients toward to zero, and continues coefficient shrinkage to reduce standard error in coefficient estimates. Further, in a 5-fold cross validation procedure, data are randomly divided into five equal-sized samples. Four samples are used to fit the model, and the fitted model is used to obtain prediction errors for the hold-out sample. An out-of-sample test is repeated for all five sub-samples. Prediction errors are combined to compute a 5-fold cross validation error. The model with the lowest validation error is deemed best. For parsimony, we selected the best 10 factors determined by the LAR LASSO procedure. Although *HML* and *SMB* were not among the 10 best factors that were part of our 5-factor model, we added them back to obtain the 12-factor benchmark model shown in (2).

$$\begin{aligned} R_{i,t} - RF_t = {} & a_i + b_i RMO_t + s_i SMB_t + h_i HML_t + m_i TERM_t + d_i DEF_t \\ & + \gamma_1 MKTLIQ_{t-1} + \gamma_2 MKTLIQ_{t-1} \cdot TERM_t + \gamma_3 MKTLIQ_{t-1} \cdot DEF_t \\ & + \gamma_4 \left(\frac{PRC}{DIV}\right)_{t-1} \cdot TERM_t + \gamma_5 \left(\frac{PRC}{DIV}\right)_{t-1} \cdot DEF_t \\ & + \gamma_6 \, EQVOL_{t-1} \cdot TERM_t + \gamma_7 \, EQVOL_{t-1} \cdot DEF_t + \varepsilon_{i,t} \end{aligned} \tag{2}$$

In (1), intercept terms a_i on gross and net returns represent average total excess returns from selection and timing; in (2), they represent average excess returns from selection. Differences between intercept terms for (1) and (2) represent average excess returns from timing.

The first two rows of Table 3 Panel A report the equal-weighted (EW) and value-weighted (VW) average excess returns across all, government, and corporate bond funds. For EW returns, annualized average excess gross returns, CONST*12: Gross Returns, is 1.3% across all funds, and 1.2% and 1.6% for government and corporate bond funds, respectively. EW average gross returns are statistically significant across all funds, including government and corporate bond funds. Annualized EW and VW average excess net returns, CONST*12: Net Returns, are positive but not statistically significant. Results based on parametric *t*-statistics suggest bond mutual funds generate positive gross returns but returns net of expenses are not statistically significantly different than zero.

<Insert Table 3 here.>

In Table 3 Panel A, *TERM* coefficients and associated *t*-statistics in the 5-factor benchmark model suggest *TERM* has the highest and most significant impact on monthly excess returns from the combined effect of selection and timing skill. The percent change in EW excess returns for each percent change in *TERM* is 0.33 for the entire sample, and 0.30 and 0.37 for government and corporate bond funds.

DEF coefficients suggest *DEF* has the second-highest impact. The percent change in EW net returns for each percent change in *DEF* is 0.20 for the entire sample, and 0.09 and 0.41, for government and corporate bond funds. VW net returns for each percentage change in *DEF* resemble those based on EW net returns. These results are consistent with our expectation that *DEF* is more important in explaining corporate than government bond fund returns.

RMO has the third-highest impact. The EW percent change in net returns for each percent change in *RMO* is 0.03 for the entire sample, and 0.05 for corporate bond funds, statistically significantly different from zero at the 1% level. For government bond funds, the EW *RMO* coefficient is not statistically different from zero. These results are consistent with the view that economic factors that impact equity risk will most affect corporate rather than government bond fund returns.

VW slope coefficients for *TERM*, *DEF*, and *RMO* resemble those based on EW, but are slightly larger in magnitude, and, in the case of government bond funds, the coefficient on *RMO* is statistically significantly different from 0 at the 5% or greater level. Although EW and VW slope coefficients for *SMB* and *HML* are not significant at the aggregate level, these equity risk factors could help explain bond fund returns at the individual fund level.

From the 12-factor benchmark model in Table 3 Panel B, *TERM* coefficients and related *t*-statistics suggest *TERM* has the highest and most significant impact on excess returns from selection. For EW returns, the percent change in excess returns from a percent change in *TERM* is 0.36 for the entire sample, and 0.33 and 0.41 for government and corporate bond funds. *DEF* and *RMO* are second and third highest in importance, positive and significant except for *RMO* on corporates. Magnitudes and statistical significance are generally similar for VW returns.

Furthermore, market timing variables matter. For EW returns, coefficients on $MKTLIQ_{t-1}$ are negative and significant except for government bond funds. However, for EW returns, the coefficients on $MKTLIQ_{t-1} \times DEF_t$ are not statistically significant. The coefficient on DEF_t is positive and statistically different from zero, as is the coefficient on the interaction term $PRC/DIV_{t-1} \times TERM_t$. Results for VW and EW returns are similar.

In contrast to the 5-factor benchmark model, for EW and VW returns, annualized average excess gross and net returns are positive and statistically significant across all funds, as well as government and corporate bond funds. Although total annualized net returns shown in Panel A are not statistically significant, results in Panel B suggest active bond mutual fund managers possess selection skill.

III. Bootstrap Approach

To test whether realized (actual) alphas in fund returns are nonzero, we bootstrap simulated returns. Bootstrapped simulated returns have the properties of actual fund returns, except that a fund's actual alpha is set to zero for every fund. For the 5- and 12-factor benchmark model, we estimate alpha for each fund using monthly observations over the sample period January 1, 1999 to December 31, 2016 as a proxy for its true alpha. For each bond mutual fund, estimated alpha is subtracted from monthly returns to obtain demeaned monthly returns. In subsequent discussion, we assess the effect of uncertainty about true alpha on bootstrap simulations.

Using demeaned monthly fund returns, a simulation run is a random sample with replacement of 216 months, drawn from January 1999 to December 2016. In each simulation run, we estimate bootstrapped alpha for each fund using the 5- or 12-factor benchmark model, dropping funds that do not have the requisite number of observations needed for regressions. Each simulation run produces a cross-section of bootstrapped precision-adjusted alphas.

Our 10,000 simulation runs maintain the same number of months.[10] Because a simulation run is the same random sample of months for all funds, simulations capture the cross-correlation of fund returns and their effects on the distribution of precision-adjusted alphas. Additionally, joint sampling of fund and explanatory returns captures any correlated heteroskedasticity of explanatory returns and

[10]See Fama and French (2010, p.1925). Kosowski et al. (2006) introduce a potential bias by simulating funds rather than months.

benchmark model residual errors. Further, because a fund may not be in the sample over the entire January 1999 to December 2016 period, the distribution of precision-adjusted alpha will depend on the number of months funds are in a simulation run through its degrees of freedom. Distributions of precision-adjusted alpha for funds that are oversampled in a simulation run will have more degrees of freedom (and thinner extreme tails) than distributions of actual precision-adjusted alpha on observed fund returns. Our focus on precision-adjusted alpha rather than alpha controls for differences in economic and statistical significance due to differences in residual variance and in the number of months that funds are in a simulation run. Over- and under-sampling of fund returns within a simulation run will tend to balance over the 10,000 runs used to make inferences.

Note that setting true alpha equal to zero on gross and net fund returns implies different assumptions about skill in tests. For net returns, setting true alpha to zero assumes managers have sufficient skill to generate expected returns that cover all costs. In contrast, setting true alpha to zero for gross returns assumes managers have just enough skill to produce expected returns to cover all costs except those reported as expenses.

A. *Distribution of Actual and Simulated Precision-Adjusted Alpha on All Bond Mutual Funds*

We apply a Fama and French 5-factor model of bond returns-like model to bond mutual funds to capture precision-adjusted alpha from the combination of selection and timing. A second 12-factor benchmark model that includes seven additional factors from Chen et al. (2010) to proxy for timing in bond fund returns captures precision-adjusted alpha from selection. We use 10,000 bootstrap simulations of monthly bond fund gross and net returns, assuming true alpha is zero, to estimate precision-adjusted alpha for each fund. We compare average simulated precision-adjusted alpha with actual precision-adjusted alpha on gross and net returns, percent of simulated precision-adjusted alpha below actual precision-adjusted alpha, and the parametric probability that statistically positive (negative) actual precision-adjusted alpha indicates good (bad) performance.

Our bootstrap analysis initially focuses on our entire sample of bond funds. Subsequently, we examine the potential effect of asset specialization in government or corporate bonds, assets under management (AUM), average effective fund duration for government bond funds, average fund credit rating for corporate bond funds, and short-run horizons, on precision-adjusted alpha.

Table 4 reports simulated and actual precision-adjusted alpha at each percentile across all bond mutual funds sorted by precision-adjusted alpha. Results in columns 1 to 4 are for the 5-factor model using gross returns. For example, at the first percentile, average simulated precision-adjusted alpha of -2.58 is worse than actual precision-adjusted alpha of -1.84. Moreover, 85.1% of simulated observations are worse than actual. Based on bootstrap results, active fund management reduces the magnitude and likelihood of negative precision-adjusted alpha. The parametric *p*-value of 0.03 at the first percentile shows precision-adjusted alpha of -1.84 to be statistically significant, yielding an opposite inference about the value of active fund management. At the 20^{th} percentile, actual precision-adjusted alpha of 0.48 beats an average simulated precision-adjusted alpha of -0.96, and 99.6% of simulated observations are less than actual. But the parametric *p*-value of 0.32 fails to identify the superiority of actual over simulated precision-adjusted alpha. A percent simulated precision-adjusted alpha less than actual precision-adjusted alpha of 80% implies that actual precision-adjusted alpha is four times more likely to be greater than simulated precision-adjusted alpha.

<Insert Table 4 here.>

Results in columns 9 through 12 for the 5-factor model using net returns confirm that parametric tests bias against finding outperformance. Negative precision-adjusted alpha is more likely to be statistically significant, and positive less likely to be statistically significant. At the 1^{st} percentile, an actual precision-adjusted alpha of -3.27 is worse than average simulated precision-adjusted alpha of -2.58, and only 16.9% of simulated observations are worse than actual. At this percentile, the parametric *p*-value correctly identifies actual as bad performance. But at the 10^{th} through 50^{th} percentile, *p*-values fail to recognize outperformance. Actual precision-adjusted alpha is positive, and the percentage that simulated precision-adjusted alpha less than actual at least 80.2%. At the 60^{th} through 99^{th} percentile, parametric tests correctly show that actual precision-adjusted alpha is positive and statistically significant.

In short, the 5-factor benchmark model shows positive and significant precision-adjusted alpha on gross returns at all percentiles, and on a net returns basis, for the top 10th through 99th percentiles. Importantly, Table 4 shows parametric tests produce 'false negatives'. Negative precision-adjusted alpha is more likely to appear statistically significant when it is not significant, and positive precision-adjusted alpha is less likely to appear statistically significant when it is significant.

Results for the 12-factor model on gross returns in columns 5 through 8, and on net returns in columns 13 through 16, corroborate prior conclusions. Results for all sample bond funds suggest that adjusting returns for timing, selection generates significant precision-adjusted alpha. On gross returns, actual precision-adjusted alpha exceeds simulated precision-adjusted alpha in the 20th to 99th percentiles, and in the 30th to 99th percentiles on net returns.

Again, parametric statistics understate outperformance. Statistically significant negative precision-adjusted alpha in the 1st to 5th percentiles on gross returns, and 1st to 10th percentiles on net returns, falsely imply poor overall and selection performance, respectively. Statistically insignificant positive precision-adjusted alpha in the 10th to 40th percentiles on gross returns, and 20th to 60th percentiles on net returns, fail to detect good performance.

The cumulative and probability density functions of estimated simulated and actual precision-adjusted alpha at each percentile across all bond mutual funds for the 5- and 12-factor benchmark models using gross returns are shown in Figure 1. Results based on net returns are depicted in Figure 2. These figures portray both on a gross return and net return basis that bond fund managers possess overall skill, and skill that stems from selection.

<Insert Figures 1 and 2 here.>

B. Uncertainty about True Alpha

Our bootstrap simulations are predicated on the assumption that fund realized (actual) alpha is a proxy for its true alpha. To assess the impact of this assumption, we repeat simulations with random injections of alpha into each fund's demeaned 5- or 12-factor benchmark returns. Specifically, for each simulation run, we randomly draw an alpha from a normal distribution with mean 0 and annual (standard deviation) σ. Recognizing that more diversified funds may have less leeway to generate true alpha, randomly drawn alpha is scaled by the residual standard error from the fund's 5- or 12-factor benchmark regressions scaled by the average standard error from the same benchmark regression for all funds. We add the scaled alpha to the fund's demeaned 5-factor or 12-factor benchmark returns.

We then randomly draw with replacement a sample of 216 months, and for each fund estimate 5- or 12-factor benchmark regressions to compute precision-adjusted alpha. Effectively, these simulations use returns that have the properties of actual fund returns, except that for each fund realized (actual) alpha is replaced with an alpha drawn from a known distribution of true alpha that is normal with mean zero and annual (standard deviation) σ. We perform 10,000 simulations per run, and each fund gets a new drawing of alpha each run. To examine power, we vary the annual standard deviation σ of true alpha from 0.25% to 1.75% in steps of 0.25%.

Kernel distributions for actual and simulated alpha on net and gross returns from estimated 5- and 12-factor benchmark models are shown in Figure 3. The distributions, which exhibit significant negative skewness and positive kurtosis, are far from normally distributed. The annual σ of simulated alpha for the 5- and 12-factor benchmark is 2.70% and 19.61% respectively.[11]

<Insert Figure 3 here.>

Table 5 shows the cross-section of precision-adjusted alpha estimates for actual net returns at each percentile from Table 4. For each value of annual σ for injected alpha, the table reports average simulated precision-adjusted alpha estimates and percentage of precision-adjusted alpha less than actual by percentile from 10,000 simulation runs. We use these results to draw inferences about the amount of dispersion in true alpha that would be too extreme. Specifically, what annual σ of true alpha is necessary to make the cross-section of average simulated precision-adjusted alpha resemble that of actual fund precision-adjusted alpha? Our interest is in the values of annual σ that match the extreme tails of precision-adjusted alpha estimates for actual net returns. Because the normality assumption for true alpha is an approximation, we do not expect a single value of annual σ to completely capture the tails of the precision-adjusted alpha estimates for actual net returns.

[11]Figure 3 shows monthly standard errors of simulated α for the 5- and 12-factor benchmark models of 0.78% and 5.66%.

<Insert Table 5 here.>

From Table 5 Panel A for the 5-factor benchmark on net returns, the cross-section of simulated precision-adjusted alpha approximates actual precision-adjusted alpha at the lower and upper tails of the distribution at threshold annual σs of 0.50% and 1.25% respectively. An injected annual σ of 0.75% is necessary to make simulated precision-adjusted alpha worse than actual at the lower tail. The percent simulated less than actual precision-adjusted alpha ranges from 73.9% to 97.7% between the 1st and 10th percentiles, consistent with simulated precision-adjusted alpha being more likely to be less than actual precision-adjusted alpha at the lower tail. But at the upper tail, an injected annual σ of 1.75% is necessary to make simulated precision-adjusted alpha better than actual precision-adjusted alpha. The percent simulated less than actual precision-adjusted alpha ranging from 47.8% to 4.1% at the 90th to 99th percentiles is consistent with simulated precision-adjusted alpha being more likely to be higher than actual precision-adjusted alpha at the upper tail.

For the 12-factor benchmark, the cross-section of simulated precision-adjusted alpha approximates actual precision-adjusted alpha at the lower and upper tails of the distribution at threshold annual σ of 0.50% and 1.25%, respectively. An injected annual σ of 0.75% is necessary to make simulated precision-adjusted alpha worse than actual at the lower tail. The percent simulated less than actual precision-adjusted alpha ranges from 82.6% to 75.1% at the 1st to 10th percentiles, consistent with the simulated precision-adjusted alpha being more likely to be less than actual precision-adjusted alpha at the lower tail. But at the upper tail, an injected annual σ of 1.75% is necessary to make simulated precision-adjusted alpha better than actual. The percent simulated less than actual precision-adjusted alpha ranges from 70.4% to 18.8% at the 90th to 99th percentiles, consistent with the simulated precision-adjusted alpha being more likely to be higher than actual precision-adjusted alpha at the upper tail.

For the 5-factor benchmark, the annual σ at the upper tail of simulated alpha from combining an annual σ of 2.70% from measurement error and lower bound on dispersion in true alpha of 1.75% is 3.22% (or 0.93% per month). Similarly, for the 12-factor benchmark, the annual σ at the upper tail of simulated alpha from combining an annual σ of 19.61% from measurement error and lower bound on the dispersion in true alpha of 1.75% is 19.68% (or 5.68% per month). The combined monthly standard errors for the 5- and 12-factor benchmark models are 7.7 (= 0.93/0.12) and 21.0 (= 5.68/0.27) times the monthly standard error of actual alpha. Our bootstrap simulations have considerable statistical power.[12]

IV. Asset Specialization and AUM

To assess potential effects of asset specialization and fund size on bond mutual fund performance, we focus on net returns. For asset specialization, we differentiate between government and corporate bond mutual funds. Among government bond mutual funds, we examine short (0-5 year), intermediate (5-10 year), long (10-30 year), and missing average effective duration funds. Among corporate bond mutual funds, we stratify by credit rating. AAA denotes corporate mutual funds with average credit ratings of AAA (AAA to AAA- if rated by S&P, or Aaa if rated by Moody's), AA (AA+ to AA-, or Aa1 to Aa3), A (A+ to A-, or A1 to A3), B (BAA+ to BBB-, or Baa1 to Baa3), and LG (BB+ or lower, or Ba1 or lower). For fund size, we categorize funds by AUM into small ($5M to $250M AUM), mid-size ($250M to $750M AUM), and large (AUM> $750M).

A. Government vs. Corporate Bond Mutual Funds

Actual and average simulated precision-adjusted alpha for government and corporate bond mutual funds by percentile are reported in Table 6. For government bond funds, the 5-factor model shows significant positive precision-adjusted alpha from the 20th to 99th percentile, and the 12-factor model, from the 50th to 99th percentile. Selection and timing in government bond mutual funds generate significant positive precision-adjusted alpha. Additionally, comparison of magnitudes of precision-adjusted alpha from the 5- and 12-factor models suggests selection is relatively more important than timing in government bond mutual fund returns. For corporate bond funds, the 5-factor model shows significant positive precision-adjusted alpha from the 20th to 99th percentile, and the 12-factor model from the 30th to 99th percentile. Selection as well as timing are important in corporate bond mutual fund performance.

[12]From Figure 3, the monthly standard errors of actual α for the 5- and 12-factor benchmark models are 0.12% and 0.27%.

<Insert Table 6 here.>

B. Small vs. Large AUM Bond Mutual Funds

Actual and average simulated precision-adjusted alpha for bond mutual funds stratified by AUM are reported in Table 7. The 5-factor benchmark model shows significant positive precision-adjusted alpha from the 20th to 99th percentile for small funds, 30th to 99th percentile for mid-size funds, and 4th to 99th percentile for large funds. In the 12-factor benchmark model, there is significant positive precision-adjusted alpha from the 20th to 99th percentile for small funds, 50th to 96th percentile for mid-size funds, and from the 60th to 97th percentile for large funds. Selection is less important for most percentiles of small-size funds, and for mid-size and large funds. Timing is important across all fund sizes.

<Insert Table 7 here.>

C. Government and Corporate Bond Mutual Funds by AUM

Actual and average simulated precision-adjusted alpha on government and corporate bond mutual funds stratified by AUM are reported in Table 8. For government bond mutual funds, there is significant positive precision-adjusted alpha in the 5-factor benchmark model from the 90th to 99th percentile for small funds, 90th to 98th percentile for mid-size funds, and 90th to 97th percentile for large funds. In the 12-factor benchmark model, there is significant positive precision-adjusted alpha from the: 90th to 98th percentile for small and large funds, and 90th to 96th percentile for mid-size funds. For the top performing 10% of government bond mutual funds, selection and timing are important across all fund sizes.

<Insert Table 8 here.>

For corporate bond mutual funds, there is significant positive precision-adjusted alpha in the 5-factor benchmark model from the 90th to 99th percentile of small and mid-size bond mutual funds, and 90th to 98th percentile for large funds. In the 12-factor benchmark model, there is significant positive precision-adjusted alpha from the 90th to 98th percentile for small funds, 90th to 95th percentile for mid-size funds, and 90th to 96th percentile for large funds. For most of the top performing 10% of corporate bond mutual funds, selection and timing are important across all fund sizes.

D. *Government Bond Funds by Maturity and Corporate Bond Funds by Credit Rating*

Actual and average simulated precision-adjusted alphas for government bond mutual funds categorized by short, intermediate, long, and missing duration are reported in Appendix Table 1. For short (0-5 year) average duration government bond funds, there is significant positive precision-adjusted alpha in the 90^{th} to 99^{th} percentile in the 5- benchmark model, and 90^{th} to 97^{th} percentile in the 12-factor benchmark return model. Selection and timing are both important for short duration government bond funds. For the intermediate (5-10 year) and long (10-30 year) duration government bond funds, the 90^{th} to 99^{th} percentile exhibit significant negative precision-adjusted alpha in the 12-factor benchmark model, suggesting selection detracts from performance among such funds.

Actual and average simulated precision-adjusted alpha for corporate bond mutual funds categorized as AAA, AA, A, BBB, Low Grade, and No Rating are reported in Appendix Table 2. Only the top 10% of corporate bond mutual funds in the AA, BBB, and 90^{th} to 96^{th} percentile of No Rating corporate bond mutual funds, show significant positive precision-adjusted alpha in the 5-factor benchmark model. For the top 10% of these funds, the only significant positive precision-adjusted alpha in the 12-factor benchmark model is in the BBB category. Selection and timing are important for BBB rated corporate bond mutual funds. However, for AA and No Rating corporate bond mutual funds, only timing contributes to outperformance – not selection skill.

V. Short-Run Performance

A limitation of much of the literature on performance persistence is that it tends overwhelmingly to focus on short-run returns (e.g. Carhart, 1997) to draw conclusions about mutual fund manager performance (Kosowski et al., 2006; Fama and French, 2010). To assess the robustness of our long-term 18-year performance results to short-term 3-year estimation horizons, we partition our sample into 6 non-overlapping contiguous sub-periods of 36 months. Using our 5- and 12-factor benchmark models, 3-year actual alphas are estimated for each bond mutual fund. Estimated alpha is subtracted from monthly returns for each 3-year sub-period to obtain demeaned monthly returns. Simulated returns have the properties of fund returns, except that a fund's actual 3-year alpha is set to zero for each fund for each 3-year sub-period.

Using demeaned monthly fund returns, each simulation run consists of six random samples with replacement of 36 contiguous calendar months for the period January 1999 to December 2016. For each simulation run, and for each fund, we estimate bootstrapped alpha over each sub-period using the 5- or 12-factor benchmark model, dropping funds that do not have the requisite number of observations needed for regressions. Each simulation run produces a cross-section of bootstrapped precision-adjusted alphas.

<Insert Table 9 here.>

Table 9 reports simulated and actual precision-adjusted alpha by percentile for all actively managed bond mutual funds, bond funds stratified by AUM, and government and corporate bond funds. Panel A reports results for 5-factor benchmark model, and Panel B for the 12-factor benchmark model. The top performing 10% of all sample funds generate significant positive precision-adjusted alpha in the 5-factor benchmark model. However, in the 12-factor benchmark model, precision-adjusted alpha in the top performing 10% of funds is either insignificant or negative. In the short-run, timing is the source of outperformance.

The top 90th to 98th percentile of small funds, 90th to 97th percentile of mid-size funds, and 90th to 97th percentile of large funds, generate significant positive precision-adjusted alpha for the 5-factor model. Similarly, the top 90th to 97th percentile of government bond funds, and 90th to 99th percentile of corporate bond funds, show significant positive precision-adjusted alpha for the 5-factor model. However, none of the top performing 10% of small, mid-size, large, government, or corporate bond funds generate significant positive precision-adjusted alpha for the 12-factor model, and the 97th to 99th percentile of small and 90th to 99th percentile of mid-size funds generate significant negative precision-adjusted alpha. In the short-run, timing is the source of outperformance regardless of fund asset specialization, i.e. government vs. corporate bond funds, or fund size.

VI. Economic Value (EV) from Active Bond Mutual Fund Management

To estimate the annualized excess alphas from active bond management, we multiply the difference between actual and average simulated precision-adjusted alpha in prior tables by the annualized median standard error of alpha. As shown in Figure 4, the distributions of standard errors of simulated alpha from 10,000 bootstrapped estimations of demeaned monthly bond fund returns are non-normal with significant skew. Unreported results for excess alphas using average standard error of simulated alpha are on average 9.3 bps of AUM higher but exhibit similar patterns.

<Insert Figure 4 here.>

In the 5-factor benchmark model, annualized excess alpha represents the combined contribution of selection and timing. In the 12-factor benchmark model, it represents the contribution of selection skill. At each percentile, annualized excess alpha is then applied against AUM to compute total economic value (EV) from active bond management. Table 10 reports EV aggregated across percentiles and expressed as a percentage of average AUM in basis points. Overall is the cumulative EV from the 1st to 99th percentile.

<Insert Table 10 here.>

Bear in mind that for the top performing half of funds, actual and average simulated precision-adjusted alpha is positive at upper deciles. A positive (negative) EV indicates actual precision-adjusted alpha is better (worse) than average simulated precision-adjusted alpha. For the bottom 20% of funds, actual and average simulated precision-adjusted alpha is negative at bottom deciles. A positive (negative) EV, which indicates actual precision-adjusted alpha is less (more) negative than average simulated precision-adjusted alpha, reflects the ability of active bond fund managers to reduce downside risk.

A. EV and All Bond Mutual Funds

Total EV is 30.2 bps on AUM for the top performing half of all actively managed bond funds. EV from selection is 19.7 bps, and from timing is 10.5 bps (i.e., the difference). Across deciles in the top performing half of bond funds, total EV generally increases with average AUM. The top performing 5% of bond funds, which have the largest average AUM of $1.028 billion, achieve the highest total EV of 39.3 bps. For the top performing 5% of bond funds, EV from selection is 19.9 bps, and from timing is 19.4 bps. For the bottom 20%, active management reduces downside risk. Total EV of 10.7 bps represents the gain from negative actual precision-adjusted alpha that are better than average simulated precision-adjusted alpha; EV from simulation is 5.9 bps, and from timing is 4.8 bps.

B. *EV and Government vs. Corporate Bond Mutual Funds*

A similar pattern holds for government and corporate bond mutual funds. Total EV is 25.1 bps and 37.0 bps, for the top performing half of government bond funds and corporate bond funds, respectively. EV from selection and timing are 19.0 bps and 6.1 bps for government bond funds, and 18.2 bps and 18.8 bps for corporate bond funds. Total EV is higher for corporate than government bond funds. The contributions from selection skill to performance for government and corporate bond funds are similar. Timing is less important for government than corporate bond funds.

Across deciles in the top performing half of bond funds, total EV increases with average AUM. The top performing 5% of government and corporate bond funds, which have the largest average AUM, achieve the highest total EV. For the top performing 5%, total EV is 36.7 bps and 43.5 bps for government and corporate bond funds. EV from selection and timing are 15.7 bps and 21.0 bps for government bond funds, and 21.2 bps and 22.3 bps for corporate bond funds. For the top performing 5%, total EV is higher for corporate than government bond funds. However, the contribution from selection skill to performance across upper deciles declines for government bond funds but rises for corporate bond funds. Selection skill is relatively less important than timing for government bond funds, but more important for corporate bond funds.

C. *EV and Large Bond Mutual Funds*

For the top performing half of large bond mutual funds, total EV of 28.3 bps is only 1.9 bps lower than total EV on all actively managed bond funds. The contribution from selection skill to EV for the top performing half of large fund is 40.8 bps, more than twice the EV from selection for the sample of all actively managed bond funds. For the top performing half of large funds, timing detracts

12.5 bps from performance. For the bottom 20% of large funds, active management reduces downside risk. Among these funds, total EV of 12.2 bps represents the gain from negative actual precision-adjusted alpha being better than average simulated precision-adjusted alpha, EV from selection of 19.4 bps shows that this gain is from selection, and EV from timing of negative 7.2 bps shows the amount timing detracts from overall performance.

Across deciles in the top performing half of bond funds, total EV increases initially with average AUM. At the top performing 5%, total EV of 25.7 bps is 2.6 bps lower than for the top performing half. EV from selection, increases with average AUM. For the top performing 5%, EV from timing is -34.1 bps, quantifying the amount by which timing detracts from the overall performance of these bond mutual funds.

In short, for large bond funds, long-term total EV on a net of expenses basis is primarily a result of selection. EV from timing is always negative.

VII. Concluding Remarks

Using a sample of U.S. open end actively managed domestic bond mutual funds between January 1999 and December 2016, this paper examines whether bond mutual fund managers possess selection and/or timing skill. We evaluate the contribution of selection and timing using 5- and 12-factor benchmark models of bond mutual fund returns.

Applying a bootstrap methodology, we show that bond mutual fund managers tend to generate significantly positive precision-adjusted alpha on a returns net of expenses basis. We quantify the extent to which precision-adjusted alpha on net returns are attributable to a combination of selection and timing skills. We show how economic value (EV) from investment ability varies by asset specialization, fund size, average duration among government bond funds, and average credit rating among corporate bond funds. We demonstrate that significant positive precision-adjusted alpha results are robust to short-term estimation windows using 3-year non-overlapping contiguous time horizons. Timing, not selection skill, is an important determinant of precision-adjusted alpha in the short-run. Selection skill is more important in long-run bond fund outperformance, but timing also matters in some categories of bond mutual funds. Comparing percentile-sorted actual against bootstrapped precision-adjusted alpha, we show that bond mutual fund managers possess skill, not just luck, and their investment abilities are attributable to a mix of selection and timing skills.

Over the long-run on a returns net of expenses basis, selection skill generates a significant portion of positive EV among top performing bond mutual funds. For the top performing half of sample bond funds, EV from selection of 40.8 bps is highest for large funds. EV from selection for the top performing half of government and corporate bond funds are similar, at 19 bps and 18.2 bps, respectively. For the top performing 5% of funds, EV from selection of 59.8 bps is highest for large bond funds. Compared to the top performing half of funds, EV from selection for the top performing 5% of government and corporate bond funds are 3.3 bps lower and 3.0 bps higher.

In contrast, timing skill detracts from performance for large bond funds. EV from timing for the top performing half and top performing 5% of large funds are -22.5 bps and -34.2 bps, respectively. However, timing generally contributes to the performance of government and corporate bond funds. For the top performing half of funds, EV from timing of 18.8 bps is highest for corporate bond funds, and EV from timing of 6.1 bps is lowest for government bond funds. For the top performing 5% of government and corporate bond funds, EV from timing are similar at 21.0 bps and 22.3 bps respectively.

REFERENCES

Admati, A., S. Bhattacharya, P. Pfleiderer, and S. Ross, 1986. On timing and selectivity. *Journal of Finance* 61, 715-732.

Blake, Christopher R., Edwin J. Elton, and Marin J. Gruber, 1993. The performance of bond mutual funds. *Journal of Business* 66, 371-403.

Chen, Yong, Wayne Ferson, and Helen Peters, 2010. Measuring the timing ability and performance of bond mutual funds. *Journal of Financial Economics* 98, 72-89.

Cici, Gjergji and Scott Gibson, 2012. The performance of corporate bond mutual funds: evidence based on security-level holdings. *Journal of Financial and Quantitative Analysis* 47, 159-178.

Edwards, A., L. Harris, and M. Piwowar, 2007. Corporate bond market transparency and transaction costs. *Journal of Finance* 62, 1421-1451.

Efron, Bradley, Trevor Hastie, Iain Johnstone, and Robert Tibshirani, 2004. Least Angle Regression. *Annals of Statistics*. 32, 407-499.

Elton, Edwin J., Martin J. Gruber, and Christopher R. Blake, 1995. Fundamental economic variables, expected returns, and bond fund performance, *Journal of Finance* 50, 1229-1256.

Elton, Edwin J., Martin J. Gruber, and Christopher R. Blake, 2001. A first look at the accuracy of the CRSP mutual fund database and a comparison of the CRSP and Morningstar mutual fund databases, *Journal of Finance 56, 2415-2430*.

Evans, Richard, 2010. Mutual fund incubation. *Journal of Finance* 65, 1581-1611.

Fama, Eugene F., and Kenneth R. French, 1993. Common risk factors in stock and bond returns. *Journal of Financial Economics* 33, 3-56.

Fama, Eugene F., and Kenneth R. French, 2010. Luck versus skill in the cross-section of mutual fund returns. *Journal of Finance* 65, 1915-1947.

Ferson, Wayne E., and Rudi W. Schadt, 1996. Measuring fund strategy and performance in changing economic conditions. *Journal of Finance* 51, 425-462.

Ferson, Wayne, Tyler Henry, and Darren Kisgen, 2006. Evaluating government bond funds using stochastic discount factors. *Review of Financial Studies* 19, 423-455.

French, Kenneth R., 2008. The cost of active investing. *Journal of Finance* 63, 1537-1573.

Gruber, Martin J., 1996. Another puzzle: The growth of actively managed mutual funds. *Journal of Finance* 51, 783-810.

Kosowski, Robert, Allan Timmermann, Russ Wermers, and Hal White, 2006. Can mutual fund “stars” really pick stocks? New evidence from a bootstrap analysis. *Journal of Finance* 61, 2551-2596.

Litterman, Robert, and Jose Scheinkman, 1991. Common factors affecting bond returns. *Journal of Fixed Income* 1, 54-61.

Tibshirani, R., 1996. Regression shrinkage and selection via the Lasso. *Journal of the Royal Statistical Society*, Series B 58, 267-288.

Table 1: Number, Assets Under Management, Equal and Value Weighted Returns of Bond Mutual Funds. This table reports the number, average assets under management (AUM), equal-weighted and value-weighted gross and net monthly returns of open-end actively managed bond mutual funds over the sample period January 1999 to December 2016. Different classes of the same fund are consolidated by AUM using the Center for Research in Securities Prices (*CRSP*) Mutual Funds Database variable CRSP_CL_GRP. Funds that reach at least $5 million in AUM (in 2006 dollars) are included. Net returns are *approximate* percent returns received by investors, defined as monthly net returns (i.e., net of expenses and 12b fees) minus the lagged one-month T-Bill rate, where gross returns are monthly net returns plus annual expense ratio/12. Gross and net returns are annualized and expressed as percentages. Panel A reports results for all funds, Panel B for government bond funds, and Panel C for corporate bond funds.

	Number of Bond Funds		Average AUM ($Mil) Bond Funds		Equal Weighted Gross Returns		Equal Weighted Net Returns		Value Weighted Gross Returns		Value Weighted Net Returns	
	≥ 1 obs	≥ 12 obs 5 yrs data	≥ 1 obs	≥ 12 obs 5 yrs data	≥ 1 obs	≥ 12 obs 5 yrs data	≥ 1 obs	≥ 12 obs 5 yrs data	≥ 1 obs	≥ 12 obs 5 yrs data	≥ 1 obs	≥ 12 obs 5 yrs data
Panel A: All Bond Mutual Funds (Government plus Corporate Bond Funds)												
All Years: 1999-2016	895	571	918.4	919.7	3.60	3.61	2.85	2.86	3.28	3.29	2.69	2.67
1999-2001	464	316	685.2	671.0	3.48	3.72	2.62	2.87	1.24	1.19	0.51	0.38
2002-2004	431	362	620.2	643.9	4.85	4.82	4.01	3.97	5.43	5.46	4.65	4.67
2005-2007	364	344	773.2	787.9	0.71	0.69	-0.08	-0.10	0.79	0.78	0.14	0.13
2008-2010	457	399	1,040.8	1,062.1	5.50	5.32	4.77	4.61	5.03	4.87	4.46	4.31
2011-2013	453	381	1,226.6	1,272.2	3.95	3.97	3.29	3.31	4.09	4.18	3.60	3.70
2014-2016	407	319	1,164.4	1,080.8	3.11	3.14	2.51	2.51	3.13	3.23	2.76	2.84
Panel B: Government Bond Mutual Funds												
All Years: 1999-2016	508	345	827.9	845.6	3.11	3.13	2.39	2.42	2.89	2.85	2.35	2.28
1999-2001	281	189	636.7	638.7	3.67	3.88	2.83	3.05	1.53	1.25	0.85	0.44
2002-2004	244	212	613.4	618.0	4.10	3.98	3.28	3.16	4.71	4.75	3.96	3.98
2005-2007	223	215	648.1	652.7	0.76	0.71	0.00	-0.05	0.82	0.80	0.24	0.23
2008-2010	278	257	933.3	952.2	4.51	4.40	3.83	3.74	4.64	4.60	4.16	4.12
2011-2013	280	254	1,155.6	1,181.7	3.17	3.23	2.54	2.61	3.32	3.32	2.89	2.89
2014-2016	270	223	980.3	1,030.2	2.44	2.59	1.86	2.01	2.33	2.37	1.97	2.01
Panel C: Corporate Bond Mutual Funds												
All Years: 1999-2016	387	226	1,079.8	1,055.2	4.44	4.51	3.64	3.69	3.86	4.00	3.20	3.32
1999-2001	183	127	756.5	718.1	3.20	3.50	2.32	2.61	0.80	0.81	0.01	0.00
2002-2004	187	150	629.4	681.3	5.86	6.04	4.98	5.14	6.40	6.48	5.59	5.66
2005-2007	141	129	982.5	1,019.5	0.64	0.66	-0.21	-0.19	0.82	0.82	0.09	0.09
2008-2010	179	142	1,218.7	1,262.3	7.13	7.00	6.33	6.20	5.25	5.20	4.57	4.52
2011-2013	173	127	1,352.7	1,453.5	5.33	5.47	4.61	4.72	5.48	5.71	4.92	5.14
2014-2016	137	96	1,539.1	1,196.7	4.48	4.38	3.82	3.66	4.40	4.96	4.01	4.51

[@]Trading costs associated with investing in individual actively managed bond mutual funds are not included, owing to potential error, bias, and lack of reporting. Appendix A of Fama and French (2010) uses passively managed benchmarks with similar styles as those of actively managed equity funds to check estimated differences associated with trading costs and finds such differences negligible. We assume the same for actively managed bond mutual funds.

Table 2: Bond Mutual Fund and the 5-Factor Model Return Summary Statistics and Correlation Matrix. Panel A reports the number of observations (NOBS), mean, median, and σ for monthly gross and net bond mutual fund returns for all funds, government bond funds by reported duration, and corporate bond funds by reported average credit rating, over the sample period January 1999 to December 2016. AAA denotes corporate mutual funds with average credit ratings of AAAs (AAA to AAA- if rated by Standard & Poor's, or Aaa if rated by Moody's), AA (AA+ to AA-, or Aa1 to Aa3), A (A+ to A-, or A1 to A3), B (BAA+ to BBB-, or Baa1 to Baa3), and LG (BB+ or lower, or Ba1 or lower). Panel B reports summary statistics for 5-factor model returns. MKTRF is the value-weighted *CRSP* monthly return minus lagged one-month T-Bill rate. SMB is the difference in monthly returns between stocks with market capitalization above and below the NYSE median. HML is the difference in monthly returns between stocks with book-to-market equity ratios in the top and bottom 30% of the NYSE. TERM is the difference in monthly returns between long-term treasuries and lagged one-month T-Bill rates. DEF is the difference in monthly return between corporate and long-term treasury bonds. RMO is the orthogonal linear projection of MKTRF on the other four factors. Panel C reports Pearson correlation coefficients for these variables. [a,b,c] denotes statistical significance of Pearson correlation coefficients at the 10%, 5%, and 1% level respectively.

		Monthly Gross Returns			**Monthly Net Returns**		
	NOBS	**Mean**	**Median**	**σ**	**Mean**	**Median**	**σ**
Panel A: Summary Statistics for Bond Mutual Fund Returns							
All Funds	65,013	0.0031	0.0026	0.0152	0.0024	0.0020	0.0152
Government	41,602	0.0026	0.0019	0.0151	0.0020	0.0014	0.0151
0 to 5 Years	19,401	0.0023	0.0019	0.0092	0.0017	0.0013	0.0092
5 to 10 Years	8,328	0.0028	0.0031	0.0169	0.0023	0.0026	0.0169
10 to 30 Years	2,539	0.0058	0.0051	0.0378	0.0054	0.0045	0.0378
Missing Duration	11,334	0.0022	0.0016	0.0128	0.0015	0.0010	0.0128
Corporate	23,411	0.0039	0.0044	0.0152	0.0032	0.0037	0.0152
AAA	183	0.0048	0.0045	0.0333	0.0040	0.0036	0.0333
AA	1,745	0.0030	0.0036	0.0128	0.0024	0.0030	0.0128
A	4,419	0.0037	0.0042	0.0148	0.0031	0.0036	0.0149
BBB	6,194	0.0041	0.0046	0.0156	0.0034	0.0038	0.0156
LG	2,592	0.0055	0.0061	0.0171	0.0047	0.0053	0.0171
No Rating	8,278	0.0034	0.0042	0.0141	0.0027	0.0035	0.0141
Panel B: Summary Statistics for 5-Factor Model Returns							
MKTRF	216	0.0043	0.0093	0.0444			
SMB	216	0.0037	0.0029	0.0349			
HML	216	0.0026	-0.0009	0.0330			
TERM	216	0.0042	0.0049	0.0316			
DEF	216	0.0002	0.0005	0.0191			
RMO	216	0.0038	0.0080	0.0380			

Panel C: Correlation Matrix

	MKRF	SMB	HML	TERM	DEF
MKTRF	1	0.2581[c]	-0.0867	-0.2718[c]	0.4798[c]
SMB	0.2581[c]	1	-0.2946[c]	-0.1285[a]	0.1560[b]
HML	-0.0867	-0.2946[c]	1	-0.0358	0.0340
TERM	-0.2718[c]	-0.1285[a]	-0.0358	1	-0.4600[c]
DEF	0.4798[b]	0.1560[b]	0.0340	-0.4600[c]	1
RMO	0.8548[c]	0	0	0	0

Table 3: Intercepts and Slope Coefficients for Monthly Returns of Bond Mutual Funds on 5- and 10-Factor Models. This table reports annualized intercepts expressed as a percent with associated *t*-statistics in parentheses for equal-weighted (EW) and value-weighted (VW) portfolio gross and net returns, using the Fama and French (1993)-style 5-factor model of bond fund returns (Panel A) and a 12-factor model of bond fund returns (Panel B). Only slope coefficients for net returns are reported; any differences in slope coefficients for gross returns are at the third significant digit. The sample period January 1999 through December 2016 contains 216 monthly observations. MKTRF is the value-weighted *CRSP* monthly return minus lagged one-month T-Bill rate. RMO is the orthogonal linear projection of MKTRF on the other four factors. SMB is the difference in monthly return between stocks with market capitalization above and below the NYSE median. HML is the difference in monthly return between stocks with book-to-market equity ratios in the top and bottom 30% of the NYSE. TERM is the difference in monthly returns between long-term treasuries and one-month lag T-Bill rate. DEF is the difference in monthly return between corporate and long-term treasury bonds. Market-wide fluctuations in liquidity, MKTLIQ, is the difference between 3-month non-financial commercial paper rate and 3-month Treasury yield. PRC/DIV is an equity market valuation factor measured as the one-month lag demeaned price/dividend ratio for the *CRSP* value-weighted index. Equity volatility, EQ VOLATILITY, is the one-month lag demeaned *CBOE* implied volatility index (VIX-OEX). [a,b,c] denotes statistical significance at the 10%, 5% and 1% level respectively.

	All Funds		**Government**		**Corporate**	
	EW	VW	EW	VW	EW	VW
Panel A: 5-Factor Model						
CONST*12: Gross Returns	1.331 [c]	1.238 [c]	1.171 [c]	1.175 [c]	1.643 [c]	1.409 [c]
	(3.265)	(2.497)	(3.109)	(2.319)	(3.169)	(2.374)
CONST*12: Net Returns	0.575	0.624	0.451	0.608	0.819	0.732
	(1.409)	(1.259)	(1.197)	(1.201)	(1.580)	(1.234)
RMO_t	0.025 [c]	0.044 [c]	0.009	0.020 [b]	0.054 [c]	0.078 [c]
	(2.863)	(4.200)	(1.098)	(1.860)	(4.861)	(6.121)
SMB_t	0.004	0.010	-0.005	-0.003	0.018	0.025
	(0.411)	(0.813)	(-0.561)	(-0.204)	(1.408)	(1.693)
HML_t	-0.002	-0.005	-0.007	-0.008	0.005	0.000
	(-0.222)	(-0.401)	(-0.712)	(-0.607)	(0.396)	(-0.025)
$TERM_t$	0.325 [c]	0.349 [c]	0.302 [c]	0.318 [c]	0.365 [c]	0.399 [c]
	(27.537)	(24.358)	(27.704)	(21.693)	(24.282)	(23.218)
DEF_t	0.203 [c]	0.281 [c]	0.090 [c]	0.126 [c]	0.409 [c]	0.499 [c]
	(10.337)	(11.796)	(4.980)	(5.186)	(16.375)	(17.444)
F-statistic	155.31 [c]	122.85 [c]	171.15 [c]	101.64 [c]	130.47 [c]	128.39 [c]
F-statistic: SMB=HML = 0	0.15	0.56	0.32	0.16	0.99	1.61
Adjusted R^2	0.782	0.739	0.798	0.701	0.751	0.748

Table 3 (contd.)

	All Funds		Government		Corporate	
	EW	VW	EW	VW	EW	VW
Panel B: 12-Factor Model						
CONST*12: Gross Returns	2.175 [c]	2.587 [c]	1.647 [c]	2.061 [c]	3.2337 [c]	3.545 [c]
	(3.952)	(3.880)	(3.061)	(2.822)	(4.930)	(4.799)
CONST*12: Net Returns	1.452 [c]	2.016 [c]	0.963 [a]	1.526 [b]	2.425 [c]	2.913 [c]
	(2.639)	(3.030)	(1.791)	(2.093)	(3.711)	(3.949)
RMO_t	0.028 [c]	0.046 [c]	0.011	0.021 [a]	0.057 [c]	0.078 [c]
	(3.383)	(4.562)	(1.391)	(1.885)	(5.793)	(7.007)
SMB_t	-0.001	0.005	-0.009	-0.006	0.012	0.021 [a]
	(-0.076)	(0.437)	(-0.961)	(-0.513)	(1.071)	(1.630)
HML_t	-0.007	-0.010	-0.009	-0.011	-0.003	-0.009
	(-0.712)	(-0.854)	(-0.954)	(-0.812)	(-0.298)	(-0.655)
$TERM_t$	0.358 [c]	0.387 [c]	0.327 [c]	0.347 [c]	0.411 [c]	0.447 [c]
	(27.241)	(24.301)	(25.430)	(19.904)	(26.287)	(25.302)
DEF_t	0.202 [c]	0.274 [c]	0.095 [c]	0.127 [c]	0.394 [c]	0.469 [c]
	(8.073)	(9.066)	(3.886)	(3.846)	(13.289)	(14.019)
$MKTLIQ_{t-1}$	-0.297 [c]	-0.466 [c]	-0.156	-0.280 [a]	-0.563 [c]	-0.747 [c]
	(-2.284)	(-2.967)	(-1.228)	(-1.626)	(-3.645)	(-4.284)
$MKTLIQ_{t-1}$ x $TERM_t$	0.763	2.522	1.601	5.994	1.099	-0.577
	(0.141)	(0.384)	(0.302)	(0.833)	(0.170)	(-0.079)
$MKTLIQ_{t-1}$ x DEF_t	7.327	15.540 [b]	9.089	14.084	8.151	16.198 [a]
	(1.036)	(1.817)	(1.315)	(1.503)	(0.970)	(1.708)
PRC/DIV_{t-1} x $TERM_t$	0.004 [c]	0.004 [c]	0.003 [c]	0.004 [c]	0.005 [c]	0.004 [c]
	(4.012)	(3.260)	(2.967)	(2.724)	(4.531)	(2.667)
PRC/DIV_{t-1} x DEF_t	0.001	0.001	0.001	0.001	-0.000	-0.001
	(0.709)	(0.449)	(0.770)	(0.609)	(-0.070)	(-0.494)
$EQVOL_{t-1}$ x $TERM_t$	-0.158	-0.287	-0.150	-0.278	-0.251	-0.409 [a]
	(-0.938)	(-1.411)	(-0.913)	(-1.249)	(-1.256)	(-1.814)
$EQVOL_{t-1}$ x DEF_t	0.092	0.021	0.023	-0.057	0.026	0.034
	(0.387)	(0.074)	(0.097)	(-0.181)	(0.090)	(0.107)
F-statistic	82.83 [c]	67.30 [c]	79.35 [c]	46.59 [c]	83.06 [c]	84.70 [c]
F-statistic: SMB=HML=0	0.27	0.64	0.70	0.37	0.80	0.80
F-test: All Interactions=0	7.15 [c]	6.75 [c]	4.00 [c]	3.20 [c]	10.61 [c]	10.26 [c]
Adjusted R^2	0.827	0.794	0.831	0.726	0.827	0.830

Table 4: All Bond Mutual Fund Precision-Adjusted Alpha Estimates for Simulated vs. Actual Gross and Net Returns by Percentile. This table reports estimated precision-adjusted alpha, $t(\alpha)$, for simulated and actual bond mutual fund gross and net returns at each percentile (*Pct*) using a 5- and 12-factor model. At each percentile, *Sim* is the average value of $t(\alpha)$ in 10,000 simulations, and %*Sim*<*Act* is the percent of 10,000 simulations that produce lower $t(\alpha)$ than actual. Superscript † (‡) denote actual $t(\alpha)$ worse (better) than simulated. Differences between actual and simulated $t(\alpha)$ may be random when %*Sim*<*Act* ≅ 50%. When %*Sim*<*Act* ≠50%, actual $t(\alpha)$ is better than simulated if *Sim*<*Act* and %*Sim*<*Act* is greater than 80% (i.e., a simulated $t(\alpha)$ lower than actual $t(\alpha)$ is four times as likely). Actual $t(\alpha)$ is worse than simulated $t(\alpha)$ if *Sim*>*Act* and %*Sim*<*Act* is less than 20% (i.e., a simulated $t(\alpha)$ lower than actual $t(\alpha)$ is one-fourth as likely). *p*-value is a parametric test of statistical significance for $t(\alpha)$ based on a Student's t-distribution with mean zero and 216 degrees of freedom. For *p*-values, superscript [a] ([b]) denote a statistically significant negative (positive) actual $t(\alpha)$.

All Bond Mutual Funds

	5-Factor Gross Returns				**12-Factor Gross Returns**				**5-Factor Net Returns**				**12-Factor Net Returns**			
Pct	Sim	Actual	%Sim< Act	p value	Sim	Actual	%Sim< Act	p value	Sim	Actual	%Sim< Act	p value	Sim	Actual	%Sim< Act	p value
1	-2.58	-1.84 ‡	85.1	0.034 [a]	-2.96	-2.13 ‡	85.7	0.017 [a]	-2.58	-3.27 †	16.9	0.001 [a]	-2.97	-2.90	47.3	0.002 [a]
2	-2.22	-1.57 ‡	82.4	0.059 [a]	-2.42	-1.96	74.3	0.026 [a]	-2.22	-2.44	33.6	0.008 [a]	-2.42	-2.24	57.1	0.013 [a]
3	-2.05	-1.27 ‡	87.9	0.103	-2.15	-1.91	62.5	0.029 [a]	-2.05	-2.03	45.6	0.022 [a]	-2.15	-2.00	56.1	0.023 [a]
4	-1.90	-0.96 ‡	93.5	0.169	-1.98	-1.74	62.3	0.041 [a]	-1.90	-1.81	50.1	0.036 [a]	-1.98	-1.96	47.8	0.026 [a]
5	-1.79	-0.82 ‡	94.0	0.207	-1.85	-1.65	59.7	0.050 [a]	-1.79	-1.51	61.4	0.066 [a]	-1.85	-1.89	43.3	0.030 [a]
10	-1.42	-0.14 ‡	99.0	0.444	-1.42	-1.00	76.0	0.158	-1.42	-0.82 ‡	80.2	0.207	-1.42	-1.40	48.9	0.082 [a]
20	-0.96	0.48 ‡	99.6	0.316	-0.93	-0.22 ‡	91.7	0.415	-0.96	-0.12 ‡	90.5	0.452	-0.93	-0.73	63.3	0.233
30	-0.64	1.20 ‡	100.0	0.116	-0.60	0.43 ‡	98.1	0.333	-0.64	0.23 ‡	91.2	0.409	-0.60	-0.15 ‡	80.2	0.439
40	-0.36	1.73 ‡	100.0	0.043	-0.32	0.99 ‡	99.5	0.161	-0.36	0.61 ‡	93.6	0.271	-0.32	0.25 ‡	86.7	0.400
50	-0.10	**2.21 ‡**	100.0	0.014 [b]	-0.06	**1.61 ‡**	99.9	0.055 [b]	-0.10	**1.06 ‡**	96.5	0.145	-0.06	**0.67 ‡**	92.4	0.251
60	0.17	2.68 ‡	100.0	0.004 [b]	0.20	2.08 ‡	100.0	0.020 [b]	0.17	1.44 ‡	97.6	0.076 [b]	0.20	1.16 ‡	96.8	0.123
70	0.45	3.18 ‡	100.0	0.001 [b]	0.48	2.70 ‡	100.0	0.004 [b]	0.45	1.88 ‡	98.4	0.031 [b]	0.48	1.60 ‡	98.3	0.056 [b]
80	0.77	3.78 ‡	100.0	0.000 [b]	0.81	3.18 ‡	100.0	0.001 [b]	0.77	2.33 ‡	98.8	0.010 [b]	0.81	2.15 ‡	99.3	0.016 [b]
90	1.23	4.33 ‡	100.0	0.000 [b]	1.26	3.86 ‡	100.0	0.000 [b]	1.23	3.00 ‡	99.3	0.002 [b]	1.26	2.75 ‡	99.4	0.003 [b]
95	1.61	4.82 ‡	100.0	0.000 [b]	1.66	4.29 ‡	100.0	0.000 [b]	1.61	3.40 ‡	99.2	0.000 [b]	1.66	3.28 ‡	99.4	0.001 [b]
96	1.73	4.93 ‡	100.0	0.000 [b]	1.78	4.49 ‡	100.0	0.000 [b]	1.73	3.55 ‡	99.2	0.000 [b]	1.78	3.40 ‡	99.4	0.000 [b]
97	1.89	5.32 ‡	100.0	0.000 [b]	1.93	4.65 ‡	100.0	0.000 [b]	1.89	3.63 ‡	99.0	0.000 [b]	1.94	3.57 ‡	99.4	0.000 [b]
98	2.07	5.62 ‡	100.0	0.000 [b]	2.17	4.78 ‡	100.0	0.000 [b]	2.07	3.86 ‡	99.2	0.000 [b]	2.17	3.76 ‡	99.0	0.000 [b]
99	2.49	6.59 ‡	100.0	0.000 [b]	2.67	5.12 ‡	98.6	0.000 [b]	2.49	4.45 ‡	99.3	0.000 [b]	2.67	4.14 ‡	96.2	0.000 [b]

Table 5: All Bond Mutual Fund Precision-Adjusted Alpha Estimates for Simulated vs. Actual Net Returns at Different Annual Standard Deviations of Injected Alpha. Panel A reports average simulated precision-adjusted alpha, $t(\alpha)$, and percent simulated $t(\alpha)$ less than actual for 10,000 simulations for annual standard deviation (σ) injections of 0.25% to 1.75% at 0.25% intervals corresponding to percentiles of bond funds reported in Table 4 for 5-factor net returns. Panel B does the same for 12-factor net returns. At different annual standard deviations of injected α, † (‡) denote critical values of standard deviation where average simulated $t(\alpha)$ is worse (better) than actual at 4:1 odds. When %*Sim*<*Act* ≠50%, actual $t(\alpha)$ is better than simulated if *Sim*<*Act* and %*Sim*<*Act* is greater than 80% (i.e., a simulated $t(\alpha)$ lower than actual $t(\alpha)$ is four times as likely). Actual $t(\alpha)$ is worse than simulated $t(\alpha)$ if *Sim*>*Act* and %*Sim*<*Act* is less than 20% (i.e., a simulated $t(\alpha)$ lower than actual $t(\alpha)$ is one-fourth as likely). Only the top (90th-99st) and bottom (1st-10th) percentiles are reported.

			All Bond Mutual Funds													
	Table 4		Annual σ (%) of Injected Alpha							Standard σ of Injected Alpha						
Pct	Sim	Actual	0.25	0.50	0.75	1.00	1.25	1.50	1.75	0.25	0.50	0.75	1.00	1.25	1.50	1.75
Panel A: 5-Factor Net Returns			**Average Simulated $t(\alpha)$**							**% Simulated < Actual**						
1	-2.58	-3.27 †	-2.69	-3.05	-3.89	-3.98	-4.98	-5.73	-6.39	20.4	34.9	73.9	79.6	98.5	99.9	100.0
2	-2.22	-2.44	-2.34	-2.65	-3.29 †	-3.43	-4.30	-4.99	-5.43	39.5	56.0	87.2	91.1	99.6	100.0	100.0
3	-2.05	-2.03	-2.16	-2.45	-3.00 †	-3.15	-3.96	-4.58	-4.89	52.1	68.0	92.1	95.0	99.8	100.0	100.0
4	-1.90	-1.81	-2.01	-2.27	-2.76 †	-2.91	-3.66	-4.20	-4.41	56.0	70.9	92.0	94.7	99.8	100.0	100.0
5	-1.79	-1.51	-1.89	-2.13	-2.58 †	-2.73	-3.43	-3.90	-4.08	67.1	79.6	95.3	97.0	99.9	100.0	100.0
10	-1.42	-0.82 ‡	-1.50	-1.68 †	-2.00 †	-2.13	-2.68	-2.88	-3.07	84.3	90.5	97.7	98.6	99.9	100.0	100.0
90	1.23	3.00 ‡	1.26	1.48	1.77	2.04	2.39 †	3.07	3.15	99.2	98.6	96.7	92.9	81.6	47.8	43.6
95	1.61	3.40 ‡	1.66	1.93	2.34	2.76	3.11	4.00	4.10	99.0	98.0	93.4	82.4	67.1	22.1	17.7
96	1.73	3.55 ‡	1.78	2.06	2.51	2.98	3.31	4.27 ‡	4.38	99.0	98.0	92.2	79.3	64.5	17.8	13.7
97	1.89	3.63 ‡	1.94	2.25	2.75	3.29	3.59	4.62 ‡	4.74	98.8	97.2	88.1	69.8	54.7	9.8	6.5
98	2.07	3.86 ‡	2.12	2.45	3.01	3.62	3.89	5.01 ‡	5.16	98.9	97.2	86.5	64.8	50.6	6.6	4.0
99	2.49	4.45 ‡	2.52	2.87	3.52	4.21	4.53	5.77 ‡	5.97	99.4	97.9	86.6	64.2	47.6	4.1	2.6
Panel B: 12-Factor Net Returns			**Average Simulated $t(\alpha)$**							**% Simulated < Actual**						
1	-2.97	-2.90	-2.87	-3.07	-3.66 †	-3.60	-4.42	-4.94	-5.34	44.3	55.6	82.6	83.6	97.9	99.5	100.0
2	-2.42	-2.24	-2.46	-2.66	-3.11 †	-3.10	-3.81	-4.30	-4.61	59.8	71.5	91.1	91.7	99.1	99.9	100.0
3	-2.15	-2.00	-2.20	-2.38	-2.75 †	-2.77	-3.41	-3.83	-4.06	59.2	70.1	88.7	89.6	98.8	99.7	100.0
4	-1.98	-1.96	-2.04	-2.21	-2.53 †	-2.57	-3.16	-3.53	-3.72	51.5	62.6	82.5	83.8	97.3	99.3	99.9
5	-1.85	-1.89	-1.90	-2.05	-2.34	-2.39	-2.93	-3.24	-3.40	46.7	56.9	76.6	78.6	95.1	98.5	99.4
10	-1.42	-1.40	-1.47	-1.58	-1.79	-1.84	-2.24	-2.36	-2.50	52.7	60.5	75.1	77.7	93.0	95.6	97.7
90	1.26	2.75 ‡	1.28	1.40	1.58	1.75	1.95 †	2.49	2.50	99.3	99.0	98.1	96.7	93.1	70.4	69.4
95	1.66	3.28 ‡	1.67	1.81	2.06	2.34	2.53 †	3.26	3.27	99.3	99.2	98.0	95.2	90.2	53.7	52.2
96	1.78	3.40 ‡	1.79	1.95	2.23	2.55	2.72 †	3.51	3.52	99.3	99.1	97.5	93.3	87.4	45.3	44.0
97	1.94	3.57 ‡	1.94	2.10	2.41	2.76	2.93 †	3.77	3.78	99.4	99.1	97.3	91.5	85.8	39.7	37.8
98	2.17	3.76 ‡	2.17	2.34	2.70	3.11	3.27	4.18	4.20	99.2	98.8	95.7	86.0	79.0	27.2	25.2
99	2.67	4.14 ‡	2.54	2.71	3.13	3.59	3.79	4.75 ‡	4.78	98.8	98.4	94.5	80.7	72.6	18.8	17.5

Table 6: All Bond Mutual Fund Precision-Adjusted Alpha Estimates for Simulated vs. Actual Net Returns for Government and Corporate Bond Funds. This table reports precision-adjusted alpha, $t(\alpha)$, for simulated and actual bond mutual fund net returns at each percentile (*Pct*) stratified by average fund AUM using a 5- and 12-factor model. At each percentile, *Sim* is the average value of $t(\alpha)$ in 10,000 simulations, and *%Sim<Act* is the percent of 10,000 simulations that produce lower $t(\alpha)$ than actual. Superscript † (‡) denote actual $t(\alpha)$ worse (better) than simulated. Differences between actual and simulated $t(\alpha)$ may be random when *%Sim<Act* ≅ 50%. When *%Sim<Act* ≠50%, actual $t(\alpha)$ is better than simulated if *Sim<Act* and *%Sim<Act* is greater than 80% (i.e., a simulated $t(\alpha)$ lower than actual $t(\alpha)$ is four times as likely). Actual $t(\alpha)$ is worse than simulated $t(\alpha)$ if *Sim>Act* and *%Sim<Act* is less than 20% (i.e., a simulated $t(\alpha)$ lower than actual $t(\alpha)$ is one-fourth as likely).

	5-Factor Net Returns						**12-Factor Net Returns**					
	Government			**Corporate**			**Government**			**Corporate**		
Pct	Sim	Actual	%Sim <Act	Sim	Actual	%Sim <Act	Sim	Actual	%Sim <Act	Sim	Actual	%Sim <Act
1	-2.52	-3.75 †	5.5	-2.45	-2.30	51.8	-2.89	-3.37	21.7	-2.86	-2.28	70.9
2	-2.21	-3.08 †	10.5	-2.20	-1.88	61.5	-2.36	-2.34	46.3	-2.42	-1.96	70.6
3	-1.97	-2.44	22.5	-2.04	-1.60	67.8	-2.07	-2.15	40.1	-2.20	-1.77	69.9
4	-1.85	-2.03	35.5	-1.91	-1.42	70.0	-1.89	-2.00	38.3	-2.04	-1.58	72.1
5	-1.73	-1.79	41.9	-1.78	-1.33	68.9	-1.77	-1.98	32.3	-1.86	-1.43	71.5
10	-1.36	-0.82	78.9	-1.44	-0.85	76.0	-1.35	-1.53	34.7	-1.44	-1.01	73.6
20	-0.92	-0.18 ‡	88.1	-1.00	-0.04 ‡	91.9	-0.89	-0.89	47.6	-0.97	-0.47	78.6
30	-0.61	0.16 ‡	88.5	-0.67	0.34 ‡	93.3	-0.57	-0.34	65.6	-0.63	0.15 ‡	91.2
40	-0.34	0.52 ‡	91.2	-0.39	0.83 ‡	96.3	-0.30	0.08	76.2	-0.33	0.63 ‡	96.0
50	-0.09	**0.92 ‡**	94.2	-0.11	**1.16 ‡**	96.6	-0.05	**0.45 ‡**	82.6	-0.06	**1.28 ‡**	99.3
60	0.16	1.35 ‡	96.8	0.16	1.56 ‡	97.4	0.20	0.91 ‡	90.8	0.21	1.61 ‡	99.4
70	0.43	1.80 ‡	98.1	0.46	1.96 ‡	97.9	0.46	1.24 ‡	92.3	0.49	2.19 ‡	99.9
80	0.75	2.20 ‡	98.3	0.79	2.56 ‡	98.9	0.78	1.67 ‡	94.7	0.83	2.48 ‡	99.7
90	1.20	2.88 ‡	99.0	1.23	3.10 ‡	99.0	1.23	2.28 ‡	96.4	1.27	3.14 ‡	99.7
95	1.57	3.40 ‡	99.2	1.60	3.44 ‡	98.8	1.63	2.90 ‡	97.8	1.65	3.57 ‡	99.6
96	1.70	3.55 ‡	99.3	1.73	3.54 ‡	98.7	1.74	3.03 ‡	97.8	1.81	3.63 ‡	99.4
97	1.83	3.59 ‡	99.1	1.87	3.82 ‡	99.1	1.90	3.28 ‡	98.3	1.95	3.76 ‡	99.3
98	2.08	3.86 ‡	99.1	2.05	4.12 ‡	99.3	2.17	3.40 ‡	96.7	2.16	3.94 ‡	99.0
99	2.50	4.44 ‡	98.6	2.33	4.84 ‡	99.8	2.67	4.19 ‡	95.6	2.57	4.04 ‡	95.2

Table 7: All Bond Mutual Fund Precision-Adjusted Alpha Estimates for Simulated vs. Actual Net Returns by AUM. This table reports precision-adjusted alpha, $t(\alpha)$, for simulated and actual bond mutual fund net returns at each percentile (*Pct*) stratified by average fund AUM using a 5- and 12-factor model. At each percentile, *Sim* is the average value of $t(\alpha)$ in 10,000 simulations, and %*Sim<Act* is the percent of 10,000 simulations that produce lower $t(\alpha)$ than actual. Superscript † (‡) denote actual $t(\alpha)$ worse (better) than simulated. Differences between actual and simulated $t(\alpha)$ may be random when %*Sim<Act* ≅ 50%. When %*Sim<Act* ≠50%, actual $t(\alpha)$ is better than simulated if *Sim<Act* and %*Sim<Act* is greater than 80% (i.e., a simulated $t(\alpha)$ lower than actual $t(\alpha)$ is four times as likely). Actual $t(\alpha)$ is worse than simulated $t(\alpha)$ if *Sim>Act* and %*Sim<Act* is less than 20% (i.e., a simulated $t(\alpha)$ lower than actual $t(\alpha)$ is one-fourth as likely).

All Bond Mutual Funds																		
	5-Factor Net Returns									**12-Factor Net Returns**								
	$5-250 Million AUM			**$250-750 Million AUM**			**>$750 Million AUM**			**$5-250 Million AUM**			**$250-750 Million AUM**			**>$750 Million AUM**		
Pct	Sim	Actual	%Sim <Act	Sim	Actual	%Sim <Act	Sim	Actual	%Sim <Act	Sim	Actual	%Sim <Act	Sim	Actual	%Sim <Act	Sim	Actual	%Sim <Act
1	-2.93	-3.14	35.2	-3.53	-2.66 ‡	80.1	-3.66	-3.62	38.9	-4.19	-3.05	78.4	-5.35	-3.79	77.7	-3.96	-3.23	59.5
2	-2.41	-2.66	31.6	-2.66	-2.41	61.7	-2.63	-2.07	72.9	-2.90	-2.27‡	80.1	-4.42	-2.69 ‡	90.4	-3.46	-2.48	75.1
3	-2.16	-2.01	53.9	-2.33	-2.28	49.0	-2.38	-1.92	71.4	-2.47	-2.03	74.8	-3.38	-2.24 ‡	90.1	-2.65	-2.17	68.5
4	-1.99	-1.69	64.1	-2.13	-2.11	47.0	-2.09	-1.49 ‡	82.2	-2.22	-1.95	65.9	-2.83	-2.04 ‡	87.4	-2.39	-2.17	57.8
5	-1.87	-1.60	61.5	-2.00	-1.99	45.9	-1.99	-1.15 ‡	92.5	-2.04	-1.85	60.4	-2.47	-1.89 ‡	82.9	-2.17	-2.00	57.3
10	-1.45	-0.92	79.1	-1.54	-1.16	74.8	-1.50	-0.99 ‡	80.2	-1.53	-1.35	60.7	-1.72	-1.46	68.4	-1.55	-1.76	32.8
20	-0.98	-0.35 ‡	85.6	-1.02	-0.60	79.4	-0.99	-0.35 ‡	88.0	-1.00	-0.57 ‡	79.8	-1.08	-0.92	62.4	-0.97	-1.19	31.7
30	-0.64	0.06 ‡	89.1	-0.65	0.00 ‡	92.1	-0.64	0.10 ‡	92.3	-0.64	-0.15 ‡	85.0	-0.67	-0.48	65.7	-0.60	-0.77	35.1
40	-0.35	0.44 ‡	92.3	-0.35	0.41 ‡	95.5	-0.34	0.45 ‡	93.8	-0.35	0.31 ‡	92.0	-0.34	-0.13	68.9	-0.29	-0.11	63.8
50	-0.08	**0.76 ‡**	93.3	-0.07	**0.76 ‡**	96.8	-0.06	**0.78 ‡**	94.5	-0.07	**0.70 ‡**	95.0	-0.04	**0.38 ‡**	84.3	-0.01	**0.32**	75.6
60	0.18	1.10 ‡	94.6	0.21	1.08 ‡	97.0	0.22	1.37 ‡	98.5	0.20	1.16 ‡	97.9	0.25	0.89 ‡	92.7	0.27	0.84 ‡	88.4
70	0.47	1.48 ‡	96.2	0.52	1.46 ‡	97.4	0.51	1.79 ‡	98.8	0.49	1.56 ‡	98.4	0.58	1.43 ‡	97.3	0.58	1.33 ‡	93.5
80	0.81	2.04 ‡	97.9	0.88	1.92 ‡	97.9	0.86	2.46 ‡	99.4	0.83	1.98 ‡	98.8	0.97	1.89 ‡	97.6	0.94	1.93 ‡	96.9
90	1.29	2.76 ‡	98.9	1.40	2.56 ‡	98.0	1.38	2.97 ‡	99.1	1.34	2.47 ‡	98.3	1.59	2.68 ‡	97.8	1.50	2.93 ‡	99.1
95	1.71	3.19 ‡	98.7	1.87	3.16 ‡	98.2	1.88	3.12 ‡	96.8	1.80	3.01 ‡	98.3	2.30	3.28 ‡	93.8	2.12	3.31 ‡	95.6
96	1.85	3.29 ‡	98.6	2.01	3.27 ‡	98.0	1.99	3.20 ‡	96.3	1.96	3.07 ‡	97.3	2.69	3.32 ‡	83.8	2.34	3.34 ‡	91.7
97	2.02	3.49 ‡	98.6	2.22	3.45 ‡	97.3	2.28	3.59 ‡	95.7	2.17	3.20 ‡	95.8	3.27	3.47	69.1	2.60	3.45 ‡	87.1
98	2.30	3.70 ‡	98.4	2.57	3.60 ‡	93.7	2.53	3.59 ‡	90.7	2.53	3.33 ‡	89.4	4.26	3.62	45.8	3.41	3.83	72.9
99	2.94	4.45 ‡	95.6	3.52	4.54 ‡	85.6	3.56	4.27	77.4	3.76	3.99	69.0	5.16	3.95	33.1	3.96	4.11	64.8

Table 8: Government and Corporate Bond Mutual Fund Precision-Adjusted Alpha Estimates for Simulated vs. Actual Net Returns by AUM. This table reports precision-adjusted alpha, $t(\alpha)$, estimates for simulated and actual government bond mutual fund net returns at each percentile (*Pct*) stratified by fund average AUM using a 5- and 12-factor model. At each percentile, *Sim* is the average value of $t(\alpha)$ in 10,000 simulations, and *%Sim<Act* is the percent of 10,000 simulations that produce lower $t(\alpha)$ than actual. † (‡) denote actual returns worse (better) than simulated returns. Differences between actual and simulated $t(\alpha)$ may be random when *%Sim<Act* ≅ 50%. When *%Sim<Act* ≠50%, actual $t(\alpha)$ is better than simulated if *Sim<Act* and *%Sim<Act* is greater than 80% (i.e., a simulated $t(\alpha)$ lower than actual $t(\alpha)$ is four times as likely). Actual $t(\alpha)$ is worse than simulated $t(\alpha)$ if *Sim>Act* and *%Sim<Act* is less than 20% (i.e., a simulated $t(\alpha)$ lower than actual $t(\alpha)$ is one-fourth as likely).

	5-Factor Net Returns									**12-Factor Net Returns**								
	$5-250 Million AUM			**$250-750 Million AUM**			**>$750 Million AUM**			**$5-250 Million AUM**			**$250-750 Million AUM**			**>$750 Million AUM**		
Pct	Sim	Actual	%Sim <Act	Sim	Actual	%Sim <Act	Sim	Actual	%Sim <Act	Sim	Actual	%Sim <Act	Sim	Actual	%Sim <Act	Sim	Actual	%Sim <Act
Government Bond Mutual Funds																		
1	-2.79	-3.75 †	10.3	-3.60	-2.66	75.6	-4.09	-3.62	48.2	-4.16	-3.37	63.3	-5.02	-3.79	69.3	-3.66	-3.97	29.8
2	-2.33	-2.98 †	15.5	-2.65	-2.37	60.9	-3.14	-2.44	64.2	-2.95	-2.64	58.6	-3.89	-2.82	74.9	-3.06	-2.48	61.6
3	-2.10	-2.54	22.2	-2.29	-2.28	46.8	-2.54	-1.92	74.0	-2.41	-2.15	63.8	-3.36	-2.36 ‡	82.1	-2.60	-2.17	61.8
4	-1.94	-2.01	41.1	-2.10	-2.26	35.4	-2.22	-1.49 ‡	85.7	-2.14	-2.03	54.4	-2.68	-2.24	68.2	-2.24	-2.02	55.6
5	-1.81	-1.66	55.4	-1.99	-1.99	46.5	-2.01	-1.15 ‡	92.5	-1.96	-1.96	45.9	-2.42	-2.04	70.1	-1.99	-2.00	45.2
10	-1.41	-0.81 ‡	83.7	-1.52	-1.19	71.2	-1.48	-1.01	79.1	-1.47	-1.51	43.6	-1.65	-1.70	43.2	-1.46	-1.76	27.1
90	1.25	2.56 ‡	98.0	1.34	2.58 ‡	98.2	1.35	2.95 ‡	99.2	1.30	2.31 ‡	96.7	1.59	2.18 ‡	87.7	1.49	2.57 ‡	96.7
95	1.66	3.06 ‡	98.4	1.81	2.99 ‡	97.3	1.89	3.03 ‡	95.0	1.75	2.61 ‡	94.1	2.36	2.87 ‡	79.9	2.06	3.14 ‡	93.7
96	1.79	3.16 ‡	98.2	1.92	3.22 ‡	98.0	2.11	3.20 ‡	92.9	1.90	2.76 ‡	93.6	2.62	3.28 ‡	83.4	2.32	3.26 ‡	89.3
97	1.96	3.23 ‡	97.6	2.13	3.41 ‡	97.0	2.47	3.59 ‡	90.0	2.13	3.01 ‡	92.9	3.32	3.30	61.6	2.69	3.31 ‡	80.3
98	2.22	3.29 ‡	95.4	2.53	3.60 ‡	92.1	3.13	3.59	73.7	2.58	3.13 ‡	82.0	3.80	3.46	53.5	3.21	4.11 ‡	82.0
99	2.81	3.55 ‡	84.1	3.60	4.33	77.7	4.17	4.27	62.3	3.83	3.26	45.8	4.78	4.09	46.1	3.75	4.45	74.7
Corporate Bond Mutual Funds																		
1	-2.99	-2.73	53.6	-3.00	-2.42	68.8	-3.38	-2.07 ‡	80.7	-4.27	-2.55 ‡	87.0	-4.73	-2.37 ‡	94.2	-3.80	-3.23	53.8
2	-2.42	-1.95	69.0	-2.54	-2.41	51.5	-2.44	-1.57 ‡	82.4	-3.11	-2.01 ‡	87.4	-4.17	-1.63 ‡	99.1	-3.00	-2.28	67.1
3	-2.17	-1.69	71.4	-2.28	-2.11	55.7	-2.44	-1.57 ‡	82.4	-2.55	-1.77 ‡	84.4	-3.69	-1.45 ‡	98.8	-3.00	-2.28	67.1
4	-2.01	-1.60	67.1	-2.11	-2.08	47.6	-2.05	-1.34 ‡	81.8	-2.26	-1.43 ‡	88.4	-3.19	-1.42 ‡	97.5	-2.42	-2.17	54.2
5	-1.88	-1.49	66.4	-1.98	-1.87	53.0	-1.88	-1.13 ‡	84.1	-2.07	-1.35 ‡	85.7	-2.80	-1.39 ‡	95.7	-2.42	-2.17	54.2
10	-1.47	-1.09	67.1	-1.55	-0.85 ‡	89.7	-1.46	-0.79 ‡	83.3	-1.57	-0.91 ‡	85.6	-1.85	-1.21 ‡	83.8	-1.65	-1.82	37.9
90	1.30	2.99 ‡	99.1	1.48	2.51 ‡	95.3	1.36	3.08 ‡	98.7	1.37	2.77 ‡	98.9	1.59	3.20 ‡	99.3	1.53	3.27 ‡	99.0
95	1.72	3.57 ‡	99.3	1.93	3.16 ‡	96.7	1.79	3.12 ‡	95.4	1.83	3.22 ‡	98.2	2.51	3.47 ‡	87.6	2.28	3.45 ‡	90.0
96	1.86	3.70 ‡	99.3	2.07	3.27 ‡	96.1	1.96	3.22 ‡	93.7	2.00	3.33 ‡	97.3	2.89	3.51	79.3	2.28	3.45 ‡	89.9
97	2.03	4.12 ‡	99.6	2.25	3.45 ‡	95.4	2.31	3.43 ‡	89.4	2.27	3.58 ‡	95.7	3.39	3.62	69.3	2.84	3.57	79.2
98	2.31	5.17 ‡	99.8	2.51	3.54 ‡	91.5	2.31	3.43 ‡	89.4	2.81	3.99 ‡	89.6	3.96	3.62	55.1	2.84	3.57	79.2
99	2.99	5.74 ‡	97.0	2.99	4.84 ‡	95.0	3.09	3.60	71.9	3.90	4.18	67.7	4.44	3.81	47.0	3.71	3.83	63.6

Table 9: Bond Mutual Fund 3-Year Precision-Adjusted Alpha Estimates for Simulated vs. Actual Net Returns. This table reports 3-year precision-adjusted alpha, $t(\alpha)$, for simulated and actual government bond mutual fund net returns at each percentile (*Pct*) for all funds and stratified by average fund AUM, for government bond funds, and for corporate bond funds, using a 5- and 12-factor model. At each percentile, *Sim* is the average value of $t(\alpha)$ in 10,000 simulations, and *%Sim<Act* is the percent of 10,000 simulations that produce lower $t(\alpha)$ than actual. Superscript † (‡) denote actual $t(\alpha)$ worse (better) than simulated. Differences between actual and simulated $t(\alpha)$ may be random when *%Sim<Act* ≅ 50%. When *%Sim<Act* ≠50%, actual $t(\alpha)$ is better than simulated if *Sim<Act* and *%Sim<Act* is greater than 80% (i.e., a simulated $t(\alpha)$ lower than actual $t(\alpha)$ is four times as likely). Actual $t(\alpha)$ is worse than simulated $t(\alpha)$ if *Sim>Act* and *%Sim<Act* is less than 20% (i.e., a simulated $t(\alpha)$ lower than actual $t(\alpha)$ is one-fourth as likely).

	3-Year $t(\alpha)$ by Bond Mutual Fund Categories																	
	All Bond Funds			$5-250 Million AUM			$250-750 Million AUM			>$750 Million AUM			Government			Corporate		
Pct	Sim	Actual	%Sim <Act	Sim	Actual	%Sim <Act	Sim	Actual	%Sim <Act	Sim	Actual	%Sim <Act	Sim	Actual	%Sim <Act	Sim	Actual	%Sim <Act
Panel A: 5-Factor Net Returns																		
1	-3.42	-2.93	66.0	-3.85	-3.18	70.9	-4.91	-3.13 ‡	92.2	-3.88	-2.79 ‡	83.5	-3.49	-2.87	70.0	-3.32	-3.17	47.0
2	-2.81	-2.52	59.0	-2.98	-2.77	55.1	-3.40	-2.67 ‡	80.9	-3.01	-2.10 ‡	89.1	-2.84	-2.54	58.5	-2.69	-2.26	67.7
3	-2.52	-2.10	68.1	-2.63	-2.44	54.2	-2.85	-2.40	72.3	-2.63	-1.83 ‡	89.1	-2.55	-2.24	60.3	-2.39	-2.02	66.5
4	-2.32	-1.89	70.9	-2.40	-2.24	53.5	-2.55	-2.22	66.9	-2.40	-1.71 ‡	86.1	-2.35	-1.89	70.0	-2.20	-1.88	65.2
5	-2.16	-1.76	70.7	-2.23	-2.04	56.1	-2.34	-2.13	59.8	-2.22	-1.58 ‡	85.7	-2.20	-1.77	69.5	-2.06	-1.75	65.6
10	-1.66	-1.38	66.8	-1.69	-1.47	63.2	-1.71	-1.52	63.1	-1.65	-1.21 ‡	80.8	-1.70	-1.34	70.3	-1.58	-1.45	56.2
90	1.49	2.46 ‡	95.5	1.52	2.28 ‡	92.9	1.60	2.44 ‡	94.7	1.54	2.63 ‡	96.3	1.48	2.51 ‡	95.4	1.50	2.42 ‡	93.8
95	1.98	2.95 ‡	93.0	2.05	2.81 ‡	89.8	2.23	2.99 ‡	90.1	2.09	3.05 ‡	92.4	1.96	2.94 ‡	91.8	1.97	2.95 ‡	92.5
96	2.13	3.09 ‡	92.2	2.22	2.95 ‡	88.3	2.45	3.11 ‡	86.9	2.26	3.10 ‡	89.1	2.11	3.07 ‡	91.1	2.12	3.10 ‡	91.8
97	2.33	3.29 ‡	91.5	2.46	3.20 ‡	88.0	2.78	3.29 ‡	80.6	2.50	3.27 ‡	86.5	2.30	3.29 ‡	91.2	2.31	3.29 ‡	91.3
98	2.63	3.63 ‡	91.3	2.84	3.55 ‡	85.7	3.37	3.59	66.3	2.88	3.43	78.1	2.59	3.63 ‡	91.1	2.63	3.58 ‡	89.5
99	3.31	4.16 ‡	85.2	3.88	4.16	68.1	4.96	3.91	27.1	3.84	3.77	56.8	3.36	3.96	78.5	3.32	4.24 ‡	84.8
Panel B: 12-Factor Net Returns																		
1	-6.25	-2.93 ‡	99.39	-7.18	-3.14 ‡	99.66	-7.68	-3.46 ‡	100.00	-6.43	-2.48 ‡	99.66	-6.14	-2.96 ‡	98.92	-5.89	-2.93 ‡	97.03
2	-4.97	-2.35 ‡	98.74	-5.91	-2.59 ‡	99.31	-6.97	-3.04 ‡	100.00	-5.78	-2.26 ‡	99.57	-4.90	-2.34 ‡	98.24	-4.84	-2.52 ‡	94.52
3	-4.25	-2.24 ‡	96.00	-4.92	-2.26 ‡	98.93	-6.39	-2.66 ‡	99.57	-5.11	-2.17 ‡	98.80	-4.23	-2.26 ‡	94.89	-4.17	-2.09 ‡	95.02
4	-3.85	-2.14 ‡	92.84	-4.27	-2.14 ‡	97.45	-5.71	-2.36 ‡	99.35	-4.49	-2.12 ‡	97.42	-3.79	-2.18 ‡	90.72	-3.77	-1.90 ‡	94.39
5	-3.54	-2.06 ‡	90.33	-3.86	-1.98 ‡	96.08	-5.01	-2.27 ‡	98.52	-4.02	-2.08 ‡	94.94	-3.49	-2.11 ‡	86.84	-3.50	-1.81 ‡	92.56
10	-2.58	-1.48 ‡	89.12	-2.76	-1.45 ‡	93.36	-3.08	-1.65 ‡	94.51	-2.72	-1.65 ‡	87.39	-2.62	-1.51 ‡	87.24	-2.51	-1.43 ‡	87.95
90	2.00	1.72	43.70	2.12	1.75	39.02	2.52	1.67 †	16.75	2.17	1.81	39.38	2.00	1.67	42.48	2.02	1.92	52.85
95	2.87	2.36	40.12	3.18	2.34	27.06	4.51	2.46 †	6.24	3.43	2.54	29.28	2.81	2.23	36.92	2.90	2.57	48.63
96	3.20	2.55	37.60	3.62	2.49	20.03	5.26	2.63 †	3.27	3.98	2.64	20.56	3.12	2.38	33.11	3.19	2.64	41.13
97	3.59	2.69	29.31	4.28	2.70 †	12.79	5.97	2.91 †	2.29	4.65	2.78 †	12.63	3.55	2.64	29.83	3.62	2.94	39.63
98	4.32	3.08	22.96	5.42	3.12 †	6.77	6.83	3.24 †	1.49	5.41	3.12 †	10.13	4.26	3.03	24.63	4.29	3.17	28.87
99	5.83	3.35 †	5.90	6.85	3.39 †	1.49	7.89	3.54 †	0.00	6.21	3.97 †	14.16	5.65	3.31 †	8.34	5.49	3.68 †	18.38

Table 10: Cumulative Economic Value Across All Bond Mutual Funds. Cumulative assets under management (AUM) is the product of the number of funds and average AUM. In model 1, Economic Value (EV) is computed as the triple product. At each percentile, the difference between actual and average simulated precision-adjusted alpha, multiplied by the annualized median standard error of simulated alpha, is the estimated excess alpha from active bond management. Excess alpha is then multiplied by incremental AUM at each percentile. Overall represents 1st to 99th percentiles of bond funds in each group.

		5-Factor Net Returns		**12-Factor Net Returns**			**5-Factor Net Returns**		**12-Factor Net Returns**	
Percentile	No of Funds	Ave AUM ($M)	EV/ AUM (bps)	Ave AUM ($M)	EV/ AUM (bps)	No. of Funds	Ave AUM ($M)	EV/ AUM (bps)	Ave AUM ($M)	EV/ AUM (bps)
		All Bond Funds					**AUM>$750M**			
Bottom										
5%	29	379	*-3.4*	482	*-0.8*	9	1,276	*10.7*	1,092	*40.0*
10%	57	318	*2.7*	529	*1.0*	17	1,275	*10.7*	1,236	*24.2*
20%	57	318	*10.7*	759	*5.9*	33	1,229	*12.2*	1,404	*19.4*
Top										
50%	333	893	*30.2*	771	*19.7*	96	2,460	*28.3*	2,667	*40.8*
40%	277	786	*33.2*	724	*20.0*	80	2,463	*30.2*	2,955	*42.3*
30%	220	847	*34.7*	774	*20.2*	64	2,397	*31.4*	3,107	*45.1*
20%	164	969	*35.8*	701	*20.6*	47	2,715	*32.0*	3,434	*48.0*
10%	107	993	*38.3*	685	*20.3*	31	2,853	*30.4*	3,310	*54.8*
5%	51	1,028	*39.3*	880	*19.9*	15	2,962	*25.7*	4,664	*59.8*
Overall	559	751	*25.8*	746	*16.0*	162	2,333	*23.5*	2,276	*35.0*
		Government Bond Funds					**Corporate Bond Funds**			
Bottom										
5%	18	407	*-11.4*	343	*-7.9*	12	372	*7.6*	558	*9.4*
10%	35	309	*-4.7*	637	*-1.7*	23	268	*9.1*	652	*5.7*
20%	69	447	*6.3*	689	*2.7*	46	260	*15.3*	768	*8.5*
Top										
50%	204	830	*25.1*	717	*19.0*	133	1,004	*37.0*	747	*18.2*
40%	169	759	*27.9*	675	*19.3*	111	911	*39.3*	773	*18.5*
30%	135	757	*30.1*	701	*19.5*	88	945	*40.8*	798	*19.5*
20%	100	869	*31.4*	752	*19.7*	65	1,096	*41.9*	768	*19.6*
10%	66	944	*33.8*	873	*18.1*	43	1,023	*43.0*	569	*19.9*
5%	31	889	*36.7*	850	*15.7*	20	918	*43.5*	530	*21.2*
Overall	342	707	*20.6*	700	*14.8*	224	823	*32.8*	819	*15.9*

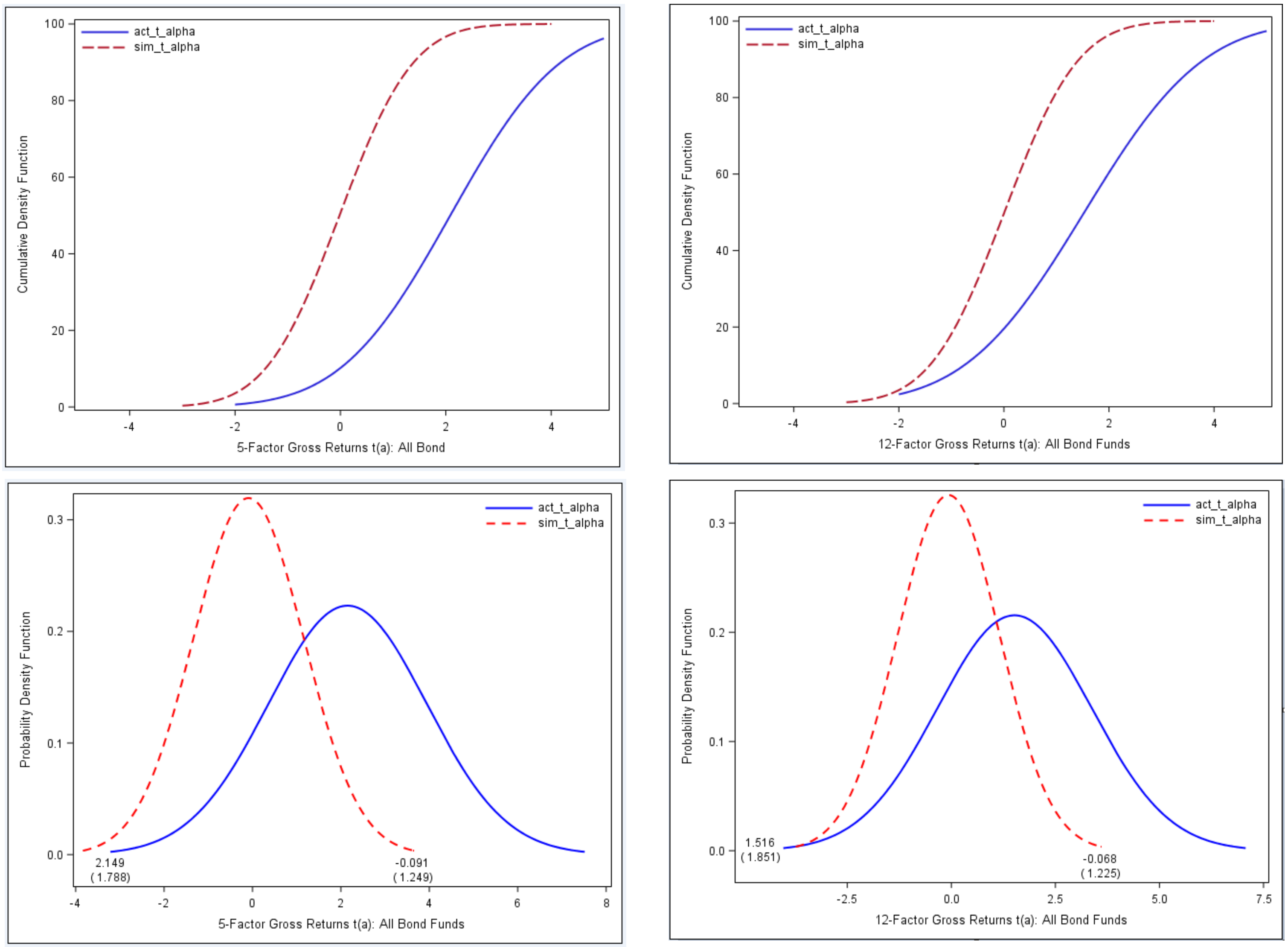


Figure 1: Simulated vs. Actual Cumulative and Probability Density Functions of $t(\alpha)$ using a 5-factor and 12-factor Model of Gross Returns for All Bond Mutual Funds. Solid lines are estimated $t(\alpha)$ from regressions of actual returns over the entire sample period. Dotted lines are estimated average $t(\alpha)$ from 10,000 bootstrapped simulations. Numbers from left to right below probability density functions indicate means and standard deviations for actual and simulated $t(\alpha)$.

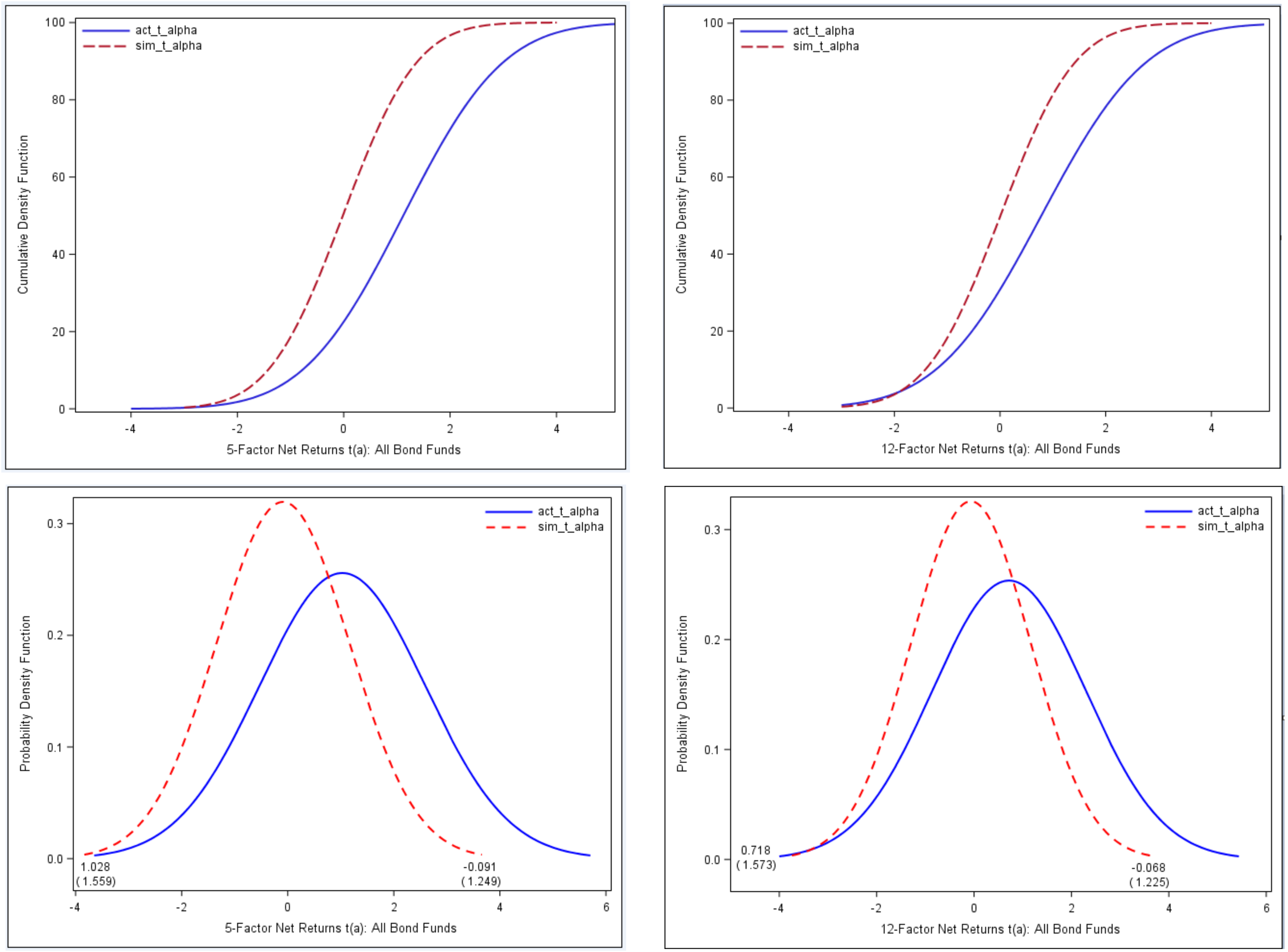


Figure 2: Simulated vs. Actual Cumulative and Probability Density Functions of $t(\alpha)$ using a 5-factor and 12-factor Model of Net Returns for All Bond Mutual Funds. Solid lines are estimated $t(\alpha)$ from regressions of actual returns over the entire sample period. Dotted lines are estimated average $t(\alpha)$ from 10,000 bootstrapped simulations. Numbers from left to right below probability density functions indicate means and standard deviations for actual and simulated $t(\alpha)$.

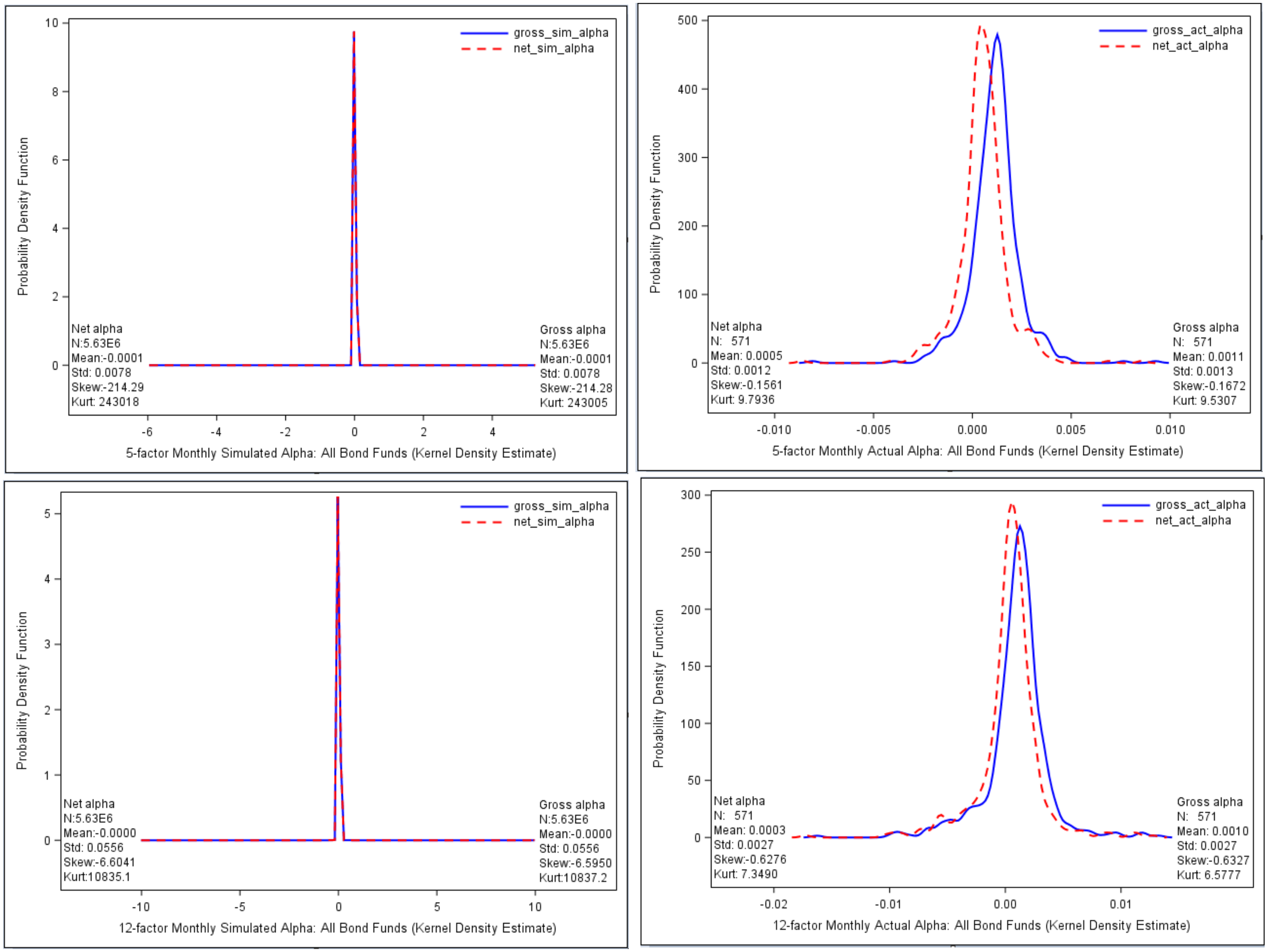


Figure 3: Kernel Density Functions of Estimated Simulated and Actual α for 5- and 12-factor Benchmark Models.

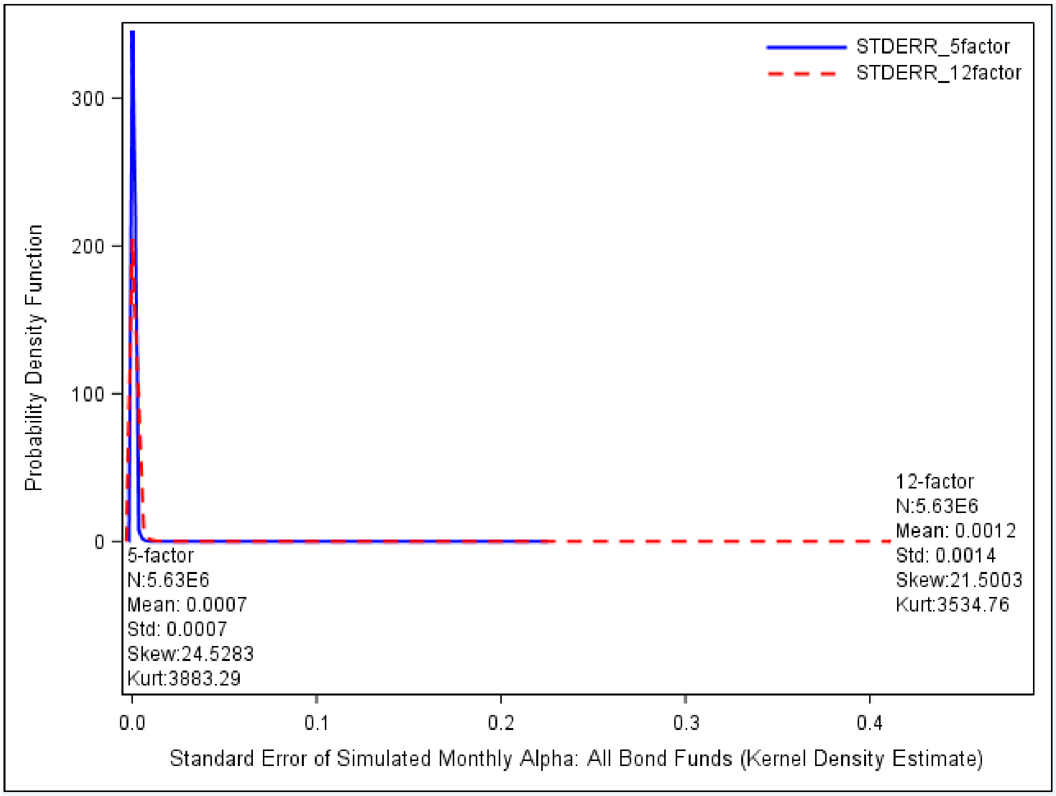


Figure 4: Kernel Density Functions of Estimated Standard Error of Simulated α on 5- and 12-factor Benchmark Models for All Bond Mutual Funds.

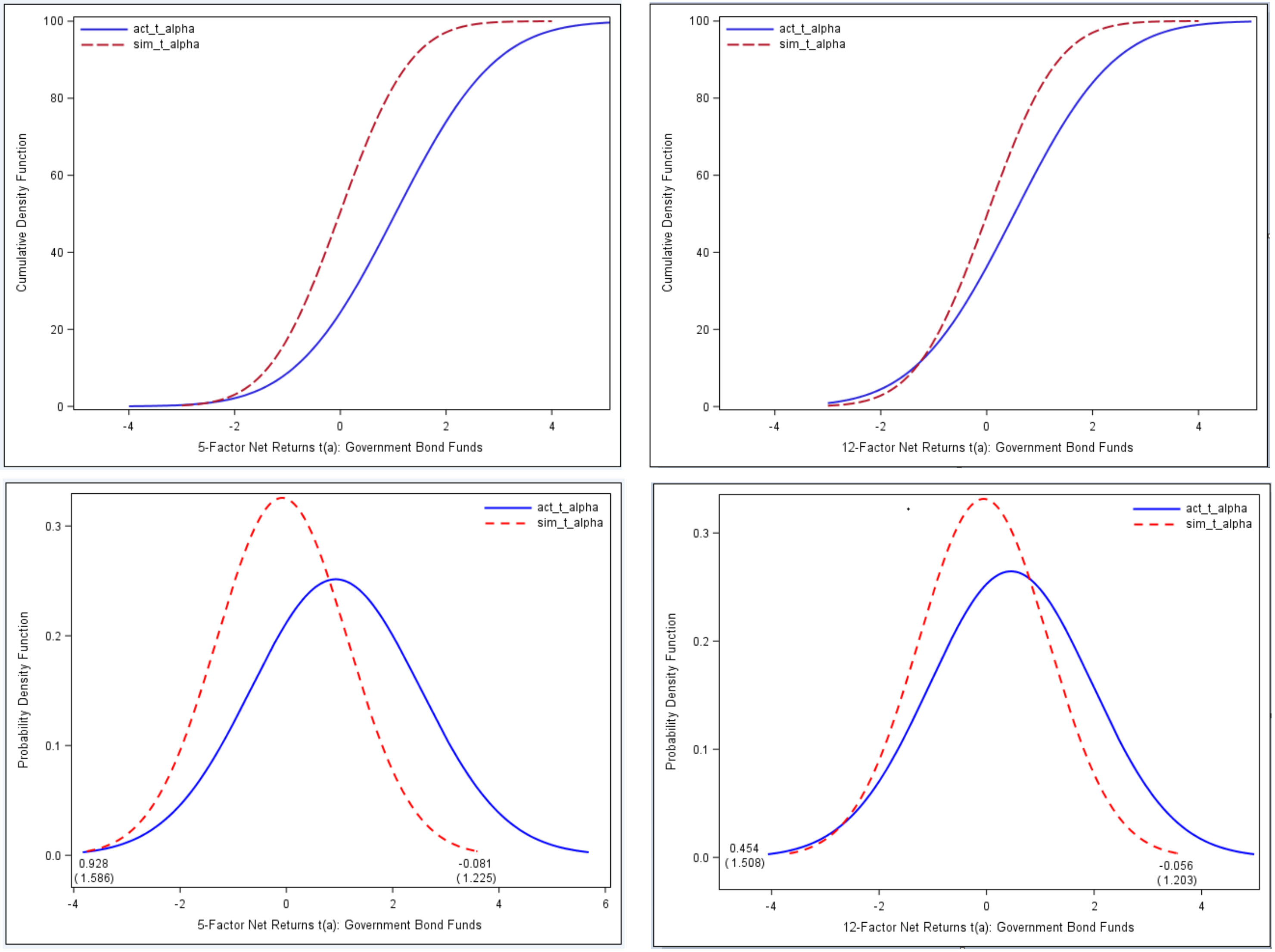
APPENDIX

Appendix Table 1: Government Bond Mutual Fund $t(\alpha)$ Estimates for Simulated vs. Actual Net Returns by Duration. Panels A and B in this table report $t(\alpha)$ for simulated and actual government bond mutual fund net returns at each percentile (*Pct*) stratified by average fund duration using a 5- and 12-factor model. At each percentile, *Sim* is the average value of $t(\alpha)$ in 10,000 simulations, and *%Sim<Act* is the percent of 10,000 simulations that produce lower $t(\alpha)$ than actual. Superscript † (‡) denote actual $t(\alpha)$ worse (better) than simulated. Differences between actual and simulated $t(\alpha)$ may be random when *%Sim<Act* ≅ 50%. When *%Sim<Act* ≠50%, actual $t(\alpha)$ is better than simulated if *Sim<Act* and *%Sim<Act* is greater than 80% (i.e., a simulated $t(\alpha)$ lower than actual $t(\alpha)$ is four times as likely). Actual $t(\alpha)$ is worse than simulated $t(\alpha)$ if *Sim>Act* and *%Sim<Act* is less than 20% (i.e., a simulated $t(\alpha)$ lower than actual $t(\alpha)$ is one-fourth as likely).

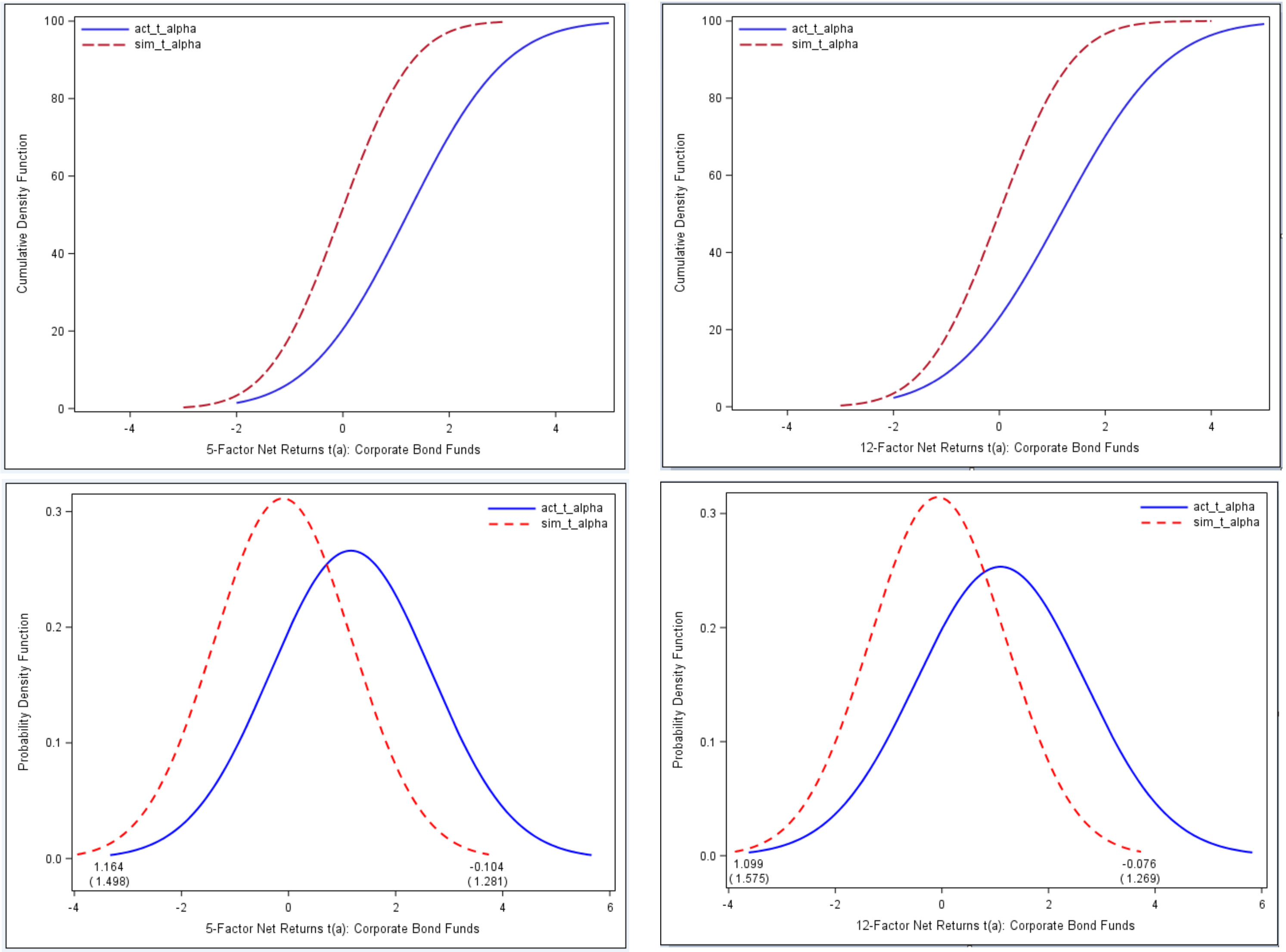
	Government Bond Mutual Funds											
	0 to 5 Years			**5 to 10 Years**			**10 to 30 Years**			**Missing Effective Duration**		
Pct	Sim	Actual	%Sim<Act	Sim	Actual	%Sim<Act	Sim	Actual	%Sim<Act	Sim	Actual	%Sim<Act
Panel A: 5-Factor Net Returns												
1	-4.89	-3.21 ‡	97.0	-4.99	-2.42 ‡	99.9	-2.98	-2.47	69.2	-4.66	-4.76	38.6
2	-4.11	-2.97 ‡	93.3	-4.23	-1.90 ‡	100.0	-2.98	-2.47	69.2	-3.58	-2.87 ‡	81.3
3	-3.56	-2.61 ‡	93.5	-3.74	-1.72 ‡	100.0	-2.98	-2.47	69.2	-3.06	-2.43 ‡	85.0
4	-3.15	-2.20 ‡	96.5	-3.20	-1.61 ‡	99.8	-2.30	-2.37	43.3	-2.79	-2.20 ‡	87.5
5	-2.92	-2.04 ‡	95.5	-2.99	-1.59 ‡	99.7	-2.24	-2.37	39.5	-2.58	-2.02 ‡	86.2
10	-2.08	-0.94 ‡	99.1	-2.19	-1.37 ‡	94.7	-1.83	-2.24	23.6	-1.84	-0.89 ‡	99.2
90	1.67	3.18 ‡	99.5	1.97	1.78	36.9	1.56	1.13	27.4	2.02	2.56 ‡	87.2
95	2.27	3.63 ‡	99.1	2.80	2.68	42.2	2.23	1.92	40.2	2.74	3.14	78.4
96	2.43	3.66 ‡	98.5	3.01	2.76	32.9	2.34	1.92	35.6	2.95	3.19	68.0
97	2.71	3.88 ‡	97.5	3.49	2.83 †	15.0	3.54	4.12	73.0	3.22	3.39	65.2
98	3.11	4.00 ‡	92.2	3.90	3.45	30.5	3.54	4.12	73.0	3.74	3.48	40.4
99	3.73	4.48 ‡	84.5	4.50	3.54 †	16.1	3.54	4.12	73.0	4.72	4.21	32.8
Panel B: 12-Factor Net Returns												
1	-3.85	-2.41 ‡	98.0	-4.25	-2.35 ‡	98.2	-3.69	-2.18 ‡	82.9	-4.51	-4.13	46.7
2	-3.22	-2.09 ‡	97.4	-3.56	-2.31 ‡	95.0	-3.69	-2.18 ‡	82.9	-3.49	-3.21	63.4
3	-2.85	-1.92 ‡	97.4	-3.16	-2.10 ‡	95.9	-3.69	-2.18 ‡	82.9	-2.93	-2.65	65.3
4	-2.51	-1.91 ‡	90.1	-2.73	-2.02 ‡	88.4	-2.42	-2.09	58.4	-2.69	-2.34	69.4
5	-2.33	-1.86 ‡	87.3	-2.55	-2.00 ‡	81.8	-2.29	-2.00	58.5	-2.40	-2.24	56.1
10	-1.73	-1.25 ‡	87.1	-1.92	-1.78	57.4	-1.74	-1.86	39.2	-1.70	-1.52	67.1
90	1.90	2.50 ‡	93.8	1.79	1.43 †	14.3	1.57	1.08 †	10.3	2.09	2.43 ‡	85.7
95	2.59	3.02 ‡	88.6	2.37	1.69 †	3.5	1.96	1.27 †	5.0	2.72	2.83	65.7
96	2.77	3.16 ‡	83.6	2.54	1.80 †	2.8	2.04	1.57	28.8	2.99	2.84	41.7
97	3.08	3.41 ‡	86.9	2.94	1.83 †	0.4	2.93	1.87 †	19.3	3.22	2.95	31.8
98	3.39	3.68	79.1	3.29	2.05 †	1.3	2.93	1.87 †	19.3	3.74	3.01 †	8.2
99	4.00	4.14	63.9	3.86	2.78 †	9.1	2.93	1.87 †	19.3	4.76	3.51 †	7.8

Appendix Table 2: Corporate Bond Mutual Fund $t(\alpha)$ Estimates for Simulated vs. Actual Net Returns by Credit Rating. Panels A and B in this table report $t(\alpha)$ for simulated and actual corporate bond mutual fund net returns at each percentile (*Pct*) stratified by average credit rating using a 5- and 12-factor model. At each percentile, *Sim* is the average value of $t(\alpha)$ in 10,000 simulations, and *%Sim<Act* is the percent of 10,000 simulations that produce lower $t(\alpha)$ than actual. Superscript † (‡) denote actual $t(\alpha)$ worse (better) than simulated. Differences between actual and simulated $t(\alpha)$ may be random when *%Sim<Act* ≅ 50%. When *%Sim<Act* ≠50%, actual $t(\alpha)$ is better than simulated if *Sim<Act* and *%Sim<Act* is greater than 80% (i.e., a simulated $t(\alpha)$ lower than actual $t(\alpha)$ is four times as likely). Actual $t(\alpha)$ is worse than simulated $t(\alpha)$ if *Sim>Act* and *%Sim<Act* is less than 20% (i.e., a simulated $t(\alpha)$ lower than actual $t(\alpha)$ is one-fourth as likely).

	Corporate Bond Mutual Funds																	
	AAA			AA			A			BBB			Low Grade			No Rating		
Pct	Sim	Actual	%Sim <Act	Sim	Actual	%Sim <Act	Sim	Actual	%Sim <Act	Sim	Actual	%Sim <Act	Sim	Actual	%Sim <Act	Sim	Actual	%Sim <Act
Panel A: 5-Factor Net Returns																		
1	-4.32	-0.68 ‡	99.0	-6.02	-2.57 ‡	99.8	-5.92	-2.18 ‡	100.0	-4.84	-2.57 ‡	99.9	-5.48	-1.84 ‡	99.9	-4.24	-1.93 ‡	99.9
2	-4.32	-0.68 ‡	99.0	-4.97	-1.83 ‡	100.0	-4.68	-1.89 ‡	100.0	-4.31	-2.30 ‡	99.9	-4.06	-1.68 ‡	99.7	-3.65	-1.87 ‡	99.8
3	-4.32	-0.68 ‡	99.0	-4.64	-1.83 ‡	100.0	-4.07	-1.76 ‡	100.0	-3.97	-2.28 ‡	99.8	-4.03	-1.68 ‡	99.7	-3.21	-1.83 ‡	99.2
4	-4.32	-0.68 ‡	99.0	-4.12	-1.77 ‡	99.9	-3.67	-1.72 ‡	100.0	-3.70	-2.24 ‡	99.6	-3.31	-1.55 ‡	99.2	-2.91	-1.83 ‡	97.8
5	-4.32	-0.68 ‡	99.0	-3.95	-1.77 ‡	99.9	-3.39	-1.57 ‡	99.9	-3.49	-2.23 ‡	98.9	-3.30	-1.55 ‡	99.1	-2.74	-1.73 ‡	97.5
10	-4.31	-0.68 ‡	99.0	-2.97	-0.99 ‡	100.0	-2.53	-1.08 ‡	99.9	-2.66	-1.83 ‡	95.0	-2.23	-1.03 ‡	98.2	-2.08	-1.26 ‡	95.5
90	3.92	2.15 †	5.4	1.86	2.52 ‡	87.8	2.32	2.78 ‡	83.3	2.05	2.70 ‡	88.6	2.49	2.54	55.5	1.75	2.80 ‡	96.9
95	3.93	2.15 †	5.4	2.72	3.32 ‡	89.9	3.35	3.25	41.7	2.72	3.55 ‡	92.9	3.27	3.15	51.2	2.47	3.17 ‡	89.9
96	3.93	2.15 †	5.4	2.87	3.32 ‡	84.6	3.70	3.39	35.7	2.92	3.57 ‡	88.1	3.28	3.15	50.5	2.66	3.18 ‡	83.3
97	3.93	2.15 †	5.4	3.29	4.22 ‡	87.1	4.16	3.47	20.4	3.18	4.12 ‡	92.3	3.79	3.74	59.4	3.01	3.24	69.1
98	3.93	2.15 †	5.4	3.61	4.22	79.2	4.83	3.60 †	9.1	3.57	5.03 ‡	95.1	3.81	3.74	58.6	3.52	4.06	75.4
99	3.93	2.15 †	5.4	4.66	7.49 ‡	88.7	6.09	4.34 †	11.2	4.29	5.17 ‡	80.6	5.01	4.30	41.2	4.21	4.29	55.4
Panel B: 12-Factor Net Returns																		
1	-2.14	-1.26 ‡	97.8	-4.84	-2.79 ‡	90.7	-6.19	-3.32 ‡	98.8	-5.16	-3.52 ‡	93.0	-4.50	-2.30 ‡	91.8	-4.78	-1.83 ‡	99.9
2	-2.14	-1.26 ‡	97.8	-3.88	-2.79	78.6	-4.87	-2.80 ‡	98.7	-4.40	-2.62 ‡	98.3	-3.15	-2.30	75.0	-4.02	-1.77 ‡	99.8
3	-2.14	-1.26 ‡	97.8	-3.45	-2.33 ‡	85.7	-4.17	-1.76 ‡	100.0	-3.91	-2.35 ‡	97.9	-3.02	-1.70 ‡	94.4	-3.59	-1.69 ‡	99.5
4	-2.14	-1.26 ‡	97.8	-3.01	-2.33	75.4	-3.71	-1.74 ‡	99.8	-3.54	-2.28 ‡	96.2	-2.49	-1.70 ‡	85.6	-3.02	-1.53 ‡	98.9
5	-2.14	-1.26 ‡	97.8	-2.80	-2.33	69.1	-3.36	-1.60 ‡	99.7	-3.26	-2.21 ‡	94.2	-2.44	-1.23 ‡	98.6	-2.80	-1.42 ‡	99.2
10	-2.13	-1.26 ‡	97.6	-1.89	-1.12 ‡	98.2	-2.34	-1.40 ‡	97.9	-2.31	-1.51 ‡	92.6	-1.68	-1.09 ‡	87.2	-1.98	-0.88 ‡	98.9
90	3.68	2.64 †	5.4	2.74	2.19 †	16.8	2.37	2.35	61.5	2.26	2.63 ‡	83.5	3.20	2.78 †	6.1	2.10	2.64 ‡	89.6
95	3.68	2.64 †	5.3	3.59	3.64	61.8	3.12	3.14	48.4	3.01	3.38 ‡	87.4	3.73	2.98 †	1.0	2.73	3.12	75.5
96	3.68	2.64 †	5.3	3.77	3.64	48.5	3.32	3.25	51.8	3.20	3.63 ‡	90.3	3.76	3.11 †	1.1	2.88	3.14	68.4
97	3.68	2.64 †	5.3	4.12	3.64	27.0	3.54	3.48	49.8	3.44	3.90 ‡	85.6	4.08	3.11 †	0.2	3.33	3.16	37.1
98	3.68	2.64 †	5.3	4.49	5.02 ‡	80.1	3.93	3.90	62.8	3.77	4.28 ‡	84.2	4.16	3.66 †	15.0	3.72	3.28 †	14.5
99	3.68	2.64 †	5.3	5.22	5.02	60.5	4.99	4.32	48.6	4.41	4.45	63.7	5.15	3.66 †	1.2	4.19	3.35 †	0.5



Appendix Figure 1: Simulated vs. Actual Cumulative and Probability Density Functions of $t(\alpha)$ using a 5-factor and 12-factor model of Net Returns for Government Bond Funds. Solid lines are estimated $t(\alpha)$ from regressions of actual returns over the entire sample period. Dotted lines are estimated average $t(\alpha)$ from 10,000 bootstrapped simulations. Numbers from left to right below probability density functions indicate means and standard deviations for actual and simulated $t(\alpha)$.



Appendix Figure 2: Simulated vs. Actual Cumulative and Probability Density Functions of $t(\alpha)$ using a 5-factor and 12-factor Model of Net Returns for Corporate Bond Funds. Solid lines are estimated $t(\alpha)$ from regressions of actual returns over the entire sample period. Dotted lines are estimated average $t(\alpha)$ from 10,000 bootstrapped simulations. Numbers from left to right below probability density functions indicate means and standard deviations for actual and simulated $t(\alpha)$.